

Residential Energy Consumer Education



AGRICULTURAL EXTENSION SERVICE UNIVERSITY OF MINNESOTA

Interested in Solar?

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If you can answer yes to the following questions, then you are ready to consider solar energy for heating your home and hot water. If you are planning to build a new house, you may wish to install solar heating at the same time, or provide space for solar collectors and heat storage. If so, be sure that you can answer yes to the 10 questions with your new house.

Check, if yes

1. Is your house relatively air-tight?
(Use the candle test to look for drafts around windows, doors and foundations. Your house should not change air more than once per hour. Weatherstripping and caulking are necessary in most cases.)
2. Do you set your thermostat lower at night?
(You may want to buy an automatic thermostat for nighttime setback.)
3. Have you had your furnace "tuned up" in the last three years, and do you change the air filters at least twice each winter?
(A tune-up is not costly and can trim your heating bill by 10 percent. If your furnace is old, you may wish to consider buying a new furnace for higher efficiency.)
4. Do you have storm windows or double glass on *all* your windows, and storm doors on all your outside doors?
(Storms should be tightly fitted. Weatherstripping should provide a tight seal around windows and doors. You might also consider adding thick drapes or shutters on the inside of your windows. Vestibules are effective in preventing heat loss from outside doors.)
5. Do you have an adequately insulated attic?
(The joists should be completely covered. An overall ceiling R-value of 38 is recommended. If your attic is finished, insulation should nearly fill the space between rafters — allowing some space, however, for ventilation air to circulate under the roofing boards or plywood.)
6. Have you insulated the basement walls, at least two feet below ground level?
(Rigid insulation can be added on the outside, but must be covered with a durable waterproof material.)
7. Do all exterior walls of your house have adequate insulation?
(You may have to consult a professional, or open a wall to know. Depending on what type of insulation is in the wall to start with, you may wish to fill the wall cavity or add insulation sheathing to the outside. An R-value of 19 is now recommended for the walls of new houses.)
8. Have you insulated all the exposed hot water pipes in the basement?
(Kits are available to wrap electric water heaters with blanket-type insulation. Wrapping is not recommended for gas water heaters.)
9. Do you use your solar window heaters?
(Every south facing window is a solar collector if you faithfully open drapes on sunny days in the winter and close the drapes at night or on cloudy days. Insulated shutters closed at night are even better.)
10. Do you use a solar clothes dryer, at least in the summer?
(Hang your wash on the line outside.)

If your answer to all of the above questions was no, and you decided to correct each problem, your heating bill could be reduced by more than half. If you answered yes to some questions and went ahead to correct the others, you would be making a wise choice of improvements before considering a solar-heating system.

A household that can answer yes to the 10 questions may wish to consider solar. In one sense the heat from the sun is free, but on the other hand, do not forget that a loan to install the solar-heating system has to be repaid. Or, even if you can afford to install solar without taking a loan, then you want to recover your money plus interest within a reasonable time. Solar must be considered in terms of how much it will cost to install and how much it will save each year during the years to come.

The amount you will save each year depends on the type and size of the solar system you install, the weather, your house, and the cost of fuel that you use. In general, a system consisting of flat-plate solar collectors, heat storage, and automatic controls can typically save 60 percent of the annual heating bill for a qualified house (qualified means yes answers to the ten questions). A "60-percent system" would have a solar collector area of about 700 square feet for an average sized home (1200-1500 square feet of floor area). For a greater percentage of solar heating, you would need a larger collector area and larger storage capacity (or a smaller house). For example, about 1000 square feet of collector with 1-2 day storage capacity

is required to reach 70 percent solar heating in the average sized house. The extra 10 percent may not be worth the cost of an added 300 square feet of solar collector. Economists call this "diminishing returns."

This year, if you had the 60-percent solar system installed, you could save \$300, for example, if your annual heating bill was \$500. Next year, your annual bill will be more because of fuel price increases (although since winter severity varies from year to year, so do the annual bills). On the average, you can expect your heating bill to go up about 10 percent per year. This increase is the main reason that some homeowners are interested in solar.

If you took a loan to install the solar system, assume, for example, that your monthly mortgage payments for the system added up to \$480 per year. If you "save" \$300 on heating bills in the first year, you really have a net loss of \$180.00 for the year, because your cost of owning the solar system is more than the heating bill savings. In about six years, however, your annual heating bill saving will be \$483 and you are then "breaking even." Every year after that, you save because the heat bill reduction is more than the annual mortgage payment. Fortunately, mortgage payments stay the same for a given loan until it is all paid. The table below shows the break-even point in cash flow, and also a cumulative "score" that indicates when you are money ahead by owning the solar-heating system.

Normally, the lending institution will require a down payment on a loan for a solar installation. To continue

Year	Mortgage Payment	Heating Bill Without Solar	Heating Bill With Solar	Heating Bill Savings	Net Savings (Cash Flow Per Year)	"Score"
0	\$1000				-1000	-1000
1	480	500	\$200	\$ 300	- 180	-1180
2	480	550	220	330	- 150	-1330
3	480	605	242	363	- 117	-1447
4	480	665	266	399	- 81	-1528
5	480	732	292	440	- 40	-1568
6	480	805	322	483	3	-1565
7	480	886	354	532	52	-1513
8	480	974	390	584	104	-1409
9	480	1072	428	644	164	-1245
10	480	1179	472	707	227	-1018
11	480	1297	519	778	298	- 720
12	480	1426	570	856	376	- 344
13	480	1568	627	941	461	+ 117 BINGO
14	480	1725	690	1035	555	+ 672
15	480	1897	759	1138	658	+1330

the example, assume the solar system costs \$5800 installed and the bank wants a \$1000 down payment. Your loan would be \$4800, and payments would be about \$480 per month. Now, the question is "how long will it be before we get back the down payment?" To answer this, examine the following table.

The answer is that it would be 12½ years before the down payment is paid back. An investment-minded homeowner would consider that his down payment could earn interest if it had been deposited in a bank account instead of spent on a solar installation. With a real rate of return of 2 percent (discounting inflation), payback occurs in about 13 years.

A word of advice can be given with this table. When the heating bill savings begin, start immediately to save that money. It will be easy to forget what your total heating bill per month would have been if you had not installed solar. Ask neighbors who have a similar size house what their heating bills are or consult with your utility company for up-to-date information. By holding onto the yearly savings, you can repay your mortgage early and save interest payments.

The example just given assumed that a solar installation capable of supplying 60 percent of annual home heating can be purchased and installed for \$5800 (1978 dollars). This is not very likely, but could be possible if the homeowner does the installation work. Even then, a "60-percent system" will probably cost \$6,000-\$7,000, because many solar systems components are still custom-made. Simpler, homemade solar heating can be installed at lower cost but generally will not provide a large percentage of the home heating.

Because there are many variables in the performance and payback of solar heating, the University of Minnesota Agricultural Extension Service is preparing more detailed guidelines for Minnesotan's who wish to consider the solar option. As emphasized in this publication, **the condition of your house should receive your attention before you make an investment in a solar installation.** Button-up air leaks and insulate before you even consider solar. If you are building a new home, high standards of insulation, tight construction, and high quality windows should take priority before purchasing solar equipment.

The figures used in solar heating payback are for example only. Actual solar systems available vary considerably in cost and performance, and careful com-

parisons based on engineering data should be made before you buy. (See Figures 1 and 2.) If you are comparing solar collectors, remember that a trouble-free system must be very durable. Glass covers are preferable to plastic, and all-metal ducts or pipes are better than systems with rubber parts.

Figure 1. Schematic Diagram of Warm-Air Flat-Plate System

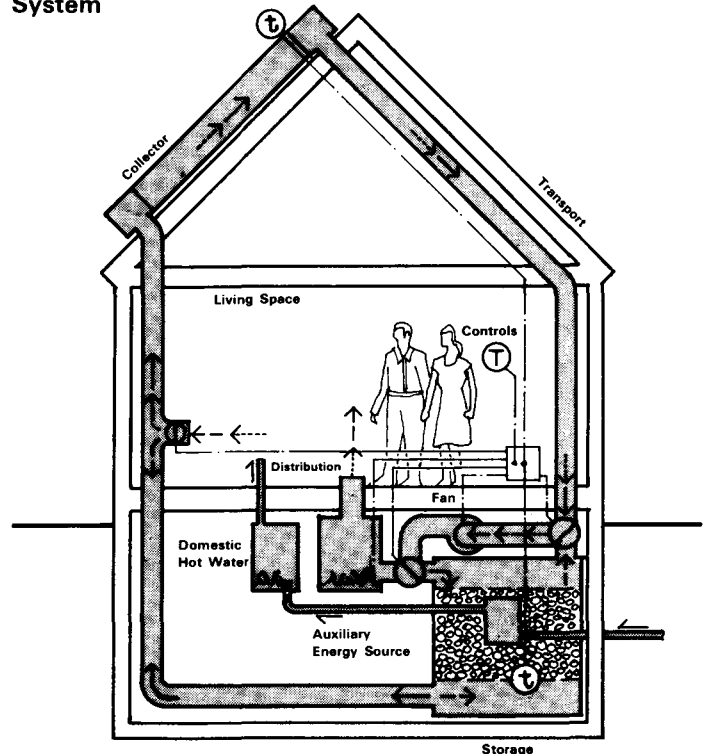
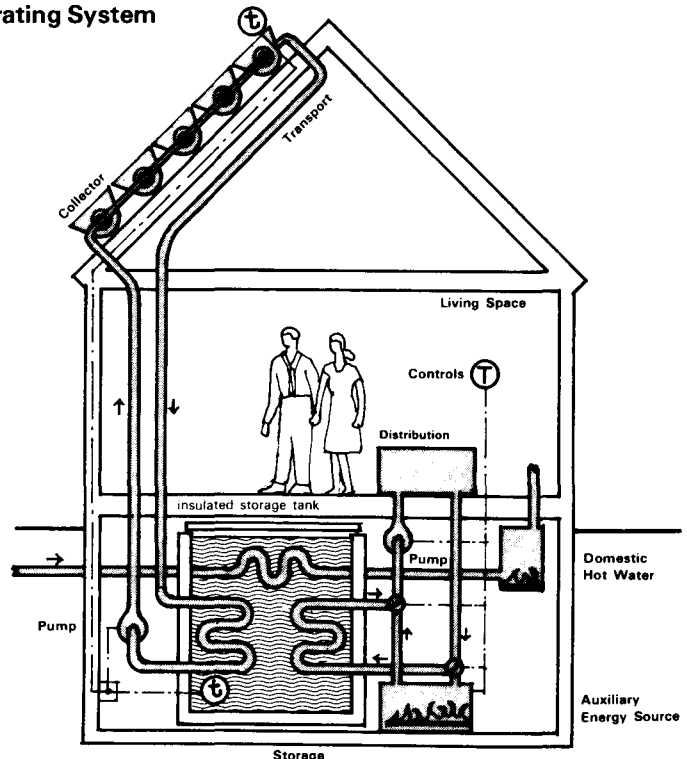


Figure 2. Schematic Diagram of Warm-Water Concentrating System



SOURCES

Two lists of information sources on insulating and solar heating are provided below:

I. Items toward the end of this first list are technical references for engineering design. Ordering instructions appear with each listing.

1. Contact the Minnesota Energy Agency (MEA) for **Conservation Guides 1-6**.

Home Energy Audit — 1

Ceiling Reinsulation — 2

Cooling Your Home — 3

Windows and Doors — 4

Weatherstripping and Caulking — 5

Domestic Water Heating — 6

The MEA also can send you a list of solar equipment suppliers you may wish to contact after doing some of your own study.

Minnesota Energy Agency
720 American Center Building
150 East Kellogg Boulevard
St. Paul, Minnesota 55101
(612) 296-5175
(800) 652-9028 toll free from outstate

2. Contact the National Solar Heating and Cooling Information Center for items from the "Solar Bulletin September 1977" which is attached to the end of this folder. Most items from the National Center are free.

National Solar Heating and Cooling
Information Center
P.O. Box 1607
Rockville, Maryland 20850
(800) 523-2929 toll free

3. *A List of Terms in Residential Energy*, Extension Folder 384, Roger A. Peterson, 1978, available from Agricultural Extension Service, University of Minnesota 55108. 15¢, order by number. Includes many solar heating terms.
4. *Understanding Heat Loss and Energy Conservation Codes*, Extension Folder 389, Roger A. Peterson, 1978, available from Agricultural Extension Service, University of Minnesota 55108. 20¢, order by number.
5. "Low Technology Solar Houses That Work with Nature," Travis Price, *Popular Science* magazine, December, 1976. (See the *Reader's Guide to Periodical Literature* at your local library for additional magazine articles.)

6. *Solar Dwelling Design Concepts*, AIA Research Corporation, 1977, available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. \$2.30 GPO Stock No. 023-000-0034-1. (Easy reading, well illustrated.)

7. *The Solar Home Book*, Bruce Anderson, 1976, available from Chesire Books, Church Hill, Harrisville, NH 03450. \$7.50. (Easy reading, well-illustrated, explains passive solar heating also.)

8. *Designing and Building a Solar House, Your Place in the Sun*, Donald Watson, 1977, available from Environmental Action Reprint Service, 2239 East Colfax, Denver, CO 80206. \$8.95. (Easy reading, well-illustrated, explains passive solar heating also.)

9. *Applications of Solar Energy for Heating and Cooling of Buildings*, ASHRAE GRP 170, edited by Richard C. Jordan and Benjamin Y.H. Liu, 1977, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, 347 East 47th Street, New York, New York 10017. (An excellent comprehensive technical source.)

10. *Passive Solar Heating and Cooling*, Conference and Workshop Proceedings, May 18-19, 1976, Albuquerque, NM available from National Technical Information Service, U.S. Department of Commerce, Springfield, VA 22161. \$12.50. (Contains many semi-technical and a few technical papers on passive solar, including moveable insulation systems.)

11. *HUD Intermediate Property Standards Supplement: Solar Heating and Domestic Hot Water Systems*, U.S. Department of Housing and Urban Development, 1977, available from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402. \$12.00, Order No. 4930-2 (Highly recommended before you buy or build solar.)

12. *Passive Design Ideas for the Energy Conscious Architect*, by the National Solar Heating and Cooling Information Center, P.O. Box 1607, Rockville, MD 20850, free. (This booklet gives many ideas to the designer or owner-builder for energy saving passive solar heating, earth berming, "underground" houses, shutters, greenhouses, and other features that do require complex mechanical equipment.)

13. *Solar Heated Houses for New England and Other North Temperate Climates*, by Mass-design Architects and Planners, Inc., 138 Mt. Auburn St., Cambridge, Mass. 02138, \$7.50. (Gives excellent summaries of several solar house designs, with schematics, elevations, plans, and graphs of heating load versus heat sources. Very concise presentation.)
14. *Solar Heating Design by the f-Chart Method*, by William A. Beckman, Sanford A. Klein, and John A. Duffie, 1977, John Wiley & Sons Publishers, New York, New York. (Gives design economics analysis procedure.)
15. *Solar Energy Thermal Processes*, by John A. Duffie and William A. Beckman, 1974, John Wiley & Sons Publishers, New York, NY. (Theory of heat transfer and fluid flow as applied to solar collectors and storage systems, solar radiation description.)
16. *ASHRAE Standard 90-75, Energy Conservation in New Building Design*, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, 1975, available from ASHRAE Circulation Sales Department, 345 East 47th Street, New York, NY 10017. \$10.35. (Minnesota State Building Code Energy Standards are based upon "ASHRAE 90-75." Designers should realize that codes require minimum standards, and better thermal design, exceeding state codes, is a good practice.)

Some of the books on the above list are available from the Environmental Conservation Library (ECOL), Minneapolis Public Library, 300 Nicollet Mall, Minneapolis, MN 55401, (612) 372-6609, and ECOL books may be requested through your local library. You may wish to ask for the "Alternative Energy Sources" bibliography from ECOL for further readings.

II. Items on this list are taken from *Solar Bulletin*, 1977, National Solar Heating and Cooling Information Center.

1. Publications

(Available from the National Solar Heating and Cooling Information Center, P.O. Box 1607, Rockville, MD 20850.)

Solar Energy and Your Home, HUD-PDR-186 (6), June 1977. (Answers most frequently asked questions about solar energy.)

Solar Hot Water and Your Home, June 1977. (Presents the basic facts about solar water heating.)

Solar Access and Land Use: State of the Law, 1977. (Part of a larger study, "Legal Barriers to Solar Heating and Cooling"; deals with the legal issues related to solar access.)

State Solar Legislation, May 1977. (Lists enacted state legislation pertaining to solar.)

The Sun: Design Opportunities for Architects and Engineers, HUD-PDR-211, February 1977. (Brief guide to solar topics of importance to architects and engineers.)

Residential Energy from the Sun, HUD-PDR-202, December 1976. (Description of HUD's Solar Heating and Cooling Demonstration Program.)

Bookmarks (brief one-paragraph descriptions) are also available on the following topics:

- Active System Solar Cooling
- Passive System Solar Cooling
- Domestic Hot Water System
- Active Air Collector
- Active Liquid Collector
- Passive Solar Heating System

2. Standards and Data Collection

Plan for the Development and Implementation of Standards for Solar Heating and Cooling Applications, NBSIR 76-1143, August 1976. NTIS, Rept. No. PB 257 769, \$4.00.

Thermal Data Requirements and Performance Evaluation Procedures for the National Solar Heating and Cooling Demonstration Program, NBSIR 76-1137, August 1976. NTIS, Rept. No. PB 257 770, \$5.00.

Interim Performance Criteria for Solar Heating and Combined Heating/Cooling Systems and Dwellings, January 1975. GPO, SD Catalog No. C13.6/2:504, \$1.90.

HUD Intermediate Minimum Property Standards Supplement: Solar Heating and Domestic Hot Water Systems, 1977. GPO, Order No. 4930-2, \$12.00.

3. Bibliographies and Current Awareness

Solar Energy: A Bibliography, ERDA, March 1976. NTIS, Citations, Rept. No. TID-3351-R1P1, \$13.75; Indexes, Rept. No. TID-3351-R1P2, \$10.75. (Contains 9732 references to scientific and technical literature on solar energy.)



Solar Energy Update . . . ERDA. NTIS, 1977
Subscription No. NTISUB/C145, \$27.50 per
year. Monthly update to *Solar Energy: A
Bibliography*.

Solar Status is periodically mailed to selected
audiences on the mailing list of the National
Solar Heating and Cooling Information Center.
(Covers topics of interest related to the
Demonstration Program.)

Solar Energy Research and Development is
distributed periodically by the Energy Research
and Development Administration (ERDA),
Division of Solar Energy, Washington, DC
20545. (Describes new research projects and
developments.)

Publications marked GPO are available from:
Superintendent of Documents
U.S. Government Printing Office
Washington, DC 20504

Publications marked NTIS are available from:
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22151

Several special bibliographies are also avail-
able from the National Solar Heating and Cool-
ing Information Center. Reading list on solar
energy:

- Passive Solar Energy Design and Systems
- Underground Houses
- Geodesic Domes
- Energy Conservation in Buildings
- Plating and Selective Surfaces
- Practical and Do-It-Yourself Projects
- Eutectic Salts
- Solar Air Conditioning
- Solar Assisted Heat Pumps
- Bibliography for Children & Young Adults
- Market Potential and Projections
- Sources of Climatic Data
- Solar Retrofit
- Solar Heated Greenhouses
- Solar Energy and Public Utilities

4. Guides to Other Sources of Information

The following Special Lists are also available
from the National Solar Heating and Cooling
Information Center:

- Architects and Designers Familiar with
Passive Solar Design
- Computer Programs for Solar System
Performance and Sizing
- Conferences, Workshops, Seminars and
Short Courses on Solar
- Films/Slides on Solar Energy
- Solar House Plans
- Solar Mobile Home Information
- Sources of Information on Alternative
Energies
- Testing Facilities for Solar Equipment
- Vocational/Technical Schools/Courses
- Solar Kits (of Equipment Components)
- Solar Newsletters
- Solar Directories (of Information)
- Solar Equipment Manufacturers

Other residential energy publications available from the
Agricultural Extension Service, University of Minnesota.

A List of Terms in Residential Energy, Roger A. Peterson,
Extension Folder 384.

Residential Energy Information Source List, Roger A. Peter-
son, Extension Folder 385.

*First Things First, What to Do Before Investing in Home
Insulation*, Extension Folder 386.

Minnesota Energy Prices, Roger A. Peterson, Extension
Folder 387.

Hot Water and Your Home Energy Budget, Roger A. Peter-
son and Wanda W. Olson, Extension Folder 388.

Understanding Heat Loss and Energy Conservation Codes,
Roger A. Peterson, Extension Folder 389.

Air Conditioner Efficiency, Roger A. Peterson, Extension
Folder 394.