Net-Metering Information Booklet

This <u>Net Metering Information Booklet</u> is made available to help inform our Coos-Curry Electric Cooperative Members of the Net-Metering process, Net Metering requirements and to provide basic information for Net Metering.

This information is not intended to be used as a design guide but rather as a reference document for Net-Metering on Coos-Curry Electric Cooperative utility system.

<u>COOS-CURRY ELECTRIC COOPERATIVE GUIDELINES FOR INTERCONNECTION OF NET-METERING FACILITIES</u>

Oregon law requires utilities to offer net-metering service to their Members. This brochure describes the Coos-Curry Electric Cooperative requirements for the interconnection of net-metering facilities. Coos-Curry Electric Cooperative primary concern is that all net-metering facilities be interconnected safely and in accordance with all applicable codes and regulations without adverse affects to the electrical system and to other Members. A secondary concern is that the costs associated with net-metering services are borne by those Members requesting this service.

<u>NET-METERING FACILITIES</u>

Net-metering facilities are certain generating resources with a capacity of up to 30kW. Net-metering facilities can be hydro, wind, solar, fuel cell, landfill gas, digester gas, waste dedicated energy crops available on a renewable basis or low-emission nontoxic biomass based on solid organic fuels from wood, forest or field residues. Additionally, the net-metering facilities must be located on the Member’s premises.

<u>GENERAL INTERCONNECTION REQUIREMENTS</u>

- Net-metering facilities must comply with all applicable codes and regulations. The Oregon Building Codes Division must approve the installation of all net-metering facilities.
- Net-metering facilities must not adversely affect the safety of Coos-Curry Electric Cooperative personnel or the reliability and power quality of the utility system.
- Net-metering facilities must automatically disconnect from the utility system when the power to the utility system is lost.
- A readily accessible, lockable, manual disconnect switch will be required for non-approved inverter installations and/or when the Net-metering connections, less than 600 volts, have a maximum disconnect rating of 30 amperes or greater.

- Approval for operation in parallel with Coos-Curry Electric Cooperative system must be obtained prior to the operation of any Net-metering system.

CODE REQUIREMENTS

The Member is responsible for the design, installation, operation, and maintenance of their Net-metering facility. The Oregon Building Codes Division has responsibility for inspecting and approving the installation of Net-metering facilities. Members should contact the Building Codes Division for information about the current code requirements.

Coos-Curry Electric Cooperative does not design or install Net-metering facilities.

LOCKABLE MANUAL DISCONNECT FOR NET-METERING FACILITY INSTALLATIONS GREATER THAN 30 AMPERES AND/OR WITH A NON-APPROVED INVERTER

A readily accessible, lockable, manual disconnect switch is required so that Coos-Curry Electric Cooperative personnel can disconnect Net-metering facilities from the utility power system. Net-metering facilities will be disconnected for the following reasons:

- When maintenance is required on the adjacent utility power system

- When operation of the Net-metering facilities could adversely affect the reliability of the utility power system

- When operation of the Net-metering facilities could degrade the quality or service to other Members of Coos-Curry Electric Cooperative.

MEMBER-GENERATOR RESPONSIBILITIES

- Arrange for the design and installation of the Net-metering facility including the equipment required for the interconnection with the utility system

- Have the installation and interconnection of the net-metering facility approved by the Oregon State Building Codes Division

- Complete and submit the attached Coos-Curry Electric Cooperative **Net-metering Application**. The application provides Coos-Curry Electric Cooperative information that is necessary to develop the Net-metering Contract and also to make sure the Cooperative Net-metering facility requirements are met.

- Schedule an on-site Net-metering Facilities review with the Coos-Curry Electric Cooperative Net-metering Program representative(s). The on-site facility review will allow Coos-Curry Electric Cooperative the opportunity to review the completed installation including verifying the proper operation of the safety disconnects, the net meter and also verify proper safety signage is in place.

- Execute a Net-metering Contract with Coos-Curry Electric Cooperative for the net-metering facility. This document will be developed by Coos-Curry Electric Cooperative upon the satisfactory On-Site Facility Review of the Net-metering Facility.

- Operate the Net-metering facility safely and in accordance with the operating guidelines from the manufacturer

- Maintain the net-metering facility in accordance with the manufacturer's specifications

COOS-CURRY ELECTRIC COOPERATIVE NET-METERING PROGRAM REPRESENTATIVES

Contact: Zane Adams ph: 541-332-6190 (direct) ph: 541-373-3306 (cell)

Matt Mjelde ph: 541-332-6179 (direct) ph: 541-661-4003 (cell)

43050 Hwy 101 (PO Box 1268) ph: 541-332-3931 Office
Port Orford Oregon 97465

COOS-CURRY ELECTRIC COOPERATIVE WEBSITE INFORMATION

Website Information: http://**www.ccec.coop**

↓ (Select)

member services

↓ (Select)

► Net Metering

STATE OF OREGON DEPARTMENT OF ENERGY WEBSITE INFORMATION

Website Information: http://**www.oregon.gov/ENERGY/**

↓ (Select)

► Renewable Energy

↓ (Select)

Solar
Wind
Hydro

Coos-Curry Electric Cooperative, Inc. (CCEC)

Net Metering Application Form

NET METER TYPE	☐ Solar ☐ Wind ☐ Hydro ☐ Fuel Cell ☐ Other _______________		
APPLICANT	MEMBER NAME		MEMBER PHONE NUMBER
	COMPANY NAME		COMPANY PHONE NUMBER
	MAILING ADDRESS		
	CITY	STATE	ZIP CODE
	EMAIL ADDRESS		CELL PHONE NUMBER
SYSTEM INSTALLER	CONTACT NAME		PHONE NUMBER
	COMPANY NAME (If Applicable)		COMPANY PHONE NUMBER
	MAILING ADDRESS		
	CITY	STATE	ZIP CODE
	EMAIL ADDRESS		STATE CONTRACTOR NUMBER
CONSULTANT (If Applicable)	CONTACT NAME		PHONE NUMBER
	COMPANY NAME (if applicable)		COMPANY PHONE NUMBER
	MAILING ADDRESS		
	CITY	STATE	ZIP CODE
	EMAIL ADDRESS		
FACILITY INFORMATION	CCEC ACCOUNT NUMBER	RESIDENTIAL OR COMMERCIAL	ESTIMATED COMMISSIONING DATE
	LOCATION OF NET METERING INSTALLATION (Physical Address)		
	CITY	STATE	ZIP CODE
	COUNTY	COUNTY MAP NUMBER	COUNTY TAX LOT NUMBER
	MAP INFORMATION (Willamette Meridian) Township: _________S Range:_________W Section:____________ 1/4 Section:_______ (NW, NE, SE, SW)		

Coos-Curry Electric Cooperative, Inc. (CCEC)

Net Metering Application Form

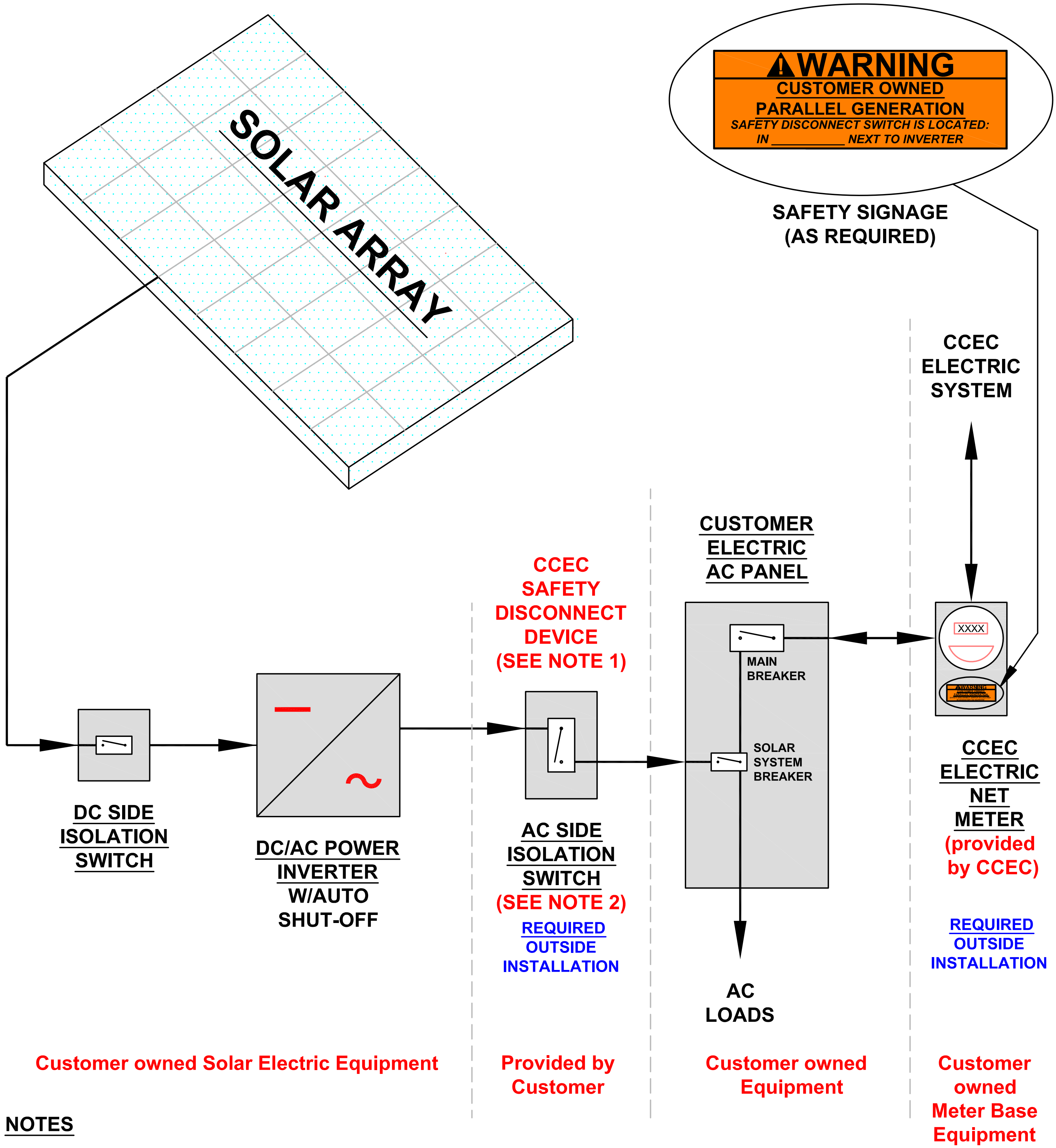
GENERATING INFORMATION	ENERGY (Hydro, Solar, Wind, Fuel Cell) SOURCE	GENERATOR KIND (Photovoltaic, Wind Turbine, Water Turbine, Fuel Cell)	
	GENERATOR SIZE (Individual Rated) Watts orAmps	NO. OF GENERATOR UNITS	TOTAL ELECTRICAL GENERATION CAPACITY kW or kVA
	TYPE (Inverter Controlled, Induction, Synchronous)	ENERGY STORAGE (Size & No. of Batteries)	DISCONNECT (Auto or Manual, Visible Type)

COMPONENT SYSTEM INFORMATION	COMPONEN/SYSTEM (Include Description, Manufacturer, Model Number, Ratings, Lab Certification) 1.
	COMPONEN/SYSTEM (Include Description, Manufacturer, Model Number, Ratings, Lab Certification) 2.
	COMPONEN/SYSTEM (Include Description, Manufacturer, Model Number, Ratings, Lab Certification) 3.
	COMPONEN/SYSTEM (Include Description, Manufacturer, Model Number, Ratings, Lab Certification) 4.
	COMPONEN/SYSTEM (Include Description, Manufacturer, Model Number, Ratings, Lab Certification) 5.

OTHER INFORMATION/SKETCH	

SUBMITTED BY	NAME (Please Print)	DATE
	SIGNATURE	PHONE NUMBER

<u>CCEC USE ONLY</u>	MEMBER ACCOUNT NUMBER	POLE NUMBER	LOCATION NUMBER
	METER NUMBER	SERVICE AREA	OTHER INFORMATION
	METER FORM/SIZE	SERVICE VOLTAGE & PHASE	

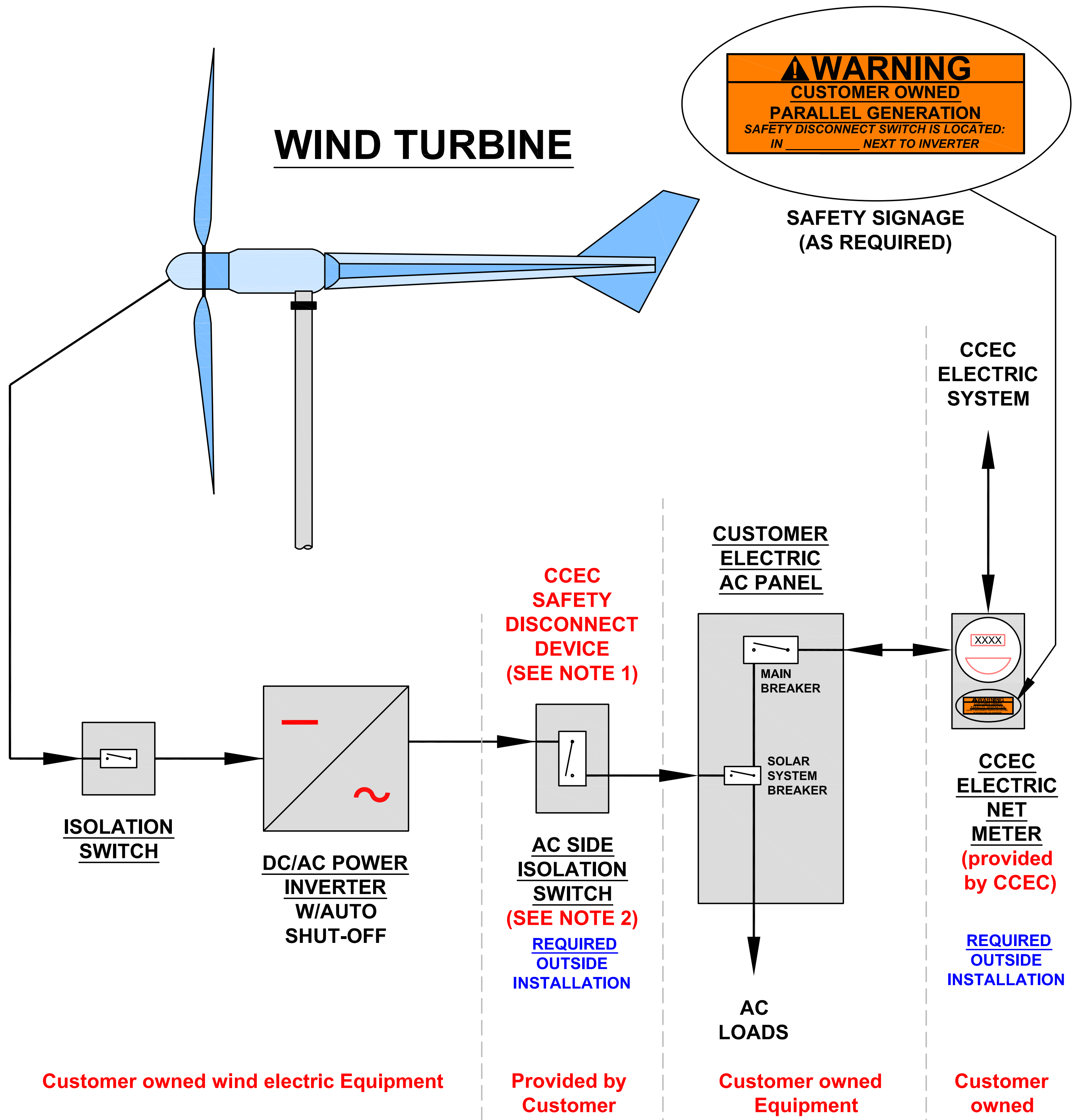


NOTES

1. A SAFETY DISCONNECT DEVICE LOCATED ADJACENT TO THE CCEC METER IS NOT REQUIRED WHEN AN APPROVED INVERTER-BASED FACILITIY IS USED FOR SERVICES LESS THAN 600 VOLTS AND A MAXIMUM DISCONNECT RATING OF 30 AMPS. IN THESE INSTANCES, AN INVERTER LOCK-OUT/TAG-OUT DISCONNECT SWITCH LOCATED NEXT TO THE INVERTER IS ACCEPTABLE.

2. WHEN REQUIRED, THE AC SIDE ISOLATION SWITCH MUST BE INSTALLED OUTSIDE AND WITHIN 4 FT OF CCEC ELECTRIC METER. SWITCH SHALL BE MOUNTED 5 FT ABOVE GROUND.

NET METERING SYSTEMS SOLAR ELECTRIC EQUIPMENT DIAGRAM		
Coos-Curry Electric Cooperative, Inc.	REVISION: 1.2	DATE: 04-05-2010
	DWG NO: NMET-01	



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NET METERING SYSTEMS
WIND ELECTRIC
EQUIPMENT DIAGRAM

Coos-Curry Electric Cooperative, Inc.

REVISION:	DATE:
1.2	06-24-2010
DWG NO:	
NMET-02	

COOS-CURRY ELECTRIC COOPERATIVE
NET METERING INTERCONNECTION AGREEMENT/CONTRACT

This Net-Metering Interconnection Agreement/Contract made and entered into this day of ___*Date*_____, by and between *Member-generator name and address* __(the "Member-generator") and COOS CURRY ELECTRIC COOPERATIVE, INC., P.O. BOX 1268, PORT ORFORD, OR 97465 (the "Cooperative").

WHEREAS Member-generator wishes to connect sell and the Cooperative agrees to purchase energy produced by the Facility (as defined below) on the following terms and conditions:

Facility Description:
(Described on attached Exhibits

Exhibit "A" - System Information & Certifications

Facility location:

Net Metering Facility Address, located in the _XX_ ¼ of Section ____00__, Township_00 South, Range _00_ West, Willamette Meridian, _xxxxx County, Oregon, Map Tax Lot No 0000-000-00000

NOW THEREFORE, in consideration of the mutual covenants hereinafter set forth, it is mutually agreed as follows:

1. **Net Metering Facility:** The Member-generator's net-metering facility (the **"Facility"**) shall mean the generating facility described in **the Exhibits** attached hereto. The Facility shall consist of a solar photovoltaic power generating facility with a maximum output capacity of 0,000 Watts (_1.00_KW) that is located on The Member-generator's premises, that is interconnected with and operates in parallel with The Cooperative's transmission and distribution facilities, and is intended primarily to offset part or all of the Member-generator's own electrical requirements. The Member-generator shall be responsible for the design, installation and operation of the Facility and for obtaining and maintaining all required permits and approvals related thereto. This Agreement/Contract is applicable only to the net-metering facility described in Exhibit A and the Member-generator shall not make any modification to the Facility without the prior written consent of the Cooperative.

2. **Net Energy:** Net energy is the difference between electrical energy consumed by the Member-generator from the Cooperative's electrical supply system and the electrical energy generated by the Member-generator and fed back into the Cooperative's electrical supply system. Excess energy is net energy where the energy generated by the Member-generator exceeds the energy consumed by the Member-customer. The Cooperative acquires ownership of the excess energy and all renewable attributes associated with it, including Renewable Energy Credits (RECs).

3. **Measurement of Net Energy**: Bi-directional metering equipment will be in installed to measure the flow of electrical energy in each direction. The bi-directional metering equipment shall be installed at the Cooperative's expense. The bi-directional metering equipment shall be used to provide information necessary to accurately bill or credit the Member-generator and to collect electrical generating system performance information for research purposes.

4. **Price and Payment Methodology**: All service shall be billed pursuant to The Cooperative's appropriate Rate Schedule. Credits for net energy flow into the Cooperative's electrical supply system shall be apportioned according to the Net Metering rate schedule.

5. **Interconnection**: The Member-generator shall provide the electrical interconnection on its side of the bi-directional metering equipment. At the Member-generator's expense, the Cooperative will make such modifications to the Cooperative's system as are reasonably necessary to accommodate the Facility. The cost for such modifications is estimated $_0.00_, due in advance of construction. The Member-generator shall ensure, at its own expense that the Facility includes all equipment necessary to meet applicable safety, power quality, and interconnection requirements established from time to time by the Cooperative's policies, the National Electric Code, National Electric Safety Code, the Institute of Electrical and Electronic Engineers, the Oregon State Building Codes Division, and Underwriters Laboratories. The Member-generator shall not commence parallel operation of the Facility until the Cooperative has inspected the Facility, including all interconnection equipment, and issued a written approval for its operation.

6. **Disconnection**: The Member-generator shall furnish and install, on its side of the metering equipment, a safety disconnect device capable of fully disconnecting and isolating the Facility from the Cooperative's electric supply system. The equipment shall be designed and operated to automatically disconnect or shut down during scheduled or unscheduled outages to insure that it will not back feed any part of the Cooperative's distribution system.

   A visible disconnect switch, located adjacent to the Cooperative's bi-directional metering equipment, will not be required when the service is 600 volts or less and the approved inverter-based facility does not impact the Member-generator's service conductors more than 30 amperes. In these instances, an inverter lock-out/tag-out disconnect switch located next to the inverter will be accepted as the safety disconnect device.

   When required by the Cooperative for net metering facilities that exceed the 30 ampere connection rule, a disconnect device shall be located adjacent to the Cooperative's bi-directional metering equipment and shall be of the visible break type in a metal enclosure that can be secured by a padlock. The disconnect device shall be accessible to the Cooperative's personnel at all times and shall conform to

National Electric Code standards. The Cooperative shall have the right to disconnect the Facility from the Cooperative's electric supply system when necessary to maintain safe and reliable electrical operating conditions or, if in the Cooperative's sole judgment, the Facility at any time adversely affects the operation of the Cooperative's electrical system or the quality and reliability of the Cooperative's service to other customers. The Cooperative shall have the right to require that the Facility remain disconnected until such time as the Cooperative determines, in it sole discretion, that the condition(s) requiring the disconnection have ended or been corrected.

The Cooperative may stop Net Metering from the Member-generator when necessary for the Cooperative to construct, install, maintain, repair, replace, remove, investigate, or inspect any equipment or facilities within its electric system. The Cooperative will notify the Member-generator before it stops purchasing electricity in this way: The Cooperative will notify the Member-generator in a manner consistent with that of notifying all other members in that consumer class.

7. **Safety and Operation 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 Net Metering Facilities must operate in a manner which will insure the safety of employees and the general public, and must allow electric service to other consumers to remain within prescribed limits.

   The Member-generator shall furnish, install, operate and maintain in good order and repair, all without cost to the Cooperative, all equipment required for the safe operation of the Facility in parallel with the Cooperative's electrical supply system including, but not be limited to, equipment necessary to (1) establish and maintain automatic synchronism with the Cooperative's electric supply system and (2) automatically disconnect the Facility from the Cooperative's electrical supply system in the event of overload or outage of the Cooperative's electrical supply system. The Facility must be designed to operate within allowable operating standards for the Cooperative's supply system. The Facility must not adversely affect the quality or reliability of service provided to the Cooperative's other customers.

8. **Installation and Maintenance:** Except for the bi-directional metering equipment owned by the Cooperative, all equipment on the Member-generator's side of the delivery point, including any required disconnect device, shall be provided and maintained in satisfactory operating condition by the Member-generator and shall remain the property and responsibility of the Member-generator. The Cooperative will bear no responsibility for the installation or maintenance of the Member-generator's equipment or for any damage to property as a result of any failure or malfunction thereof. The Cooperative shall not be liable, directly or indirectly for permitting or continuing to allow the interconnection of the Facility or for the acts or omissions of the Member-generator or the failure of malfunction of any equipment of the Member-generator that causes loss or injury, including death, to any party.

9. **<u>Electrical Characteristics</u>:** The single rated equipment capacity of the Net Metering Facility to be connected in parallel with a low voltage service shall be no greater than 10 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 10 kW will be permitted if engineering calculations indicate that the installation will not adversely affect the operational characteristics of the Cooperative's system.

   The electrical characteristics of the Facility shall conform with standards established by the Cooperative. The standards include voltage, current, frequency, harmonics, and automatic synchronization etc. Wherever possible the Cooperative will base its standards on industry wide standards.

   The Member-generator shall endeavor to operate the Facility as near unity power factor as possible. For Facilities with rated capacity above 10 hp, the Cooperative reserves the right to require the Member-generator to install power factor correction equipment or reimburse the Cooperative for its cost of installing power factor correction equipment.

10. **<u>Indemnity and Liability</u>:** The Member-generator shall defend, hold harmless, and indemnify The Cooperative and its directors, officers, employees, and agents against any and all loss, liability, damage, claim, cost, charge, demand, or expense (including any direct, indirect or consequential loss, liability, damage, claim, cost, charge, demand, or expense, including attorney's fees) for injury or death to persons, including employees of the Cooperative and the Member-generator, and damage to property, including property of the Cooperative and the Member-generator, arising out of or in connection with (a) the engineering, design, construction, maintenance, repair, operation, supervision, inspection, testing, protection or ownership of the Facility, or (b) the making of replacements, additions, betterment to, or reconstruction of the Facility, provided, however, The Member-generator's duty to indemnify the Cooperative hereunder shall not extend to loss, liability, damage, claim, cost charge, demand, or expense resulting from interruptions in electrical service to the Cooperative's customers other than the Member-generator. The Member-generator's obligation to indemnify the Cooperative hereunder shall apply regardless of whether the Cooperative is alleged or determined to have been contributory, concurrently, jointly, or independently negligent.

11. **<u>Access</u>:** Authorized Cooperative employees shall have the right to enter upon the Member-generator's property at any time for the purposes of inspection and/or operating the disconnect device and meters and making additional tests concerning the operation and accuracy of the Cooperative's meters.

12. **<u>Membership:</u>** The Member-generator is hereby bound by the provisions of the Articles of Incorporation and Bylaws of the Cooperative as from time to time

amended, and by such policies, rules and regulations as may from time-to-time be adopted by the Cooperative Board of Directors.

13. **Relationship of the Parties:** This Agreement contains the entire agreement between the Cooperative and the Member-generator and may not be modified except in writing signed by both parties. Nothing in this Agreement shall be construed to imply a joint venture or partnership between the parties.

14. **Assignment:** This Agreement/Contract may not be assigned by the Member-generator in whole or in part without the prior written consent of the Cooperative, which consent may be granted or withheld at the Cooperative's sole and absolute discretion.

15. **Terms and Termination Rights:**
    This Agreement becomes effective when signed by both the Member-generator and the Cooperative, and shall continue in effect until terminated.

    After fulfillment of any applicable fees or rate schedule obligations, the Member-generator may terminate this Agreement at any time by giving the Cooperative at least thirty (30) days prior written notice.

    The Cooperative may terminate this Agreement/Contact by giving the Member-generator at least thirty (30) days prior written notice that the Member-generator is in default of any of the terms and conditions of this Agreement/Contract, payments, so long as the notice specifies the basis for termination, and there is an opportunity to cure the default.

    This Agreement/Contract will terminate automatically upon: (1) any change of ownership of the Member-generator (if the Member-generator is not an individual or family), (2) any change in ownership of the Facility or the premises upon which the Facility is located, or (3) any change in the location of the Facility. This Agreement/Contact may also be terminated, if there is a change in Oregon State statutes that is determined to be applicable to this Agreement/Contract and authorizes its termination.

    This Agreement may also be terminated at any time by mutual agreement of the Member-generator and the Cooperative.

    In such event, the Member-generator shall, no later than the date of termination of Agreement/Contract, completely disconnect the Member-generator Facility from parallel operation with Cooperative's system.

16. **Severability:** Should any provision of the Agreement/Contact be or become void, illegal, or unenforceable, the validity or enforceability of the other provisions of the Agreement/Contract shall not be affected and shall continue in force. The Parties will, however, use their best endeavors to agree on the replacement of the void,

illegal, or unenforceable provision(s) with legally acceptable clauses which correspond as closely as possible to the sense and purpose of the affected provisions and the Agreement/Contract as a whole. If a suit or action is instituted in connection with any controversy arising out of this Agreement/Contract, the prevailing party shall be entitled to recover, in addition to costs, such sums as the court may adjudge reasonable as attorney's fees, whether in initial litigation or upon appeal.

17. **Due Authorization:** The Member-generator represents that he/she has the authority to execute this Agreement/Contract, and that all persons required to create terms, conditions and agreements/contracts hereof as covenants running with the land, have executed this Agreement/Contract below.

18. **Binding Effect:** It is mutually agreed by and between the parties hereto that the conditions, terms, and covenants of this Agreement/Contract shall be binding upon and shall inure to the benefit of the heirs, executors, administrators, successors and assigns of the respective parties hereto.

19. Acceptance:

IN WITNESS WHEREOF, the Parties hereto have caused two originals of this Agreement to be executed by their duly authorized representatives.

Member-Generator:

Name:____________________________ (Signature)

Name:____________________________ (Printed)

Date:__________________/_____/______

Name:____________________________ (Signature)

Name:____________________________ (Printed)

Date:__________________/_____/______

Cooperative:

Name (Signature)____

Name (Printed) ____

Title (Printed) ____

Date ___________________________

"EXHIBIT A"

System Information and Certifications

Section 1. Member-generator Information

Name:____

Mailing Address: ______________________________________

Phone ____________________

Utility Member-generator Account Number (from utility bill):______________________

Section 2. Net-metering Facility Information

Electric System Type (Check Box): ☐ Solar ☐ Wind ☐ Fuel Cell ☐ Hydro

Generator Size (kW AC) ______________________________________ (   )

Generator Manufacturer: ________________ Generator Model:______________

Inverter Manufacturer: ____________________ Inverter Model:________________

Inverter Serial Number: :________________

Inverter Power Rating ______________ Inverter Location: _________________

Section 3. Installer Information

Installer: ____

Address:____

Phone:_______________________ Installation Date _____________________

Email:____

Section 5. Certification(s)

1. (If an inverter is used) The net metering facility's inverter meets the requirements of IEEE 929-2000, "Recommended Practice for Utility Interface of Photovoltaic (PV) Systems" and Underwriters Laboratories (UL) Subject 1741, "Standard for Static Inverters and Charge Controllers for Use in Photovoltaic Power Systems"; and the National Electric Code (NEC), Article 705.

Signed ____ Date __________

Name (Printed) ____

Company ____

2. The system has been installed to my satisfaction and I have been given system warranty information and an operations manual. I have been instructed regarding the proper operation of the net metering facility and associated equipment. Also, the installation has received approval and certification from the Oregon Building Codes Division.

Signed (Owner) ____________________________________Date _______________

Name (Printed) ____

POLICY NO. 300-050

TITLE: NET-METERING

I. OBJECTIVE

This policy defines the terms and conditions under which Coos-Curry Electric Cooperative, Inc. (CCEC) will provide bi-directional net-metering to service Members who desire to install alternative, on-site, renewable member-owned generation sources.

II. POLICY

A. This program is offered in compliance with the State of Oregon ORS 757.300. CCEC's net-metering service will be made available until the time that the cumulative rated capacity of all the eligible member-owned energy sources equals one-half of one percent (0.5%) of CCEC's prior five-year average single-hour peak load.

B. This policy is to be administered in accordance with CCEC's policy and rules concerning Electric Service and Line Extensions.

C. Net-metering is defined as measuring the difference between the electricity supplied by CCEC and the electricity generated by a member-generator and fed back to CCEC over the applicable billing period.

D. NET-METERING SERVICE – net-metering service is available, on an equal basis, to Members ("member-generator") who own and operate a net-metered generating facility subject to all of the following conditions:

1. Generates electricity using solar power; wind power; hydroelectric power; landfill gas; digester gas; waste; dedicated energy crops available on a renewable basis; low-emission, nontoxic biomass based on solid organic fuels from wood, forest or field residues; geothermal

energy; or renewable marine energy, including wave energy, wave-wind hybrid energy and tidal energy.

2. Nameplate generating capacity of not more than twenty-five kilowatts (25 kW).

3. Net-metered facilities are located on the member-generator's premises or, if directly connected to the member generator's premises, the territorial sea as defined in ORS 196-405 or the outer continental shelf.

4. Generating facilities operate in parallel with CCEC's existing transmission and distribution system.

5. Generating facilities are intended primarily to offset part or all of the Member's own electrical requirements.

E. NET-METERING PROGRAM

1. The aggregated level of net- metered generation for CCEC will be limited to one-half of one percent (0.5%) of CCEC's single-hour peak load for the previous five (5) years. Net-metering requests will be on a "first come, first served" basis as net-metering capacity is available under the limit. At the beginning of each year CCEC will sum the total net-metered generation connected to its system to determine remaining net-metering capacity available for connection of new net-metered.

2. CCEC will allow interconnection of net- metered facilities to its system and will provide bi-directional metering (metering electrical power in both forward and reverse in order to provide the net-metering service to the member-generator. The member-generator, using CCEC guidelines, shall be responsible for the installation and costs associated with the meter base facilities used for net-metering.

3. In situations where modifications to CCEC's facilities are required (upgrades, etc.) to interconnect the net-metered facility, CCEC's costs for the modifications will be the responsibility of the member-generator.

4. The member-generator will be billed the monthly rate class base charge for their net-metered service. The following sections 5 and 6 describe how billing for energy consumption will be handled.

5. Net-metered energy is the total electrical energy supplied to CCEC by a qualifying net- metered facility subtracted from the total amount of energy supplied by CCEC to the net-metered facility over a given billing period. If the amount of energy supplied to CCEC is greater than the amount of energy delivered by CCEC, the difference in kilowatt-hours shall be defined as excess energy. Excess energy shall be banked and used to offset future consumption.

6. Annually, or more frequently if determined by CCEC, any remaining unused, banked excess energy will be credited to the member-generator or granted to CCEC's low-income energy assistance program, as elected by the member-generator. The value of any excess energy shall be based upon the cost of wholesale electric power purchased by CCEC ("Avoided Cost"). The valuation shall include energy charges, capacity charges, and any other applicable charges blended into one rate per kilowatt-hour.

7. CCEC assumes the responsibility for distribution of electricity that has been generated by a member-generator and fed back to the electric utility and acquires ownership of all renewable attributes associated with such electricity including Renewable Energy Credits or RECs.

F. NET-METERING REQUIREMENTS

1. A member-generator will be required to complete and sign a Net-Metering Contract/Agreement with CCEC that covers the specific terms, agreements, and issues such as safety, insurance, ownership, responsibilities, charges, and power quality. A Contract/Agreement may also be required of a member-generator to recover costs for engineering and/or construction that is necessary for connecting and operating a net-metered facility interconnected to the CCEC system.

2. The member-generator, without cost to CCEC, shall be ultimately responsible for securing all necessary permissions, permits, etc. required for the construction and safe operation of the net-metering generating system and interconnection facility.

3. A net-metered system must include, at the member-generator's own expense, all equipment necessary to meet applicable safety, power quality, and interconnection requirements established by the National Electrical Code (NEC), National Electrical Safety Code (NESC), State of Oregon building codes (electrical permit), and all other applicable federal, state, and local rules and regulations relative to net-metering. All safety and operating procedures of the interconnection and net-metering facilities will be required to remain in compliance with the Occupational Safety and Health Administration (OSHA) standard 29 CFR 1910-269.

4. The member-generator will be required on a continual basis to keep the net-metered generating system and interconnection facility maintained and operating in compliance with applicable codes and permit requirements.

5. The member-generator shall be responsible for all costs associated with his/her facility, including costs related to any modifications that may be required by CCEC for the purpose of safety, reliability, power quality, and meter reading.

III. RESPONSIBILITY

The General Manager/Chief Executive Officer (GM/CEO) shall be responsible for administering this policy.

ATTEST:

/s/ Daryl Robison
Daryl Robison, Secretary

Date: 04/30/2019

Date of Previous Revisions:	**04/27/2017**
	03/26/2015
	03/28/2013
	01/26/2012
	03/31/2011
Replaced PB#80	***04/22/2010***
Date Adopted:	***08/26/2005***

COOS-CURRY ELECTRIC COOPERATIVE, INC.
PO BOX 1268
PORT ORFORD OR 97465

NET-METERING SERVICE

	Schedules:
70	Residential 15
72	General Service, Single Phase 34
73	General Service, Three Phase 36
74	Small Commercial, Single Phase 44
75	Small Commercial, Three Phase 46
77	Irrigation, Single Phase 25
78	Irrigation, Three Phase 26

APPLICABLE

This net-metering rate is supplemental to the member's current rate schedule and is provided in accordance with Coos-Curry Electric Cooperative, Inc's (CCEC) net-metering policy and the member-generator's Net-Metering Interconnection Contract.

AVAILABILITY

Available to any member normally served under CCEC's other member rate schedule who has a qualifying net-metering facility. Net-metering service will be made available, on a "first come, first serve" basis, until such time that the total aggregate rated generating capacity used by the eligible members equals one-half of one percent (0.5%) of the prior five-year average single-hour peak load of CCEC. Net-metering request will be on an "as net-metering capacity becomes available under the limit."

DEFINITIONS

Net-metering is defined as measuring the difference between the electricity supplied by an electric utility and the electricity generated by a member-generator and fed back to the electric utility over the applicable billing period.

QUALIFYING NET-METERING GENERATING FACILITY

A Qualified net-metering generating facility generates electricity using:

1. Solar power, wind power, fuel cells, hydroelectric power, landfill gas, digester gas, waste, dedicated energy crops available on a renewable basis or low-emission, nontoxic biomass based on solid organic fuels from wood, forest or field residues.
2. Nameplate generating capacity of not more than thirty kilowatts (30kW).
3. Net-metering facilities are located on the member-generator's premises.
4. Generating facilities that operate in parallel with CCEC's existing transmission and distribution system.

TYPE OF SERVICE

Type of service is 60 Hertz, alternating current, at supply voltages, single or three-phase, that apply to the member-generator's applicable rate schedule.

NET-METERING

CCEC will install metering equipment capable of measuring bi-directional electric energy flow separately as follows: (a) the electrical energy delivered by CCEC to the member-generator, and (b) the electrical energy delivered by the member-generator to CCEC. Metering equipment shall be capable of metering both energy (in kilowatt-hours) and demand (in kilowatts), if necessary, to bill member-generator under CCEC's appropriate rate schedule.

NET-METERING RATE

Member-generator net-metering monthly bill is calculated from the following components:

A) BASE CHARGE ---The member-generator will be billed the monthly base charge equal to the rate class of the net-metered service.

B) DEMAND CHARGE ---The member-generator will be billed the demand charge (kW) equal to the rate class of the net-metered service for energy supplied by CCEC. No demand charge credits will be given to the member-generator for energy generated by the member-generator.

C) ENERGY CHARGE AND CREDIT ---

C1) Energy supplied by Cooperative

Energy supplied from CCEC (forward energy flow) over a given billing period.

C2) Energy supplied by member-generator

Generated energy supplied to CCEC (reverse energy flow) over a given billing period.

NET-METERING MONTHLY BILL CALCULATION --

Total Monthly Bill = **A** + **B** + **C1** - **C2**

Where **A**	=	the base charge of the rate class of the metered service
Where **B**	=	the demand charge, if applicable, for the rate class of the metered service
Where **C1**	=	the energy charge for energy supplied by Cooperative for the rate class of the metered service
Where **C2**	=	the energy credit for energy supplied by member-generator

If, over a given billing period, C2 is greater than C1, the difference in kWh's shall be banked and used to offset future consumption. Annually, or more frequently if determined by CCEC, any remaining unused, banked kWh will be credited to the member-generator at the avoided cost rate or granted to CCEC's low-income energy assistance program, as elected by the member-generator.

TERMS OF PAYMENT

All bills become due and payable at time of member-generator's receipt of bill.

Effective with bills rendered on and after January 1, 2014.

Revised & approved 11/21/2013 Reviewed 09/09/2014, 05/28/2015, 12/17/2015

DOE / GO-10097-377
FS 231
March 1997

ENERGY EFFICIENCY AND RENEWABLE ENERGY CLEARINGHOUSE

Photovoltaics: Basic Design Principles and Components

If you are thinking of generating your own electricity, you should consider a photovoltaic (PV) system—a way to generate electricity by using energy from the sun. These systems have several advantages: they are cost-effective alternatives in areas where extending a utility power line is very expensive; they have no moving parts and require little maintenance; and they produce electricity without polluting the environment.

This publication will introduce you to the basic design principles and components of PV systems. It will also help you discuss these systems knowledgeably with an equipment supplier or system installer. Because this publication is not intended to cover everything about designing and installing a PV system, a list of additional PV resources is provided at the end.

Jim Yost / PIX01809

This stand-alone PV system consists of four modules, each with 36 cells. It provides power for lights, radios, televisions, and other loads at remote homes in New Mexico.

Introduction to PV Technology

Single *PV cells* (also known as "solar cells") are connected electrically to form *PV modules,* which are the building blocks of PV systems. The module is the smallest PV unit that can be used to generate substantial amounts of PV power. Although individual PV cells produce only small amounts of electricity, PV modules are manufactured with varying electrical outputs ranging from a few watts to more than 100 watts of direct current (DC) electricity. The modules can be connected into *PV arrays* for powering a wide variety of electrical equipment.

Two primary types of PV technologies available commercially are crystalline silicon and thin film. In crystalline-silicon technologies, individual PV cells are cut from large single crystals or from ingots of crystalline silicon. In thin-film PV technologies, the PV material is deposited on glass or thin metal that mechanically supports the cell or module. Thin-film-based modules are produced in sheets that are sized for specified electrical outputs.

In addition to PV modules, the components needed to complete a PV system may include a battery charge controller, batteries, an inverter or power control unit (for alternating-current loads), safety disconnects and fuses, a grounding circuit, and wiring. (See *Balance-of-System Equipment* section.)

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Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 20% postconsumer waste

Hundreds of cost-effective applications for PV systems have been developed.

PV System Applications

Many people are familiar with PV-powered calculators and watches, the most common small-scale applications of PV. However, there are numerous large-scale, cost-effective PV applications, including:

- **Water pumping** for small-scale remote irrigation, stock watering, residential uses, remote villages, and marine sump pumps;
- **Lighting** for residential needs, billboards, security, highway signs, streets and parking lots, pathways, recreational vehicles, remote villages and schools, and marine navigational buoys;
- **Communications** by remote relay stations, emergency radios, orbiting satellites, and cellular telephones;
- **Refrigeration** for medical and recreational uses;
- **Corrosion protection** for pipelines and docks, petroleum and water wells, and underground tanks;
- **Utility grids** that produce utility- or commercial-scale electricity; and
- **Household appliances** such as ventilation fans, swamp coolers, televisions, blenders, stereos, and other appliances.

The decreasing cost of PV systems and the increasing number of manufacturers and dealers for PV equipment have contributed to widespread use of the technology. In PV's early days, do-it-yourselfers had to search for companies that manufactured PV modules and often had to adapt or reconfigure components from other non-PV systems. Today, dealers offer ready-to-use systems and state-of-the-art equipment designed specifically for PV systems. Many dealers have computer software that helps to design systems and specify appropriate components. As PV markets expand, dealers are gaining greater experience with PV applications, making it cheaper and easier to purchase PV systems.

How Do I Select a PV Dealer?

Choosing a PV professional will be one of your most important decisions. If you choose a competent dealer, you won't need to know all the details of designing, purchasing, and installing your PV system. Instead, you can rely on the dealer's expertise to design and install a system that meets your needs. However, just like buying a car or a television, you must have confidence in the dealer's products and services and be an informed consumer. With the growth of the PV industry, the number of regional dealers, mail-order businesses, and local distributors has expanded rapidly. Many telephone directories contain listings for PV dealers under the "Solar" heading.

Professional credentials are one indication of a PV dealer's knowledge and qualifications. Ask dealers what PV-related courses they have taken, certifications they have earned, and licenses they have received.

A second consideration is the dealer's experience in the field. How long has the company been in business? The local Better Business Bureau can advise you whether any customers have registered complaints about the dealer. You should also ask the dealer how many systems like yours he or she has designed and installed. Ask to see installations, and talk with owners of systems similar to the one you want to purchase.

A third consideration in selecting a system installer is the variety and quality of products offered for each component of the system. Because PV systems are often designed for a specific site, one company's products may not be appropriate for all applications. Competent dealers will stock components manufactured by several companies. A variety of product options will help ensure that the most appropriate components are available for your system. When a dealer recommends a product, ask what the recommendation is based on, whether there are consumer or independent testing facility reports you can read, and whether the products are listed with Underwriters Laboratories (UL).

Fourth, consider the service agreements and performance guarantees the dealer provides and the warranties given by the product manufacturers. No system is maintenance-free, nor will all components function flawlessly forever. When problems emerge with your system, what services will the dealer provide? What warranties do the manufacturers provide? What costs should you expect to pay, and which costs will be assumed by the dealer and / or the manufacturer?

Finally, you should compare prices from different dealers. Because distribution channels and dealer networks have expanded dramatically, the opportunity to "shop around" is much greater today. If possible, approach more than one dealer about a draft design and cost estimate for your system.

In the United States, PV systems must have unobstructed southern exposure.

When Are PV Systems Appropriate?

People select PV systems for a variety of reasons. Some common reasons for selecting a PV system include:

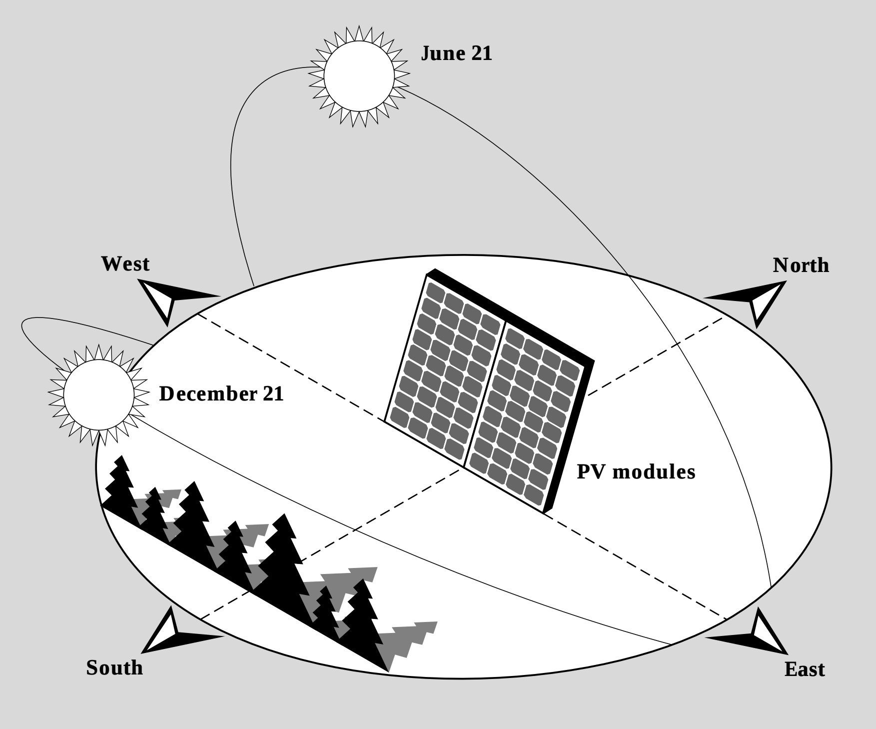
- **Cost**—When the cost is high for extending the utility power line or using another electricity-generating system in a remote location, a PV system is often the most cost-effective source of electricity.
- **Reliability**—PV modules have no moving parts and require little maintenance compared to other electricity-generating systems.
- **Modularity**—PV systems can be expanded to meet increased power requirements by adding more modules to an existing system.
- **Environment**—PV systems generate electricity without polluting the environment and without creating noise.
- **Ability to combine systems**—PV systems can be combined with other types of electric generators (wind, hydro, and diesel, for example) to charge batteries and provide power on demand.

PV systems are not cost-effective for all applications. The following discussion gives some general guidelines to consider when deciding whether a PV system is appropriate for your situation.

First, if your site is already connected to a utility grid, or within one-quarter mile of the grid, a PV system will probably not be cost-effective. Each utility company spreads the cost of its power plants and fuel costs among all its customers. Most utilities can provide electricity to consumers for about 6 cents to 14 cents per kilowatt-hour. When you install a PV system, you are essentially installing your own mini-utility system. You pay all the costs of generating the electricity you consume. Although the sun's energy is free, the PV equipment is not free. The electricity generated by PV systems at current module and balance-of-system prices can cost 20 cents to 40 cents per kilowatt-hour, depending on the installation cost and intensity and duration of the sunlight at the site.

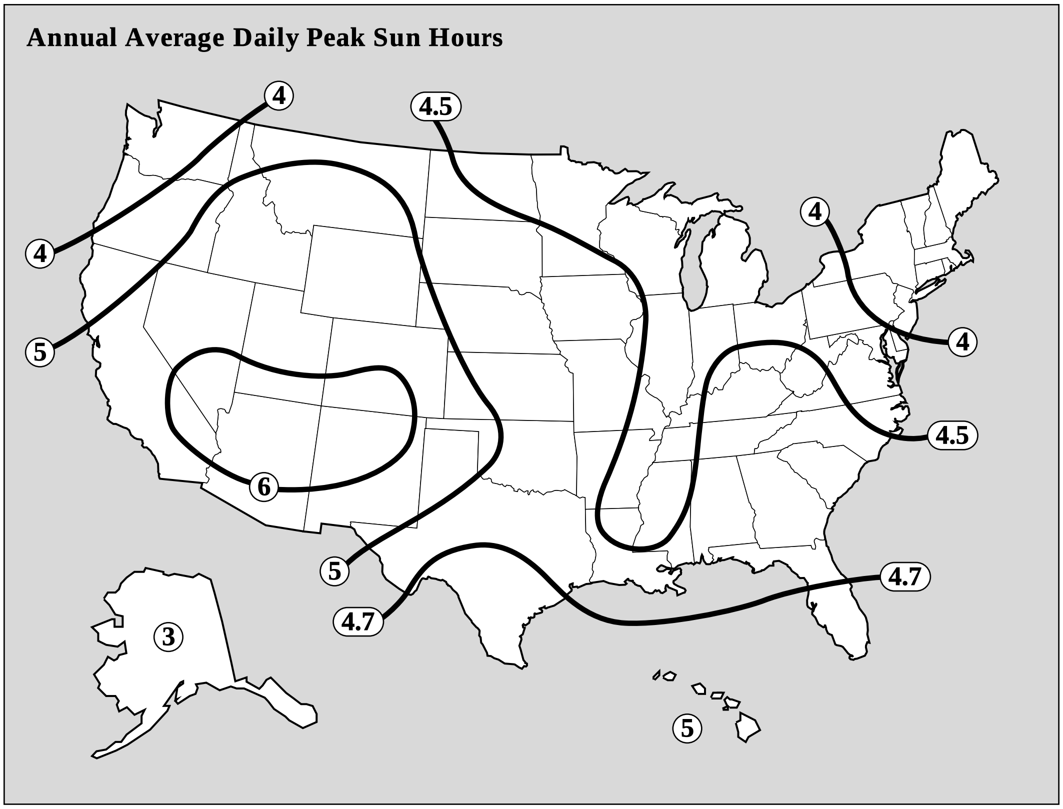
Second, small PV systems are not practical for powering space-heating systems, water heaters, air conditioners, electric stoves, or electric clothes dryers. These loads require a large amount of energy to operate, which will increase the size and cost of your PV system. Therefore, select the most energy-efficient loads available. For example, if your PV system will power lights, look for the most energy-efficient light bulbs. If your system will pump water for toilets and showers, look for the most water-conserving fixtures.

Sun's Path in the Sky



The sun's noontime height above the horizon changes seasonally. This is important to consider when siting and positioning a PV array.

Where you live will determine the number of PV modules your system will need.



This diagram illustrates the annual average daily peak sun hours for the United States.

Is My Site Adequate for PV?

A PV system designer can conduct a detailed site assessment for you. To save the dealer time (and possibly save yourself some money), you can conduct a preliminary assessment to determine whether your site has potential for a PV system. Contact the Energy Efficiency and Renewable Energy Clearinghouse (EREC—see *Source List*) for more information on conducting a detailed site feasibility assessment.

There are three factors to consider when determining whether your site is appropriate.

First, systems installed in the United States must have a southern exposure. For maximum daily power output, PV modules should be exposed to the sun for as much of the day as possible, especially during the peak sun hours of 10 a.m. to 3 p.m.

Second, the southern exposure must be free of obstructions such as trees, mountains, and buildings that might shade the modules. Consider both summer and winter paths of the sun, as well as the growth of trees and future construction that may cause shading problems.

Finally, the unobstructed southern exposure must also have appropriate terrain and sufficient space to install the PV system. A flat, grassy site is appropriate terrain, whereas a steep, rocky hillside is not.

Make sure you have selected the most energy-efficient loads possible.

How Does Weather Affect PV Module Output?

Unlike utility power plants, which produce electricity constantly despite the time of day and year or the weather, the output of PV modules is directly related to these two factors.

Where you live will affect the number of PV modules you will need for power, because different geographic regions experience different weather patterns. Seasonal variations affect the amount of sunlight available to power a PV system. The above map shows annual average “peak sun hours” for regions in the United States.

How to Size Your PV System

To size your PV system, you must first know your energy needs, which you figure by listing all your daily loads. A load includes anything that uses electricity from your power source, such as lights, televisions, radios, or batteries. Some loads need electricity all the time, such as refrigerators, whereas others use electricity less often, such as power saws. To determine your total energy consumption, multiply the wattage of the appliance by the number of hours it is used in a day. Some appliances do not give the wattage, so you may have to calculate the wattage by multiplying the amperes times the volts. After adding the totals for each appliance, you can decide what power output you need for your PV system.

Example

Load	Daily Use (hrs)		Wattage		Total Energy Consumption (watt-hrs)
Radio	2	x	25	=	50
Lamps (fluorescent)	3	x	27	=	81
VCR	0.5	x	30	=	15
Television	6	x	60	=	360
Total Daily Energy Consumption					**506 watt-hrs**

For the items listed above, you would need a system that produces an average daily energy output of 506 watt-hours. Obviously, different parts of the country receive varying amounts of sunlight. Because sunlight is the source of power for PV, you must determine the daily amount of sunlight in your region. Remember that PV systems are rated by peak watt, which is the amount of power produced when the module receives 1,000 watts per square meter of exposure to the sun (insolation).

Let's examine two locations: Albuquerque, New Mexico, and Pittsburgh, Pennsylvania. Albuquerque is a fairly sunny area. In Albuquerque, for each peak watt that a PV module is rated, it will produce a yearly average of 6.2 watt-hrs* of electricity daily. In Pittsburgh, a cloudier area, the same module will produce an average of 2.4 watt-hrs* of electricity daily.

If you wanted to use a PV system in Albuquerque for the appliances listed in the table, you would divide 506 watt-hrs by 6.2, divide that by 0.8 to account for inefficiency of the batteries and, finally, multiply by 1.2 to cover anything that may have been overlooked. You find that you would need a PV system rated at 124 peak watts. If you were buying 50-watt modules, you would need three modules, because you round up to the next highest number.

506 ÷ 6.2 = 82

82 ÷ 0.8 = 103

103 x 1.2 = 124

124 ÷ 50 = 3 modules

For Pittsburgh, you would divide 506 watt-hrs by 2.4, divide by 0.8, and multiply by 1.2, which yields 317 peak watts, or seven modules at 50 watts each.

506 ÷ 2.4 = 211

211 ÷ 0.8 = 264

264 x 1.2 = 317

317 ÷ 50 = 7 modules

Determining your daily energy consumption can be done through simple calculations like the example above or with the aid of sophisticated computer programs. If you are seriously considering purchasing a PV system, there are also other factors to consider. You may want to refer to other sources (see *Source List*) for more precise ways to make your calculations.

*This is based on the winter average. For more precise calculations, consult month-by-month averages and use the lowest monthly average.

Module temperature also affects output. The conversion efficiency of crystalline-silicon modules falls significantly at elevated module temperatures.

When designing a PV system, be sure your PV installer obtains data specific to your area, rather than relying on general data. The National Oceanic and Atmospheric Administration began collecting solar data nearly 20 years ago. The National Renewable Energy Laboratory's Renewable Resource Data Center (see *Source List*) can provide solar radiation information, as can EREC. Some state energy offices also have solar data-collection programs to assist solar designers. Finally, books are available that contain solar data on most major cities in the United States, and a few of these are listed in the *Reading List*.

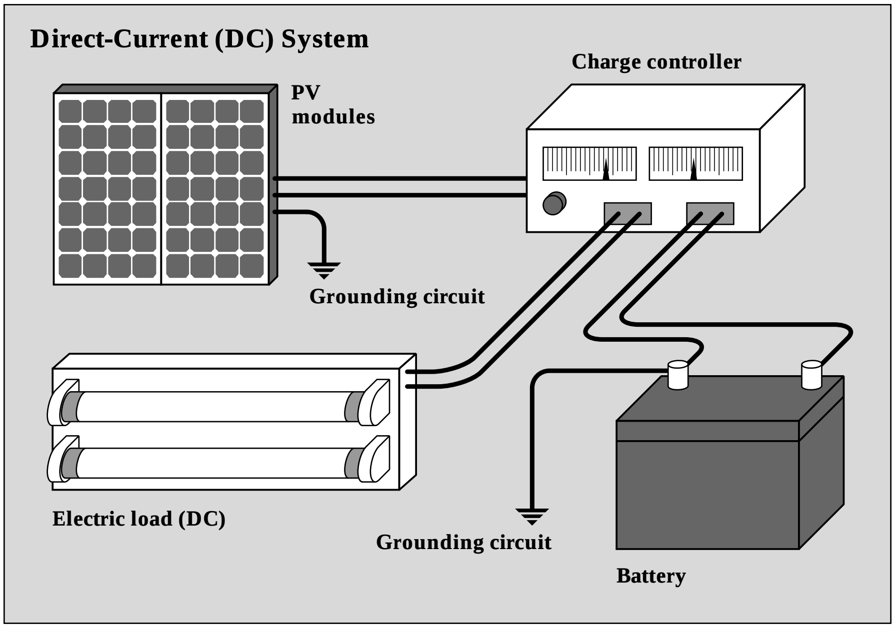
Sizing the System to Meet Your Needs

After you have assessed the appropriateness of your site, you need to determine how much electricity your PV system must generate. This depends on how much electricity your loads require. Again, your dealer can help you with sizing a system that will meet your needs. The sidebar illustrates the steps involved in sizing a PV system. You can also contact EREC for more specific information on sizing.

Balance-of-System Equipment

In addition to the PV modules, you must purchase balance-of-system (BOS) equipment. This includes battery charge controllers, batteries, inverters (for loads requiring alternating current), wires, conduit, a grounding circuit, fuses, safety disconnects, outlets, metal structures for supporting the modules, and any additional components that are part of the PV system. Below, we'll discuss PV and BOS configurations first for loads requiring direct current, then for loads needing alternating current.

Note that, in many systems, the cost of BOS equipment can equal or exceed the cost of the PV modules. When examining the costs of PV modules, remember that these costs do not include the cost of BOS equipment. Ask your PV dealer about the BOS equipment required by your system.



This figure illustrates the configuration of the PV modules and BOS equipment in a basic direct-current system with battery storage. (Circuit breakers and safety fuses are not shown.)

In addition to the PV modules, you will need to purchase balance-of-system (BOS) equipment.

Direct-Current System Equipment

Charge Controller. The charge controller regulates the flow of electricity from the PV modules to the battery and the load. The controller keeps the battery fully charged without overcharging it. When the load is drawing power, the controller allows charge to flow from the modules into the battery, the load, or both. When the controller senses that the battery is fully charged, it stops the flow of charge from the modules. Many controllers will also sense when loads have taken too much electricity from batteries and will stop the flow until sufficient charge is restored to the batteries. This last feature can greatly extend the battery's lifetime.

Controllers generally cost between $20 and $400, depending on the ampere capacity at which your PV system will operate and the monitoring features you want. When selecting a controller, make sure it has the features you need; cost should be a secondary consideration.

Battery. The battery stores electricity for use at night or for meeting loads during the day when the modules are not generating sufficient power to meet load requirements. To provide electricity over long periods, PV systems require deep-cycle batteries. These batteries, usually lead-acid, are designed to gradually discharge and recharge 80% of their capacity hundreds of times. Automotive batteries are shallow-cycle batteries and should not be used in PV systems because they are designed to discharge only about 20% of their capacity. If drawn much below 20% capacity more than a few dozen times, the battery will be damaged and will no longer be able to take a charge.

Deep-cycle batteries cost from about $65 up to $3,000. The cost depends on the type, capacity (ampere-hours), the climatic conditions in which it will operate, how frequently it will receive maintenance, and the types of chemicals it uses to store and release electricity. A PV system may have to be sized to store a sufficient amount of power in the batteries to meet power demand during several days of cloudy weather. This is known as "days of autonomy." Consult with your PV dealer before selecting batteries for your system.

Most types of batteries contain toxic materials that may pose serious health and safety problems. The National Electric Code (NEC), battery companies, and PV system designers recommend that lead-acid and wet cell batteries, which give off explosive hydrogen gas when recharging, be located in a well-ventilated space isolated from the other electrical components of the system and away from living spaces. Allow enough space for easy access during maintenance, repair, and replacement. Most important, maintain the battery according to the manufacturer's instructions, and recycle the batteries properly when they wear out.

Alternating-Current System Equipment

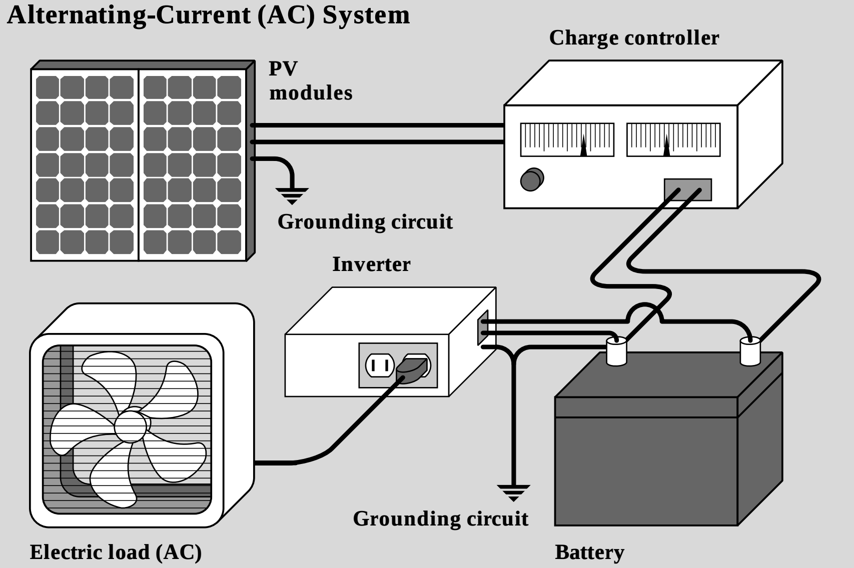
Inverter. AC systems also require an inverter, which changes the DC electricity produced by PV modules and stored in batteries into AC electricity. Different types of inverters produce a different "quality" of electricity. For example, lights, televisions, and power tools can operate on lower-quality electricity, but computers, laser printers, and other sophisticated electronic equipment require the highest-quality electricity. So, you must match the power quality required by your loads with the power quality produced by the inverter.

The National Electric Code contains provisions and requirements for PV systems.

Inverters for most stand-alone applications (i.e., those systems not connected to the utility grid) cost less than $1 per rated output watt. The cost is affected by several factors, including the quality of the electricity it needs to produce; whether the incoming DC voltage is 12, 24, 36, or 48 volts; the number of AC watts your loads require when they are operating normally; the amount of extra surge power your AC loads need for short periods; and whether the inverter has any additional features such as meters and indicator lights.

Tell your PV dealer if you plan to add additional AC loads in the future. If you are considering building another room onto your house or adding electrical loads, consider purchasing an inverter with a larger input and output rating than you currently need. This may be less costly than replacing it with a larger one later.

Alternating-Current (AC) System



Most household appliances operate on alternating current (AC). This illustrates a basic configuration of the PV modules and BOS equipment in an AC system. (Circuit breakers and safety fuses are not shown.)

The National Electric Code

The National Electric Code (NEC) was established in 1897 to ensure safety in all systems that generate, store, transport, and consume electricity. You or the dealer who installs your PV system should be careful to follow NEC's equipment requirements so that the PV system can be approved by local electric code officials. Be aware that many states require all electrical equipment to be installed by a licensed electrician.

However, many local code officials are not familiar with PV systems. Though you follow the provisions of NEC, you may have difficulty convincing a code official that you have installed a code-approved system. Contact and educate (if necessary) local code officials before you purchase and install the system. Throughout the installation process, invite them to observe what you or your dealer have done before you build any enclosure around wiring, connections, or other components. This will help ensure that your system receives approval and will also help future PV installers to get code approval.

Local insurance providers and lenders may also need to be educated about the safety, reliability, and cost-effectiveness of PV systems. Obtaining insurance will be easier in states where PV systems are more common.

What Else Do I Need to Consider?

No PV system is maintenance-free. Schedule regular inspections of your system to ensure that the wiring and contacts are free from corrosion, the modules are clear of debris, and the mounting equipment has tight fasteners.

You should also monitor the power output of your PV modules, the state-of-charge and electrolyte level of your batteries, and the actual amount of power that your loads use. Writing this information in a notebook is a good way to track your system's performance and help you determine whether your system is operating as designed. Monitoring will also help you understand the relationships between your system's power production, storage capability, and load requirements.

PV Can Power Your Future

PV systems can be cost-effective options for providing electricity to your home or remote site. However, they are not appropriate for all situations. Deciding whether a PV system is right for you depends on many factors. Therefore, conduct careful research and consult with PV equipment dealers and others who have installed these systems. If you then decide that a PV system is right for you, the power of the sun will take on a new meaning in your life.

Source List

The following are just a few of the many organizations that can help you with locating PV equipment dealers in your area and designing and installing PV systems.

The Energy Efficiency and Renewable Energy Clearinghouse (EREC)
P.O. Box 3048
Merrifield, VA 22116
(800) 363-3732
Fax (703) 893-0400
E-mail: doe.erec@nciinc.com

EREC provides free general and technical information to the public on the many topics and technologies pertaining to energy efficiency and renewable energy, including PV systems, solar energy, and solar radiation data.

Equipment, Dealers, and Installers

Renewable Energy & Efficiency Training Institute (RETI)
1800 M Street, NW
Suite 300
Washington, DC 20036
(202) 496-1417
Fax: (202) 496-1494

RETI offers customized PV design, installation, and maintenance programs to meet the needs of a wide range of customer groups.

Solar Energy Industries Association (SEIA)
122 C Street, NW
4th Floor
Washington, DC 20001
(202) 383-2600
Fax: (202) 383-2670

SEIA is the national trade organization of PV and solar thermal manufacturers and component suppliers.

Training Programs

Florida Solar Energy Center (FSEC)
Photovoltaic System Design Assistance and Training Center
1679 Clearlake Road
Cocoa, FL 32922-5703
(407) 638-1000
Fax: (407) 638-1010

FSEC offers workshops on a variety of topics related to PV system design and use.

Siemens Solar Industries (formerly Arco Solar)
Photovoltaic Technology and System Design Training Course
4650 Adohr Lane
Camarillo, CA 93012
(805) 388-6561
Fax: (805) 388-6395

Siemens offers a one-week training program on PV technology and system design.

Solar Energy International (SEI)
P.O. Box 715
Carbondale, CO 81623
(970) 963-8855
Fax: (970) 963-8866

SEI offers training programs on PV system design and installation, as well as on wind energy, mini-hydro systems, and solar home design. SEI also sells books on a variety of renewable energy topics.

On-Line Renewable Energy Information

Energy Efficiency and Renewable Energy Network (EREN)
http://www.eren.doe.gov

EREN is the Department of Energy's premier resource for information about renewable energy and energy efficiency technologies, including solar radiation and photovoltaic data.

National Renewable Energy Laboratory (NREL)
http://www.nrel.gov

NREL, one of the Department of Energy's national laboratories, leads the nation toward a sustainable energy future by developing renewable energy technologies. Its Web site includes information on many renewable energy topics. See NREL's Renewable Resource Data Center, at http://www.rredc.nrel.gov, for solar radiation information.

Reading List

Periodicals, Books, Pamphlets, and Reports

Consumer Guide to Solar Energy, S. Sklar, Bonus Books, Chicago, 1991.

Home Power Magazine: The Hands-On Journal of Home-Made Power, Home Power, Inc., P.O. Box 520, Ashland, OR 97520; (916) 475-3179; www. homepower.com.

Photovoltaic Fundamentals, National Renewable Energy Laboratory, Document No. DE-91015001, available from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161, 1991.

The Solar Electric House, S. Strong, Sustainability Press, Still River, MA, 1993.

Solar Electricity: A Practical Guide to Designing and Installing Small Photovoltaic Systems, S. Roberts, Prentice Hall, NJ, 1991.

Stand-Alone Photovoltaic Systems: Handbook of Recommended Design Practices, Sandia National Laboratory, Document No. SAND87-7023, available from National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161, 1991 (revised).

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FS 135
January 1997

ENERGY EFFICIENCY AND RENEWABLE ENERGY CLEARINGHOUSE

Small Wind Energy Systems for the Homeowner

In the 1920s and '30s, farm families throughout the Midwest used wind to generate enough electricity to power their lights and electric motors. The use of wind power declined with the government-subsidized construction of utility lines and fossil fuel power plants. However, the energy crisis in the 1970s and a growing concern for the environment generated an interest in alternative, environmentally friendly energy resources. Today, homeowners in rural and remote locations across the nation are once again examining the possibility of using wind power to provide electricity for their domestic needs.

This publication will help you decide whether a wind system is practical for you. It will explain the benefits, help you assess your wind resource and possible sites, discuss legal and environmental obstacles, and analyze economic considerations such as pricing.

Benefits of Wind Power

A wind energy system can provide you with a cushion against electric power price increases. Wind energy systems help reduce U.S. dependence on fossil fuels, and they are nonpolluting. If you live in a remote location, a small wind energy system can help you avoid the high costs of having the utility power lines extended to your site.

Although wind energy systems involve a significant initial investment, they can be

Warren Gretz, PIX 00042

Unlike yesteryear's windmill, today's wind turbines use technological innovations that have substantially reduced the cost of electricity generated from wind power.

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competitive with conventional energy sources when you account for a lifetime of reduced or altogether avoided utility costs. The length of the payback period—the time before the savings resulting from your system equal the cost of the system itself—depends on the system you choose, the wind resource on your site, electricity costs in your area, and how you use your wind system.

Is Wind Power Practical for You?

Wind turbines for domestic or rural applications range in size from a few watts to thousands of watts and can be applied economically for a variety of power demands.

Small wind energy systems can be used in connection with an electricity transmission and distribution system (called *grid-connected* systems), or in *stand-alone* applications that are not connected to the utility grid. A grid-connected wind turbine can reduce your consumption of utility-supplied electricity for lighting, appliances, and electric heat. If the turbine cannot deliver the amount of energy you need, the utility makes up the difference. When the wind system produces more electricity than the household requires, the excess can be sold to the utility. With the interconnections available today, switching takes place automatically. Stand-alone wind energy systems can be appropriate for homes, farms, or even entire communities (a co-housing project, for example) that are far from the nearest utility lines. Either type of system can be practical if the following conditions exist.

Conditions for Stand-Alone Systems

- You live in an area with average annual wind speeds of *at least* 9 miles per hour (4.0 meters per second).
- 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.
- You have an interest in gaining energy independence from the utility.
- You would like to reduce the environmental impact of electricity production.
- You acknowledge the intermittent nature of wind power and have a strategy for using intermittent resources to meet your power needs.

Conditions for Grid-Connected Systems

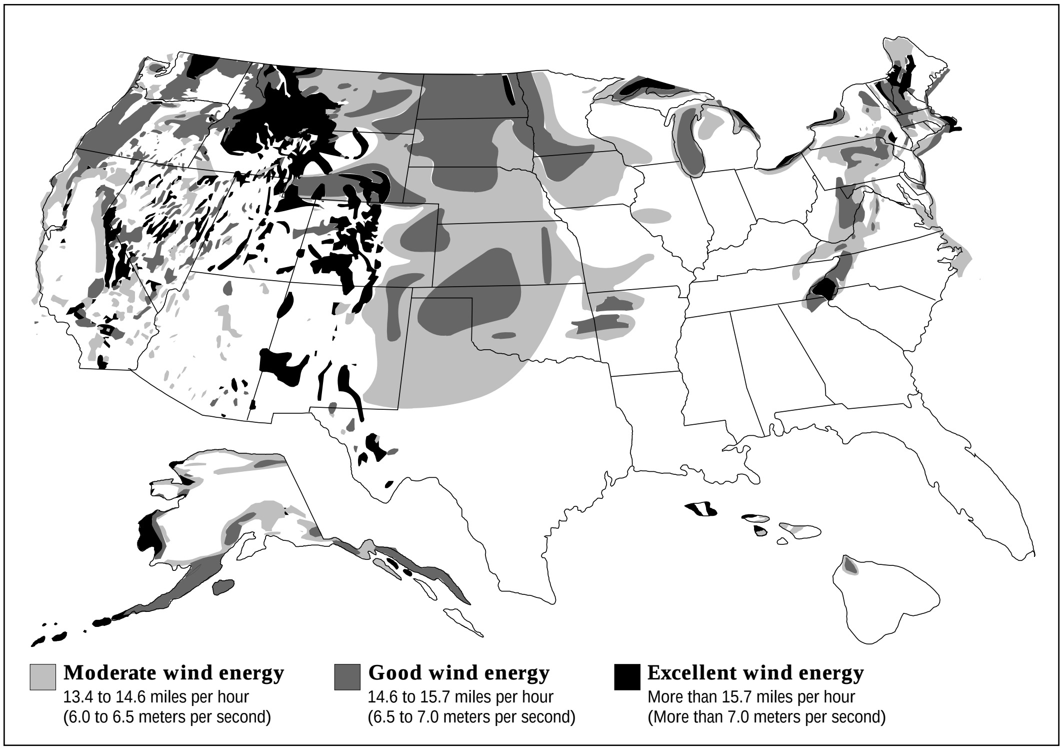
- You live in an area with average annual wind speeds of *at least* 10 miles per hour (4.5 meters per second).
- Utility-supplied electricity is expensive in your area (about 10 to 15 cents per kilowatt hour).
- The utility's requirements for connecting your system to its grid are not prohibitively expensive.
- Local building codes or covenants allow you to legally erect a wind turbine on your property.
- You are comfortable with long-term investments.

Is Your Site Right?

The U.S. Department of Energy (DOE) has compiled wind resource maps that are available from the American Wind Energy Association and the National Technical Information Service (see *Source List*). The DOE maps are good sources for regional information and can show whether wind speeds in your area are generally strong enough to justify investing in a wind system.

Wind-turbine manufacturers can use computer models to predict their machines' performance at a specific location. They can also help you size a system based on your electricity needs and the specifics of local wind patterns. However, you will need site-specific data to determine the wind resource of your exact location. If you do not have on-site data and want to obtain a clearer, more predictable picture of your wind resource, you may wish to measure wind speeds at your site for a year. You can do this with a recording anemometer, which generally costs $500 to $1500. The most accurate readings are taken at "hub height" (i.e., the elevation at the top of the tower where you will install the wind turbine—see the section on "Wind System Basics" that follows). This requires placing the anemometer high enough to avoid turbulence created by trees, buildings, and other obstructions. The standard wind sensor height used to obtain data for the DOE maps is 33 feet (10 meters).

In favorable locations, a wind turbine can reduce your consumption of utility-supplied electricity.



This map gives general information on the average wind resources available across the country. Of course, the actual wind resource on your site will vary depending on such factors as typography and structure interference.

You can have varied wind resources within the same property. If you live in complex terrain, take care in selecting the installation site. If you site your wind turbine on the top or on the windy side of a hill, for example, you will have more access to prevailing winds than in a gully or on the leeward (sheltered) side of a hill on the same property. Consider existing obstacles and plan for future obstructions, including trees and buildings, which could block the wind. Also realize that the power available in the wind increases proportionally to its speed (velocity) cubed (v^3). This means that the amount of power you get from your generator goes up exponentially as the wind speed increases. For example, if your site has an annual average wind speed of about 12.6 miles per hour (5.6 meters per second), it has twice the energy available as a site with a 10 mile per hour (4.5 meter per second) average.

Additional Considerations

In addition to the factors listed previously, you should also:

- research potential legal and environmental obstacles,
- obtain cost and performance information from manufacturers,
- perform a complete economic analysis that accounts for a multitude of factors (see the case study),
- understand the basics of a small wind system, and
- review possibilities for combining your system with other energy sources, backups, and energy efficiency improvements.

You should establish an energy budget to help define the size of turbine that will be needed. Since energy efficiency is usually less expensive than energy production, making your house more energy efficient first will likely result in being able to spend less money since you may need a smaller wind turbine to meet your needs.

Wind is derived from solar energy. When the sun heats the earth's surface unevenly, it creates differences in air temperature and atmospheric pressure, which causes wind.

Potential Legal and Environmental Obstacles

Before you invest any time and money, research potential legal and environmental obstacles to installing a wind system. Some jurisdictions, for example, restrict the height of the structures permitted in residentially zoned areas, although variances are often obtainable (see "Wind System Basics," which follows). Your neighbors might object to a wind machine that blocks their view, or they might be concerned about noise. Consider obstacles that might block the wind in the future (large planned developments or saplings, for example). If you plan to connect the wind generator to your local utility company's grid, find out its requirements for interconnections and buying electricity from small independent power producers.

Pricing a System

When you are confident that you can install a wind machine legally and without alienating your neighbors, you can begin pricing systems and components.

Approach buying a wind system as you would any major purchase. Obtain and review the product literature from several manufacturers. Lists of manufacturers are available from the American Wind Energy Association (AWEA, see *Source List*); however, not all small turbine manufacturers are members of AWEA. Manufacturer information can also be found at times in the periodicals listed in the *Reading List*. Once you have narrowed the field, research a few companies to be sure they are recognized wind energy businesses and that parts and service will be available when you need them. Also, find out how long the warranty lasts and what it includes.

Ask for references of customers with installations similar to the one you are considering. Ask system owners about performance, reliability, and maintenance and repair requirements, and whether the system is meeting their expectations.

The Economics of Wind Power for Home Use

A residential wind energy system can be a good long-term investment. However, because circumstances such as electricity rates and interest rates vary, you need to decide whether purchasing a wind system is a smart financial move for you. The case study that follows illustrates the many factors and calculations you will need to consider. Be sure you or your financial adviser conduct a thorough analysis before you buy a wind energy system.

Grid-connected-system owners may be eligible to receive a small tax credit for the electricity they sell back to the utility. For 1996, it was 1.6 cents per kilowatt hour. The National Energy Policy Act of 1992 and the 1978 Public Utilities Regulatory Policy Act (PURPA) are two programs that apply to small independent power producers. PURPA also requires that the utility sell you power when you need it. Be sure you check with your local utility or state energy office before you assume any buy-back rate. Some Midwestern rates are very low (less than $.02 / kWh), but some states have state-supported buy-back rates that encourage renewable energy generation. In addition, some states have "net billing," where utilities purchase excess electricity for the same rate at which they sell it. (The Energy Efficiency and Renewable Energy Clearinghouse—see *Source List*—has more information on net billing.)

Also, some states offer tax credits and some utilities offer rebates or other incentives that can offset the cost of purchasing and installing wind systems. Check with your state's department of revenue, your local utility, public utility commission, or your local energy office for information.

Wind System Basics

All wind systems consist of a wind turbine, a tower, wiring, and the "balance of system" components: controllers, inverters, and / or batteries.

Wind Turbines

Home wind turbines consist of a *rotor*, a *generator* mounted on a frame, and (usually) a *tail*. Through the spinning blades, the rotor captures the kinetic energy of the

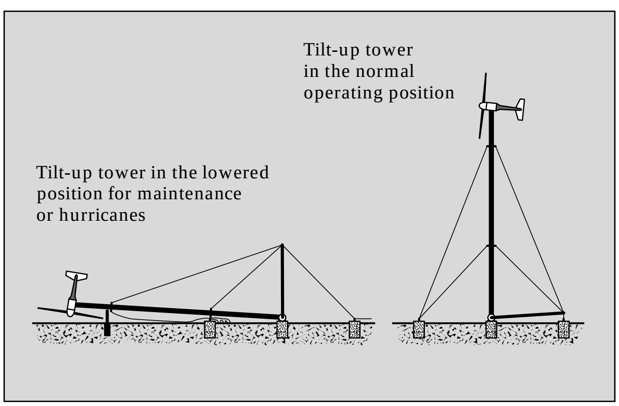
The highest average wind speeds in the United States are generally found along sea coasts, on ridge lines, and on the Great Plains, but many areas have wind resources strong enough to power a wind generator economically.

wind and converts it into rotary motion to drive the generator. Rotors can have two or three blades, with three being more common. The best indication of how much energy a turbine will produce is the diameter of the rotor, which determines its "swept area," or the quantity of wind intercepted by the turbine. The frame is the strong central axis bar onto which the rotor, generator, and tail are attached. The tail keeps the turbine facing into the wind.

A 1.5-kilowatt (kW) wind turbine will meet the needs of a home requiring 300 kilowatt-hours (kWh) per month, for a location with a 14-mile-per-hour (6.26-meters-per-second) annual average wind speed. The manufacturer will provide you with the expected annual energy output of the turbine as a function of annual average wind speed. The manufacturer will also provide information on the maximum wind speed in which the turbine is designed to operate safely. Most turbines have automatic speed-governing systems to keep the rotor from spinning out of control in very high winds. This information, along with your local wind speed distribution and your energy budget, is sufficient to allow you to specify turbine size.

Towers

To paraphrase a noted author on wind energy, "the good winds are up high." Because wind speeds increase with height in flat terrain, the turbine is mounted on a tower. Generally speaking, the higher the tower, the more power the wind system can produce. The tower also raises the turbine above the air turbulence that can exist close to the ground. A general rule of thumb is to install a wind turbine on a tower with the bottom of the rotor blades at least 30 feet (9 meters) above any obstacle that is within 300 feet (90 meters) of the tower.



Bergey Windpower

Towers can be hinged so they can be lowered to the ground for maintenance or during very high winds.

Experiments have shown that relatively small investments in increased tower height can yield very high rates of return in power production. For instance, to raise a 10-kW generator from a 60-foot tower height to a 100-foot tower involves a 10% increase in overall system cost, but it can produce 25% more power.

There are two basic types of towers: *self-supporting* (free standing) and *guyed.* Most home wind power systems use a guyed tower. Guyed-lattice towers are the least expensive option. They consist of a simple, inexpensive framework of metal strips supported by guy cables and earth anchors.

However, because the guy radius must be one-half to three-quarters of the tower height, guyed-lattice towers require enough space to accommodate them. Guyed towers can be hinged at the base so that they can be lowered to the ground for maintenance, repairs, or during hazardous weather such as hurricanes. Aluminum towers are prone to cracking and should be avoided.

Balance of System

Stand-alone systems require batteries to store excess power generated for use when the wind is calm. They also need a charge controller to keep the batteries from overcharging. Deep-cycle batteries, such as those used to power golf carts, can discharge and recharge 80% of their capacity hundreds of times, which makes them a good option for remote renewable energy systems. Automotive batteries are shallow-cycle batteries and should not be used in renewable energy systems because of their short life in deep cycling operations.

In very small systems, direct current (DC) appliances operate directly off the batteries. If you want to use standard appliances that require conventional household alternating current (AC), however, you must install an inverter to convert DC electricity to AC. Although the inverter slightly lowers the overall efficiency of the system, it allows the home to be wired for AC, a definite plus with lenders, electrical code officials, and future home buyers.

The power available in the wind increases proportionally to the cube of its velocity (v^3).

For safety, batteries should be isolated from living areas and electronics because they contain corrosive and explosive substances. Lead-acid batteries also require protection from temperature extremes.

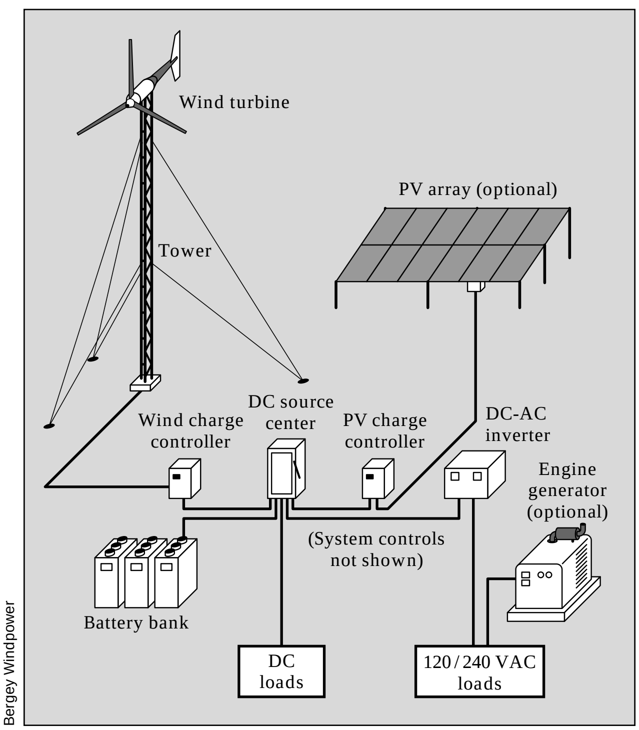
In grid-connected systems, the only additional equipment is a power conditioning unit (inverter) that makes the turbine output electrically compatible with the utility grid. No batteries are needed. Work with the manufacturer and your local utility on this.

Hybrid Wind Systems

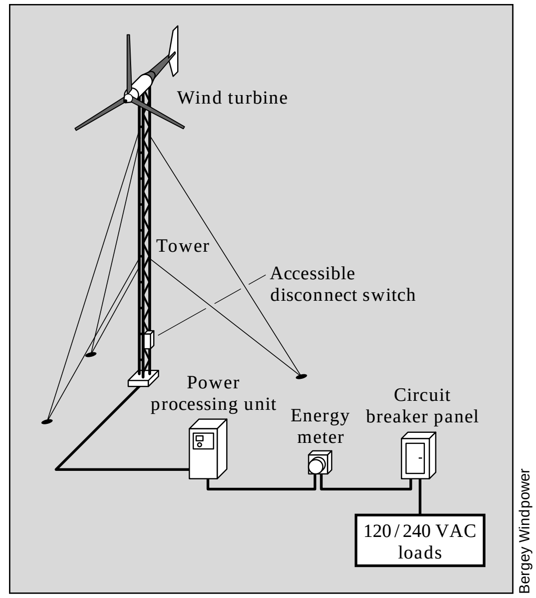
According to many renewable energy experts, a stand-alone "hybrid" system that combines wind and photovoltaic (PV) technologies offers several advantages over either single system. (For more information on solar electric—or photovoltaic—systems, contact the Energy Efficiency and Renewable Energy Clearinghouse—see *Source List*.)

In much of the United States, wind speeds are low in the summer when the sun shines brightest and longest. The wind is strong in the winter when there is less sunlight available. Because the peak operating times for wind and PV occur at different times of the day and year, hybrid systems are more likely to produce power when you need it.

For the times when neither the wind generator nor the PV modules are producing electricity (for example, at night when the wind is not blowing), most stand-alone systems provide power through batteries and/or an engine-generator powered by fossil fuels.



Hybrid systems, which use both wind and photovoltaic components to capitalize on the strengths of each technology, can offer more reliability than either system alone.



A wind system that hooks into the existing power grid makes economic sense if electricity is expensive and the electrical load coincides with windy weather.

If the batteries run low, the engine-generator can be run at full power until the batteries are charged. Adding a fossil-fuel-powered generator makes the system more complex, but modern electronic controllers can operate these complex systems automatically. Adding an engine-generator can also reduce the number of PV modules and batteries in the system. Keep in mind that the storage capability must be large enough to supply electrical needs during noncharging periods. Battery banks are typically sized for one to three days of windless operation.

The Future of Wind Power

By investing in a small wind system, you can reduce your exposure to future fuel shortages and price increases and reduce pollution. Deciding whether to purchase a wind system, however, is complicated; there are many factors to consider. But if you have the right set of circumstances, a well-designed wind energy system can provide you with many years of cost-effective, clean, and reliable electricity.

Today's wind power systems are durable, reliable, and efficient, capable of producing clean, cost-effective power.

Case Study: Wind Power Economics of a Home System

Note: In this analysis, we have assumed a certain set of conditions, such as wind regime, maintenance costs, etc. Your analysis will differ for your set of circumstances. This case study is for illustration purposes only.

A New England homeowner is considering taking out a 20-year loan to purchase a $10,000 wind system (turbine, tower, inverter, and battery storage) for generating her own electricity, instead of paying her full electricity bills for the next 20 years.

Assume that the wind turbine she has chosen is rated at 3 kilowatts with the turbine 80 feet (24 meters) above the ground, and that she lives in a Class 4 wind regime (average wind speed of 12.5 to 13.4 miles per hour [5.6 to 6 meters per second] measured at 33 feet [10 meters] above the ground). Given these assumptions, the turbine can produce an estimated 9000 kilowatt hours (kWh) per year, or 750 kWh per month. Also assume, for the sake of simplicity, that she will use all of the electricity herself and will not sell any back to the utility. Therefore, the value of the electricity to her is equal to the retail price she pays the utility; in this case, 12 cents per kWh.

Continuing to Pay Electricity Bills
If she continues to pay her electricity bills without the wind turbine, the retail value of the electricity is $1,080 the first year. In later years, the price of electricity increases. For this analysis, we assume that the cost of electricity increases at the same rate as inflation—3% a year. Thus, the 9000 kWh will cost $1,112 in the second year, $1,146 the third year, and so forth, until the total inflation-adjusted cost of electricity for 20 years is $29,020.

Purchasing a Wind System
She can obtain the least-expensive loan by taking out a second mortgage on her home. She can borrow $10,000 at 8%, and make payments of $1,019 for 20 years. But she can deduct the portion of her payments that go toward interest at her 30% combined federal and state tax rate. Thus, after taxes, her annual payment is $779 for the first year, and increases to $996 as the interest deduction decreases in later years.

However, there are other costs to owning a wind turbine. Her property taxes will be higher because the wind turbine increases the value of her property. She will pay additional insurance since her standard homeowner's policy does not cover liability from the wind tower. And she will hire a local mechanic to climb the tower and grease the bearings every year. Altogether, she figures these operations and maintenance (O&M) costs will be about 1 cent / kWh or $100 per year in today's dollars. Let us assume for this analysis that taxes, insurance, and labor rates increase at the same rate as inflation. Thus, annual O&M costs increase to $175 in the 20th year. So, over 20 years, her total inflation-adjusted cost for buying a wind system is $19,678.

Net Present Value of Both Options
However, our example is still not complete. Economists tell us that future dollars are worth less than present dollars. It is better to have money now, rather than in the future, so we can use it to invest and earn more money. Even though inflation increases her annual electricity payments after 20 years to $1,894, those are *future* dollars, so they are worth less than today's dollars. Economists refer to this devaluation as the net present value factor, the rate at which future dollars are discounted compared to present dollars. This discount rate is equal to the rate of return that she could make on an investment of equivalent risk and liquidity to a wind turbine. In this evaluation, assume her opportunity for return on investment with today's dollars (i.e., the discount rate for her future dollars) is 10% a year.

Therefore, projecting her electric utility payments into the future to, say, the end of the first year, the dollars are worth 90% of what they were at the beginning of the year. At the end of the second year, the dollars are worth 90% of what they were at end of the previous year. (Notice the value of her future dollars depreciates at a compounded rate.) Considering these adjustments, her annual electricity payment in the 20th year is actually worth only $156 in today's dollars. Thus, her total cost of buying electricity for 20 years, adjusted for inflation and present value factors, is only $8,927 in today's dollars.

Another way to think of it is that her payment in the 20th year is really a *deferred* payment. She does not have to pay $29,020 today. Since the utility company allows her to pay her bills *as she uses the electricity*, she does not have to make any large capital expenditures. So she has more of her money to invest for 20 years. This would not be true if she had to pay for 20 years of electricity up front.

But net present value factors also apply to purchasing a wind system, because she is making deferred payments on her loan. Her payments of $1,154 in year 20 are really worth only $95 in today's dollars, for instance. Therefore, her total cost for buying a wind system, adjusted for inflation and net present value, is only $6,426 in today's dollars.

The Final Analysis
So in real terms, she saves $2,501 over 20 years by purchasing a wind system, as opposed to continuing to pay her electricity bills. An added benefit is that she would avoid the release of 40 tons (40 metric tons) of carbon dioxide, 800 pounds (363 kilograms) of nitrogen oxide, and 280 pounds (127 kilograms) of sulfur dioxide into the atmosphere—the amount of pollution that a utility company in the Northeast would emit to supply her electric load for 20 years, on average.

Source List

The following organizations can provide you with information to help decide whether a wind energy system is right for you.

Alternative Energy Institute (AEI)
West Texas A&M University
Box 248
Canyon, TX 79016
(806) 656-2296
Fax (806) 656-2733

AEI conducts field trials at its Wind Turbine Test Center and is a source of information on small wind turbines.

American Wind Energy Association (AWEA)
122 C Street, NW, 4th Floor
Washington, DC 20001
(202) 383-2500
Fax (202) 383-2505

AWEA is a source for DOE wind maps, lists of manufacturers and dealers, information on wind power tax credits, and other wind energy information.

National Technical Information Service (NTIS)
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4650
http://www.ntis.gov

NTIS has over 3 million publications that are available to the public. They offer a free catalog that lists a selection of these documents.

For free information about many kinds of energy efficiency and renewable energy topics, contact:

The Energy Efficiency and Renewable Energy Clearinghouse (EREC)
P.O. Box 3048
Merrifield, VA 22116
(800) 363-3732
Fax: (703) 893-0400
E-mail: doe.erec@nciinc.com

EREC provides free general and technical information to the public on the many topics and technologies pertaining to energy efficiency and renewable energy.

You may also contact your state and local energy offices for information on region-specific information on small wind energy systems.

Reading List

Periodicals

Backwoods Home
1257 Siskiyou Boulevard, #213
Ashland, OR 97520
(916) 459-3300

This publication is devoted to independent living, including independent energy systems.

Home Energy
2124 Kittredge Street, No. 95
Berkeley, CA 94704-9942
(510) 524-5405

This source provides information on reducing energy consumption.

Home Power
P.O. Box 520
Ashland, OR 97520-0520
(916) 475-3179

This periodical provides practical information, case studies, and advice on designing, installing, and living with small power systems.

Books

A Siting Handbook for Small Wind Energy Conversion Systems, Battelle Pacific Northwest Laboratory, National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161, 1980.

The Wind Power Book, J. Park, Chesire Books, Palo Alto, CA, 1981. This book is currently out of print, so check your local library for availability.

Wind Power for Home & Business: Renewable Energy for the 1990s and Beyond, P. Gipe, Chelsea Green Publishing Company, P.O. Box 130, Route 113, Post Mills, VT 05058-0130, 1993.

Wind Energy Resource Atlas of the U.S., Battelle Pacific Northwest Laboratories. Available from the American Wind Energy Association or the National Technical Information Service (see *Source List*).