Solar Energy

People's Energy Cooperative

Your Touchstone Energy® Cooperative

People's Energy Cooperative
Requirements for Interconnection

People's Energy Cooperative is obligated by State and Federal law to interconnect with and purchase electricity from co-generators and small power producers. The diagram on the following page shows metering requirements for compliance.

Interested parties should contact People's Energy Cooperative for copies of our Member Service Agreement for Cogeneration Facilities as well as a copy of our Application for Interconnection and rate schedules.

People's Energy Cooperative
1775 Lake Shady Ave S
Oronoco, MN 55960

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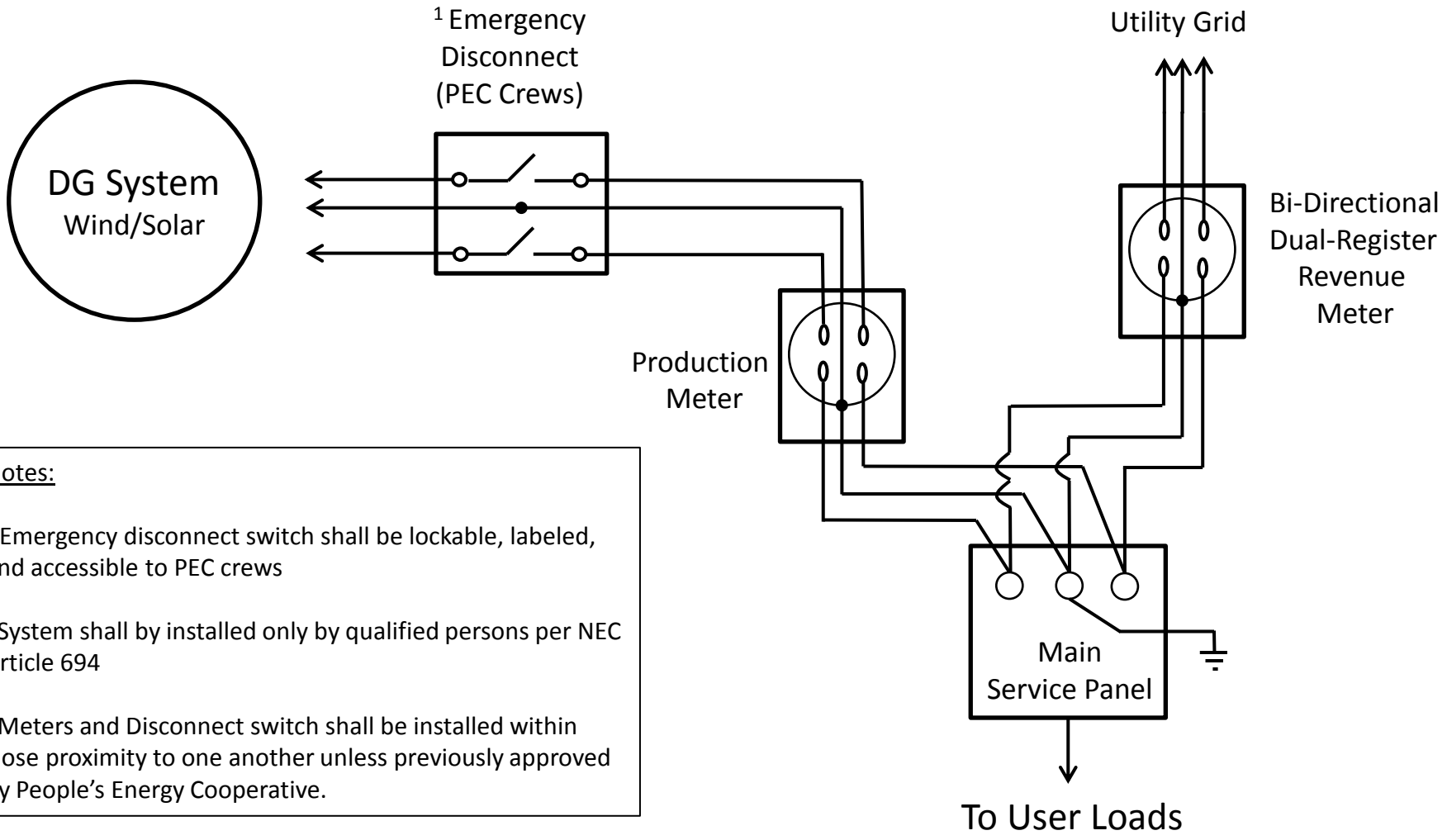
People's Energy Cooperative

Your Touchstone Energy® Cooperative

Distributed Generation Metering Diagram (Single Phase)



Notes:

[1] Emergency disconnect switch shall be lockable, labeled, and accessible to PEC crews

[2] System shall by installed only by qualified persons per NEC Article 694

[3] Meters and Disconnect switch shall be installed within close proximity to one another unless previously approved by People's Energy Cooperative.

PEOPLE'S ENERGY COOPERATIVE
Interconnection Process for Distributed Generation Systems

Introduction
This document has been prepared to explain the process established in the State of Minnesota, to interconnect a Generation System with People's Energy Cooperative (PEC). This document covers the interconnection process for all types of Generation Systems which are rated 10MW's or less of total generation Nameplate Capacity; are planned for interconnection with PEC's Distribution System; are not intended for wholesale transactions and aren't anticipated to affect the transmission system. This document does not discuss the interconnection Technical Requirements, which are covered in the "PEC **Distributed Generation Interconnection Requirements"** document. This other interconnection requirements document also provides definitions and explanations of the terms utilized within this document. To interconnect a Generation System with PEC, there are several steps that must be followed. This document outlines those steps and the Parties' responsibilities. At any point in the process, if there are questions, please contact the Generation Interconnection Coordinator at PEC. Since this document has been developed to provide an interconnection process which covers a very diverse range of Generation Systems, the process appears to be very involved and cumbersome. For many Generation Systems the process is streamlined and provides an easy path for interconnection.

The promulgation of interconnection standards for Generation Systems by the Minnesota Public Utilities Commission (MPUC) must be done in the context of a reasonable interpretation of the boundary between state and federal jurisdiction. The Federal Energy Regulatory Commission (FERC) has asserted authority in the area; at least as far as interconnection at the transmission level is concerned. This, however, leaves open the question of jurisdiction over interconnection at the distribution level. The Midwest Independent System Operator's (MISO) FERC Electric Tariff, (first revised volume 1, August 23,2001) Attachment R (Generator Interconnection Procedures and Agreement) states in section 2.1 that "Any existing or new generator connecting at transmission voltages, sub-transmission voltages, or distribution voltages, planning to engage in the sale for resale of wholesale energy, capacity, or ancillary services requiring transmission service under the Midwest ISO OATT must apply to the Midwest ISO for interconnection service". Further in section 2.4 it states that "A Generator not intending to engage in the sale of wholesale energy, capacity, or ancillary services under the Midwest ISO OATT, that proposes to interconnect a new generating facility to the distribution system of a Transmission Owner or local distribution utility interconnected with the Transmission System shall apply to the Transmission Owner or local distribution utility for interconnection". It goes on further to state "Where facilities under the control of the Midwest ISO are affected by such interconnection, such interconnections may be subject to the planning and operating protocols of the Midwest ISO…."

Through discussions with MISO personnel and as a practical matter, if the Generation System Nameplate Capacity is not greater in size than the minimum expected load on the distribution substation, that is feeding the proposed Generation System, and Generation System's energy is not being sold on the wholesale market, then that installation may be considered as not "affecting" the transmission system and the interconnection may be considered as governed by this process. If the Generation System will be selling energy on the wholesale market or the Generation System's total Nameplate Capacity is greater than the expected distribution substation minimum load, then the Applicant shall contact MISO (Midwest Independent System Operator) and follow their procedures.

GENERAL INFORMATION

A) Definitions

1) "Applicant" is defined as the person or entity that is requesting the interconnection of the Generation System with PEC and is responsible for ensuring that the Generation System is designed, operated and maintained in compliance with the Technical Requirements.

2) "Area EPS" is defined as an electric power system (EPS) that serves Local EPS's. Note. Typically, an Area EPS has primary access to public rights-of-way, priority crossing of property boundaries, etc.

3) "Area EPS Operator" is the entity who operates the Area EPS. *Also PEC.*

4) "Dedicated Facilities" is the equipment that is installed due to the interconnection of the Generation System and not required to serve other PEC customers.

5) "Distribution System" is the PEC facilities which are not part of the PEC Transmission System or any Generation System.

6) "Extended Parallel" means the Generation System is designed to remain connected with the Area EPS for an extended period of time.

7) "Generation" is defined as any device producing electrical energy, i.e., rotating generators driven by wind, steam turbines, internal combustion engines, hydraulic turbines, solar, fuel cells, etc.; or any other electric producing device, including energy storage technologies.

8) "Generation Interconnection Coordinator" is the person or persons designated by PEC to provide a single point of coordination with the Applicant for the generation interconnection process.

9) "Generation System" is the interconnected generator(s), controls, relays, switches, breakers, transformers, inverters and associated wiring and cables, up to the Point of Common Coupling.

10) "Interconnection Customer" is the party or parties who will own/operate the Generation System and are responsible for meeting the requirements of the agreements and Technical Requirements. This could be the Generation System applicant, installer, owner, designer, or operator.

11) "Local EPS" is an electric power system (EPS) contained entirely within a single premises or group of premises

12) "Nameplate Capacity" is the total nameplate capacity rating of all the Generation included in the Generation System. For this definition the "standby" and/or maximum rated kW capacity on the nameplate shall be used.

13) "Open Transfer" is a method of transferring the local loads from PEC to the generator such that the generator and PEC are never connected together.

14) "Point of Common Coupling" is the point where the Local EPS is connected to a PEC facility.

15) "Quick Closed" is a method of generation transfer which does not parallel or parallels for less then 100msec with PEC and has utility grade timers which limit the parallel duration to less then 100 msec with PEC.

16) "Technical Requirements" "is the "People's Energy Cooperative (PEC) Distributed Generation Interconnection Requirements".

17) "Transmission System" means those facilities as defined by using the guidelines established by the Minnesota State Public Utilities Commission; "In the Matter of Developing Statewide Jurisdictional Boundary Guidelines for Functionally Separating Interstate Transmission from Generation and Local Distribution Functions" Docket No. E-015/M-99-1002.

B) Dispute Resolution

The following is the dispute resolution process to be followed for problems that occur with the implementation of this process.

1) Each Party agrees to attempt to resolve all disputes arising hereunder promptly, equitably and in a good faith manner.

2) In the event a dispute arises under this process, and if it cannot be resolved by the Parties within thirty (30) days after written notice of the dispute to the other Party, the Parties shall submit the dispute to mediation by a mutually acceptable mediator, in a mutually convenient location in the State of Minnesota. The Parties agree to participate in good faith in the mediation for a period of 90 days. If the parties are not successful in resolving their disputes through mediation, then the Parties may refer the dispute for resolution to the Minnesota Public Utilities Commission, which shall maintain continuing jurisdiction over this process

C) Area EPS Generation Interconnection Coordinator.

PEC shall designate a Generation Interconnection Coordinator(s) and this person or persons shall provide a single point of contact for an Applicant's questions on this Generation Interconnection process. This Generation Interconnection Coordinator will typically not be able to directly answer or resolve all of the issues involved in the review and implementation of the interconnection process and standards, but shall be available to provide coordination assistance with the Applicant

PEC Distributed Generation Interconnection Coordinator
Russell Halgerson, System Engineer
(507) 364-7000

D) Engineering Studies

During the process of design of a Generation System interconnection between a Generation System and PEC, there are several studies which many need to be undertaken. On the Local EPS (Customers side of the interconnection) the addition of a Generation System may increase the fault current levels, even if the generation is never interconnected with PEC's grid. The Interconnection Customer may need to conduct a fault current analysis of the Local EPS in conjunction with adding the Generation System. The addition of the Generation System may also affect PEC's grid and special engineering studies may need to be undertaken looking at PEC's facilities with the Generation System included. Appendix D, lists some of the issues that may need to receive further analysis for the Generation System interconnection.

While, it is not a straightforward process to identify which engineering studies are required, we can at least develop screening criteria to identify which Generation Systems may require further analysis. The following is the basic screening criteria to be used for this interconnection process.

1) Generation System total Nameplate Capacity does not exceed 5% of the radial circuit expected peak load. The peak load is the total expected load on the radial circuit when the other generators on that same radial circuit are not in operation.

2) The aggregate generation's total Nameplate Capacity, including all existing and proposed generation, does not exceed 25% of the radial circuit peak load and that total is also less then the radial circuit minimum load.

3) Generation System does not exceed 15% of the Annual Peak Load for the Line Section, which it will interconnect with. A Line Section is defined as that section of the distribution system between two sectionalizing devices in PEC's Distribution System.

4) Generation System does not contribute more than 10% to the distribution circuit's maximum fault current at the point at the nearest interconnection with PEC's primary distribution voltage.

5) The proposed Generation System total Nameplate Capacity, in aggregate with other generation on the distribution circuit, will not cause any distribution protective devices and equipment to exceed 85 percent of the short circuit interrupting capability.

6) If the proposed Generation System is to be interconnected on a single-phase shared secondary, the aggregate generation Nameplate Capacity on the shared secondary, including the proposed generation, does not exceed 20kW.

7) Generation System will not be interconnected with a "networked" system

E) Scoping Meeting

During Step 2 of this process, the Applicant or PEC has the option to request a scoping meeting. The purpose of the scoping meeting shall be to discuss the Applicant's interconnection request and review the application filed. This scoping meeting is to be held so that each Party can gain a better understanding of the issues involved with the requested interconnection. PEC and Applicant shall bring to the meeting personnel, including system engineers, and other resources as may be reasonably required, to accomplish the purpose of the meeting. The Applicant shall not expect PEC to complete the preliminary review of the proposed Generation System at the scoping meeting. If a scoping meeting is requested, PEC shall schedule the scoping meeting within the 15 business day review period allowed for in Step 2. PEC shall then have an additional 5 days, after the completion of the scoping meeting, to complete the formal response required in Step 2. The Application fee shall cover PEC's costs for this scoping meeting. There shall be no additional charges imposed by PEC for this initial scoping meeting.

F) Insurance

1) At a minimum, in connection with the Interconnection Customer's performance of its duties and obligations under this Agreement, the Interconnection Customer shall maintain, during the term of the Agreement, general liability insurance, from a **qualified insurance agency with a B+ or better rating by "Best" and with a combined single limit of not less then:**

   a) **Two million dollars ($2,000,000) for each occurrence if the Gross Nameplate Rating of the Generation System is greater then 250kW.**

   b) **One million dollars ($1,000,000) for each occurrence if the Gross Nameplate Rating of the Generation System is between 40kW and 250kW.**

   c) **Three hundred thousand ($300,000) for each occurrence if the Gross Nameplate Rating of the Generation System is less then 40kW.**

   d) **Such general liability insurance shall include coverage against claims for damages resulting from (i) bodily injury, including wrongful death; and (ii) property damage arising out of the Interconnection Customer's ownership and/or operating of the Generation System under this agreement.**

2) The general liability insurance required shall, by endorsement to the policy or policies, (a) include PEC as an additional insured; (b) contain a severability of interest clause or cross-liability clause; (c) provide that PEC shall not by reason of its inclusion as an additional insured incur liability to the insurance carrier for the payment of premium for such insurance; and (d) provide for thirty (30) calendar days' written notice to PEC prior to cancellation, termination, alteration, or material change of such insurance.

3) If the Generation System is connected to an account receiving residential service from PEC and its total generating capacity is smaller then 40kW, then the endorsements required in Section F.2 shall not apply.

4) The Interconnection Customer shall furnish the required insurance certificates and endorsements to PEC prior to the initial operation of the Generation System. Thereafter, PEC shall have the right to periodically inspect or obtain a copy of the original policy or policies of insurance.

5) Evidence of the insurance required in Section F.1. shall state that coverage provided is primary and is not excess to or contributing with any insurance or self-insurance maintained by PEC.

6) If the Interconnection Customer is self-insured with an established record of self-insurance, the Interconnection Customer may comply with the following in lieu of Section F.1 – 5:

7) Interconnection Customer shall provide to PEC, at least thirty (30) days prior to the date of initial operation, evidence of an acceptable plan to self-insure to a level of coverage equivalent to that required under section F.1.

8) If Interconnection Customer ceases to self-insure to the level required hereunder, or if the Interconnection Customer is unable to provide continuing evidence of its ability to self-insure, the Interconnection Customer agrees to immediately obtain the coverage required under section F.1.

9) Failure of the Interconnection Customer or PEC to enforce the minimum levels of insurance does not relieve the Interconnection Customer from maintaining such levels of insurance or relieve the Interconnection Customer of any liability.

G) Pre-Certification

The most important part of the process to interconnect generation with Local EPS and PEC is safety. One of the key components of ensuring the safety of the public and employees is to ensure that the design and implementation of the elements connected to the electrical power system operate as required. To meet this goal, all of the electrical wiring in a business or residence, is required by the State of Minnesota to be listed by a recognized testing and certification laboratory, for its intended purpose. Typically we see this as “UL” listed. Since Generation Systems have tended to be uniquely designed for each installation they have been designed and approved by Professional Engineers. This process has been set up to be able to deal with these uniquely designed systems. As the number of Generation Systems installed increase, vendors are working towards creating equipment packages which can be tested in the factory and then will only require limited field testing. This will allow us to move towards “plug and play” installations. For this reason, this interconnection process recognizes the efficiently of “pre-certification” of Generation System equipment packages that will help streamline the design and installation process.

An equipment package shall be considered certified for interconnected operation if it has been submitted by a manufacture, tested and listed by a nationally recognized testing and certification laboratory (NRTL) for continuous utility interactive operation in compliance with the applicable codes and standards. Presently generation paralleling equipment that is listed by a nationally recognized testing laboratory as having met the applicable type-testing requirements of UL 1741 and IEEE 929 shall be acceptable for interconnection without additional protection system requirements. An "equipment package" shall include all interface components including switchgear, inverters, or other interface devices and may include an integrated generator or electric source. If the equipment package has been tested and listed as an integrated package which includes a generator or other electric source, it shall not required further design review, testing or additional equipment to meet the certification requirements for interconnection. If the equipment package includes only the interface components (switchgear, inverters, or other interface devices), then the Interconnection Customer shall show that the generator or other electric source being utilized with the equipment package is compatible with the equipment package and consistent with the testing and listing specified for the package. Provided the generator or electric source combined with the equipment package is consistent with the testing ad listing performed by the nationally recognized testing and certification laboratory, no further design review, testing or additional equipment shall be required to meet the certification requirements of this interconnection procedure. A certified equipment package does not include equipment provided by PEC.

The use of Pre-Certified equipment does not automatically qualify the Interconnection Customer to be interconnected to PEC. An application will still need to be submitted and an interconnection review may still need to be performed, to determine the compatibility of the Generation System with PEC.

H) Confidential Information

Except as otherwise agreed, each Party shall hold in confidence and shall not disclose confidential information, to any person (except employees, officers, representatives and agents, who agree to be bound by this section). Confidential information shall be clearly marked as such on each page or otherwise affirmatively identified. If a court, government agency or entity with the right, power, and authority to do so, requests or requires either Party, by subpoena, oral disposition, interrogatories, requests for production of documents, administrative order, or otherwise, to disclose Confidential Information, that Party shall provide the other Party with prompt notice of such request(s) or requirements(s) so that the other Party may seek an appropriate protective order or waive compliance with the terms of this Agreement. In the absence of a protective order or waiver the Party shall disclose such confidential information which, in the opinion of its counsel, the party is legally compelled to disclose. Each Party will use reasonable efforts to obtain reliable assurance that confidential treatment will be accorded any confidential information so furnished.

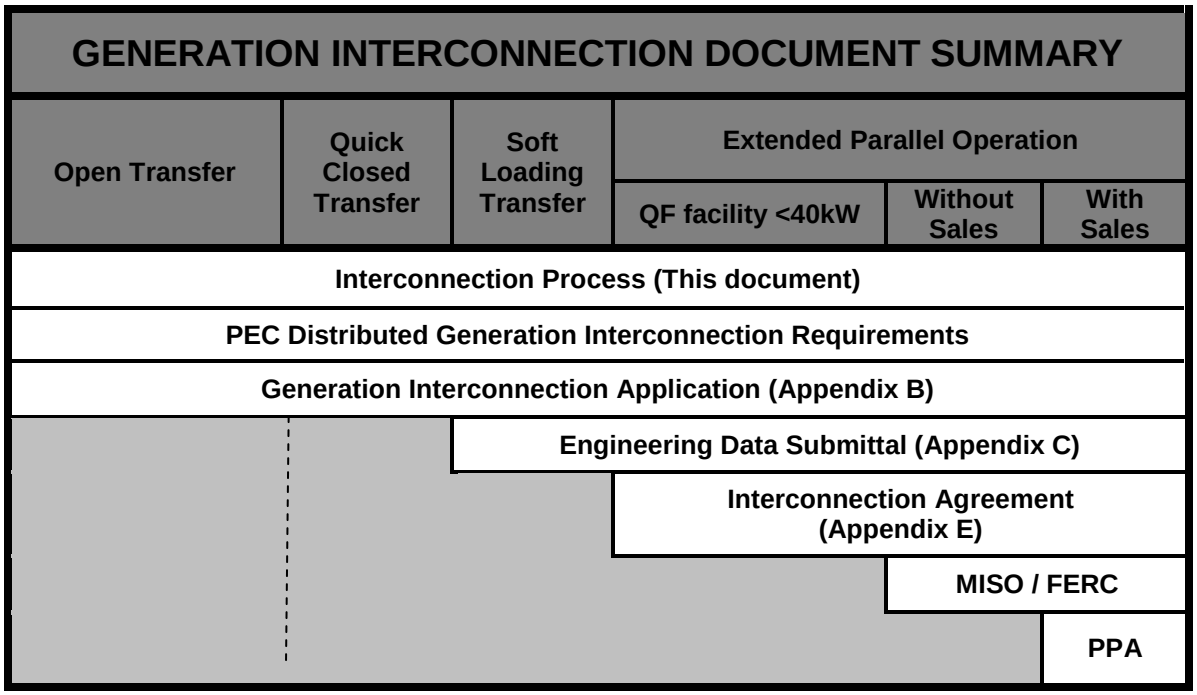
I) Non-Warranty.

Neither by inspection, if any, or non-rejection, nor in any other way, does PEC give any warranty, expressed or implied, as to the adequacy, safety, or other characteristics of any structures, equipment, wires, appliances or devices owned, installed or maintained by the Applicant or leased by the Applicant from third parties, including without limitation the Generation System and any structures, equipment, wires, appliances or devices pertinent thereto.

J) Required Documents

The chart below lists the documents required for each type and size of Generation System proposed for interconnection.

Find your type of Generation System interconnection, across the top, then follow the chart straight down, to determine what documents are required as part of the interconnection process.



Interconnection Process = "PEC Interconnection Process for Distributed Generation Systems." (This document)

PEC Distributed Generation Interconnection Requirements = "PEC Distributed Generation Interconnection Requirements"

Generation Interconnection Application = the application form in Appendix B of this document.

Engineering Data Submittal = The Engineering Data Form/Agreement, which is attached as Appendix C of this document.

Interconnection Agreement = "PEC Interconnection Agreement for the Interconnection of Extended Parallel Distributed Generation Systems with Electric Utilities", which is attached as Appendix E to this document.

MISO. = Midwest Independent System Operator, www.midwestiso.org

FERC = Federal Energy Regulatory Commission, www.ferc.gov

PPA = Power Purchase Agreement.

Process for Interconnection

Step 1 - Application (By Applicant)

Once a decision has been made by the Applicant, that they would like to interconnect a Generation System with PEC, the Applicant shall supply PEC with the following information:

1) Completed Generation Interconnection Application (Appendix C), including;
   a) One-line diagram showing;
      i) Protective relaying.
      ii) Point of Common Coupling.
   b) Site plan of the proposed installation.
   c) Proposed schedule of the installation.
2) Payment of the application fee, according to the following sliding scale.

Generation Interconnection Application Fees

Interconnection Type	≤ 20kW	>20kW & ≤250kW	>250kW & ≤500kW	> 500 kW & ≤1000kW	>1000 kW
Open Transfer	$0	$0	$0	$100	$100
Quick Closed	$0	$100	$100	$250	$500
Soft Loading	$100	$250	$500	$500	$1000
Extended Parallel (Pre Certified System)	$0	$250	$1000	$1000	$1500
Other Extended Parallel Systems	$100	$500	$1500	$1500	$1500

This application fee is to contribute to PEC's labor costs for administration, review of the design concept and preliminary engineering screening for the proposed Generation System interconnection.

For the Application Fees chart, above;
The size (kW) of the Generation System is the total maximum Nameplate Capacity of the Generation System.

Step 2 - Preliminary Review (By PEC)

Within 15 business days of receipt of all the information listed in Step 1, the PEC Generation Interconnection Coordinator shall respond to the Applicant with the information listed below. (If the information required in Step 1 is not complete, the Applicant will be notified, within 10 business days of what is missing and no further review will be completed until the missing information is submitted. The 15-day clock will restart with the new submittal.)

As part of Step 2 the proposed Generation System will be screened to see if additional Engineering Studies are required. The base screening criteria is listed in the general information section of this document.

1) A single point of contact with PEC for this project. (Generation Interconnection Coordinator)

2) Approval or rejection of the generation interconnection request.
   a) Rejection – PEC shall supply the technical reasons, with supporting information, for rejection of the interconnection Application.
   b) Approval - An approved Application is valid for 6 months from the date of the approval. PEC's Generation Interconnection Coordinator may extend this time if requested by the Applicant

3) If additional specialized engineering studies are required for the proposed interconnection, the following information will be provided to the Applicant. Typical Engineering Studies are outlined in Appendix D. The costs to the Applicant, for these studies, shall not exceed the values shown in the following table for pre-certified equipment.

Generation System Size	Engineering Study Maximum Costs
<20kW	$0
20kW – 100kW	$500
100kW – 250kW	$1000
>250kW or not pre-certified equipment	Actual costs

   a) General scope of the engineering studies required.
   b) Estimated cost of the engineering studies.
   c) Estimated duration of the engineering studies.
   d) Additional information required to allow the completion of the engineering studies.
   e) Study authorization agreement.

4) Comments on the schedule provided.

5) If the rules of MISO (Midwest Independent System Operator) require that this interconnection request be processed through the MISO process, the Generation Interconnection Coordinator will notify the Applicant that the generation system is not eligible for review through the State of Minnesota process.

Step 3 - Go-No Go Decision for Engineering Studies (By Applicant)

In this step, the Applicant will decide whether or not to proceed with the required engineering studies for the proposed generation interconnection. If no specialized engineering studies are required by PEC, PEC and the Applicant will automatically skip this step.

If the Applicant decides NOT to proceed with the engineering studies, the Applicant shall notify PEC's Generation Interconnection Coordinator, so other generation interconnection requests in the queue are not adversely impacted. Should the Applicant decide to proceed, the Applicant shall provide the following to PEC's Generation Interconnection Coordinator:

1) Payment required by PEC for the specialized engineering studies.

2) Additional information requested by PEC to allow completion of the engineering studies.

Step 4 - Engineering Studies (By PEC)

In this step, PEC will be completing the specialized engineering studies for the proposed generation interconnection, as outlined in Step 2. These studies should be completed in the time frame provided in step 2, by PEC. It is expected that PEC shall make all reasonable efforts to complete the Engineering Studies within the time frames shown below. If additional time is required to complete the engineering studies the PEC Generation Interconnection Coordinator shall notify the Applicant and provide the reasons for the time extension. Upon receipt of written notice to precede, payment of applicable fee, and receipt of all engineering study information requested by PEC Operator in step 2, PEC shall initiate the engineering studies.

Generation System Size	Engineering Study Completion
<20kW	20 working days
20kW – 250kW	30 working days
250kW – 1MW	40 working days
> 1MW	90 working days

Once it is known by PEC that the actual costs for the engineering studies will exceed the estimated amount by more the 25%, then the Applicant shall be notified. PEC shall then provide the reason(s) for the studies needing to exceed the original estimated amount and provide an updated estimate of the total cost for the engineering studies. The Applicant shall be given the option of either withdrawing the application, or paying the additional estimated amount to continue with the engineering studies.

Step 5 - Study Results and Construction Estimates (By PEC)

Upon completion of the specialized engineering studies, or if none was necessary, the following information will be provided to the Applicant.

1) Results of the engineering studies, if needed.

2) Monitoring & control requirements for the proposed generation.

3) Special protection requirements for the Generation System interconnection.

4) Comments on the schedule proposed by the Applicant.

5) Distributed Generation distribution constrained credits available

6) Interconnection Agreement (if applicable).

7) Cost estimate and payment schedule for required Area EPS work, including, but not limited to;
   a) Labor costs related to the final design review.
   b) Labor & expense costs for attending meetings
   c) Required Dedicated Facilities and other Area EPS modification(s).
   d) Final acceptance testing costs.

Step 6 - Final Go-No Go Decision (By Applicant)

In this step, the Applicant shall again have the opportunity to indicate whether or not they want to proceed with the proposed generation interconnection. If the decision is NOT to proceed, the Applicant will notify PEC's Generation Interconnection Coordinator, so that other generation interconnections in the queue are not adversely impacted. Should the Applicant decide to proceed, a more detailed design, if not already completed by the Applicant, must be done, and the following information is to be supplied to PEC's Generation Interconnection Coordinator:

1) Applicable up-front payment required by PEC, per Payment Schedule, provided in Step 5. (if applicable)

2) Signed Interconnection Agreement (if applicable).

3) Final proposed schedule, incorporating PEC comments. The schedule of the project should include such milestones as foundations poured, equipment delivery dates, all conduit installed, cutover (energizing of the new switchgear/transfer switch), PEC work, relays set and tested, preliminary vendor testing, final PEC acceptance testing, and any other major milestones.

4) Detailed one-line diagram of the Generation System, including the generator, transfer switch/switchgear, service entrance, lockable and visible disconnect, metering, protection and metering CT's / VT's, protective relaying and generator control system.

5) Detailed information on the proposed equipment, including wiring diagrams, models and types.

6) Proposed relay settings for all interconnection required relays.

7) Detailed site plan of the Generation System.

8) Drawing(s) showing the monitoring system (as required per table 5A and section 5 of the "PEC Distributed Generation Interconnection Requirements". Including a drawing which shows the interface terminal block with PEC monitoring system.

9) Proposed testing schedule and initial procedure, including;
   a) Time of day (after-hours testing required?).
   b) Days required.
   c) Testing steps proposed.

Step 7 - Final Design Review (By PEC)

Within 15 business days of receipt of the information required in Step 6, PEC's Generation Interconnection Coordinator will provide the Applicant with an estimated timetable for final review. If the information required in Step 6 is not complete, the Applicant will be notified, within 10 business days of what information is missing. No further review may be completed until the missing information is submitted. The 15-business day clock will restart with the new submittal. This final design review shall not take longer then 15 additional business days to complete, for a total of 30 business days.

During this step, PEC shall complete the review of the final Generation System design. If the final design has significant changes from the Generation System proposed on the original Application which invalidate the engineering studies or the preliminary engineering screening, the Generation System Interconnection Application request may be rejected by PEC and the Applicant may be requested to reapply with the revised design.

Upon completion of this step the Generation Interconnection Coordinator shall supply the following information to the Applicant.

1) Requested modifications or corrections of the detailed drawings provided by the Applicant.

2) Approval of and agreement with the Project Schedule. (This may need to be interactively discussed between the Parties, during this Step)

3) Final review of Distributed Generation Credit amount(s) (where applicable).

4) Initial testing procedure review comments. (Additional work on the testing process will occur during Step 8, once the actual equipment is identified)

Step 8 - Order Equipment and Construction (By Both Parties)

The following activities shall be completed during this step. For larger installations this step will involve much interaction between the Parties. It is typical for approval drawings to be supplied by the Applicant to PEC for review and comments. It is also typical for PEC to require review and approval of the drawings that cover the interconnection equipment and interconnection protection system. If PEC also requires remote control and/or monitoring, those drawings are also exchanged for review and comment.

By the Applicant's personnel:

1) Ordering of Generation System equipment.
2) Installing Generation System.
3) Submit approval drawings for interconnection equipment and protection systems, as required by PEC.
4) Provide final relay settings provided to PEC.
5) Submit Completed and signed Engineering Data Submittal form.
6) Submit proof of insurance, as required by PEC tariff(s) or interconnection agreements.
7) Submit required State of Minnesota electrical inspection forms ("blue Copy) filed with PEC.
8) Inspecting and functional testing Generation System components.
9) Work with PEC personnel and equipment vendor(s) to finalize the installation testing procedure.

By PEC personnel:

1) Ordering any necessary PEC equipment.
2) Installing and testing any required equipment.
   a) Monitoring facilities.
   b) Dedicated Equipment.
3) Assisting Applicant's personnel with interconnection installation coordination issues
4) Providing review and input for testing procedures.

Step 9 - Final Tests (By PEC / Applicant)

(Due to equipment lead times and construction, a significant amount of time may take place between the execution of Step 8 and Step 9.) During this time the final test steps are developed and the construction of the facilities are completed.

Final acceptance testing will commence when all equipment has been installed, all contractor preliminary testing has been accomplished and all AREA EPS preliminary testing of the monitoring and dedicated equipment is completed. One to three weeks prior to the start of the acceptance testing of the generation interconnection the Applicant shall provide, a report stating;

- That the Generation System meets all interconnection requirements.
- All contractor preliminary testing has been completed.
- The protective systems are functionally tested and ready.
- And provides a proposed date that the Generation System will be is ready to be energized and acceptance tested.

For non-type certified systems a Professional Electrical Engineer registered in the State of Minnesota is required to provide this formal report.

For smaller systems scheduling of this testing may be more flexible, as less testing time is required than for larger systems.

In many cases, this testing is done after hours to ensure no typical business-hour load is disturbed. If acceptance testing occurs after hours, PEC's labor will be billed at overtime wages. During this testing, PEC will typically run three different tests. These tests can differ depending on which type of communication / monitoring system(s) PEC decides to install at the site.

For, problems created by PEC or any PEC equipment that arise during testing, PEC will fix the problem as soon as reasonably possible. If problems arise during testing which are caused by the Applicant or Applicant's vendor or any vendor supplied or installed equipment, PEC will leave the project until the problem is resolved. Having the testing resume will then be subject to PEC personnel time and availability.

Step 10 - (By PEC)

After all PEC's acceptance testing has been accomplished and all requirements are met, PEC shall provide written approval for normal operation of the Generation System interconnection, within 3 business days of successful completion of the acceptance tests.

Step 11 - (By Applicant)

Within two (2) months of interconnection, the Applicant shall provide PEC with updated drawings and prints showing the Generation System as it were when approved for normal operation by PEC. The drawings shall include all changes which were made during construction and the testing process.

Attachments:

Attached are several documents which may be required for the interconnection process. They are as follows;

Appendix A: Flow chart showing summary of the interconnection process.

Appendix B: Generation Interconnection Application Form.

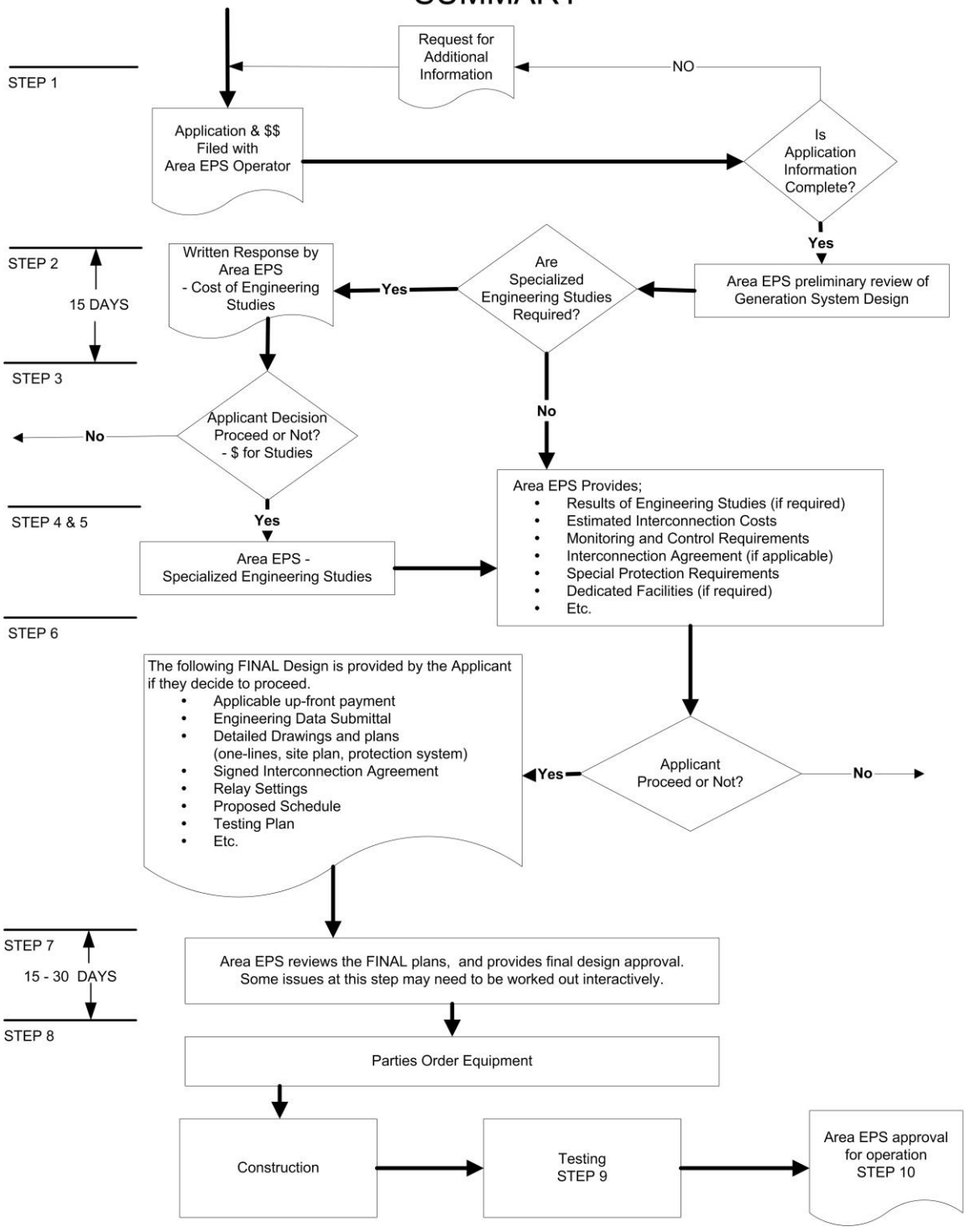
Appendix C: Engineering Data Submittal Form.

Appendix D: Engineering Studies: Brief description of the types of possible Engineering Studies that may be required for the review of the Generation System interconnection.

Appendix E: State of Minnesota Interconnection Agreement for the Interconnection of Extended Paralleled Distributed Generation Systems with Electric Utilities.

APPENDIX A

DISTRIBUTED GENERATION INTERCONNECTION PROCESS SUMMARY



WHO SHOULD FILE THIS APPLICATION: Anyone expressing interest to install generation which will interconnect with People's Energy Cooperative (PEC). This application should be completed and returned to the PEC Generation Interconnection Coordinator, in order to begin processing the request.

INFORMATION: This application is used by PEC to perform a preliminary interconnection review. The Applicant shall complete as much of the form as possible. The fields in BOLD are required to be completed to the best of the Applicant's ability. The Applicant will be contacted if additional information is required. The response may take up to 15 business days after receipt of all the required information.

COST: A payment to cover the application fee shall be included with this application. The application fee amount is outlined in the "PEC Interconnection Process for Distributed Generation Systems".

OWNER/APPLICANT		
Company / Applicant's Name:		
Representative:	**Phone Number:**	**FAX Number:**
Title:		
Mailing Address:		
Email Address:		

LOCATION OF GENERATION SYSTEM INTERCONNECTION
Street Address, legal description or GPS coordinates:

PROJECT DESIGN / ENGINEERING (if applicable)		
Company:		
Representative:	Phone:	FAX Number:
Mailing Address:		
Email Address:		

ELECTRICAL CONTRACTOR (if applicable)		
Company:		
Representative:	Phone:	FAX Number:
Mailing Address:		
Email Address:		

GENERATOR		
Manufacturer:		Model:
Type (Synchronous Induction, Inverter, etc):		**Phases: 1 or 3**
Rated Output (Prime kW):	**(Standby kW):**	**Frequency:**
Rated Power Factor (%):	**Rated Voltage (Volts):**	Rated Current (Amperes):
Energy Source (gas, steam, hydro, wind, etc.)		

TYPE OF INTERCONNECTED OPERATION	
Interconnection / Transfer method: □ **Open** □ **Quick Open** □ **Closed** □ **Soft Loading** □ **Inverter**	
Proposed use of generation: (Check all that may apply) □ **Peak Reduction** □ **Standby** □ **Energy Sales** □ **Cover Load**	**Duration Parallel:** □ **None** □ **Limited** □ **Continuous**
Pre-Certified System: Yes / No (Circle one)	**Exporting Energy Yes / No (Circle one)**

ESTIMATED LOAD INFORMATION		
The following information will be used to help properly design the interconnection. This Information is not intended as a commitment or contract for billing purposes.		
Minimum anticipated load (generation not operating):	**kW:**	**kVA:**
Maximum anticipated load (generation not operating):	**kW:**	**kVA:**

ESTIMATED START/COMPLETION DATES	
Construction start date:	**Completion (operational) date:**

DESCRIPTION OF PROPOSED INSTALLATION AND OPERATION
Attach a single line diagram showing the switchgear, transformers, and generation facilities. Give a general description of the manner of operation of the generation (cogeneration, closed-transition peak shaving, open-transition peak shaving, emergency power, etc.). Also, does the Applicant intend to sell power and energy or ancillary services and/or wheel power over Area EPS facilities. If there is an intent to sell power and energy, also define the target market.

SIGN OFF AREA:

With this Application, we are requesting the PEC Generation Interconnection Coordinator to review the proposed Generation System Interconnection. We request that PEC identifies the additional equipment and costs involved with the interconnection of this system and to provide a budgetary estimate of those costs. We understand that the estimated costs supplied by PEC, will be estimated using the information provided. We also agree that we will supply, as requested, additional information, to allow PEC to better review this proposed Generation System interconnection. We have read the "PEC Distributed Generation Interconnection Requirements" and will design the Generation System and interconnection to meet those requirements.

Applicant Name (print):

Applicant Signature: **Date:**

SEND THIS COMPLETED & SIGNED APPLICATION AND ATTACHMENTS TO THE PEC ENGINEERING DEPARTMENT

PEOPLE'S ENERGY COOPERATIVE
ENGINEERING DATA SUBMITTAL
For the Interconnection of Distributed Generation

APPENDIX C

WHO SHOULD FILE THIS SUBMITTAL: Anyone in the final stages of interconnecting a Generation System with PEC. This submittal shall be completed and provided to PEC's Generation Interconnection Coordinator during the design of the Generation System, as established in the "PEC Interconnection Process for Distributed Generation Systems".

INFORMATION: This submittal is used to document the interconnected Generation System. The Applicant shall complete as much of the form as applicable. The Applicant will be contacted if additional information is required.

OWNER / APPLICANT		
Company / Applicant:		
Representative:	Phone Number:	FAX Number:
Title:		
Mailing Address:		
Email Address:		

PROPOSED LOCATION OF GENERATION SYSTEM INTERCONNECTION
Street Address, Legal Description or GPS coordinates:

PROJECT DESIGN / ENGINEERING (if applicable)		
Company:		
Representative:	Phone:	FAX Number:
Mailing Address:		
Email Address:		

ELECTRICAL CONTRACTOR (if applicable)		
Company:		
Representative:	Phone:	FAX Number:
Mailing Address:		
Email Address:		

TYPE OF INTERCONNECTED OPERATION	
Interconnection / Transfer method: □ Open □ Quick Open □ Closed □ Soft Loading □ Inverter	
Proposed use of generation: (Check all that may apply) □ Peak Reduction □ Standby □ Energy Sales □ Cover Load	Duration Parallel: □ None □ Limited □ Continuous
Pre-Certified System: Yes / No (Circle one)	Exporting Energy Yes / No (Circle one)

GENERATION SYSTEM OPERATION / MAINTENANCE CONTACT INFORMATION		
Maintenance Provider:	Phone #:	Pager #:
Operator Name:	Phone #:	Pager #:
Person to Contact before remote starting of units		
Contact Name:	Phone #:	Pager #:
	24hr Phone #:	

GENERATION SYSTEM OPERATING INFORMATION	
Fuel Capacity (gals):	Full Fuel Run-time (hrs):
Engine Cool Down Duration (Minutes):	Start time Delay on Load Shed signal:
Start Time Delay on Outage (Seconds):	

ESTIMATED LOAD		
The following information will be used to help properly design the interconnection. This Information is not intended as a commitment or contract for billing purposes.		
Minimum anticipated load (generation not operating):	kW:	kVA:
Maximum anticipated load (generation not operating):	kW:	kVA:

REQUESTED CONSTRUCTION START/COMPLETION DATES	
Design Completion:	
Construction Start Date:	
Footings in place:	
Primary Wiring Completion:	
Control Wiring Completion:	
Start Acceptance Testing:	
Generation operational (In-service):	

(Complete all applicable items, Copy this page as required for additional generators)

SYNCHRONOUS GENERATOR (if applicable)

Unit Number:	Total number of units with listed specifications on site:		
Manufacturer:	Type:	Phases: 1 or 3	
Serial Number (each)	Date of manufacture:	Speed (RPM):	Freq. (Hz);
Rated Output (each unit) kW Standby:	kW Prime:	kVA:	
Rated Power Factor (%):	Rated Voltage(Volts):	Rated Current (Amperes):	
Field Voltage (Volts):	Field Current (Amperes):	Motoring Power (kW):	

Synchronous Reactance (X_d):	% on	kVA base
Transient Reactance (X'_d):	% on	kVA base
Subtransient Reactance (X''_d):	% on	kVA base
Negative Sequence Reactance (X_s):	% on	kVA base
Zero Sequence Reactance (X_o):	% on	kVA base

Neutral Grounding Resistor (if applicable):

I^2t or K (heating time constant):

Exciter data:

Governor data:

Additional Information:

INDUCTION GENERATOR (if applicable)

Rotor Resistance (R_r):	Ohms	Stator Resistance (R_s):	Ohms
Rotor Reactance (X_r):	Ohms	Stator Reactance (X_s):	Ohms
Magnetizing Reactance (X_m):	Ohms	Short Circuit Reactance (X_d''):	Ohms
Design Letter:		Frame Size:	
Exciting Current:		Temp Rise (deg C°):	

Rated Output (kW):

Reactive Power Required: k Vars (no Load) kVars (full load)

If this is a wound-rotor machine, describe any external equipment to be connected (resistor, rheostat, power converter, etc.) to rotor circuit, and circuit configuration. Describe ability, if any, to adjust generator reactive output to provide power system voltage regulation.

Additional Information:

PRIME MOVER (Complete all applicable items)

Unit Number:	Type:		
Manufacturer:			
Serial Number:		Date of Manufacture:	
H.P. Rated:	H.P. Max:	Inertia Constant:	lb.-ft.^{2}
Energy Source (hydro, steam, wind, wind etc.):			

INTERCONNECTION (STEP-UP) TRANSFORMER (If applicable)		
Manufacturer:	kVA:	
Date of Manufacture:	Serial Number:	
High Voltage: kV	Connection: delta wye	Neutral solidly grounded?
Low Voltage: kV	Connection: delta wye	Neutral solidly grounded?
Transformer Impedance (Z):	% on	kVA base
Transformer Resistance (R):	% on	kVA base
Transformer Reactance (X):	% on	kVA base
Neutral Grounding Resistor (if applicable)		

TRANSFER SWITCH (If applicable)	
Model Number:	Type:
Manufacturer:	Rating(amps):

INVERTER (If applicable)		
Manufacturer:	Model:	
Rated Power Factor (%):	Rated Voltage (Volts):	Rated Current (Amperes):
Inverter Type (ferroresonant, step, pulse-width modulation, etc.):		
Type of Commutation: forced line	Minimum Short Circuit Ratio required:	
Minimum voltage for successful commutation:		
Current Harmonic Distortion	Maximum Individual Harmonic (%):	
	Maximum Total Harmonic Distortion (%):	
Voltage Harmonic Distortion	Maximum Individual Harmonic (%):	
	Maximum Total Harmonic Distortion (%):	
Describe capability, if any, to adjust reactive output to provide voltage regulation:		
NOTE: *Attach all available calculations, test reports, and oscillographic prints showing inverter output voltage and current waveforms.*		

POWER CIRCUIT BREAKER (if applicable)					
Manufacturer:			Model:		
Rated Voltage (kilovolts):			Rated Ampacity (Amperes):		
Interrupting Rating (Amperes):			BIL Rating:		
Interrupting Medium (vacuum, oil, gas, etc.)			Insulating Medium (vacuum, oil, gas, etc.)		
Control Voltage (Closing):	(Volts)	AC	DC		
Control Voltage (Tripping):	(Volts)	AC	DC	Battery	Charged Capacitor
Close Energy (circle one):	Spring	Motor	Hydraulic	Pneumatic	Other
Trip Energy (circle one):	Spring	Motor	Hydraulic	Pneumatic	Other
Bushing Current Transformers (Max. ratio):			Relay Accuracy Class:		
CT'S Multi Ratio? (circle one); No / Yes:	(Available taps):				

MISCELLANEOUS (Use this area and any additional sheets for applicable notes and comments)

SIGN OFF AREA
This Engineering Data Submittal documents the equipment and design of the Generation System. We agree to supply the Area EPS Operator with an updated Engineering Data Submittal any time significant changes are made in the equipment used or the design of the proposed Generation System. The Applicant agrees to design, operate and maintain the Generation System within the requirements set forth by the "State of Minnesota Distributed Generation Interconnection Requirements".
Applicant Name (print):
Applicant Signature: **Date:**

SEND THIS COMPLETED & SIGNED ENGINEERING DATA SUBMITTAL AND ANY ATTACHMENTS TO THE AREA EPS GENERATION INTERCONNECTION COORDINATOR

APPENDIX D

Engineering Studies

For the engineering studies there are two main parts of the study: 1. Does the distributed generator cause a problem? and 2. What would it cost to make a change to handle the problem? The first question is relatively straightforward to determine as the PEC Engineer reviews the proposed installation. The second question typically has multiple alternatives and can turn into an iterative process. This iterative process can become quite large for more complex generation installations. For the Engineer there is no "cook book" solution which can be applied.

For some of the large generation installations and/or the more complex interconnections PEC Operator may suggest dividing up the engineering studies into the two parts; identify the scope of the problems and attempt to identify solutions to resolve the problems. By splitting the engineering studies into two steps, it will allow for the Applicant to see the problems identified and to provide the Applicant the ability to remove the request for interconnection if the problems are too large and expensive to resolve. This would then save the additional costs to the Applicant for the more expensive engineering studies; to identity ways to resolve the problem(s).

This appendix provides an overview of some of the main issues that are looked at during the engineering study process. Every interconnection has its unique issues, such as relative strength of the distribution system, ratio of the generation size to the existing area loads, etc. Thus many of the generation interconnections will require further review of one or several of the issues listed.

- Short circuit analysis – the system is studied to make sure that the addition of the generation will not over stress any of the PEC equipment and that equipment will still be able to clear during a fault. It is expected that the Applicant will complete their own short circuit analysis on their equipment to ensure that the addition of the generation system does not overstress the Applicant's electrical equipment.

- Power Flow and Voltage Drop
  - Reviews potential islanding of the generation
  - Will PEC Equipment be overloaded
    - Under normal operation?
    - Under contingent operation? With backfeeds?

- Flicker Analysis –
  - Will the operation of the generation cause voltage swings?
    - When it loads up? When it off loads?
  - How will the generation interact with Area EPS voltage regulation?
  - Will PEC capacitor switching affect the generation while on-line?

- Protection Coordination
  - Reclosing issues – this is where the reclosing for the distribution system and transmission system are looked at to see if the Generation System protection can be set up to ensure that it will clear from the distribution system before the feeder is reenergized.
    - Is voltage supervision of reclosing needed?
  - Is transfer-trip required?
  - Do we need to modify the existing protection systems? Existing settings?
  - At which points do we need "out of sync" protection?
  - Is the proposed interconnection protection system sufficient to sense a problem on the Area EPS?
  - Are there protection problems created by the step-up transformer?

- Grounding Reviews
    - Does the proposed grounding system for the Generation System meet the requirements of the NESC? "National Electrical Safety Code" published by the Institute of Electrical and Electronics Engineers (IEEE)

- System Operation Impact.
    - Are special operating procedures needed with the addition of the generation?
    - Reclosing and out of sync operation of facilities.
    - What limitations need to be placed on the operation of the generation?
    - Operational Var requirements?

UNIFORM STATEWIDE CONTRACT FOR COGENERATION AND SMALL POWER PRODUCTION FACILITIES

THIS CONTRACT is entered into _____, ____, by People's Energy Cooperative (hereafter called "Utility") and _____ (hereafter called "QF").

RECITALS

The QF has installed electric generating facilities, consisting of _____ _____(Description of facilities), rated at _____ kilowatts of electricity, on property located at _____ _____

The QF is prepared to generate electricity in parallel with the Utility.

The QF's electric generating facilities meet the requirements of the Minnesota Public Utilities Commission (hereafter called "Commission") rules on Cogeneration and Small Power Production and any technical standards for interconnection the Utility has established that are authorized by those rules.

The Utility is obligated under federal and Minnesota law to interconnect with the QF and to purchase electricity offered for sale by the QF.

A contract between the QF and the Utility is required by the Commission's rules.

AGREEMENTS

The QF and the Utility agree:

1. The Utility will sell electricity to the QF under the rate schedule in force for the class of customer to which the QF belongs.

2. The Cooperative Electric Association or Municipally Owned Electric Utility will buy electricity from the QF under the current rate schedule filed with the Commission. The QF elects the rate schedule category hereinafter indicated:

____ a. Average retail utility energy rate under part 7835.3300.
____ b. Simultaneous purchase and sale billing rate under part 7835.3400.
____ c. Time-of-day purchase rates under part 7835.3500.

A copy of the presently filed rate schedule is attached to this contract.

3. The Public Utility will buy electricity from the QF under the current rate schedule filed with the Commission. If the QF has less than 40 kilowatts capacity, the QF elects the rate schedule category hereinafter indicated:

____ a. Average retail utility energy rate under part 7835.4013.
____ b. Simultaneous purchase and sale billing rate under part 7835.4014.
____ c. Time-of-day purchase rates under part 7835.4015.

A copy of the presently filed rate schedule is attached to this contract.

4. The Public Utility will buy electricity from the QF under the current rate schedule filed with the Commission. If the QF is not a net metered facility and has at least 40 kilowatts capacity but less than 1,000 kilowatt capacity, the QF elects the rate schedule category hereinafter indicated:

____ a. Simultaneous purchase and sale billing rate under part 7835.4014.

____ b. Time-of-day purchase rates under part 7835.4015.

A copy of the presently filed rate schedule is attached to this contract.

5. The Public Utility will buy electricity from a net metered facility under the current rate schedule filed with the Commission or will compensate the facility in the form of a kilowatt-hour credit on the facility's energy bill. If the net metered facility has at least 40 kilowatts capacity but less than 1,000 kilowatts capacity, the QF elects the rate schedule category hereinafter indicated:

____ a. Kilowatt-hour energy credit on the customer's energy bill, carried forward and applied to subsequent energy bills, with an annual true-up under part 7835.4017.

____ b. Simultaneous purchase and sale billing rate under part 7835.4014.

____ c. Time-of-day purchase rates under part 7835.4015.

A copy of the presently filed rate schedule is attached to this contract.

6. The rates for sales and purchases of electricity may change over the time this contract is in force, due to actions of the Utility or of the Commission, and the QF and the Utility agree that sales and purchases will be made under the rates in effect each month during the time this contract is in force.

7. The Public Utility, Cooperative Electric Association, or Municipally Owned Electric Utility will compute the charges and payments for purchases and sales for each billing period. Any net credit to the QF, other than kilowatt-hour credits under clause 5, will be made under one of the following options as chosen by the QF:

____ a. Credit to the QF's account with the Utility.

____ b. Paid by check to the QF within 15 days of the billing date.

8. Renewable energy credits associated with generation from the facility are owned by:

_____

9. The QF must operate its electric generating facilities within any rules, regulations, and policies adopted by the Utility not prohibited by the Commission's rules on Cogeneration and Small Power Production which provide reasonable technical connection and operating specifications for the QF. This agreement does not waive the QF's right to bring a dispute before the Commission as authorized by Minnesota Rules, part 7835.4500, and any other provision of the Commission's rules on Cogeneration and Small Power Production authorizing Commission resolution of a dispute.

10. The Utility's rules, regulations, and policies must conform to the Commission's rules on Cogeneration and Small Power Production.

11. The QF will operate its electric generating facilities so that they conform to the national, state, and local electric and safety codes, and will be responsible for the costs of conformance.

12. The QF is responsible for the actual, reasonable costs of interconnection which are estimated to be $_____. The QF will pay the Utility in this way: _____

_____

_____

13. The QF will give the Utility reasonable access to its property and electric generating facilities if the configuration of those facilities does not permit disconnection or testing from the Utility's side of the interconnection. If the Utility enters the QF's property, the Utility will remain responsible for its personnel.

14. The Utility may stop providing electricity to the QF during a system emergency. The Utility will not discriminate against the QF when it stops providing electricity or when it resumes providing electricity.

15. The Utility may stop purchasing electricity from the QF when necessary for the Utility to construct, install, maintain, repair, replace, remove, investigate, or inspect any equipment or facilities within its electric system. The Utility will notify the QF before it stops purchasing electricity in this way: PEC will attempt to call or physically visit the site to inform the member. During an emergency situation, notification will be made after the disconnection has been performed.

16. The QF will keep in force liability insurance against personal or property damage due to the installation, interconnection, and operation of its electric generating facilities. The amount of insurance coverage will be $ 300,000.00 (The amount must be consistent with the Commission's interconnection standards under Minnesota Rules, part 7835.4750).

17. This contract becomes effective as soon as it is signed by the QF and the Utility. This contract will remain in force until either the QF or the Utility gives written notice to the other that the contract is canceled. This contract will be canceled 30 days after notice is given.

18. This contract contains all the agreements made between the QF and the Utility except that this contract shall at all times be subject to all rules and orders issued by the Public Utilities Commission or other government agency having jurisdiction over the subject matter of this contract. The QF and the Utility are not responsible for any agreements other than those stated in this contract.

THE QF AND THE UTILITY HAVE READ THIS CONTRACT AND AGREE TO BE BOUND BY ITS TERMS. AS EVIDENCE OF THEIR AGREEMENT, THEY HAVE EACH SIGNED THIS CONTRACT BELOW ON THE DATE WRITTEN AT THE BEGINNING OF THIS CONTRACT.

QF	People's Energy Cooperative
By: _____	By: _____
(Printed Name)	(Printed Name)
_____	_____
(Signature)	(Signature)

QF Mailing address:

_____

Statutory Authority:
MS s 216A.05; 216B.08; 216B.164

History:
9 SR 993; L 1998 c 254 art 1 s 107; 40 SR 348

Published Electronically:

October 12, 2015

PEOPLE'S ENERGY COOPERATIVE
Minnesota 59 Olmsted
Oronoco, Minnesota

Schedule PG-1, PG-1B & PG-1C: Cogeneration & Small Power Production: Net Energy Billing

Effective: This rate shall become effective with May 2017 energy use.

Availability: Available to all members where the member has qualified small power production or cogeneration facilities with capacity of less than 40 kW connected in parallel with the cooperative's facilities, receives non-time of day retail electric service, offsets energy delivered by the Cooperative, and do not select either the 'Time of Day Purchase' or 'Simultaneous Purchase & Sale Billing" rates. The member is required to execute an electric service agreement with People's Energy Cooperative.

Service Characteristics: Alternating current, 60 Hz, at available voltages.

Adjustment of Rate
This rate and all Cooperative rates are subject to change from time-to-time by action taken by the Cooperative's Board of Directors. This action can include changes to applicable charges and credits (energy purchases and other) that are identified as part of the rate currently in effect, or added in the future, and are allowable under Minnesota State Statute Section §216B.164.

Basic Service Charge: A monthly charge will be applied to the consumer to cover the Cooperative's ongoing costs associated with the cogeneration account as follows;

PG-1: Single-phase General Service	$0 per month
PG-1B: Three-phase General Service	$0 per month
PG-1C: Three-phase General Service/demand	$0 per month

Distribution Grid Access Fee: A distribution grid access fee will be applied to all qualified small power or cogeneration facilities interconnected on or after May 1, 2016. The distribution grid access fee will be applied monthly at $3.03 per kW for each kW the facility's nameplate is above 3.5 kW to a maximum of $27.00. If a system that is installed before May 1, 2016 adds additional capacity, the additional capacity will be subject to the fee.

Energy Rate: The cooperative shall pay or credit the member monthly for all energy furnished during the month at the appropriate rate shown below. All applicable rates will be adjusted by the Power Cost Adjustment (PCA) when applicable. The rate selected shall be at the member's option and shall conform to the capacity rules established by the Minnesota Public Utility Commission. Members with qualified facilities with capacity of 40 kW to 100 kW will be moved to the 'Simultaneous Purchase & Sale Billing Rate' unless the member selects the 'Time of Day Purchase Rate' Members with qualified facilities that exceed 100 kW may agree with the cooperative to execute this standard agreement with the 'Time of Day Purchase Rate' or the parties may agree that a negotiated agreement is more appropriate.

The cooperative shall pay the member as follows:

Type of Service	Rate
PG-1: General Service	$0.11493 per kWh
PG-1B: Three phase General Service	$0.11196 per kWh
PG-1C: Three phase General Service/demand	$0.06503 per kWh

Metering: Separate metering will be required to measure energy delivered to the Cooperative.

Interconnection Charges: The costs of interconnecting a qualifying facility and any costs associated with subsequent necessary modifications are the responsibility of the consumer and the Cooperative will assess the consumer for all appropriate charges incurred by the Cooperative.

Terms and Conditions of Service: This rate is subject to the terms and conditions of the Cooperative's Electric Service Standards.

PEOPLE'S ENERGY COOPERATIVE
Minnesota 59 Olmsted
Oronoco, Minnesota

Schedule PG-1X: Cogeneration & Small Power Production: Simultaneous Purchase and Sale Billing Service

Effective: This rate shall become effective with May 2017 energy use.

Availability: Available to all members where the member has qualified small power production or cogeneration facilities with capacity of less than 40 kW connected in parallel with the cooperative's facilities, receives non-time of day retail electric service, and do not select either the 'Net Energy Billing' or 'Time of Day Purchase' rates, and members where the cogeneration facilities are a capacity of 40 kW to 100 kW and do not select the 'Time of Day Purchase' rate. The member is required to execute an electric service agreement with People's Cooperative Services.

Service Characteristics: Alternating current, 60 Hz, at available voltages.

Adjustment of Rate
This rate and all Cooperative rates are subject to change from time-to-time by action taken by the Cooperative's Board of Directors. This action can include changes to applicable charges and credits (energy purchases and other) that are identified as part of the rate currently in effect, or added in the future, and are allowable under Minnesota State Statute Section §216B.164.

Basic Service Charge: A monthly charge will be applied to the consumer to cover the Cooperative's ongoing costs associated with the cogeneration account as follows;

PG-1: Single-phase General Service	$0 per month
PG-1B: Three-phase General Service	$0 per month
PG-1C: Three-phase General Service/demand	$0 per month

Energy Rate: The cooperative shall pay or credit the member monthly for all energy furnished during the month at the appropriate rate shown below. All applicable rates will be adjusted by the Power Cost Adjustment (PCA) when applicable. The rate selected shall be at the member's option and shall conform to the capacity rules established by the Minnesota Public Utility Commission. Members with qualified facilities that exceed 100 kW may agree with the cooperative to execute this standard agreement with the 'Time of Day Rate' or the parties may agree that a negotiated agreement is more appropriate.

The cooperative shall pay the member as follows:

	Rate
Energy Payment per kWh	$0.068883 per kWh
Capacity Payment for Firm Power per kWh	$0.00 per kWh

Metering: Separate metering will be required to measure energy delivered to the Cooperative.

Interconnection Charges: The costs of interconnecting a qualifying facility and any costs associated with subsequent necessary modifications are the responsibility of the consumer and the Cooperative will assess the consumer for all appropriate charges incurred by the Cooperative.

Terms and Conditions of Service: This rate is subject to the terms and conditions of the Cooperative's Electric Service Standards.

PEOPLE'S ENERGY COOPERATIVE
Minnesota 59 Olmsted
Oronoco, Minnesota

Schedule PG-1TOD: Cogeneration & Small Power Production: Time of Day Purchase

Effective: This rate shall become effective with May 2017 energy use.

Availability: Available to all members where the member has qualified small power production or cogeneration facilities connected in parallel with the cooperative's facilities. Required for qualified facilities with capacity equal to or greater than 40 kW and less than or equal to 100 kW. 'Time of Day' rates are available with the mutual consent of the cooperative and the member for qualified facilities with capacity of less than 40 kW and with capacity greater than 100 kW when firm power is provided. The member is required to execute an electric service agreement with People's Cooperative Services.

Service Characteristics: Alternating current, 60 Hz, at available voltages.

Adjustment of Rate
This rate and all Cooperative rates are subject to change from time-to-time by action taken by the Cooperative's Board of Directors. This action can include changes to applicable charges and credits (energy purchases and other) that are identified as part of the rate currently in effect, or added in the future, and are allowable under Minnesota State Statute Section §216B.164.

Basic Service Charge: A monthly charge will be applied to the consumer to cover the Cooperative's ongoing costs associated with the cogeneration account as follows;

PG-1: Single-phase General Service	$0 per month
PG-1B: Three-phase General Service	$0 per month
PG-1C: Three-phase General Service/demand	$0 per month

Energy Rate: The cooperative shall pay or credit the member monthly for all energy furnished during the month at the appropriate rate shown below. All applicable rates will be adjusted by the Power Cost Adjustment (PCA) when applicable. The rate selected shall be at the member's option and shall conform to the capacity rules established by the Minnesota Public Utility Commission. Members with qualified facilities that exceed 100 kW may agree with the cooperative to execute this standard agreement with the 'Time of Day Rate' or the parties may agree that a negotiated agreement is more appropriate.

The cooperative shall pay the member as follows:

Energy furnished on-peak	
Summer season	$0.065040per kWh
Winter season	$0.047130 per kWh
Energy furnished off-peak	
Summer season	$0.031106 per kWh
Winter season	$0.031106 per kWh
Capacity Payment for Firm Power per kWh	$0.00 per kWh

Metering: Separate metering will be required to measure energy delivered to the Cooperative.

Interconnection Charges: The costs of interconnecting a qualifying facility and any costs associated with subsequent necessary modifications are the responsibility of the consumer and the Cooperative will assess the consumer for all appropriate charges incurred by the Cooperative.

Terms and Conditions of Service: This rate is subject to the terms and conditions of the Cooperative's Electric Service Standards.

PEOPLE'S ENERGY COOPERATIVE
Minnesota 59 Olmsted
Rochester, Minnesota

Rider for Distributed Generation: Effective February 2013 (Schedule A):

APPLICATION
The Rider for Distributed Generation is applicable to any Customer taking service under one of the Cooperative's standard electric rate schedules and who has entered into an Electric Service Agreement with the Cooperative for the interconnection and operation of an on-site extended parallel distributed generation system as follows:

1. The distributed generation system must be an operable, permanently installed or mobile generation facility connected in parallel to the utility distribution system serving the customer receiving retail electric service at the same site.
2. The distributed generation system must be fueled by either natural gas, a renewable fuel, or another similarly clean fuel or combination of fuels.
3. The distributed generation system cannot have more than 10 MW of interconnected capacity at a point of common coupling to Cooperative's distribution system.
4. The interconnection and operation of the distributed generation system at each point of common coupling shall be considered as a separate application of the Rider.
5. All provisions of the applicable standard service schedule shall apply to distributed generation service under this Rider except as noted below.

In lieu of service under this Rider, Customer and Cooperative may pursue reasonable transactions outside the Rider; or Customer may take service, as applicable, under Cooperative's Rider for Parallel Generation as established under Minnesota Rules 7835 – Cogeneration and Small Power Production.

DEFINITIONS
Customer is an entity receiving retail electric service from Cooperative at the same site as the distributed generation system.

Extended Parallel means the distributed generation system is designed to remain connected with the Cooperative's distribution system for an extended period of time.

Scheduled Maintenance service is energy, or energy and capacity, supplied by the Cooperative during scheduled maintenance of the Customer's non-utility source of electric energy supply (distributed generation system).

Unscheduled Outage service is energy, or energy and capacity, supplied by the Cooperative during unscheduled outages of the Customer's non-utility source of electric energy supply (distributed generation system).

All other definitions shall be as described in Cooperative's *Distributed Generation Interconnection Requirements* and *Interconnection Process for Distributed Generation Systems.*

CHARGES FOR SERVICE
Services provided under this Rider may include services from the Cooperative to Customer and from Customer to Cooperative. The following rates, charges, credits and payments are applicable for such services in addition to all applicable charges for service being taken under Cooperative's standard rate schedule:

SERVICES FROM COOPERATIVE TO CUSTOMER
A monthly service charge, equal to the service charge contained in the base tariff to which this Rider is attached, will be applied to this Rider to recover costs of administering this Rider.

Interconnection Services
Interconnection services include services such as engineering/design studies, Cooperative system upgrades and testing as further described in Cooperative's *Distributed Generation Interconnection Requirements* and *Interconnection Process for Distributed Generation Systems*. Charges for such interconnection services shall be as described in the Cooperative's *Distributed Generation Interconnection Requirements* and *Interconnection Process for Distributed Generation Systems.*

Supply Services
Supply services include standby services such as scheduled maintenance, unscheduled outages and supplemental service as provided under Cooperative's *Rider for Standby Service*.

Transmission Services
Transmission services include reservation and delivery of capacity and energy on either a firm or non-firm basis and those ancillary services that are necessary to support the transmission of capacity and energy from resources to loads while maintaining reliable operation over Transmission Providers' Transmission System. These ancillary services include services such as Scheduling, System Control and Dispatch Service, Reactive Supply and Voltage Control from Generation Sources, Regulation and Frequency Response, Generator Imbalance, Operating Reserve – Spinning Reserve and Operating Reserve – Supplemental Reserve. Transmission Services are provided as applicable under Cooperative's wholesale power supplier's approved Open Access Transmission Tariff (OATT).

Distribution Services
Distribution services include reservation and delivery of capacity and energy and those indirect services that are necessary to support the delivery of capacity and energy over Cooperative's distribution system. These indirect services include allocated support services or expenses such as operation and maintenance, customer accounts, customer service and information, administrative and general, depreciation, interest and taxes. Customers requiring contracted distribution standby service of more than 60 kW and/or delivery of energy and capacity over Cooperative's distribution system to a third party will be charged for such distribution services at a rate equal to the distribution charge specified in the Cooperative's *Rider for Standby Service*.

SERVICES FROM CUSTOMER TO COOPERATIVE

Capacity/Energy

Customer may sell all of the energy produced by the distributed generation system to the Cooperative, use all the distributed generation energy to meet its own electrical requirements, or use a portion of the energy from the distributed generation system to meet its own electrical needs and sell the remaining energy to the Cooperative.

If the Customer offers to sell energy to the Cooperative, the energy and capacity will be purchased by the Cooperative's wholesale power supplier under the rates, terms and conditions for such purchases as established by the wholesale power supplier.

Distribution Credits

A distribution credit may be given if the distributed generation system allows the Cooperative to defer or avoid distribution system upgrades. Distribution credits to the Customer should equal the Cooperative's avoided distribution costs resulting from the installation and operation of the distributed generation system. The Cooperative shall provide, upon Customer's written request, areas of the distribution system that could be likely candidates for distribution credits as determined through the Cooperative's normal planning process. The Cooperative shall also provide to the Customer the minimum size distributed generation system required in each of the areas to qualify for the distribution credit along with general operational requirements necessary for the distributed generation system to meet, so as to be able to receive distribution credits.

Upon receiving an interconnection application from the Customer for a distributed generation interconnection, along with a written request for distribution credits, the Cooperative will complete an initial screening study to determine if the project has the potential to receive distribution credits. The Customer shall be responsible for the cost of the screening study. If the Cooperative's study shows that there exists potential for distribution credit, the Cooperative shall, at its own expense, pursue further study to determine the distribution credit, as part of its annual distribution planning study. If the study cannot be incorporated as part of the Cooperative's annual distribution planning study, the study shall be pursued with Customer's approval at Customer's expense. If distribution credits are identified, the credits will be paid in conjunction with an agreement with the Customer to supply distribution support utilizing the Customer's generation system.

Renewable Credits

If Customer installs a renewable distributed generation system and the Cooperative's wholesale power supplier's purchase of energy and capacity from such facility allows the wholesale power supplier to avoid the need to purchase renewable energy elsewhere, the purchase of such renewable energy and capacity will reflect the avoided cost of renewable purchases as provided under the wholesale power supplier's applicable rates, terms and conditions for such purchases.

Tradable Emissions Credits

If the purchase of energy and capacity by the Cooperative's wholesale power supplier under the "must buy" provision described above results in the wholesale power supplier receiving an economic value associated with tradable emissions, the trade-able emissions credits will be provided to Customer under terms established by the wholesale power supplier that reflects the economic value of such emission credits received by the wholesale power supplier.

TERMS AND CONDITIONS OF SERVICE
The following terms and conditions apply to this Rider:

1. The service hereunder is subject to Cooperative's *Interconnection Process for Distributed Generation Systems* and *Distributed Generation Interconnection Requirements* as may be modified from time-to-time.

2. The Cooperative will install all metering equipment necessary to monitor services provided, to ensure adequate measurements are obtained to support necessary application of rates, charges, credits and payments. Customer will be charged an up-front lump sum for the installed cost of such metering equipment and expected future operation and maintenance expenses for this metering equipment.

3. The Customer will be compensated monthly for all energy delivered to Cooperative's wholesale power supplier. The timing for these payments is subject to annual review.

4. The Customer shall make provision for on-site metering. All energy received from and delivered to the Cooperative shall be separately metered. The Cooperative may require metering of the generation output.

5. The Customer shall pay for all interconnection costs incurred by the Cooperative made necessary by the installation of the distributed generation system.

6. Power and energy purchased by the Customer from the Cooperative shall be under the applicable retail rates for the purchase of electricity.

7. The Cooperative reserves the right to disconnect the Customer's generator from its system if it interferes with the operation of the Cooperative's equipment or with the equipment of other Cooperative Customers.

8. The Customer shall execute an Electric Service Agreement with the Cooperative which may include, among other provisions, a minimum term of service.

BILLING AND TERMS OF PAYMENT
Billing and terms of payment shall be governed as set forth in the Cooperative's applicable base rate schedule.

To the extent that the Cooperative receives service from the Customer under this Rider, payment for such services shall be netted against any charges for Cooperative-supplied services hereunder.

PEOPLE'S ENERGY COOPERATIVE
Oronoco, Minnesota

Rider for Standby Service: Effective February 2014 (Schedule B)

APPLICATION

The Rider for Standby Service is required under the following provisions for any customer needing scheduled maintenance service or unscheduled outage service who is receiving electric service under one of the Cooperative's firm retail electric rate schedules and who has entered into a contract with the Cooperative for the interconnection and operation of an on-site extended parallel distributed generation system:

1. Contracts will be made for this service provided the Cooperative has sufficient capacity available in production, transmission and distribution facilities to provide such service at the location where the service is requested.

2. Power production equipment (distributed generation system) at the customer's site shall not operate in parallel with the Cooperative's system until the installation has been inspected by an authorized Cooperative representative and final written approval is received from the Cooperative to commence parallel operation.

3. The minimum term of service taken under this Rider shall be one (1) year or such longer period as may be required under an Electric Service Agreement. Following this initial one year period, a customer receiving standby service may terminate standby service and establish service under a firm service tariff schedule within the same timeframe as would be required of a new customer with a similar firm service load. Such timeframe may be dependent on the Cooperative's ability to adjust its generation capability, including reserve margin, for the increased firm load due to customer's selection of firm service from the Cooperative.

4. Energy provided to the customer under this Rider is limited to energy used during a forced outage or planned maintenance of the customer's distributed generation system.

Exceptions to this Application include:

A. Any customer taking service under the Cooperative's Rider for Parallel Generation as established under Minnesota Rules 7835 shall not be required to take service under this Rider for Standby Services required to temporarily back-up distributed generation systems rated at less than 40 kW;

B. Any customer taking service under Cooperative's Rider for Distributed Generation Service shall not be required to take service under this Rider for Standby Services required to temporarily back-up distributed generation systems rated at 60 kW or less. However, the Cooperative reserves the right to limit the number of Distributed Generation customers receiving such an exception based on financial considerations; or

C. Any customer, in lieu of service under this Rider, may provide physical assurance to ensure that standby service is not taken. A customer requesting physical assurance shall agree to furnish and install an approved load limiting device which shall be set and sealed by the Cooperative so that the customer's use of service will not exceed customer's contracted demand. The installed cost of the load-limiting device shall be paid by customer.

DEFINITIONS

Contracted Standby Demand is the quantity specified in Customer's Electric Service Agreement as the maximum amount of firm or non-firm standby service the Cooperative is obligated to supply.

Extended Parallel means the distributed generation system is designed to remain connected with the Cooperative's distribution system for an extended period of time.

Firm Service refers to a utility's most reliable, constant electric service. A utility would interrupt the supply of electricity to a firm service customer only as a last resort.

Non-Firm Service refers to electric service that a utility provides only to the extent that it has capacity not being used to meet the needs of firm-service customers at the moment.

Scheduled Maintenance service is energy, or energy and capacity, supplied by the Cooperative during scheduled maintenance of the customer's non-utility source of electric energy supply (distributed generation system).

Unscheduled Outage service is energy, or energy and capacity, supplied by the Cooperative during unscheduled outages of the customer's non-utility source of electric energy supply (distributed generation system).

All other definitions shall be as described in the Cooperative's *Distributed Generation Interconnection Requirements* and *Interconnection Process for Distributed Generation Systems.*

CHARGES FOR SERVICE

The following Reservation and Usage Fees are applicable in addition to all charges for service being taken under the Cooperative's base rate schedule.

Reservation Fees

Charges as specified below for the reservation of firm or non-firm generation, transmission and distribution service per month per kW will each be applied to the customer's Contracted Standby Demand as specified in Customer's Electric Service Agreement with the Cooperative:

	Firm Service ($ Per kW)	Non-Firm Service ($ Per kW)
Generation	*	**
Transmission	*	**
Distribution	$9.62	$6.56

* Firm standby service generation and transmission Reservation Fees will be billed under the rates, terms and conditions of the Cooperative's wholesale power supplier.

** Non-firm standby service generation and transmission Reservation Fees will be billed under the rates, terms and conditions of the Cooperative's wholesale power supplier.

Usage Fees

Demand Charge:

If the customer registers electrical usage from the Cooperative during a billing month, such usage may result in demand charges which may vary between the customer contracting for Firm Standby Service or Non-Firm Standby Service.

If usage of a firm standby customer results in wholesale capacity charges to the Cooperative, the metered demand of such usage will be charged at the demand rate as contained in the base tariff to which this Rider is attached *minus* the applicable Reservation Fees paid by the customer during such billing month. The reduction in the base tariff billing demand will be provided up to the amount of Contracted Standby Demand. Any metered demand for the customer's electrical usage from the Cooperative that exceeds the Contracted Standby Demand level will be billed at the full demand rate specified in the base tariff. In addition, the customer's Contracted Standby Demand will be adjusted as specified in the Billing Demand clause of this Rider. If the customer registers electrical usage from the Cooperative during a billing month that also coincides with the Cooperative's wholesale power supplier's applicable billing peak, the additional demand charges may be applied by the Cooperative to ensure that the customer fully compensates the Cooperative for such wholesale power costs.

Power may not be available when needed for a non-firm standby customer. If power is available and usage of a non-firm standby customer results in wholesale capacity charges to the Cooperative, the metered demand of such usage will be charged at no less than the demand rate as contained in the base tariff to which this Rider is attached *minus* the applicable Reservation Fees paid by the customer during such billing month. Any higher demand charges for non-firm demand use will reflect higher wholesale demand costs incurred to provide such service. The reduction in the base tariff billing demand will be provided up to the amount of the Contracted Standby Demand. Any metered demand for the customer's electrical usage from the Cooperative, that exceeds the Contracted Standby Demand level, will be billed at the full demand rate specified in the base tariff. In addition, the customer's Contracted Standby Demand will be adjusted as specified in the Billing Demand clause of this Rider. If the customer registers electrical usage from the Cooperative during a billing month that also coincides with the Cooperative's wholesale power supplier's applicable billing peak, the additional demand charges may be applied by the Cooperative to ensure that the customer fully compensates the Cooperative for such wholesale power costs.

Energy Charge:
Energy actually used by a firm standby customer under this Rider will be charged at the same energy rate as contained in the base tariff to which this Rider is attached.

If energy is available for a non-firm standby customer, the energy actually used under this Rider will be charged at no less than the energy rate contained in the base tariff to which this Rider is attached. Any higher energy charges for non-firm energy use will reflect higher wholesale energy costs incurred to provide such energy.

Rate Adjustments:
Bills shall be subject to all adjustments applicable to the base schedule to which this Rider is attached.

BILLING DEMAND

The customer shall contract for a specific kilo-Watt demand of standby service sufficient to meet the customer's requirements when the distributed generation system is not being operated. In the event the Contracted Standby Demand is exceeded in any month by a higher billing demand, such higher demand shall be considered as the new billing demand for the month. The billing demand for Reservation Fees thereafter shall not be less than the newly established billing demand for the remainder of the contract. Such adjustment of billing demand applicable to Reservation Fees will recognize circumstances where on-going firm service is being provided in addition to standby service.

STRANDED INVESTMENT

Any customer who installs load-limiting equipment to ensure that standby service is not taken (physical assurance) and does not intend to deliver power into the distribution system will have the option of making a lump sum payment to the Cooperative for stranded distribution investment. If such lump sum payment is not made, the customer will be subject to distribution standby charges based on the customer's typical demands incurred prior to requesting physical assurance status.

BILLING AND TERMS OF PAYMENT

Billing and terms of payment shall be governed as set forth in the Cooperative's applicable base rate schedule.

TERMS AND CONDITIONS OF SERVICE

1. The customer shall execute an Electric Service Agreement with the Cooperative which shall specify:
    a. Standard rate schedule (to which this Rider is attached);
    b. Contracted Standby Demand;
    c. Generator Nameplate Rating; and
    d. Type of Standby Service (firm or non-firm).

2. Service hereunder is subject to the Cooperative's *Interconnection Process for Distributed Generation Systems* and *Distributed Generation Interconnection Requirements* as may be modified from time-to-time.

3. The Cooperative will install all metering equipment necessary to monitor services provided to ensure adequate measurements are obtained to support necessary application of charges. The customer will be charged an up-front lump sum fee for the installed cost of such metering equipment and expected future operation and maintenance expenses for this metering equipment.

4. The customer shall make provision for on-site metering. All energy received from and delivered to the Cooperative shall be separately metered. The Cooperative may require metering of the generation output.

5. The customer shall pay for all interconnection costs incurred by the Cooperative made necessary by the installation of the distributed generation system.

6. The Cooperative reserves the right to disconnect the customer's generator from its system if it interferes with the operation of the Cooperative's equipment or with the equipment of other Cooperative customers.

7. The Cooperative shall not be obligated to supply standby service for a customer's load in excess of the capacity for which the customer has contracted.

8. The customer shall be liable for all damages or costs caused by the customer's use of power in excess of contracted for capacity.

9. The Cooperative may require the customer to furnish and install an approved load limiting device which shall be set and sealed by the Cooperative so that the customer's use of service will not exceed the number of kilo-Watts contracted for by the customer.

10. The customer shall annually furnish documentation to the Cooperative confirming the maximum capacity and reliability of the power source for which the customer requires Standby Service.

11. The Cooperative and the customer will coordinate the planning and determining of a schedule for performance of periodic maintenance of the customer's facilities, such maintenance shall be scheduled to avoid wholesale power billing costs or as agreed upon in the contract. The Cooperative will require the customer to provide reasonable notice of its proposed schedule for maintenance. The duration of the agreed maintenance schedule may thereafter be extended only with the consent of the Cooperative in response to the customer's request received prior to the end of the maintenance period.

12. The Cooperative reserves the right to establish a minimum charge in order to recover the costs of facilities required to serve such load. Said charge shall be specified in the Electric Service Agreement.

13. The Cooperative may be reimbursed by the customer for costs which are incurred, or which have been previously incurred, in providing facilities which are used principally or exclusively in supplying service for any portion of the customer's requirements which are to be normally supplied from a source of power other than the Cooperative's electric system.

14. All electricity delivered shall be for the exclusive use of the customer and shall not be resold.

15. The customer shall indemnify the Cooperative against all liability which may result from any and all claims for damages to property and injury or death to persons which may arise out of or be caused by the installation, maintenance, presence, or operation of the co-generation facility or by any related act or omission of the customer, its employees, agents, contractors or subcontractors.

PEOPLE'S ENERGY COOPERATIVE
Minnesota 59 Olmsted
Oronoco, Minnesota

Schedule 901: SMEC Cogeneration and Small Power Producers, Net Energy Billing Schedule

Service Area: All Minnesota Service Areas Formerly Served by IPL

Effective: This rate shall become effective May 2017 energy use.

Availability: Applicable for net energy billing service to any consumer with a qualifying facility of less than 40 kW capacity receiving non-time of day electric service with metered energy only. Metered energy billed will be total energy metered as delivered by the Cooperative, less metered energy delivered to the Cooperative from the qualifying facility for the same billing period and at the same location. Service will be contracted for a minimum period of twelve months.

Consumers with qualifying facilities of less than 40 kW but more than 20 kW have the option of receiving service on the Purchase and Sale Billing Schedule, Rate Designation 902.

Meter Charge: $1.75/month* (For Single Phase Service)

Distribution Grid Access Fee: A distribution grid access fee will be applied to all qualified small power or cogeneration facilities interconnected on or after May 1, 2016. The distribution grid access fee will be applied monthly at $3.03 per kW for each kW the facility's nameplate is above 3.5 kW to a maximum of $27.00. If a system that is installed before May 1, 2016 adds additional capacity, the additional capacity will be subject to the fee.

Energy Delivered to Consumer: All kWh delivered by the Cooperative that is in excess of energy delivered to the Cooperative by the qualifying facility at the same location will be billed at the Cooperative's standard applicable rate.

Energy Delivered to Cooperative: For all kWh delivered to the Cooperative in excess of kWh delivered by the Cooperative, the Cooperative will pay the consumer the following amount for the respective class of service:

Service Classification	Rate Schedule	Rate
Residential (901R)	160, 167, 168, 170, 310, 350	$0.10542 per kWh
General Service (901)	260, 267, 268, 290, 297, 298	$0.06462 per kWh
Farm (901F)	410, 420	$0.09024 per kWh
Large Power and Lighting (901L)	360, 367, 368, 540	$0.05438 per kWh

* For Comparison Only: Meter Charge $0.05753 per day

Power Cost Adjustment: Rider PCA is applicable to energy payments from consumer.

Metering: Separate metering will be required to measure energy delivered to the Cooperative.

Interconnection Charges: The costs of interconnecting a qualifying facility and any costs associated with subsequent necessary modifications are the responsibility of the consumer and the Cooperative will assess the consumer for all appropriate charges incurred by the Cooperative.

Rules and Regulations: Service hereunder is subject to the provisions of the Cooperative's Electric Service Standards.

PEOPLE'S ENERGY COOPERATIVE
Minnesota 59 Olmsted
Oronoco, Minnesota

Schedule 902: SMEC Cogeneration and Small Power Producers, Purchase and Sale Billing Schedule

Service Area: All Minnesota Service Areas Formerly Served by IPL

Effective: This rate shall become effective May 2017 energy use.

Availability: Applicable to any consumer with a qualifying facility of less than 40 kW capacity who receives service from the Cooperative on an appropriate standard non-time of day retail rate for electric service. Service will be contracted for a minimum period of twelve months.

Meter Charge: $4.05/month* (For Single Phase Service)

Power and/or Energy Delivered to Consumer: Power and energy delivered to the consumer at the same location shall be billed on the appropriate retail rate schedule for the class of consumer served.

Power and/or Energy Delivered to Cooperative: For all power and energy delivered to the Cooperative, the Cooperative will pay the following rates:

All kWh of energy:	$0.0508 per kWh
Firm Power Capacity Cost Component per kWh:	$0.00920 per kWh

* For Comparison Only: Meter Charge $0.13315 per day

Firm Power Definition: To qualify as firm power delivery under this schedule, the consumer shall have supplied power to the Cooperative with not less than a 65 percent on-peak capacity factor. The on-peak capacity factor shall be determined as the average on-peak metered capacity (on-peak kW hrs divided by on-peak hours) divided by the highest 15 minute metered on-peak kW capacity for the same period.

Power Cost Adjustment: Rider PCA is applicable to energy payments from consumer.

Metering: Separate metering will be required to measure power and/or energy delivered to the Cooperative.

Interconnection Charges: The costs of interconnecting a qualifying facility and any costs associated with subsequent necessary modifications are the responsibility of the consumer and the Cooperative will assess the consumer for all appropriate charges incurred by the Cooperative.

Rules and Regulations: Service hereunder is subject to the provisions of the Cooperative's Electric Service Standards.

PEOPLE'S ENERGY COOPERATIVE
Minnesota 59 Olmsted
Oronoco, Minnesota

Schedule 903: SMEC Cogeneration and Small Power Producers, Time of Day Purchase

Service Area: All Minnesota Service Areas Formerly Served by IPL

Effective: This rate shall become effective May 2017 energy use.

Availability: Applicable to any qualifying facility with capacity of 40 kW or more and less than or equal to 100 kW and optional for qualifying facilities with capacity less than 40 kW. Time-of-day rates are optional for qualifying facilities with capacity greater than 100 kW if these qualifying facilities provide firm power. Service will be contracted for a minimum period of twelve months.

Meter Charge: $6.25/month* (For Single Phase Service)

Power and/or Energy Delivered to Consumer: Power and energy delivered to the consumer at the same location shall be billed on the appropriate retail rate schedule for the class of consumer served.

Power and/or Energy Delivered to Cooperative: For all power and energy delivered by the consumer, the Cooperative shall pay the following rates:

On-peak energy:	$0.0551per kWh
Off-peak energy:	$0.04800 per kWh
Firm Power Capacity Cost Component per kWh:	$0.02375 per on-peak kWh

* For Comparison Only: Meter Charge $0.20547 per day

Firm Power Definition: To qualify as firm power delivery under this schedule, the consumer shall have supplied power to the Cooperative with not less than a 65 percent on-peak capacity factor. The on-peak capacity factor shall be determined as the average on-peak metered capacity (on-peak kWh divided by on-peak hours) divided by the highest 15 minute metered on-peak kW capacity for the same period.

Power Cost Adjustment: Rider PCA is applicable to energy payments from consumer.

Metering: Separate metering will be required to measure power and/or energy delivered to the Cooperative.

Interconnection Charges: The costs of interconnecting a qualifying facility and any costs associated with subsequent necessary modifications are the responsibility of the consumer and the Cooperative will assess the consumer for all appropriate charges incurred by the Cooperative.

Rules and Regulations: Service hereunder is subject to the provisions of the Cooperative's Electric Service Standards.

PEOPLE'S ENERGY COOPERATIVE
Minnesota 59 Olmsted
Oronoco, Minnesota

Rider N: SMEC Non-Residential Renewable Energy Program

Service Area: All Minnesota Service Areas Formerly Served by IPL

Effective: This rate shall become effective August 2015 energy use.

Availability: A voluntary program that supports the growth of renewable energy by allowing non-residential consumers to purchase energy from the Cooperative that is derived from renewable sources. The sales arrangements of renewable energy from the Renewable Energy program supplies are such that the power supply is only sold once to retail consumers. Initiation and termination of a consumer's participation shall be effective with the next practicable meter reading date after the Cooperative is notified by the consumer.

Consumers can choose any monthly dollar amount of participation in the program. This contribution toward the purchase of renewable energy will be added to the consumer's normal monthly bill.

Power Cost: Consumers will pay the Power Cost Adjustment (PCA) as calculated in Rider PCA on their monthly utility bills, but they will receive a billing adjustment for participating kWh purchases if the actual PCA on their monthly utility bills is greater than the fixed Second Nature PCA. The monthly kWh participation will be calculated by determining the monthly Renewable Energy contribution amount divided by a 2-cent per kWh premium for participation in the program. The billing adjustment will be applied after the end of each calendar year or after the last month of a consumer's participation in the program. The fixed Renewable Energy PCA will be recalculated on an annual basis with the most recent actual 12-month period of energy costs and applied in the first calendar month of each year.

Small Power Production Facility or Cogeneration Facility

Terms and Conditions

1.0 **Requirements for Interconnection:**

1.1 **Cooperative Membership:** Any Individual, or corporation, or partnership wishing to interconnect with the Cooperative's electric system shall become a Member of the Cooperative in accordance with the Bylaws of the Cooperative.

1.2 **Member Service Agreement:** The owner of a QF wishing to interconnect with the Cooperative's system will be required to sign a Member Service Agreement. The Agreement commits the Cooperative and the Member to operation under the terms and conditions of the Agreement.

1.3 **Application for Interconnection:** The Cooperative requires that all QF's file an Application for Interconnection not less than 30, nor more than 90 days, prior to the proposed date of an interconnection. The Application includes the Cooperative's Requirements for Interconnection. All QF's are required to abide by the requirements as stated and provide the Cooperative with the following information:

A. Technical specifications of all power production and interconnection equipment.

B. Proposed date of interconnection.

C. Projected net output or consumption by the QF.

The Cooperative shall accept or reject the Application for Interconnection within 30 working days. Acceptance depends on the accuracy of information provided on the Application and on the QF's proposed compliance with the National Electrical Code, the National Electrical Safety Code, the Cooperative's Service Rules and Regulations, and other local codes which apply to cogeneration and small power production facilities. If, in the Cooperative's opinion, the proposed facility does not qualify, the Cooperative will provide the Member with a written explanation. Acceptance of the Application shall not be construed as permission to interconnect with the Cooperative's system.

1.4 **Inspection:** An Inspections Certificate issued by the state electrical inspector having jurisdiction in the QF's area is required to assure wiring complies with the National Electrical Code, National Electrical Safety Code, and other applicable local electrical codes.

An Inspection Certificate issued by the local governing agency is required to assure compliance with building codes and environmental rules and regulations where applicable.

1.5 **Interconnection Costs:** The Member shall reimburse the Cooperative for its incremental cost resulting from interconnecting with the QF. The incremental interconnection cost shall include all reasonable costs of connection, switching, metering, transmission, distribution, safety provisions, and administrative costs incurred by the Cooperative directly related to the installation and maintenance of the physical facilities necessary to permit interconnected operations with the QF, to the extent such costs are in excess of the corresponding costs which the Cooperative would have incurred had it not interconnected.

1.6 **Interconnection:** Interconnection is permitted only after all of the requirements stated in Sections 1.0 and 2.0 are met and only after written authorization to interconnect is issued by the Cooperative. This authorization cannot be issued until all interconnection costs are paid and does not relieve the member from the responsibility of installing, operating, and maintaining the facilities in a responsible and safe manner.

If, in the opinion of the Cooperative, the Member fails to abide by the terms and conditions of the Member Service Agreement, including subsequent operation of his generating facilities in a non-qualifying manner, the Cooperative will no longer be obligated to operate in parallel and purchase any capacity and energy made available and may notify the Member to disconnect the generating facilities from the Cooperative's system. In the event the Member fails to immediately comply with a disconnect notice, the Cooperative reserves the right to make such disconnection including the discontinuation of electric service if necessary.

1.7 **Cooperative Access:** Employees and authorized representatives of the Cooperative have the right to enter upon the Member's property at any reasonable time to ensure continued compliance with the Cooperative's Safety and Operating Standards and the accuracy of its meters. Such inspection by the Cooperative shall not relieve the Member from the responsibility of installing, operating, and maintaining the facilities in a responsible and safe manner.

1.8 **Automatic Shutdown and Disconnection:** In order to provide adequate safety to the Cooperative's employees when performing certain operation and maintenance on the Cooperative's system it is essential that a means be available to automatically shut down and/or disconnect the QF from the system upon interruption of the utility source voltage such that there is no possibility that the QF could back-feed through the service transformer and energize the primary system. The Member shall furnish and install an Underwriter's Laboratory (UL) listed manual disconnect switch which shall be located between the Member's QF and the Cooperative's system and readily accessible by Cooperative personnel. The location of the switch shall be approved by the Cooperative and shall be housed in an approved enclosure which can be secured with a padlock or locking device. Where feasible and with mutual consent, the Cooperative may permit the use of a service transformer disconnect in place of the Member furnished disconnect switch.

2.0 **Safety and Operating Standards:**

Safety and Operating Standards under which the Cooperative operates are imposed to protect Cooperative employees and the general public and are intended to guarantee a quality of service to the consumer members. All QF's must operate in a manner that will ensure the safety of the employees and the general public and must allow electric service to other consumers to remain within prescribed limits.

2.1 **Isolation of Qualifying Facility:** The Cooperative reserves the right to open the disconnect switch (isolating the Member's QF) without prior notice for any of the following reasons:

A. A system emergency and/or maintenance operations require such action.

B. A potentially hazardous condition relating to the QF is discovered.

C. The operation of the QF interferes with the quality of service provided to other Members and/or the operation of the Cooperative's system.

2.2 **Disclaimer:** The Cooperative does not assume any responsibility for the safety and electrical protection of the Member's facilities irrespective of the condition of the Cooperative's facilities. The Cooperative shall not be liable to the Member for any damage to the Member's facility, including damage caused by disconnection of the

QF from the Cooperative's system by automatic or manual devices or pursuant to the Safety and Operating Standards.

2.3 **Single Phase Limitations:** The rated capacity of the QF to be connected in parallel with a low voltage service shall be no greater than 20 KW for single phase installations, unless authorized in writing by the Cooperative consistent with the Cooperative's limitation for single phase motors. Single phase installations greater than 20KW will be permitted if engineering calculations indicate that the installation will not adversely affect the operational characteristics of the Cooperative's system.

2.4 **Quality of Service:** Operation of the QF must not cause any reduction in the quality of service provided to other consumers nor interfere with the operation of the Cooperative's system. The Member shall be responsible for taking whatever corrective action might be required and/or reimbursing the Cooperative for the cost of corrective action which it deems necessary to restore service to prescribed limits.

2.5 **Electrical Characteristics:** The electrical characteristics of the QF shall conform with standards established by the Cooperative. The standards may include voltage, current, frequency, harmonics, and automatic synchronization, etc. Wherever possible, the Cooperative will base its standards on industry wide standards.

2.6 **Power Factor:** The Member shall endeavor to operate the QF as near unity power factor as possible. For QF's with rated capacity above 50KW, the Cooperative reserves the right to require the Member to install power factor correction equipment or reimburse the Cooperative for its cost of installing power factor correction equipment.

3.0 **Metering:**

The Cooperative will meter the QF to obtain billing data and to fulfill its reporting requirements.

3.1 **Required Metering:** Two meters are required. One meter will be installed in such a manner that it records only the energy sold by the Cooperative to the QF. The second meter will be installed in such a manner that it records only the energy sold by the QF to the Cooperative. The QF shall pay for the requisite metering as an interconnection cost. In addition to required metering, the Cooperative, at its option but with the consent of the QF, may install additional metering equipment for the collection of data for research

purposes. The Cooperative will furnish such research metering equipment and pay all associated operation and maintenance.

3.2 **Meter Reading:** The meters shall be read monthly, at the same time and in the same manner as prescribed for other Members of the Cooperative in the same consumer classification. Monthly meter readings are required from all consumer classifications. Metering records shall be available for inspection at all reasonable times.

4.0 **Service Condition:**

The furnishing and taking of service hereunder shall be subjected to the Service Rules and Regulations of the Cooperative. Such Service Rules and Regulations are subject to change from time to time by superseding schedules as published by the Cooperative.

5.0 **Insurance:**

The Member, at his sole cost and expense, shall obtain and maintain an insurance policy that provides liability insurance covering the operation of the QF and its associated equipment of not less than $ 300,000. In addition, it is the Member's responsibility to consider that the liabilities of operating a QF may exceed $ 300,000, so adequate coverage should be obtained to protect the Member's possible exposure to liability claims. Said policy shall include the Cooperative as an additional insured. Satisfactory evidence of such insurance shall be provided to the Cooperative before the QF will be allowed to operate with the disconnect switch in the closed position. The Member shall notify the Cooperative of any policy changes and of the periodic policy renewals.

Midwest Region Consumer's Guide to Buying a Solar Electric System

Consumers in the Midwest (Illinois, Iowa, Minnesota, Missouri, Nebraska, and Wisconsin) are showing increased interest in solar electric systems for their homes and businesses. This booklet is designed to guide consumers through the process of buying a solar electric system. Photovoltaic, or PV systems, are reliable, pollution free and use a renewable source of energy—the sun.

Aside from technological advances and cost reductions in PV technology, several state and federal PV programs and incentives are available to Midwest region customers that are making PV systems more economical than ever before. For example, several states offer financial assistance in the form of grants, tax abatements and tax credits to prospective PV customers.

The availability of net metering, which should be verified with each utility company, can also make renewable energy installation more attractive. Net metering is a practice that credits utility customers for the electricity their system generates, so that at the end of a billing period they are charged only for the "net" electricity they purchase. In most cases, a single bidirectional meter monitors only the net amount of electricity sold or purchased. In essence, the electric meter will run backward when the PV system generates more power than is being used.

A word of caution: this is not a technical guide for designing or installing a system—for that information, consumers should consider consulting an experienced PV system designer or system supplier (PV provider) who will have detailed technical specifications and other necessary information. A PV system can be a substantial investment and, as with any investment, careful planning will help ensure the right decisions are made.

These materials also provide information on PV programs, incentives and policies for states in the Midwest. As PV technology advances, this guide will be updated and provide more detailed information on state PV programs and policies.

Innovative Power Systems, Inc. /PIX09315

This home in Northfield, MN, may have an old-fashioned feel, but its 3.3-kilowatt utility-connected solar-electric shingle system gives it modern efficiency.

Contents

Background

What is a solar electric, or photovoltaic, system?

PV technology converts sunlight directly into electricity. It works during daylight hours, but more electricity will be produced when the light is more intense (a sunny day) and is striking the PV modules directly (when the rays of sunlight are perpendicular to the PV modules). Unlike solar systems for heating water, PV technology does not use the sun's heat. Instead, PV produces electricity directly from the electrons freed by the interaction of sunlight with semiconductor materials in the PV cells.

The basic building block of PV technology is the solar cell. PV cells are wired together to produce a PV module, also called a PV panel, which is the smallest PV component sold commercially. A PV system tied to the utility grid consists of one or more PV modules (array) connected to an inverter that changes the system's direct-current (DC) electricity to alternating current (AC), which is compatible with the utility grid and able to power devices such as lights, appliances, computers and televisions. Batteries may be included in the system to provide back-up power in case utilities experience power outages. Components that support the PV array, called balance-of-system, include the items in the diagram to the right.

System users do not need to understand the detailed physics of how PV works to understand its appeal: investing in PV allows users to produce their own electricity with no noise, air pollution or moving parts while using a clean, renewable resource. A PV system will never run out of fuel and it will not increase our oil imports from overseas. In fact, it may not even contribute to the trade deficit, because many PV system components are manufactured in the United States. Because of these unique characteristics, PV technology has been called the ultimate energy source for the 21st century.

Before deciding to buy a PV system, consumers should understand the current status of the technology:

First, PV produces power intermittently because it works only during daylight hours. This is not a problem for PV systems connected to the utility grid, because additional electricity needed by system owners is automatically delivered by their utility.

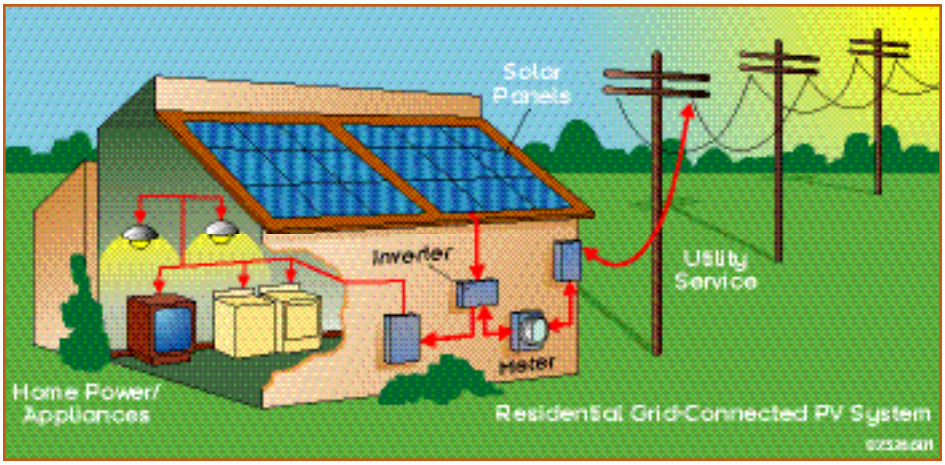
Second, PV-generated electricity is more expensive than conventional utility-supplied electricity. Improved manufacturing has reduced the cost to less than 1 percent of what it was in the 1970s, but the cost (amortized over the life of the system) can be 2–3 times higher than the kilowatt-hour (kWh) rate charged by the utilities in the Midwest region for traditional electric power. Net metering, which allows residents to spin their electric meters backwards and offset demand, can help make PV more affordable. Various incentives may also make it cost-effective.

Finally, unlike electricity purchased month-by-month from a utility, PV power comes with a high initial investment and no monthly charge thereafter. This means that buying a PV system is like paying years of electric bills up front. System owners will probably appreciate the reduction in their monthly electric bills, but the initial expense may be significant. By financing a PV system, system costs can be spread over many years, while grants and other financial incentives can help make the cost more manageable.

Investing in a PV System

Why buy a PV system?

People decide to buy PV systems for a variety of reasons. Some want to help preserve



Solar panels convert the sun into direct-current electricity, which is converted to alternating current by the inverter for use by home appliances. This grid-connected system can either use power from or contribute power to the local utility.

Patrick Engineering/PIX09514

The solar panels on the roof of the Metcalfe Federal Building in Chicago, IL, contribute to both the building's energy supply and the campaign to make Chicago a center for green technology.

the earth's finite fossil-fuel resources and reduce air pollution. Others believe it makes sense to spend money on an energy-producing improvement to their property. Some like the security of reducing the amount of electricity bought from the utility, because it makes them less vulnerable to power outages and future increases in the price of electricity. PV systems might also make sense for rural homeowners. In cases where a house is off the grid and there are no utility lines available, PV often becomes the most economical choice for both the consumer and the utility. Finally, some people appreciate the independence that a PV system provides. Whatever the reason, solar energy is widely considered an energy source of choice for the future.

What kind of building is a good place for a PV system?

The questions below will help determine the best locations for PV systems.

Where and how should a PV system be mounted for best performance?

Usually, the best location for a PV system is a south-facing roof, but roofs that face east or west may also be acceptable. A well-designed PV system needs clear and unobstructed access to the sun's rays for most or all of the day, throughout the year. An initial assessment can be made and, if the location looks promising, PV providers have the tools to trace the sun's path at a chosen location and determine whether a home or business can make use of a PV system.

The orientation of a PV system (the compass direction that the system faces) will affect performance. In the Midwest region, the sun is always in the southern half of the sky and is higher in the summer and lower in the winter. Flat roofs work well for PV systems because the modules can be mounted flat on the roof facing the sky or mounted on frames tilted toward the south at an optimal angle.

If a rooftop cannot be used, solar modules can also be placed on the ground, either on a fixed mount or a tracking mount that follows the sun to orient the PV modules for maximum performance. Other options (used most often in multi-family or commercial applications) include mounting structures that create covered parking or provide shade as window awnings.

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

To make the best use of a PV system, the modules must have a clear "view" of the sun for most or all of the day—unobstructed by trees, roof gables, chimneys, buildings and other features of a home and the surrounding landscape. It is important to note that although the area where a system is mounted may be unshaded during one part of the day, it may be shaded during another. If this is the case, this shading may substantially reduce the amount of electricity that a system will produce. Existing laws in Iowa, Minnesota, Missouri, Nebraska, and Wisconsin establish rights to protect solar access through the creation of a Solar Easement. More information on solar access laws is provided in the final section of this guide (State PV Programs).

What kind of roof is on the building, and what is its condition?

Some roof types are simpler and cheaper to work with, but a PV system can be installed on any type. Typically, composition shingles are easiest to work with and slate is the most difficult. An experienced solar installer will know how to work on all roof types and can use roofing techniques that eliminate the possibility of leaks. PV providers should know if a PV system will affect a roof's warranty.

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

How much area is needed on a roof or property?

The amount of space needed for a PV system is based on the physical size of the system. Most residential systems require as little as 50 square feet (for a small "starter"system) up to as much as 1,000 square feet. A rule of thumb is that a square foot of single- or poly-crystalline PV module area produces 10 watts of power in bright sunlight. Therefore, a 1,000-watt system may require 80 to 300 square feet of roof area, depending on the type of PV module used. The amount of roof area needed also depends on the PV module's efficiency in converting sunlight to electricity. The table above displays typical roof-area requirements for varying PV system sizes and module efficiency figures.

PV System Area Requirements (square feet)

PV Module Efficiency (%)	PV Capacity Rating (Watts)						
	100	250	500	1000	2000	4000	10000
4	30	75	150	300	600	1200	3000
8	15	38	75	150	300	600	1500
12	10	25	50	100	200	400	1000
16	8	20	40	80	160	320	800

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

If location limits the physical size of a system, a system that uses more efficient PV modules may be installed. Greater efficiency means the module uses less surface area to convert sunlight into a given amount of electric power. PV modules are available today in a range of types and some offer more efficiency per square foot than others. System sizing is discussed later in this booklet and should also be discussed with the PV provider.

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

The first step toward designing a PV system is to analyze current electricity use in a home or business. Energy efficiency is very important when sizing a PV system. Before installing a system, it is important to make sure a home or business is as energy efficient as possible. Every kilowatt-hour that can be trimmed off the projected annual use in a PV-based system will reduce initial set-up costs. For example, a new, highly efficient refrigerator may cost $1,000 but it could avoid the need for an additional 1 kW on the PV system (which could cost $6,000–$10,000). A PV system makes most sense once all cost effective energy efficiency improvements have been made.

It is important to first determine how much of the current electricity needs will be met by the PV system. A utility can provide the building's total electricity use, measured in kilowatt-hours, over the last 12 months (or past electric bills can be reviewed if available). PV providers can determine how much electricity a new PV system will produce on an annual basis (also measured in kilowatt-hours) and compare that number to a building's annual electricity demand to get an idea of how much electricity from the utility will be offset by the system. For example, if it is determined that 50 percent of the electricity needs of a home or business should be met by the PV system, PV providers can examine past electricity consumption and determine the size of the PV system needed to achieve that goal. The next section provides more information on estimating electricity savings.

As a system is sized, it is important to consider the economies of scale that can decrease the cost per kilowatt-hour as the size of the system increases. Balance-of-

system and labor costs for a small system may be nearly as much as those for a large system. Therefore, it's worth remembering that a PV provider is likely to offer a better price to install a 2-kilowatt system all at once, than to install a 1-kilowatt this year and another similar system next year—because multiple orders and multiple site visits are more expensive.

Also, it is generally not economical to try to produce more power than needed. In some states, the utility is either not required to compensate the consumer for excess generation or is only required to do so at buyback rates that are lower than retail. Typically, this is the utility's "avoided cost" rate that may be a fraction of the retail rate provided under net metering.

How much will a PV system save system owners?

The value of a PV system's electricity will depend on how much a utility is paid for electricity and how much a utility will pay for any excess that is generated. If a utility offers net metering (and pays the full retail price for excess electricity), calculations may be fairly easy because system owners and their utility will each pay the same price for each other's electricity.

A 1-kW system should meet about 12–18 percent of the typical residential customer's needs. Given the amount of solar resource available in the Midwest region, it would produce about 1,600 kWh annually under ideal conditions (i.e., south-facing installation and proper slope of the roof). If this annual power output is multiplied by the average electricity rate (approximately 7.5 cents per kWh for residential customers) and then divided by 12, electricity generated by the PV system would reduce utility bills by about $10 a month.

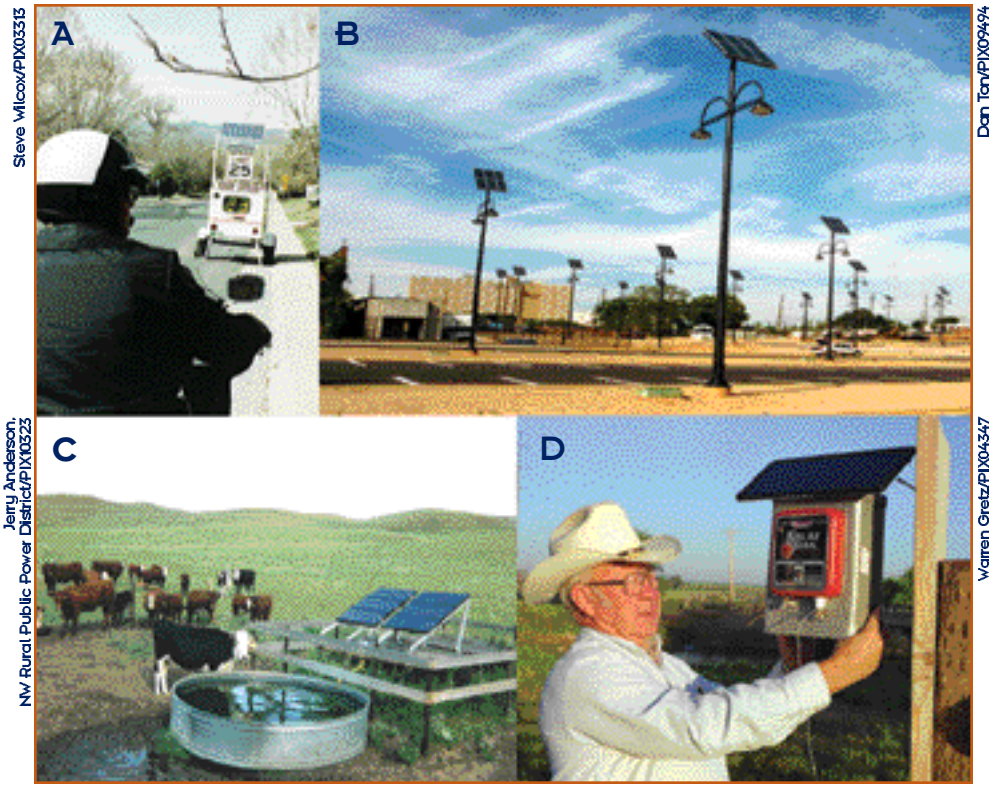
How else can PV systems be used?

Although this guide focuses primarily on PV systems that provide electricity for homes and businesses, there are many other applications for PV power. PV systems can,in many cases, be the least expensive option for applications located away from existing power lines.

PV systems can be adapted to suit any requirement, small or large. The smallest systems power calculators and wristwatches. Larger systems are used effectively worldwide to pump water for livestock, plants or humans. Since the need for water is greatest on hot sunny days, PV is a perfect fit for pumping applications. PV is also used to power remote electric fences and pond aeration. Parking and landscape lights, telecommunications equipment, highway construction signs and navigational warning signals are also excellent applications for PV.

How much does a PV system cost?

There is no single answer, but keep in mind that a solar rebate and other incentives may reduce the cost. A system's price will depend on a number of factors, including



The applications for solar electric technology are varied. A: A police officer checks a PV-powered "smart sign" to monitor traffic speed. B: PV-powered lights in a parking lot prevent the need to bury electric lines. C: PV power runs pumps for watering livestock in remote areas. D: Ranchers can rely on PV fence chargers to keep cattle from straying.

whether the home is under construction or whether the PV is integrated into the roof or mounted on top of an existing roof. The price also varies depending on the PV system rating, manufacturer, retailer and installer.

The size of a system may be the most significant factor in any equation measuring costs against benefits. Small, single PV-panel systems with built-in inverters that produce about 75 watts per hour may cost around $900 installed, or $12 per watt. These small systems will offset only a small fraction of an electricity bill. A 2-kilowatt system that will offset the electricity needs in a very energy-efficient home may cost $16,000 to $20,000 installed, or $8 to $10 per watt. At the high end, a 5-kilowatt system that will completely offset the energy needs of many conventional homes may cost $30,000 to $40,000 installed, or $6 to $8 per watt. These prices are estimates and actual costs will depend on a system's configuration, equipment options and other factors. Local PV providers can provide estimates or bids.

Are incentives available to help reduce the cost?

Some states offer programs or incentives to help "buy down"the cost of a PV system or make it easier to finance. These incentives may include: tax abatements, tax credits, state grants and low-interest financing packages. The final section of this booklet ("State Programs") provides the most up-to-date information on incentives and financing options for PV systems.

If a home is used for a business, system owners may be able to take advantage of federal financial support for PV technology through a tax credit for commercial uses of solar energy. This business energy tax credit provides businesses (but not individuals or utilities) with a 10 percent tax credit and 5-year accelerated depreciation for the cost of equipment used to generate electricity by solar technologies. These tax benefits can substantially reduce the effective cost of a PV system and should be thoroughly investigated. More information can be found on the Internet at *www.dsireusa.org*.

WI Public Service Community Foundation SolarWise for Schools /PIX07631

Workers install solar-electric panels on the De Pere High School as part of Wisconsin's SolarWise for Schools program.

How can a PV system be financed?

Although there are some special programs available for financing solar and other renewable energy investments, most options will be familiar to consumers.

One of the best ways to finance PV systems for homes is through a mortgage loan. Mortgage financing options include primary mortgages, a second mortgage, such as a U.S. Department of Housing and Urban Development (HUD) Title 1 loan, or a home-equity loan that is secured by a property. There are two advantages to mortgage financing. First, mortgage financing usually provides longer terms and lower interest rates than other loans, such as conventional bank loans. Second, the interest paid on a mortgage loan is generally deductible for federal tax purposes (subject to certain conditions). If a PV system is bought at the same time that a house is built, purchased or refinanced, adding the cost of the PV system to the mortgage loan is likely to be relatively simple and may avoid additional loan application forms or fees.

If mortgage financing is not available, people should look for other sources of financing, such as conventional bank loans. Because a PV system is a long-term investment, the terms and conditions of PV financing are likely to be the most important factor in determining the effective price of PV-generated power.

PV systems purchased for business applications are probably best financed through a company's existing sources of funds for capital purchases—usually Small Business Administration loans or conventional bank loans.

Selecting a PV Provider

Who sells and installs PV systems?

Most consumers will need to select a vendor to install their PV system. In some locations, finding a PV provider or installer can be as simple as picking up the telephone directory and looking under "Solar Energy Equipment and Systems—Dealers." However, many of those listings are for solar water-heating companies, which may not be experienced in PV system design or installation. Similarly, many electrical contractors, although proficient in typical electrical contracting work,may not have expertise in PV or with residential roof-mounting techniques. In the Midwest, prospective customers may check the following for PV system installers and designers:

- "Midwest PV Yellow Pages," available from the Iowa Department of Natural Resources Energy and Waste Management Bureau, by calling 515-281-7018 or by visiting *www.state.ia.us/dnr/energy/programs/solar*.
- Contact the utility company to see which vendors it might recommend.
- Contact a local solar energy organization for vendor recommendation.
- Conduct a search on the Internet.

How should consumers choose among PV providers?

First, compile a list of prospective PV providers. People should first consider those closest to them, because the contractor's travel costs might add to system price. Next, the providers should be contacted to find out what products and services they offer. The following questions may give consumers a good sense of a PV provider's capabilities.

Has the company installed grid-connected PV systems? If not, has it installed grid-independent PV systems?

Experience installing grid-connected systems is valuable because some elements of the installation—particularly interconnection with the local utility—are unique to these systems. Because grid-connected systems are still relatively uncommon, most contractors with PV experience have worked only on systems such as those that power remote cabins far from the nearest utility line. This means they have experience with all aspects of PV system installation except the connection with the utility grid. Although grid-connection work is different from "off-grid" work, a competent company with PV experience should not be eliminated just because it has not installed grid-connected PV systems in the past. In fact, experience with off-grid systems is valuable because grid-independent systems are more technically complicated than grid-tied systems.

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

A company or contractor that has been in business a long time has demonstrated an ability to work with customers and to compete effectively with other firms.

Is the company properly licensed?

An appropriately licensed contractor should install PV systems. This usually means either the installer or a subcontractor has an electrical contractor's license. The appropriate state agency should be contacted to verify that a given contractor is licensed to perform the installation. Local building departments also may require that the installer have a general contractor's license. Consumers should call the city and county in which they live for additional information on licensing.

Several programs and organizations, including the Department of Energy's Million Solar Roof Initiative, the Midwest Renewable Energy Association and the Interstate Renewable Energy Council, are working to develop a national training program for solar energy system installation and maintenance and a certification process for installers that will meet national standards. The North America Board of Certified Energy Practitioners (NABCEP) also is in the process of creating a certification program for installers of photovoltaic systems. The NABCEP program is intended to be a voluntary national certification recognized throughout the United States.

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

As with any project that requires a contractor, due diligence is recommended. Each state's Electrical Board can inform consumers about any judgments or complaints against a state-licensed electrician. Con-

This nature center near Cedar Rapids, IA, uses solar electricity to run low-wattage, energy-efficient lights.

sumers should call the city and county in which they live for additional information on how to check on contractors. The Better Business Bureau is another source of information on contractors.

How do consumers choose among competing bids?

If there are several bids for the installation of a PV system (and it's generally a good idea to obtain multiple bids), consumers should take steps to ensure that all of the bids received are made on the same basis. For example, comparing a bid for a system mounted on the ground against another bid for a rooftop system is like comparing apples to oranges. Similarly, different types of PV modules generate more electricity per square foot than others. Bids should clearly state the maximum generating capacity of the system (measured in watts or kilowatts). If possible, the bids should specify the system capacity in AC watts, or specify the output of the system at the inverter.

Consumers may want to obtain some estimate of the amount of energy that the system will produce on an annual basis (measured in kilowatt-hours). Because the amount of energy depends on the amount of sunlight—which varies by location, season,and year to year—it is unrealistic to expect a specific figure. A range of ±20 percent is more realistic. Bids also should include the total cost of getting the PV system operational, including hardware, installation,connection to the grid, permitting, sales tax and warranty.

What about warranties?

A warranty is a very important factor for evaluating bids. Warranties are key to ensuring that a PV system will be repaired if something should malfunction during the warranty period. PV systems should carry a full (not "limited") two-year warranty, in addition to any manufacturers' warranties on specific components. This warranty should cover all parts and labor, including the cost of removing any defective component, shipping it to the manufacturer and reinstalling the component after it is repaired or replaced. Consumers need to know who is responsible for honoring the various warranties associated with a system—the installer, the dealer, or the manufacturer. The vendor should disclose the warranty responsibility of each party. Consumers should also know the financial arrangements, such as contractor's bonds, that assure the warranty will be honored. A warranty does not guarantee that the company will remain in business. It is important to know whom to contact if there is a problem. To avoid any later misunderstandings, warranties should be read carefully, including a full review of the terms and conditions with the retailer.

Is the lowest price the "best deal"?

It might not be. A PV company is a business just like any other, with overhead and operating expenses that must be covered. It's always possible that a low price could be a sign of inexperience. Companies that plan to stay in business must charge enough for products and services to cover their costs, plus a fair profit margin. Therefore, price should not be the only consideration.

If a state has an incentive program for solar energy, it may be through a pre-selected group of contractors. If so, consumers can only get the incentive by using one of those contractors. Furthermore, most state programs require the prospective PV customer to first contact the state to apply to the grant program and verify that incentives are still available. A customer should not expect to receive incentives or grants

after they have installed a system on their own. It is important for customers to contact the state before proceeding with a solar project.

Installing a PV System

What about permits?

Some communities have a homeowners' association that might require approval for a solar system. System owners or the PV provider may need to submit plans and should gain approval from the homeowners'association before installation of the PV system begins.

Most likely, permits from the city or county building department will need to be obtained. A building permit,an electrical permit or both might be required before installing a PV system. Typically, a PV provider will take care of this, rolling the price of the permits into the overall system price. However, in some cases, a PV provider may not know how much time or money will be involved in "pulling"a permit. If so, this task may be priced on a time-and-materials basis, particularly if additional drawings or calculations must be provided to the permitting agency. In any case, permitting costs and responsibilities should be addressed at the start with a PV provider.

A variety of organizations have worked with the PV industry in the development of various codes and standards. Code requirements for PV systems vary somewhat from one jurisdiction to the next, but most requirements are based on the National Electrical Code (NEC). The NEC has a special section, Article 690, which carefully spells out requirements for designing and installing safe, reliable, code-compliant PV systems. Because most local requirements are based on the NEC, building inspectors are likely to rely on Article 690 for guidance in determining whether a PV system has been properly designed and installed. If a PV system is among the first in a community to be installed and is grid-connected, the local building department may not have approved one of these systems. If this is the case, system owners and their PV provider can speed up the process by working closely and cooperatively with local building officials to help educate them about the technology and its characteristics. Other standards are in place to prove the safety and operation of PV system components. Two of these standards, Underwriters Laboratories and Institute of Electrical and Electronic Engineers, are discussed later in this guide.

Missouri Botanical Garden/PIX10352

This Victorian home in St. Louis, MO, demonstrates the practical use of energy-efficient systems, including a 1.5-kilowatt solar-electric unit that powers all the kitchen appliances.

What about inspector and utility sign-off?

After a new PV system is installed, it may need to be inspected and "signed off" by the local permitting agency (usually a building or electrical inspector) and perhaps by the electric utility. Inspectors may require the PV provider to make corrections. This is fairly common in the construction business.

What about insurance?

If a PV system is bought for a home, a standard homeowner's insurance policy is usually adequate to meet the utility's requirements. However, system owners may wish to contact their insurance carrier or one of the groups listed in the final section of this booklet. In some states, the electric utility may require additional insurance.

Connecting a PV System to the Grid

Is connecting to the grid necessary?

The conditions of an individual site determine whether or not a system should be grid-connected.

"Off-grid" means operating the PV system independently of the utility grid. In cases where a house has no electricity and no utility lines are available, PV often becomes an economical choice for both the consumer and the utility. The cost of running a special line more than one-quarter mile can be higher than the cost of installing a PV system.

If a PV system is designed to meet only a portion of the electricity load, the system will need to be interconnected with the local utility to meet the remainder of the user's electricity needs. There are two ways that PV systems can be wired for residential homes: grid-connected and grid-connected with battery storage. Grid-connected means the PV system interfaces directly with a current utility connection. This set-up allows the consumer generator to put excess generation (when PV generation exceeds consumption) back to the grid. However, if there is a utility power outage, the system will only produce electricity if there is enough solar resource available (i.e.,during daylight hours). Grid-connected with battery storage avoids this situation. The included battery system provides back-up power in case of a utility power outage. Batteries add value to a system, but at an increased price.

If a system needs to be grid-connected, interconnection is key to the safety of both the customer and the utility lineworkers and to the protection of equipment.

How does the PV system interface with an existing utility connection?

In times when consumption exceeds generation by the PV system, the consumer simply obtains the additional power from the local utility as always. Grid-connected systems are gaining in popularity because they do not require battery storage and are more efficient in converting solar energy to electricity. Provided the utility allows net metering, grid-connected systems also tend to be the most cost effective. Under net metering, customers receive credit for excess electricity from their PV systems. In essence, the electric meter will run backward when the user is not consuming all the power the PV system generates (see following discussion). Several Midwest states offer net metering, although the terms and conditions vary in each case.

Utilities should be contacted well in advance to establish terms and conditions for interconnection requirements and net metering information before purchasing and installing a PV system.

How do system owners get an interconnection agreement?

Connecting a PV system to the utility grid will require entering into an interconnection agreement and a purchase and sale agreement. Some state utilities commissions and federal law require utility companies to supply an interconnection agreement. Some utilities have developed simplified, standardized interconnection agreements for small-scale PV systems.

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

The language in these contracts should be simple, straightforward and easy to understand. If obligations are unclear under these agreements, the utility or electrical service provider should be contacted for clarification. If questions are not adequately addressed, consumers should contact the proper state regulatory groups listed at the end of this booklet.

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

- Institute of Electrical and Electronic Engineers, P929: Recommended Practice for Utility Interface of Photovoltaic Systems. Institute of Electrical and Electronic Engineers, Inc., New York, NY (finalized in 2000). More information can be found on the Internet at *www.ieee.org*.

- Underwriters Laboratories, UL Subject 1741: Standard for Static Inverters and Charge Controllers for Use in Photovoltaic Power Systems (First Edition). Underwriters Laboratories, Inc., Northbrook, IL (December 1997). More information can be found on the Internet at *www.ul.com*.

Underwriters Laboratories (UL) has worked closely with the PV industry to help develop standardized tests to prove the safety of PV modules and inverters.

The Institute of Electrical and Electronic Engineers (IEEE) Standards Board approved the Interconnection Standard (IEEE 929-2000 Recommended Practice for Utility Interface of Photovoltaic (PV) Systems) on January 30, 2000. It provides a standard that PV interconnection hardware can be designed to, thus removing a costly situation where different utility jurisdictions require specialized hardware. The IEEE standard applies to the PV inverter, the device that converts the PV system's DC energy into utility-compatible AC energy. An important parallel effort was performed at Underwriters Laboratories, where a test procedure, UL 1741, was written that will verify that an inverter meets the requirements of IEEE 929.

It is a system owner's obligation to ensure that their PV provider uses equipment that complies with the relevant standards. Interconnection should be discussed with the utility and their requirements should be clarified before purchasing any equipment. Utilities are responsible for maintaining the safety and reliability of the grid and have legitimate concerns about the interconnection of outside systems to the network.

MSB Energy Associates/PIX10520

In the High Wind Association, a Wisconsin community that practices sustainable living, homes use solar electricity. Each system is connected to the local electric utility, which has a net metering agreement with homeowners.

What about net metering?

Net metering has been generally accepted as a way for states to encourage consumers to purchase renewable energy systems. Basically, net metering allows customers to only pay for their "net"electricity, or the amount of power consumed from the utility minus the power generated at the customer's home via the renewable energy system. Excess generation (power not consumed during the billing period) may be reimbursed at the utility's avoided cost (usually a much lower rate) or not at all. Once the utility has been contacted and has cleared a PV system for net metering, system owners should verify they are receiving credit. If the renewable energy system is generating more electricity than is being used in the building, the electric meter should be spinning in reverse. In most circumstances, the "old fashioned" meter with mechanical dials works fine. However, some newer electronic meters have trouble registering electricity flow in reverse. PV installers should know if there would be a problem with the meter.

Appendix: National, Regional, and State PV Programs, Incentives, and Contacts

National PV Programs

Borrower's Guide to Financing Solar Energy Systems

www.millionsolarroofs.org/financing_otherresources

Provides information for lenders and consumers about nationwide financing programs for photovoltaic systems and solar thermal systems that heat indoor air and water. In addition to traditional sources for home mortgage funds, eight federal government organizations—Fannie Mae, Freddie Mac, U.S. Department of Agriculture, U.S Department of Energy, U.S. Department of Housing and Urban Development, U.S. Department of Veterans Affairs, U.S. Environmental Protection Agency and U.S. Small Business Administration offer programs for financing solar energy systems and other energy efficiency improvements.

Database of State Incentives

www.dsireusa.org

Database of State Incentives for Renewable Energy (DSIRE), is a comprehensive source of information on the status of programs and incentives that promote renewable energy. The database tracks information on financial incentives, regulatory policies and awareness and investment programs. DSIRE is an ongoing project of the Interstate Renewable Energy Council (IREC), funded by the U.S. Department of Energy's Office of Power Technologies and managed by the North Carolina Solar Center.

For more information, contact:
North Carolina Solar Center
Box 7401
North Carolina State University
Raleigh, NC 27695-7401
919-515-5666
ncsun@ncsu.edu

U.S. Department of Energy's Million Solar Roofs Program

www.millionsolarroofs.org

The Million Solar Roofs Initiative (MSRI) is enabling businesses and communities to install solar systems on one million rooftops across the United States by 2010. The U.S. Department of Energy is leading this initiative by working with partners in the building industry, local governments, state agencies, the solar industry, electric service providers and non-governmental organizations to remove barriers and strengthen the demand for solar technologies.

For more information, contact:
Chicago Regional Office (IL, IN, IA, MI, MN, MO, OH, WI)
Bill Hui
One South Wacker Drive, Suite 2380
Chicago, IL 60606-4616
312-886-8586
William.Hui@ee.doe.gov

Interstate Renewable Energy Council

www.irecusa.org

The Interstate Renewable Energy Council's (IREC) mission is to accelerate the sustainable use of renewable energy in and through state, local government, and community activities.

IREC supports market-oriented services targeted at education, coordination, procurement, the adoption and implementation of uniform guidelines and standards, and consumer protection. IREC was formed in 1980 as a non-profit organization. IREC's members include state energy offices, city energy offices, other municipal and state agencies, national laboratories, solar and renewable organizations and companies, and individual members. IREC works with many partners including the federal government, national environmental and municipal organizations, regulatory commissions, state-appointed consumer representatives, energy service providers, utility groups, universities, and research institutes. IREC focuses on some of the current and often difficult issues impacting expanded renewable energy use such as rules that support renewable energy and distributed resources in a restructured market, connecting small-scale renewables to the utility grid, developing quality credentials that indicate a level of knowledge and skills competency for renewable energy professionals, and getting the right information to the right people.

For more information, contact:
IREC
P.O. Box 1156
Latham, NY 12110-1156
518-458-6059 (phone and fax)
info@irecusa.org

National Renewable Energy Laborator y

www.nrel.gov/clean_energy/photovoltaic.html

The National Renewable Energy Laboratory's (NREL) mission is to develop renewable energy and energy efficiency technologies and practices, advance related science and engineering and transfer knowledge and innovations to address the nation's energy and environmental goals. Almost 50 areas of scientific investigation include basic energy research, photovoltaics, wind energy, building technologies, advanced vehicle technologies, solar thermal electric, hydrogen, superconductivity, geothermal power, and distributed energy resources.

National Center for Photovoltaics

www.nrel.gov/ncpv

The Center's mission is to mobilize national (U.S.) resources in photovoltaics by performing world-class research and development, promoting partnering and growth opportunities, and serving as a forum and information source for the photovoltaics community. The Center is headquartered at the National Renewable Energy Laboratory in Golden, Colorado, but it is located wherever its members do business.

The Center also helps people come together to work with its researchers and one another to find ways to expand PV applications. The Center brings people together through conferences and forums to share information and concerns and the Center provides various forms of information for people with a wide range of needs.

For more information, contact:
National Renewable Energy Laboratory
1617 Cole Blvd
Golden, CO 80401-3393
303-275-3000

Sandia National Laboratories Renewable Energy Technologies Office

www.sandia.gov/pv

The purpose of Sandia's Photovoltaics Program is to develop commercially viable energy technologies based on solar, wind and geothermal resources that become significant domestic and international energy supplies, with a primary focus on the utility sector.

Sandia's Photovoltaic Program seeks to lower the cost, increase the reliability and improve the performance of photovoltaic systems. These goals can be achieved through focused research and systems development, integrated with the needs of manufacturers and users. Specific program objectives include reducing the life cycle cost of PV systems, reducing barriers to systems acceptance, providing systems engineering best practices and guidelines, and leading the national effort in performance and reliability testing, standardization, and validation.

For more information, contact:
Sandia National Laboratories, New Mexico
PO Box 5800
Albuquerque, NM 87185

or

Sandia National Laboratories, California
PO Box 969
Livermore, CA 94551

Solar Electric Power Association

www.solarelectricpower.org

The Solar Electric Power Association (SEPA), formerly the Utility Photovoltaic Utility Group, is a nonprofit association of nearly 100 energy service providers (electric utilities and energy service companies) dedicated to accelerating the use of photovoltaics for the benefit of electric utilities and their customers so that photovoltaics become a sustainable energy option and a thriving domestic industry. SEPA, with funding support from DOE, is led and managed by the market itself—the potential utility buyers of solar photovoltaic systems. SEPA programs are increasing the experience of electric utilities and their customers with photovoltaics and are stimulating growth in the demand for solar power.

Midwest PV Programs

Regional Chapters of the American Solar Energy Society

www.ases.org

The American Solar Energy Society (ASES) is a national organization dedicated to advancing the use of solar energy for the benefit of U.S. citizens and the global environment. ASES promotes the widespread use of solar energy. ASES sponsors the National Solar Energy Conference and Issue Roundtables, publishes "Solar Today" magazine, distributes solar publications, organizes a Solar Action Network, and has regional chapters throughout the country. The following is a list of Midwest ASES chapters:

- ***Heartland Renewable Energy Society (KS, MO)***
  www.heartland-res.org
  12 NW 38th Street
  Kansas City, MO 64116
  816-454-6321
  d.pratt@planetkc.com

- ***Illinois Solar Energy Association***
  www.anet-chi.com/~ISEA
  1264 Harvest Court
  Naperville, IL 60564
  630-420-1118
  casazeus2@aol.com

- ***Minnesota Renewable Energy Society***
  www.freenet.msp.mn.us/org/mres
  c/o IPS, Inc.
  1153 16th Avenue, SE
  Minneapolis, MN 55414
  651-647-0070

Environmental Law and Policy Center

www.elpc.org

The Environmental Law and Policy Center (ELPC) is a Midwest public interest environmental advocacy organization working to achieve cleaner energy resources and implement sustainable energy strategies, promote innovative and efficient transportation and land use approaches that produce cleaner air and more jobs, and develop sound environmental management practices that conserve natural resources and improve the quality of life in communities. One of ELPC's premises is that environmental progress and economic development can be achieved together.

For more information, contact:
Environmental Law and Policy Center
35 East Wacker Drive #1300
Chicago, IL 60601 USA
312-673-6500

Midwest Renewable Energy Association

www.the-mrea.org

Founded in 1990, the Midwest Renewable Energy Association (MREA) is a network for sharing ideas, resources and information to promote a sustainable future through renewable energy and energy efficiency. In 1996, MREA became a chapter of the American Solar Energy Society. The MREA currently has more than 2,018 active members from around the world representing 40 states and four foreign countries.

For more information, contact:
Midwest Renewable Energy Association
7558 Deer Road
Custer, WI 54423
715-592-6595
info@the-mrea.org

Regional Chapters of the Solar Energy Industries Association

www.seia.org

The Solar Energy Industries Association (SEIA) is the national trade association of solar energy manufacturers, dealers, distributors, contractors, and installers. SEIA's primary mission is to expand the use of solar technologies in the global marketplace. National members, combined with chapter members in 22 states, exceed 500 companies providing solar thermal and solar electric products and services. The following is a list of Midwest SEIA chapters:

- ***Great Lakes SEIA (IL, IN, MI, MN, OH, WI)***
  c/o Solar Works in Michigan
  P.O. Box 414
  Tustin, MI 49688-0414
  616-636-4995
  solarworks@wingsisp.com

- ***Heartland SEIA (IA, KS, MO, NE)***
  www.solarguide.com
  13700 West 108th Street
  Lenexa, KS 66215
  913-338-1939
  solarbeacon@msn.com

- ***WisconSUN***
  www.wisconsun.org

  WisconSUN promotes solar energy projects by marketing, reducing barriers and helping participants. WisconSUN supports projects during planning, design and installation. They also provide the information, training and project manage ment assistance needed to implement these systems successfully.

  For more information, contact:
  WisconSUN
  7507 Hubbard Ave., Suite 200
  Middleton, WI 53562
  608-831-1127 x308

State PV Programs

The following is a list of programs, contacts and incentives specific to each Midwest state in this guide. For a more complete list, please visit the "Database of State Incentives for Renewable Energy (DSIRE)," a comprehensive source of information on the status of programs and incentives that promote renewable energy. The database tracks information on financial incentives, regulatory policies and awareness and investment programs and is accessible online at *www.dsire.org*. DSIRE is an ongoing project of the Interstate Renewable Energy Council (IREC), funded by the U.S. Department of Energy's Office of Power Technologies and managed by the North Carolina Solar Center.

Illinois

Financial Incentives and Programs

Property Tax Special Assessment for Renewable Energy Systems

This statute allows for a special assessment of solar energy systems for property tax purposes. Eligible equipment includes active and passive systems, as well as wind and geothermal systems. Contact the Illinois Department of Commerce and Community Affairs for more information.

Alternative Energy Bond Fund Program

This grant program funds capital projects of any renewable energy technology up to 100 percent of the total project cost. Grants range from $60,000 to $1,000,000, and current appropriations for the program are $5 million. Note that this fund is not available for residential projects. The Bureau of Energy and Recycling under the Illinois Department of Commerce and Community Affairs administers the program.

Renewable Energy Resources Program Grants and Rebates

The Renewable Energy Resources Program (RERP) fosters investment in and the development and use of renewable energy resources within the state of Illinois. RERP distributes funds in the form of grants (for large systems) and rebates (for small systems). Grant funds may only be used for actual equipment and installation expenses. Eligible applicants include associations, individuals, private companies, public and private schools, colleges and universities, non-profit organizations, and units of state and local government. Applications are accepted on an ongoing basis. Contact the Illinois Department of Commerce and Community Affairs for more information.

Net Metering

In April 2000, Commonwealth Edison (ComEd), the investor-owned utility serving the city of Chicago and surrounding areas, established a special billing program that allows for net metering of photovoltaic and wind energy systems up to 40 kW. The program is available to all customer classes in the ComEd service area, with the total installed generating capacity not to exceed 0.1 percent of the utility's annual peak demand.

ComEd will pay the customer, on a monthly basis, the utility's avoided costs for any net excess generation. In addition, as an incentive for customers to participate in the program, ComEd will make an annual payment for the customer's total excess power put back into ComEd's system during the year (up to the amount of power the customer took from ComEd during the year). Customers will be paid at a rate representing the difference between the average avoided cost paid to the customer and the average retail rate paid by the customer during the year. Visit ComEd's Web site at *www.ucm.com/comed* for more information, or contact:

Exelon Corporation
ComEd Energy
ESO Tech.Services, 2nd Fl (02-NE-025)
Three Lincoln Centre
Oakbrook Terrace, IL 60181-4260
630-576-6783

Interconnection

Illinois has not enacted any statewide requirements for interconnection of renewable energy systems, other than standards established under the federal PURPA law. Commonwealth Edison's net metering agreement specifies that generating facilities must use an inverter listed per UL 1741. It also requires systems over 25 kilowatts to be inspected and tested by ComEd to its satisfaction. Commonwealth Edison has developed a relatively simple, user-friendly, five-page interconnection agreement for customers participating in its net metering program. Contact ComEd (see above address) for more information.

Illinois Contacts

Illinois Department of Commerce and Community Affairs Bureau of Energy and Recycling

www.commerce.state.il.us/com/energy/index.html

The Renewable Energy Resources Program is administered through the Illinois Department of Commerce and Community Affairs' (DCCA) Bureau of Energy and Recycling. The Renewable Energy Resources program fosters investment in and the development and use of renewable energy resources within the state of Illinois. This program provides rebate and grant funding for projects that increase the use of alternative energy technologies in Illinois.

For more information, contact:
Illinois Department of Commerce and Community Affairs
Bureau of Energy and Recycling
620 East Adams Street
Springfield, Illinois 62701
217-557-1925

Illinois Commerce Commission

www.icc.state.il.us

The Illinois Commerce Commission is the state's Public Utility Commission. In an age of diminishing economic regulation, the agency still holds authority in the public

interest to oversee several financial and service aspects of investor-owned electric, gas, telephone, water, and sewer utilities.

For more information, contact:
IL Commerce Commission
527 E.Capitol Avenue
Springfield, IL 62701
800-524-0795

Illinois Renewable Energy Association
www.illinoisrenew.org

The Illinois Renewable Energy Association's (IREA) mission is to be a network for sharing ideas, resources and information with individuals, businesses and communities to promote a resilient future through renewable energy, energy efficiency, and earth-friendly technology.

For more information, contact:
Illinois Renewable Energy Association
1230 E.Honey Creek Road
Oregon, IL 61061
815-732-7332

Iowa

Financial Incentives and Programs

Iowa Property Tax Exemption for Solar Systems
According to Iowa Code, Chapter 441.21, when assessing property for tax purposes, assessors shall disregard any market value added by a solar energy system to a building for the first five full assessment years. Solar energy systems are defined as follows: any system capable of collecting and converting solar radiation into thermal, mechanical or electric energy, or a system that utilizes the basic building design to maximize solar heat gain in the cold season and minimize solar heat gain in the hot season. For more information, contact the Iowa Department of Natural Resources Energy and Waste Management Bureau.

Iowa Energy Bank
www.state.ia.us/dnr/energy/programs/bem/ebank

The Iowa Energy Bank, an energy management program using energy cost savings to repay financing for energy management improvements, targets public and non-profit facilities (public schools, hospitals, private colleges, private schools, and local governments). The Iowa Energy Bank starts with an initial energy audit and helps manage the energy efficiency improvements and financing process every step of the way. Experts will customize solutions that meet the specific needs of an organization, with the assurance of high technical quality and the potential for attractive cost savings. Financing is provided through area lending institutions that create budget-neutral, affordable financial packages. For more information, contact the Iowa Department of Natural Resources Energy and Waste Management Bureau.

Solar Access Easement
Iowa's solar easement provisions allow property owners to create binding solar easements for the purpose of protecting and maintaining proper access to sunlight. For more information, contact the Iowa Department of Natural Resources Energy and Waste Management Bureau.

Alternate Energy Revolving Loan Program
www.energy.iastate.edu/about/grantloan/AERLP

The Alternate Energy Revolving Loan Program (AERLP) is administered by the Iowa Energy Center at Iowa State University and funded by the state's investor-owned utilities. The AERLP provides loans to any individual or organization that wants to build renewable energy production facilities in Iowa. Renewable energy includes technologies such as solar, biomass, wind, and hydro. Successful applicants receive a single, low-interest loan that consists of a combination of AERLP funds and lender-provided funds. The AERLP provides 50 percent of the total loan, up to a maximum of $250,000 at zero percent interest. The remainder of the loan is made by a lender at a negotiated interest rate. The maximum loan term allowed for the AERLP funds is 20 years. The borrower does not need to be an Iowa citizen but the alternate energy production facility (AEPF) must be physically located in Iowa. For more information, contact the Iowa Energy Center.

Net Metering
Created by the Iowa Utilities Board in 1983, Iowa's net metering rule allows customers with alternative energy generation systems to sell electricity to their investor-owned utilities on a netted basis against their metered retail use. The rule applies to all customer classes and requires that customers' net excess generation be purchased by the utilities at their avoided cost. For more information on Iowa's net metering rules, contact the Iowa Utilities Board.

Interconnection
Under Chapter 15.4(2) of the Iowa Administrative Code, electric utilities are required to interconnect with any qualifying facility as necessary. Contact the Iowa Utilities Board for more information.

Iowa Contacts

Iowa Department of Natural Resources Energy and Waste Management Bureau
www.state.ia.us/dnr/energy

The Energy and Waste Management Bureau is the state of Iowa's core agency for creating policies and programs that decrease its reliance on imported fossil fuels. This goal is accomplished by promoting energy efficiency and the use of renewable energy resources. Through a wide array of educational, financial and marketing programs, the Bureau is working to leverage new opportunities that save money, increase profits and improve the environment.

For more information, contact:
Iowa Department of Natural Resources
Energy and Waste Management Bureau
Wallace State Office Building
502 E 9th St
Des Moines, IA 50319-0034
515-281-5918

Iowa Utilities Board
www.state.ia.us/government/com/util

The Utilities Board regulates certain electric, natural gas, telephone and water utilities in Iowa. The most visible of the Board's activities are the approval of rate levels and review of service quality. Other important activities include the approval and monitoring of utility energy efficiency plans, administration of the Dual Party Relay System and intervention in federal regulatory cases affecting Iowa customers. The Board and staff directly assist customers by providing information and investigating complaints. Staff specialists perform audits, analyses and research,and advise the Board on pending cases. Staff also conduct continuing inspections of utilities' facilities for compliance with safety and service quality.

For more information, contact:
Iowa Utilities Board
350 Maple Street
Des Moines, IA 50319-0069
515-281-3839 or
877-565-4450

Iowa Energy Center
www.energy.iastate.edu

The Iowa Energy Center works to improve Iowa's economy and environment by helping Iowans use energy wisely. The Energy Center conducts and sponsors research regarding alternate energy and energy efficiency;educates with training, demonstrations, publications, Internet and speaking engagements; and offers low-cost financing through the Alternate Energy Revolving Loan Program that encourages construction of renewable energy projects in Iowa.

For more information, contact:
Iowa Energy Center
2521 Elwood Drive, Suite 124
Ames, IA 50010-8229
515-294-8819
iec@energy.iastate.edu

Iowa Renewable Energy Association
www.irenew.org

I-RENEW is a non-profit organization dedicated to promoting the use of renewable energy and energy conservation in Iowa. I-RENEW sponsors practical educational activities designed to reach individuals, farms, businesses, schools and utilities, while also encouraging retail opportunities. I-RENEW's educational and promotional activities include the "Iowa Sustainable Energy Sourcebook," a resource directory of individuals, businesses, researchers, organizations and suppliers in all fields of renewable energy;a quarterly newsletter offering renewables information and networking opportunities; and tours of renewable energy and energy efficiency sites in Iowa.

For more information, contact:
I-RENEW
P.O. Box 355
Muscatine, IA 52761-0355
563-288-2552
irenew@irenew.org

Minnesota

Financial Incentives and Programs

Wind and Photovoltaic Systems Exemption
This statute excludes from property taxation the value added by photovoltaic and certain wind energy systems. This statute applies to the residential, commercial, and utility sectors.

PV Sales Tax Exemption
Energy-efficient products, including photovoltaic panels, were exempted from the state sales tax as part of legislation signed by the Governor of Minnesota in July 2001. The exemption is effective for sales and purchases made after July 31, 2001, and before August 1, 2005. For more information on the Wind and Photovoltaic Systems Exemption, contact the Minnesota Department of Commerce State Energy Office.

PV Rebate Program
The Minnesota Department of Commerce will be administering a PV rebate program for commercial and residential sectors to buy down the upfront costs of grid-connected PV systems by $2,000/kW

(1-4 kW systems are eligible, based on the combined DC rating of panels). Rebates are initially available to any non-utilities and small businesses in Xcel Energy's service territory in 2002, any non-utility in Xcel Energy's Service Territory in 2003 and any non-utility in Minnesota in 2004 and 2005, funding permitting. For more information on the PV Rebate Program, contact the Minnesota Department of Commerce State Energy Office.

Solar and Wind Easements

Minnesota statutes provide for the creation of easements for solar and wind energy devices. As in many other states, these easements are voluntary contracts. The statute also notes that for tax purposes, an easement imposed on a property may decrease the property value, but an easement that benefits a property may not add value to that property.

Minnesota statutes also allow local zoning boards to restrict development for the purposes of protecting access to sunlight. Subdivisions may create variances in zoning rules in situations where undue hardships—such as lack of access to sunlight for solar energy devices—impinge on a particular property. Contact the Minnesota Department of Commerce Energy Division for more information.

Net Metering

For net metered photovoltaic systems under 40 kW in size, all Minnesota utilities use a two-page standard contract in addition to a set of interconnection requirements, both of which are available from your local utility.

Interconnection

As part of the 2001 Omnibus Energy Bill, the Minnesota legislature required the state's Public Utility Commission (PUC) to develop standards for interconnection and operation of distributed generation facilities (renewables and natural gas-fueled), up to 10 megawatts of capacity. Each utility is required to file distributed generation tariffs consistent with the standards established by the PUC, as well as maintain records and file reports annually regarding applications for interconnection of distributed generation.

Xcel, the state's largest investor-owned utility, has established "Interconnection Guidelines for Parallel Operation of Distribution Connected Customer-Owned Generation" with a three-page preliminary application form and a five-page final application form.

Until other utilities tariffs are filed and approved, however, renewable energy system owners in those service areas are likely to be subject to a utility's existing interconnection requirements for "qualifying facilities" under the federal PURPA law. For more information, contact Minnesota's Public Utilities Commission.

Minnesota Contacts

Minnesota Department of Commerce State Energy Office

www.commerce.state.mn.us/pa ges/Energy/MainModTech.htm

Major efforts are to ensure reliable energy supplies, maximize the benefits of energy efficiency and develop Minnesota's renewable energy technologies.

For more information, contact:
Minnesota Department of Commerce
State Energy Office
85 7th Place E, Suite 500
St. Paul, MN 55101-2198
651-296-5175
energy.info@state.mn.us

Minnesota Public Utilities Commission

www.puc.state.mn.us

The Minnesota Public Utilities Commission (PUC) regulates electric, natural gas and telephone service. The Commission ensures that utilities provide safe, adequate, reliable service at fair, reasonable rates.

For more information, contact:
Minnesota Public Utilities Commission
121 7th Place E.Suite 350
St. Paul, MN 55101-2147
651-296-0406
consumer.puc@state.mn.us

Minnesotans for an Energy Efficient Economy

www.me3.org

Minnesotans for an Energy-Efficient Economy (ME3) is a non-profit organization leading the transition to a clean, efficient and fair energy system. ME3 uses a combination of strategies to ensure significant and sustained progress toward a clean energy future. First, ME3 is working for a phased-in adoption of clean energy technologies and the retirement of the inefficient, dirty technologies of the past. Second, ME3 encourages behavior changes that support clean technologies and the efficient use of energy resources. Third, ME3 pushes for policy reforms to change the economic factors that drive energy decisions and investments. Throughout their work, ME3 acts to empower citizens to influence decisions on energy and the environment.

For more information, contact:
Minnesotans for an Energy-Efficient Economy
Minnesota Building, Suite 600
46 East Fourth Street
St. Paul, MN 55101
651-225-0878
info@me3.org

Missouri

Financial Incentives and Programs

Energy Loan Program
This statute-based loan program is administered by the Energy Center of Missouri under the Department of Natural Resources. Loans are available for energy efficiency and renewable energy projects for public schools (K–12) and local governments. In the future, the next sectors to be targeted for assistance include private schools and hospitals. The loans are provided at a fixed interest rate below the market rate and repayment schedules are determined on an individual project basis. For more information, contact the Missouri Department of Natural Resources Energy Center.

Solar Easement
Allows property owners to create binding solar easements for the purpose of protecting and maintaining proper access to sunlight. For more information, contact the Missouri Department of Natural Resources Energy Center.

Net Metering
Missouri does not have net metering legislation at this time.

Interconnection
No interconnection guidelines are available at this time.

Missouri Contacts

Missouri Department of Natural Resources Energy Center
www.dnr.state.mo.us/de

The Missouri Department of Natural Resources Energy Center is a non-regulatory state agency that works to protect the environment and stimulate the economy through energy efficiency and renewable energy resources and technologies.

For more information, contact:
Missouri Department of Natural Resources Energy Center
P.O. Box 176
Jefferson City, MO 65102-0176
573-751-4000
energy@mail.dnr.state.mo.us

Missouri Public Service Commission
www.psc.state.mo.us

For information regarding electric rates, contact the Missouri Public Service Commission at:
Public Information Office
Governor Office Building
200 Madison Street
PO Box 360
Jefferson City, MO 65102-0360
573-751-3234
800-392-4211
pscinfo@mail.state.mo.us

Nebraska

Financial Incentives and Programs

Low Interest Loan Program for Energy Efficiency
This program makes available low-interest loans for residential and commercial energy efficiency improvements using photovoltaic technology. The Nebraska Energy Office administers this program, which was created in 1990 using oil overcharge funds.

Those seeking a loan under this program first approach their own financial institution, which approves the project on financial terms, before contacting the State Energy Office for its approval. The State Energy Office then buys half of the loan at zero percent interest so that the total interest on the loan "from the borrower's perspective"will be half the market rate obtained through their private lending institution. For more information, contact the Nebraska State Energy Office.

Solar and Wind Easements
Nebraska's solar easement provisions allow property owners to create binding solar easements for the purpose of protecting and maintaining proper access to sunlight. Nebraska's solar access laws were updated in March 1997 to include wind. Contact the Nebraska State Energy Office for more information.

Net Metering
Nebraska is in the process of developing net metering laws.

Interconnection
Interconnection guidelines are not available at this time.

Nebraska Contacts

Nebraska State Energy Office
www.nol.org/home/NEO

The mission of the Nebraska Energy Office is to promote the efficient, economic and environmentally responsible use of energy.

For more information, contact:
Nebraska Energy Office

P.O. Box 95085
1111 "O" Street, Suite 223
Lincoln, NE 68509-5085
402-471-2867
energy@mail.state.ne.us

Nebraska Public Service Commission
www.state.ne.us/home/NPSC

The Nebraska Public Service Commission (PSC) is responsible for regulating telecommunications companies, grain warehouses and dealers, private water companies, taxicab and limousine operators, intrastate trucking companies, the placement of certain electric transmission lines, railroads, manufactured homes, recreational vehicles and modular homes.

For more information, contact:
Nebraska Public Services Commission
P.O. Box 94927
Lincoln, NE 68509-4927
402-471-3101
800-526-0017

Wisconsin

Financial Incentives and Programs

Solar and Wind Energy Equipment Exemption
This statute exempts taxpayers from any value added by a qualified renewable energy system for property tax purposes. This exemption is available for all sectors and covers the total value of the systems, without a size limit. For more information, contact the Wisconsin Division of Energy. The relevant state statute is 70.111.

Wisconsin Municipal Utility Solar Energy Cash Allowance
Some of Wisconsin's municipal utilities support residential and commercial customers' use of solar energy by providing cash incentives for qualifying projects. The solar incentives vary from community to community but may include up to $1/watt installed for PV systems (maximum incentive of $1,000). Contact your local municipal utility to determine if the program is available in your area.

Public Benefits Fund
The Wisconsin public benefits fund provides funds for the state to award grants for low-income programs and energy efficiency and renewable energy services. Criteria that have been established for the grants include: targeting energy conservation services that are the least competitive in the market; promoting environmental protection, electric system reliability, rural economic development;encouraging customer-owned renewable systems; and promoting customer education about renewable energy.

Renewable energy sources are eligible and applicable sectors include commercial, industrial, residential, general public, and utilities. For more information, contact the Wisconsin Division of Energy.

Solar Easement and Solar Siting Protection
Wisconsin statute 66.0403 allows property owners with wind or solar energy systems to apply for permits that will guarantee unobstructed access to solar and wind resources. Permits may not be granted in the case where an obstruction already exists or if the construction of such an obstruction is well into the planning stages. Statute 66.0401 restricts local jurisdictions' siting considerations or conditions placed on siting for wind or solar systems to matters of public health and safety. Contact the Public Service Commission of Wisconsin for more information.

Net Metering
In 1993, the Public Service Commission of Wisconsin authorized net metering for customer-owned systems of 20 kW and below. Net metering is available only to customers of investor-owned utilities. All technologies—not just renewables and cogeneration units—are eligible. If a customer-generator operates a renewable energy facility, then the utility pays the retail rate for net excess generation; for non-renewable generation sources, the utility pays their avoided cost for net excess generation. Contact the Public Service Commission of Wisconsin for more information.

Interconnection
Wisconsin Administrative Code § 113.0207, "Requirements for utility rules for interconnection of small customer-owned generation facilities with the utility system," has been effective since October 1,1982. The Public Service Commission has opened a docket to rewrite the rules. Changes are being proposed regarding technical and legal issues and the amount of liability insurance that is required of a renewable energy system owner. The latest draft is available at *www.wisconsindr.org*. For more information, contact the Public Service Commission.

Wisconsin Contacts

Wisconsin Department of Administration Division of Energy
www.doa.state.wi.us/depb/boe

The Division of Energy advises the governor and legislature on policies and programs for state and regional energy management,

administers federal energy efficiency funds and develops and coordinates emergency energy policies and programs. Analysts maintain up-to-date information on availability, use, prices, and regulatory issues for oil, gas, coal, renewable energy resources, and energy efficiency techniques. The Division of Energy also houses the state Energy Information Clearinghouse which responds to public requests for information.

For more information, contact:
Wisconsin Division of Energy
101 East Wilson Street, 6th Floor
P.O. Box 7868
Madison, WI 53707-7868
608-266-8234
energy@doa.state.wi.us

Public Service Commission of Wisconsin

www.psc.wi.gov

The Public Service Commission of Wisconsin is an independent regulatory agency dedicated to serving the public interest. The agency is responsible for the regulation of Wisconsin public utilities, including those that are municipally owned.

For more information, contact:
Public Service Commission of Wisconsin
610 North Whitney Way
P.O. Box 7854
Madison, WI 53707-7854
608-267-2896

Energy Center of Wisconsin

www.ecw.org

The Energy Center of Wisconsin is a private, non-profit organization dedicated to improving energy efficiency in Wisconsin. The organization provides energy-efficiency programs, research and education to residents, businesses, industry and government.

For more information, contact:
ECW
595 Science Drive
Madison, WI 53711-1076
608-238-4601
ecw@ecw.org

RENEW Wisconsin

www.renewwisconsin.org

RENEW Wisconsin, a non-profit organization headquartered in Madison, promotes clean energy strategies for powering the state's economy in an environmentally responsible manner.

For more information, contact:
RENEW Wisconsin
222 South Hamilton Street
Madison, WI 53703
608-255-4044
mvickerman@renewwisconsin.org

Wisconsin Energy Conservation Corporation

www.weccusa.org/renewables

One of the current programs for the Wisconsin Energy Conservation Corporation (WEC), Wisconsin Focus on Energy, has created a Renewable Energy Program to be a one-stop resource for Wisconsin residents and businesses. People can learn about the different renewable energy sources and decide which is right for their home or business, register for education and training opportunities around the state, obtain technical and project assistance from renewable energy experts who can share decades of practical experience, and apply for funding opportunities such as installation cash-back rewards, demonstration grants, and technical assistance grants.

For more information, contact:
WECC
211 S. Paterson Street, 3rd Floor
Madison, WI 53703
608-249-9322

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.

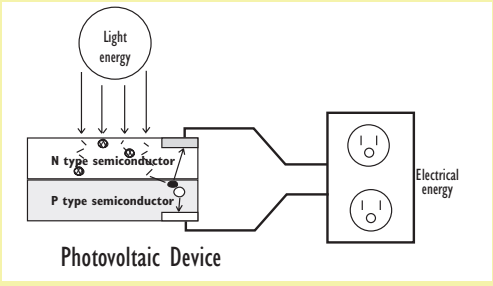
Depending on the solar resource availability and the home's electric energy consumption, a small solar electric system can lower electricity bills by 50 to 90 percent, prevent power interruptions and avoid the high costs of extending utility power lines to remote locations.

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

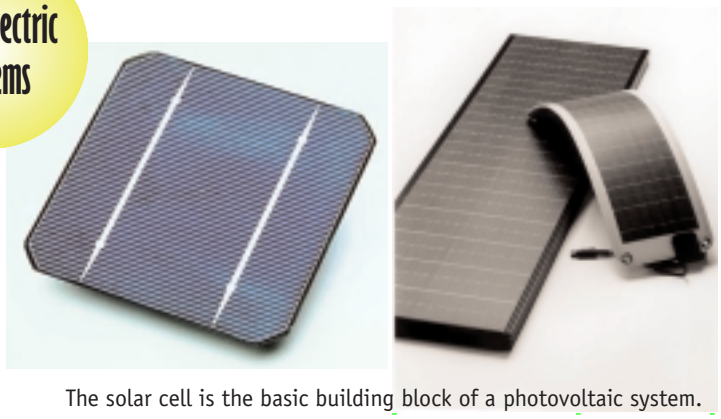
Increase solar energy usage by increasing energy efficiency

The amount of solar energy a home uses is determined more by the amount of electricity that is consumed rather than what is generated.

Pictured are two homes that use similar solar electric systems, both rated at 2.85 kilowatts, installed for $18,000 in 1996 under Xcel Energy's (then Northern States Power Company) Solar Advantage Program. The energy-efficient home receives about 71 percent of its energy from solar resources, compared to 38 percent for the average home.

The solar electric system for this home in Minnetonka, Minn., produced 2967 kilowatt-hours in 2001, meeting 71 percent of the home's electrical usage that year of 4192 kilowatt-hours. This energy-efficient home consumes about 50 percent less energy than the average home.

The solar electric system in this home in White Bear Lake, Minn., produced 2719 kilowatt hours in 2001, meeting 38 percent of the home's electrical usage that year of 7204 kilowatt-hours. The home is about average for electrical consumption.



The solar cell is the basic building block of a photovoltaic system. Individual cells can vary in size from about 1 cm (1/2 inch) to about 10 cm (4 inches) across. Although rigid panels (left) are more popular, flexible solar panels (right) offer the benefits of being lightweight, easily transportable, and they can be applied to smooth, curved surfaces. A potential drawback is that they have a lower output per square meter of surface area.

Start by increasing energy efficiency

Before choosing a solar electric system, reduce the home or business's energy consumption by increasing energy efficiency. Because energy efficiency is less expensive than energy production, increasing energy efficiency is more cost effective and will reduce the size and cost of the solar electric system that is needed. For example, replacing an older non-Energy Star refrigerator (pre-2001, when new efficiency standards were enacted) might cost $600, while trying to generate the electricity with a solar system may cost $2,000. Low power consumption always enhances a solar electric system's performance and investment.

To achieve maximum energy efficiency, take a whole-building approach. View the home or business as an energy system with interrelated parts, all of which work together to contribute to the efficiency of the system. From the insulation in the walls to the light bulbs in the fixtures, there are many ways to make a home or business more energy efficient:

- Reduce overall heating and cooling needs by up to 30 percent by investing just a few hundred dollars in proper insulation, caulking and weather-stripping products. See the Home Energy Guides "Home Insulation" and "Caulking and Weather-stripping."
- Save money and increase comfort by upgrading the heating, ventilation, and air-conditioning systems. Many new furnaces use only 20 percent of the electricity that standard furnaces use, especially those with variable-speed furnace fan motors, so shop wisely. See the Home Energy Guide "Home Heating."
- Replace the refrigerator and freezer with high efficiency models. Current refrigerator models

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

that are planned or trees that have not reached their full height. The system collectors need to be sited beyond all possible shadows of buildings and trees. Shadows at any time dramatically reduce the performance of solar electric systems and must be avoided to achieve good performance.

Whether the system is stand-alone or grid-connected, the length of the wire run between the system and the load (house, batteries, water pumps, etc.) needs to be taken into consideration. A substantial amount of electricity can be lost as a result of the wire resistance—the longer the wire run, the more electricity is lost. A larger wire reduces these losses but costs more; however, the closer the system to the building, the less this issue needs to be considered. Wire run losses are greater when using direct current (DC) instead of alternating current (AC). So, with a long wire run, it is advisable to consider converting DC to AC.

Select the proper size

The size of the solar electric system needed depends on the application—whether the system will provide supplemental power, back-up power, or power for the entire home or business.

The average home in Minnesota uses about 8,037 kWh per year, or about 670 kWh per month. However, the average energy-efficient home uses much less energy; for example, a home with a high efficiency fuel and electrically efficient air handler plus a natural gas or propane hot water heater can easily use only 3500 kWh per year.

To meet 100 percent of the home's annual energy demand of 8,037 kWh per year, an 8 kW solar electric system would be needed. A 1 kW system can provide about 1000 kWh annually, more or less depending on a specific site. The roof of a typical home can support a 2 to 3 kW solar electric system, so additional sites on the ground would be required. And this system would need to be kept free of snow for good year-round production.

The manufacturer will note the expected annual energy out-put of the system as a function of annual average solar energy available. Also check for the maximum electricity output that the system is designed to operate safely. Systems, including batteries, should have automatic overcharging components to prevent overcharging of batteries.

Solar electric systems used in residential applications can range in size from a few hundred watts to 10 kW depending on the desired amount of electricity. If the solar electric system is to supply energy for the whole house, establish an energy budget to help define the size of system that is needed. Solar electric system dealers can help size the system based on the home's electricity needs (see DOC brochure and list).

Small systems range in size from 20 watts to 1 kilowatt. The smaller (20-500 watt) systems are commonly used in a variety of applications such as charging batteries for recreational vehicles and sailboats as well as supplying power to remote cabins and lighting systems.

Smaller systems can also meet ongoing needs such as pumping water. Farmers and ranchers find that solar electric water pumps as well as solar electric fence systems are versatile tools for farm operations. Solar-electric pumping systems can be connected to the pump motor with an electric cable, permitting flexible installations.

Basic parts of a small solar electric system

Home solar electric systems are generally comprised of a collector or collectors, wiring, controllers, inverters and/or batteries and mounting brackets to optimize the exposure.

The solar electric panels need to be solidly mounted. Mounting racks must be engineered and installed to withstand the elements of wind, ice and snow. Panels can be mounted on the roof of a home, garage or shed or by themselves either on the ground or a pole.

Mounting solar electric systems on rooftops is one option, providing safe and easy access to adjust and service panels. Low angle roofs, such as the White Bear Lake installation mentioned earlier, might accumulate snow on the solar panels reducing electricity production by 2-3 percent annually. One can remove snow accumulation manually if this is considered a major issue.

Stationary mounted panels can also be adjustable, permitting solar electric panels to face the sun as near to perpendicular as possible. Many people adjust their panels two to four times a year, getting maximum exposure as the sun's path rises and falls over the passage of the seasons. The sun is much higher in the sky in the summer and lower in the winter. Solar panels mounted to the same angle as the location's latitude will produce the optimal annual electricity production without having to adjust these angles.

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. Tracking systems can improve solar electric output by up to 30 percent.

Parts required in addition to the solar panels will depend on the application of the system and whether the system is grid-connected, stand-alone, or part of a hybrid system. Most suppliers can provide an all-inclusive package.

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

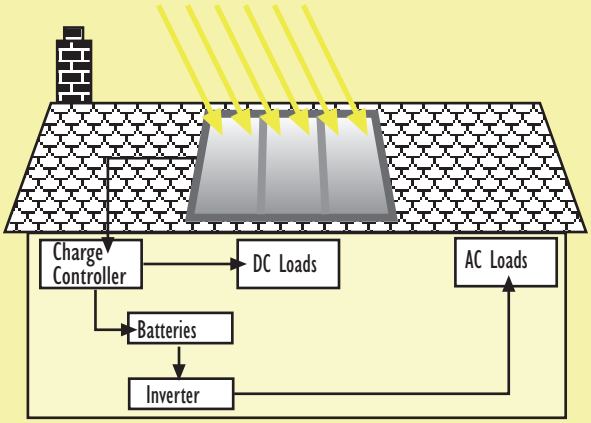
In grid-connected systems, the only additional equipment required is a power conditioning unit (inverter) and switching gear to disconnect the system from the grid in the event of a power outage. Batteries added to this configuration provide a power supply during power outage situations. Power conditioning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



PV equipment exempt from state sales tax

To help boost the development of renewable energy generation, a photovoltaic device is now exempt from Minnesota state sales tax.

A photovoltaic device is defined as a solid-state electrical device, such as a solar module, that converts light directly into direct current electricity of voltage-current characteristics that are a function of the characteristics of the light source and the materials in and design of the device.

A "solar module" is a photovoltaic device that produces a specified power output under defined test conditions, usually composed of groups of solar cells connected in series, in parallel, or in series-parallel combinations.

The tax exemption is in effect for purchases made after July 31, 2001, and before August 1, 2005. For more information, the statute citation is: Minnesota Session Laws 2001, 1st Special Session, Chapter 5, Article 12, Sec. 44.

Questions about sales tax payments should be directed to the Minnesota Department of Revenue, Sales & Use Tax Hotline, at (651) 296-6181 or 1-800-657-3777.

Rebate program reduces PV costs

In an effort to spark development of solar energy, the Minnesota Department of Commerce State Energy Office is administering a rebate program that could pay up to 25 percent of installation costs for a photovoltaic system.

The program provides a rebate of $2,000 per kilowatt for 1 to 4 kilowatts of grid-connected systems. Applications must be made before the installation begins, and rebates will be issued once installation is completed and inspected.

An example of how the program will reduce installation costs: A person who installs a 2kW system, an estimated cost of $20,000, would get a rebate of $4,000.

The rebate program is funded by Xcel Energy's Renewable Development Fund, one of the requirements stemming from the 1994 Prairie Island Nuclear Power Plant legislation. During the four-year program, approximately $1 million will be spent to install 400 kilowatts of grid-connected photovoltaic systems.

For more information on the rebate program, email the Energy Information Center at energy.info@state.mn.us or call 651-296-5175 or 1-800-657-3710. Information is also available on the web site at www.commerce.state.mn.us.

The cost of solar electric systems

Solar energy becomes more cost effective as the cost of electricity increases. Although smaller electric systems cost less in initial outlay, they are proportionally more expensive.

A small solar electric system can cost anywhere from $3,000 to $35,000 installed, depending on size, application and service agreements with the manufacturer. According to the American Solar Energy Association, the average cost for a typical home solar electric system is approximately $10 per watt (installed).

Although solar electric systems involve a significant initial investment, they can be competitive with conventional energy sources when considering a lifetime of reduced or avoided utility costs.

The length of the payback period—the time before the savings resulting from the system equals the cost of the system itself—depends on several factors including:

- the system selected,
- tax benefits or exemptions,
- potential rebates,
- production credits from the state and federal governments,
- electricity cost in the area, and
- how the solar electric system is used.

Things to consider when purchasing a solar electric system

As with any major purchase, shop comparatively for a solar electric system and get at least three bids. Review product literature from several manufacturers and read product reviews in trade magazines.

Narrow the field to a few companies and do more research to be sure they are recognized solar energy businesses and that parts and service will be available when needed. Ask for references of past customers with similar installations and contact the Better Business Bureau to check the company's integrity. Ask other system owners about performance, reliability, maintenance and repair requirements and whether the system is meeting their expectations. Also, find out the length of the warranty and what is included. The state electrical code requires that a solar electric system be inspected before activated.

For more information see the publication "Choosing a Renewable Energy Contractor," available from the Minnesota Department of Commerce Energy Information Center.

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

addressed. The utility's principal concern is that a customer's solar electric system automatically stops delivering any electricity to its power lines during a power outage. Otherwise, line workers and the public, thinking that the line is "dead," might not take normal precautions and might be hurt or even killed by the power supplied from a private electric system.

Another concern among utilities is that the power from a small solar electric system needs to synchronize properly with the utility grid and match the utility's own power in terms of voltage, frequency and power quality.

Interconnection Requirements

Most utilities and other electricity providers require customers with private energy systems to sign a formal agreement before allowing customers to interconnect to the utility grid. The terms and conditions in these agreements must be reviewed and approved by state regulatory authorities.

Insurance

In Minnesota, net metering rules allow utilities to require owners of renewable energy electric generation systems that are connected to the utility's grid to maintain $300,000 in liability insurance. This is generally found as part of a Homeowners Insurance Policy or may be added to that policy. An insurance agent or company can provide a statement of coverage to give to the utility. Utilities consider these requirements as necessary to protect them from liability for facilities they do not own and have no control over. In the 21 years since utilities have been required to allow small solar systems to interconnect with the grid there has never been a liability claim relating to electrical safety. Each utility decides whether to require insurance.

Indemnification

An indemnity is an agreement between two parties in which one party agrees to secure the other party against loss or damage arising from some act or some assumed responsibility. In the context of customer-owned generating facilities, utilities often want customers to indemnify them for any potential liability arising from the operation of the customer's generating facility.

Although the basic principle is sound—utilities should not be held responsible for property damage or personal injury attributable to someone else—indemnity provisions should not favor the utility but should be fair to both parties. Look for language that says, "each party shall indemnify the other . . ." rather than "the customers shall indemnify the utility . . ."

Utility customer charges

Customer charges can take a variety of forms, including interconnection charges, metering charges and standby charges, among others. Do not hesitate to question any charges that seem inappropriate. Federal law (Public Utility Regulatory Policies Act of 1978, or PURPA, Section 210) prohibits utilities from assessing discriminatory charges to customers who have their own generation facilities.

Hybrid Systems

Hybrid wind and solar energy systems can provide reliable off-grid power for homes, farms or even entire communities (a co-housing project, for example) that are located far from the nearest utility lines. According to many renewable energy experts, a "hybrid" system that combines wind and solar electric technologies offers several advantages over either system alone.

In Minnesota, wind speeds are low in the summer when the sun shines brightest and longest. Conversely, the wind is strong in the winter when there is less sunlight available. Because the peak operating times for wind and solar electric systems occur at different times of the day and year, hybrid systems are more likely to continually produce power when needed.

When neither the wind turbine nor the solar modules are producing electricity, most hybrid systems provide power through batteries and/or a small auxiliary backup engine-generator powered by conventional fuels, such as gasoline, diesel or even biodiesel. If the batteries run low, the engine-generator can provide power and recharge the batteries.

Adding an engine-generator makes the system more complex, but modern electronic controllers can operate these systems automatically. An engine-generator can also reduce the size of the other components needed for the system. Keep in mind that storage capacity must be large enough to supply electrical needs during non-charging periods. Battery banks are typically sized to supply the electric load for three to four days without sun, wind or recharging.

An off-grid hybrid system may be practical if:

- the location has an average annual wind speed of at least 9-mph (4.0 m/s),
- the location has unobstructed sunlight,
- a grid connection is not available or can only be made through an expensive extension; the cost of running a power line to a remote site to connect with the utility grid can be prohibitive, ranging from $15,000 to more than $50,000 per mile,

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 .

For More Information

Books

The Solar Electric House: A Design Manual for Home-Scale Photovoltaic Power Systems This book helps homeowners decide if photovoltaics are for them, how to choose the right system and determine if they want to install it themselves. By Steven J. Strong with William G. Scheller, Sustainability Press, 1987 (revised 1991), 276 pages, $21.95, ISBN 0-9637383-2-1.

Solar Electric Independent Home Meant to educate and spread the use of PV, this book was written specifically for the PV homeowner or the potential PV homeowner. Chapters on system sizing, appliances, home wiring, system installation, lighting protection and the National Electrical Code, explain how to use a PV system for greatest efficiency. By Paul Jeffrey Fowler, revised 1993, 200 pages, 25 photos, 75 CAD diagrams, $16.95, ISBN 1-879523-01-9.

The New Independent Home: People and Houses that Harvest the Sun, Wind and Water The Independent Home has become a best seller. Profiles solar homesteaders whose experiments and innovations have opened the possibility of solar living for the rest of us. By Michael Potts, Chelsea Green Publishing, 1993 (revised 2000) 416 pages, illus., color photos, $30.

Government Agencies

The Energy Information Center at the Minnesota Department of Commerce State Energy Office provides energy efficiency and renewable energy information to consumers. The Home Energy Guide series offers simple but detailed information about improving energy efficiency in the home. Many publications are available about renewable energy resources. Experts are also available to answer individual questions by phone or email. For more information visit the Department of Commerce web page at: www.commerce.state.mn.us, e-mail at: energy.info@state.mn.us, or call: 651-296-5175 or 1-800-657-3710 (Minnesota only).

Energy Savers Tips on Saving Energy and Money at Home A homeowner's guide for saving energy and reducing utility bills. Available free from U.S. Department of Energy's Energy Efficiency and Renewable Energy Clearinghouse (EREC), P.O. Box 3048, Merrifield, VA 22116. Phone: (800) 363-3732. Web site: http://www.eren.doe.gov/consumerinfo/energy_savers.

Energy Efficiency and Renewable Energy Clearinghouse P.O. Box 3048, Merrifield, VA 22116. Phone: 1-800-DOE-EREC (363-3732). Web site: http://www/eren.doe.gov.

National Climatic Data Center Federal Building 151 Patton Avenue, Asheville, NC, 28801-5001. Phone: (828) 271-4800. Web site: http://www.ncdc.noaa.gov.

U.S. Department of Commerce, National Technical Information Service 5285 Port Royal Road, Springfield, VA 22161. Phone: (800) 553-6847. Web site: http://www.ntis.gov/ordering.htm.

Non-Government Organizations

American Solar Energy Society 2400 Central Avenue, Suite. G-1 Boulder, CO 80301 Phone: 303-443-3130. Email: ases@ases.org. Web site: http://www.ases.org.

Interstate Renewable Energy Council, P.O. Box 1156, Latham, NY 12110-1156. Phone: 518-458-6059. Email: info@irecusa.org. Web site: http://www.irecusa.org/index.html.

Midwest Renewable Energy Association (MREA) A nonprofit network for sharing ideas, resources, and information with individuals, businesses and communities to promote a sustainable future through renewable energy and energy efficiency. Host of the annual Renewable Energy and Sustainable Living Fair. This three-day festival is the world's largest venue to learn about renewable energy, energy efficiency, and sustainable energy systems. The Fair offers more than 100 workshops presented by experts from across the US and working demonstrations of renewable energy and energy efficiency technologies. 7558 Deer Road, Custer, WI 54423 Phone: 715-592-6595. Email: info@the-mrea.org. Web site: www.the-mrea.org.

Minnesota Renewable Energy Society (MRES) Established in 1978, MRES is a locally-based, non- profit organization committed to developing awareness and use of renewable energy sources across Minnesota. 1916 2nd Ave South, Minneapolis, MN 55403-3927. Phone: 612-872-3285. Web site: http://freenet.msp.mn.us/org/mres/

Solar Electric Power Association (SEPA) A collaboration of utilities, energy service providers and the photovoltaic industry working together to create and encourage commercial use of new solar electric power. 1800 M Street, N.W., Suite 300 Washington, DC 20036-5802. Phone: (202) 857-0898. Email: SolarElectricPower@ttcorp.com. Web site: http://www.solarelectricpower.org/

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.

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