Solar Energy

xxx

There are five sections:

Introduction. xx

Frequently Asked Questions (FAQ). Basic questions in traditional Q/A format. When the brief answers are covered in more detail in either the Discussion or the Quik-Ref, that is indicated. (***Note:*** If you have a basic question that we missed, please email bsanders@boonieliving.com)

Discussion. An overview of both wildfires and structural fires, and preventive measures you can take. As compared to the **Quik-Ref** section, the Discussion is normal, essay-style descriptions.

Quik-Ref. A reference section that combines short answers, glossary, statistical data, directory information, and resources for further study. As compared to the **Discussion** section, the Quik-Ref is easy-in/easy-out.

Appendixes. xx ***[what for this pamphlet?]***

See also: The more general "Power" pamphlet contains an introduction to solar energy and a comparison of solar, wind, generator, and grid sources of energy.

Introduction

Fire is like water or wind: it will find the weak spot in your xxx and exploit it. A partial fire safety program is not enough if the danger materializes in ways you haven't prepared for.

texxt.

FAQ

The following questions are answered in this FAQ:

xxxx

Does a solar house look different? Will using solar energy affect my lifestyle?

Minimally, and minimally. The only visual difference is the addition of solar collectors, and those are becoming so common that many people hardly notice. And a well designed solar energy system adds only a few minor inconveniences (like checking the water level in the batteries every few months), while often making major improvements (like eliminating cold spots, and making monthly bill-paying much more pleasant). Modern solar equipment should last for 10 or more years.

What's the difference between "active" and "passive" solar energy?

Active solar energy involves producing direct current from sunlight. It is commonly called photovoltaic, and most of this pamphlet will deal with it.

Passive solar energy is the heating of ambient objects (normally water, air, or driveways) with sunlight. It's importance cannot be exaggerated, because efficient use of passive solar can cut your active solar requirements considerably.

What are the components of a photovoltaic system?

These are the main components:

Collector(s): Captures sunlight and converts it to DC electricity. Individual cells comprise a module (or panel), several of which comprise an array.

Tracker. Keeps collector(s) aimed towards the sun.

Controller. Regulates power to and from batteries.

Combiner box. xxx

Batteries: Stores the DC electricity created by the collector(s).

Inverter: Converts DC to AC.

Wires: Important because the size of the wire influences amperage (and therefore wattage).

What are the most important things I should consider when setting up a solar system?

There are three basics:

Usage. After you have put all the efficiencies you can into place, how much energy do you use?

Production. Given your location (latitude, altitude, weather, view of sun, efficiency of your collectors), how much energy can you make? This determines your collector capacity.

Storage. Given your usage, worst-case weather scenario, and your willingness to use a backup source of energy, how many days can you go without making more? This determines your battery capacity.

Details of calculating these factors are in Section 2: Overview.

Why don't I get 12 hours of energy-making value for 12 hours of sunlight?

A "full sun hour" occurs when all factors are optimal: clear sky, sun shining into collectors at approximately 90°, no obstructions. This happens only around mid-day, on a clear day, assuming the collectors are properly aimed. In mainland of the US, the average for full sun hours is between three and six. ***[insolation]***

Where should I place the collector panels?

There are three primary criteria: (1) as close to south-facing as possible, and (2) where buildings and trees don't hide the low winter sun; and (3) at approximately xx^{o} angle. As long as those three requirements are met, there are several alternatives, each with advantages and disadvantages:

Roof top: The height offers protection and (normally) an unobstructed view of the sun. But the panels are harder to get to for adjustments and repairs.

Ground: The advantages and disadvantages of ground placement are just about the reverse of roof-top location. Avoid placing them too close to the road; the glass face on the panel is easily damaged by rocks passing vehicles kick up.

Stanchion: xxxx

Isn't there more than one way to produce solar power?

There are two primary photovoltaic technologies:

crystalline silicon: xxxx

thin film: xxxx

Don't overlook **passive solar** (also called solar thermal) It does not produce power – but it provides heat naturally, so you don't have to produce as much power.

How much energy do I use? (With Public Service, I just pay the bill)

You've hit the problem exactly: when the power occurs "magically", you don't know what's really happening. Your consumption obviously will depend on your lifestyle. The table below indicates approximate energy needs for typical equipment (the figure after the slash is the brief startup surge):

Equipment	watts	Equipment	watts	Equipment	watts
coffee maker	1200	freezer	300/1500	refrigerator	58/700
clothes dryer (gas)	500/1800	laser printer	900	stereo	55
computer	50	light bulb (flouresc)	12-25	toaster	1200
dish washer (cool dry)	700/1400	microwave (1 cu foot)	1000	trash compactor	1500/1500
electric blanket	400	pump, service		TV (19", color)	80
fax machine (standby)	5	pump, well (1 HP)		wash machine (horiz)	250/750

For a more complete list, see: Appendix A.

Most families of four use between xxx and xxx. But, as you can see, babies, extensive use of power equipment, xxx, and xxx put you out of the "most families" category pretty quickly.

Should I convert the energy I produce with solar *[include wind?]* to AC, or leave it in DC?

The AC vs DC argument has been going on since Thomas Edison's marketing strategy got the better of xxx Westinghouse's in the late 1800s. Very briefly:

AC Advantages: transmits well over long distances. **AC Disadvantages:** more dangerous at high voltages.

DC Advantages: more efficient operation. **DC Disadvantages:** DC appliances are often hard to find and large utilities (refrigerators, etc.) are expensive.

If I have a good solar configuration, do I still need a backup source?

Absolutely, probably either a generator or the public service grid. It should be tested frequently and have both automatic and manual switch over to it.

Are any special permits required for solar energy?

Most jurisdictions will only inspect your electrical system in general to see that it operates properly; there are no special requirements if you are generating all or part of your power by solar technology.

Is solar equipment vulnerable to lightning?

Yes, very. If you live in an area that is prone to lightning strikes, be sure that your solar system is very well grounded ***away from all other items.***

For what is electrical energy particularly ineffective?

Heating. Electrical heating is inefficient and costly. Fortunately, passive solar is an excellent heating source, and an alternative such as propane/LP gas can pick up the rest of the heating requirement.

What voltage do I want: 12, 24, or 48?

This is primarily determined by system size: xxxx.

Can I add solar capability to an existing conventional home?

Yes, and you will see advantages – but solar energy is a holistic system, which is best designed from the ground up. For example:

- Good insulation reduces heating costs ***and*** the energy needed to distribute heated air.
- Orientation of the house and positioning of roof and windows greatly increases passive solar heating (and, to some degree, also cooling) capability, and reduces lighting costs.
- Most conventional appliances waste huge amounts of energy.

Normally the best practice with an existing conventional home, is to look first to energy conservation. Then, after savings have been achieved, consider installing a photovoltaic system.

How much space does a PV system need?

There are two parts to this question: what is needed for the panels and for the internal equipment.

Panels: Depends on capacity and where placed (roof, ground, stanchion). Normally four to eight panels, each approximately 4 X 8 feet.

Internal Equipment: Depends primarily on number of batteries, but more than a small closet, less than a small room. Ventilation (and possibly heating) will be required where the batteries are stored.

Where can I learn more?

You can choose between Websites, printed materials, and local contacts; here are some of the most important general sources. (There's a more complete list in the **Resources** in the Quik-Ref):

Websites:

xxx

Books:

xxx

Articles:

xxx

Local:

National Renewable Energy Laboratory [phone]

2. Overview of Solar Energy *[Choose better wording]*

Elements of a Successful Solar Strategy

Use all three.

Active Solar (Photovoltaic)

xxxx. Choose one or the other.

Crystaline silicon. xx

Thin film. xx

Passive Solar

Do not underestimate the power of passive solar, especially for heating.

Conservation

xxxx.

Some quick rules of thumb:

- Eliminate as many "ghost loads" as possible.
- Use only energy efficient appliances (read label on back or bottom of unit).
- Use fluorescent or xxx lighting.
- Limit electrical heating.
- Use only "on demand" water heating.
- Use "low flow" toilets and nozzles.

Consider hiring a consultant to do an energy audit; the savings can pay the cost.

Calculations

To determine your solar capacity needs, first maximize the savings as described above. Then:

1. Calculate insolution
2. Calculate your power consumption.
3. Calculate how much capacity you need at your location to produce that power.
4. Calculate how many days (worst case scenario) you would need to store that capacity.

Each of these calculations is described below.

Insolution

The first step is to determine the amount of sun you can expect. ***[summer? winter?]***

1. xxxx.
2. xxxx.
3. xxx.

The only way to improve the figure is to select a better location for the collectors, and to consider tracking. (Having a backup location for another array is good, cautious planning.)

Power Consumption

xxxx. Be strict; don't be lenient.

1. Calculate use initially.
   Use the tables in App. A.
2. Determine reasonable efficiencies.
   Consider lifestyle changes, more efficient appliances, passive solar.
3. Recalculate use.

To improve the figure, xxx.

Collector Capacity

xxx ***[see Sunelco catalog]***

1. Divide insolation figure ***[winter or summer?]*** into consumption figure. This yields watthours of production required during each hour of full sun.
2. Determine rated production capacity of selected collector panels (amps X charging volts for new equipment; best estimate for used equipment).
3. Divide line 2 into line 1. This yields the number of panels required.

To improve the figure, the only solution is to use panels with a higher rating.

Battery Capacity

xxx ***[see Sunelco catalog]***

1. Determine number of days, in the worst case scenario, that you might be unable to make power.
   Normally weather-related.
2. Modify by your willingness to resort to backup power.
3. De-rate your batteries for loss of efficiency in worst-case temperature scenario, and the reduce by .5 or .8, depending on how low you are willing to draw them down.
4. Round the number of batteries (to even number for xx-volt, to groups of 4 for xx-volt; to groups of 8 for xx-volt).

To improve the figure, increase battery capacity, or accept earlier use of backup power.

Maintenance Procedures

A well designed PV system requires only minor maintenance. ***[List either by type (i.e., "batteries"), or by tickler (i.e., "monthly")***

xxxx

3. Quik-Ref™

This section contains an acronym list, a glossary, and resources. Includes all terms used in this pamphlet, and others you might encounter as you learn about solar energy.

Acronyms & Initialisms

If more information is included in the Glossary, the bold-faced portion of the definition will indicate it. ***[check to make sure]***

AC	**alternating current**	**LED**	light-emitting diode
AWG	xxx	**NEC**	National Electric Code
COSEIA	Colorado Solar Energy Industries Assn.	**NREL**	Nat'l Renewable Energy Laboratory
DC	**direct current**	**PSIC**	Passive Solar Industries Council
DOE	Dept. of Energy	**PV**	photovoltaic
EREC	xxx	**RMS**	root mean square. (**AC**)
HBCO	high battery cut-out	**UF**	xxx
Hz	**herz**	**UL**	Underwriters Laboratories
kV	kilo**volt**	**VA**	volt-amps ***[=watts?]***
kW	kilo**watt**	**VAC**	volts AC
LBCO	low battery cut-out	**VDC**	volts DC

Glossary

xxxx. **Bold-faced** terms in the definitions are themselves entries in the Glossary.

active solar

Making electricity directly from the sun, also called **photovoltaic** (PV). *Cf.* **passive solar**.

alternating current (AC)

Current that changes polarity with a frequency that is called **hertz**. It is xxxx, but also more dangerous at high voltages. *Cf.:* **DC (direct current)**.

amperage

The measurement of the amount of current being transferred through a connector (normally a wire). *Cf.* **volts**. The basic equation is: volts X amps = watts. ***[Use better analogy than the water pipe.]***

array

A collection of **modules**. The needs of most homes requires one or more arrays, each composed of two or more modules.

batteries

xxx. There are several kinds: ***[Not all will be applicable to solar]***

alkaline: xxx

deep cycle: Refers to a lead-acid battery which can discharge nearly completely and still be usable. (Repeated discharge below 20%, however, will reduce its capability.)

lead-acid: xxx

NiCad: Nickel-cadmium. xxx

NiFe: Nickel-iron. xxx

cell

The smallest unit of PV electrical production – but it doesn't make enough to be useful, so individual cells are linked together in **modules**. An **array** is a group of (normally adjacent) modules to produce power.

charge controller

The electrical component that determines where current is distributed:

- It first provides power for items currently in use, then sends remainder to batteries if not fully charged.
- When batteries are fully charged, it discards the excess (or sends it to the utility grid, if applicable).
- It starts and stops backup power supply (such as generator or grid) in order to maintain battery capacity within set range.
- xxxx
- It creates error messages when it cannot correct a stiuation.

collector

A general term describing the solar configuration (**cells** in one or more **modules**, and modules in one or more **arrays**) that produce electricity from the sun.

crystalline silicon

One of two basic PV technologies (see also **thin film**). xxx ***[hyphenate?]***

current

There are two types of current:

alternating current (AC). It is xxxx, but also more dangerous at high voltages. ***[transported long distances?]***

direct current (DC). xxx

There are also two measurements of current: ***[the two together make wattage]***

amps. The amount of current used or transported.

volts. The pressure with which it is applied.

deep cycle

Describes a battery that can routinely be discharged down to 20% capacity without immediate damage (although rarely discharging below 50% will prolong battery life). PV batteries should always be deep cycle.

direct current (DC)

The type of current that is produced by the **collectors** and stored in the batteries; for use in most appliances, it must be converted to **alternating current** in an **inverter**. Direct current is not as dangerous as AC.

efficiency

The ratio of output to input. There are three major efficiencies to consider:

A solar **collector** has an efficiency of ± 15% (that is 15% of the sun's energy that hits the collector is converted to electricity).

Inverters also have an efficiency, which is largely dependent on power level (xxx)

Battery efficiency is largely dependent on temperature. Efficiency drops sharply with temperature; at 20º F, efficiency is less than 2/3 of what it is at 80º F.

ghost loads

Small usages of electricity that are normally overlooked:

- quick-starting circuitry (TVs, *e.g.*)
- AC-to-DC conversion cubes
- LED readouts
- smoke detectors
- answering machines
- cordless phones, etc.

Cumulatively, these loads can be significant, especially since many operate constantly, 24 hours/day. Almost all houses have at least a few, so your solar inverter runs constantly, shortening its life expectancy.

You can detect ghost loads with the following procedure:

1. xxx.
2. xxx.

Try to eliminate as many as you can (get a stove and VCR that don't have LED readouts; choose a TV that takes a few seconds to warm up; etc.). Then decide to (a) accept the ones that are left, (b) isolate them on a DC circuit, or (c) install a smaller inverter to run them, reducing the strain on your main system. ***A single LED readout on a clock means that your inverter will never get a rest.***

grid

The public power infrastructure that supplies electricity to most homes and businesses.

heating

Photovoltaic energy is not efficient for heating. These requirements are met primarily by LP gas and by **passive solar** methods.

herz

xxx

impedance

The opposition to **alternating current**. *Cf.* **resistance**.

insolation

The measurement of the amount of sunlight available. It is measured in "full sun hours", and averages 4-6 hours/day, depending on latitude, weather, season, and position of the **collectors**. ***[list loss types?]***

inverter

The equipment that converts the DC current produced by the collector to AC current that conventional appliances use. (***Note:*** Actually, many common items use DC: battery-operated appliances, computers, xxx. The 2-inch square boxes you plug into the wall are really mini-inverters.

lightning

xxxx

load

The amount of power used by any electrical item. The loads of all items currently running are cumulative.

module

A grouping of adjacent **cells**; normally the smallest practical generating unit. Generally several modules are grouped together to form an **array**, which is sometimes called a panel.

panel

See: **module**.

passive solar

The heating of ambient objects (air, water, driveways, etc.) with energy from the sun. Maximizing southern exposure is the primary method of deriving passive solar, but positioning of roof eaves and type of window glass are also involved. Dark roof colors and asphalt driveways absorb solar energy, and therefore melt snow faster. The primary passive solar technique is **solar thermal**. *Cf.* **active solar**.

photovoltaic

The conversion of sunlight to electricity, the primary type of **active solar** energy. *Cf.* **solar thermal**.

polarity

The direction of movement of electrons. In **alternating current**, the polarity is reversed at a frequency defined as **herz**; in **direct current**, the polarity does not reverse.

power

See: **watts**.

resistance

The opposition to **direct current**. *Cf.* **impedance**.

shading

Anything between the collector and the sun: clouds are the main culprit, but even the branch of leafless tree can be significant. Some types of collectors adapt to the shading problem better than others; it is even more of a problem with older technology, because besides deadening the shaded cell (causing zero production), the shade actually causes a loss of energy.

solar thermal

The absorption of sunlight by an object, thereby raising its temperature; solar thermal is the main **passive solar** technique. Good examples are: a water tank with a dark surface; a dark-colored driveway; south-facing windows.

temperature

xxx. ***[Quantify the reduction of efficiency]***

thin film

One of two basic PV technologies (see also **crystalline silicon**). xxx ***[hyphenate?]***

voltage

The measurement of the pressure of current through a wire. *Cf.* **amperage**. The basic equation is: volts X amps = watts. ***[The water pipe analogy doesn't work for me]***

wattage

The product of **amperage** times **voltage**; in other words, the measurement of the total amount of power used by an appliance. The basic equation is: volts X amps = watts.

watthour

The basic measurement used to determine the capacity that a solar system must produce: if the **collectors** can't produce more watthours than is consumed, battery reserves are drawn down; if this continues for an extended period (so that a preset minimum of battery power is reached), the designated backup source of energy is activated. Proper calculation of watthours minimizes this occurrence.

next term

def

Resources

The section is divided into (1) printed materials, (2) online materials, and (3) directory. It lists sources of information for solar energy only; there are also resource lists in the pamphlet on "Power" and "Introduction".

Printed Materials

HomePower. xxx
[annotation]. ***[Is this a mag? Put it in* "Power" *pamphlet instead of here?]]***
Passive Solar Design Strategies: Guidelines for Home Builders. Denver: Passive Solar Industries Council, n.d.
[annot
Real Goods Solar Living Sourcebook, 10th ed. Ed. by Doug Pratt. White River Junction, VT: Chlesea Green Publ., 1999. Pbk., 562pp. ISBN: 0-916571-03-3.
[annotation]

Online Materials

Alternative energy Source Page. Http://www.life.ca/subject/energy.html
[annotation]
COSEIA (Colorado Solar Energy Industries Assn.) Website. Http://www.coseia.org
[annotation]
Environmental Organization Web Directory. Http://www.webdirectory.com/science/energy/alternative_energy/Solar_Energy/
[annotation]
Jade Mountain Online Catalog. Http://www.jademountain.com
[annotation]
James Dulley's Sensible Home. Http://www.dulley.com
[Nationally syndicated columnist (Rocky Mountain News), with wide-ranging, practical advice. Online reports are more extensive, cost less than $3/each.]
Mr. Solar. Http://www.mrsolar.com
[annotation]
Real Goods Online Catalog. Http://www.realgoods.com
[annotation]
Solar & Renewable Energy Products. Http://www.ecomall.com/solarcat.htm
[annotation]
Solar Business List. Http://www.rt66.com/rbahm.business.htm
[annotation]

Solar Radiation Resource. ???rredc.nrel.gov/solar/old_data/nsrdb/atlas/
[annotation]

Directory

Entry
DirInfo
[Annotation]

Colorado Solar Energy Industries Assn. (COSEIA)
DirInfo
[Annotation]

Delta Lightning Arrestors
PO Box 1084, Big Spring, TX 79721
800/351-1464
[Maker of high-quality surge arrestors]

EREC
DirInfo
[annot.]

Kyocera
DirInfo
[xxx]

National Fire Protection Assn.
DirInfo
[Creator of National Electric Code (NEC).]

Passive Solar Industries Council
DirInfo
[annot.]

PhotoComm, Inc.
7681 E. Gray Rd.
Scottsdale, AZ 85260
800/223-9580 / 602/483-6431 (f)
[annot]

Solar Energy Resources
5447 So. Swadley Ct., Littleton, CO 80127
303/979-1899 (v) / 303/979-1577 (f) / Iwinso06@aol.com
[Authorized Photocomm dealer. Provides installation and onsite maintenance.]

Sunelco
100 Skeels St. PO Box 787, Hamilton, MT 59840-0787
406/363-6924 (v)
[Mail order retailer of solar equipment. Catalog also contains information on solar energy.]

Xantrex Technology, Inc.
5916 – 195th St., NW
Arlington, WA 98223
360/435-8826 / 360/435-2229 (f)
www.traceengineering.com
[annot]

4. Appendixes

xxxx

A: List of Electrical Loads

Common household items. (Given in xxx; figure after the slash is brief startup surge.)

Table A.1: List of Electrical Loads

[Table of loads]

B: Next Appendix

xxx

Intellectual Property

The following trademarks, registered trademarks, and service marks are held as indicated.

Mark	Ownership
Quik-Ref™	BoonieLiving, LLC
National Electric Code®	National Fire Protection Assn.
NEC®	National Fire Protection Assn.
Photocomm	xxx
Real Goods	xxx
Trace™	Trace Engineering
xxx	xxx

Do-List:

Photo-grey windows