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WIND WATER STEAM GEOTHERMAL HYDROGEN HYDROELECTRIC SOLAR ELECTRIC TIDES
WAVES COAL WOOD NUCLEAR PETROLEUM HYDROCARBONS METHANE BUTANE PROPANE
NATURAL GAS MARSH GAS BATTERIES STORAGE TANKS GENERATORS MOTORS PIPELINES
CONSERVATION CONVERSION UTILIZATION STORAGE TRANSMISSION VOLTAGE CURRENT
POWER ENERGY FORCE ILLUMINANCE PRESSURE HEAT WORK BTU CALORIE ERG JOULE
WATT FOOT-POUNDAL DYNE NEWTON FOOTCANDLE WIND WATER STEAM GEOTHERMAL
HYDROGEN HYDROELECTRIC SOLAR ELECTRIC TIDES JOULE COAL WOOD NUCLEAR WAVES
PETROLEUM HYDROCARBONS METHANE BUTANE PROPANE NATURAL GAS MARSH GAS
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Solar Water Heating

Oregon Systems

Performance: Most solar water heating systems in Oregon are sized to provide from 50 to 70 percent of a household's hot water needs annually.

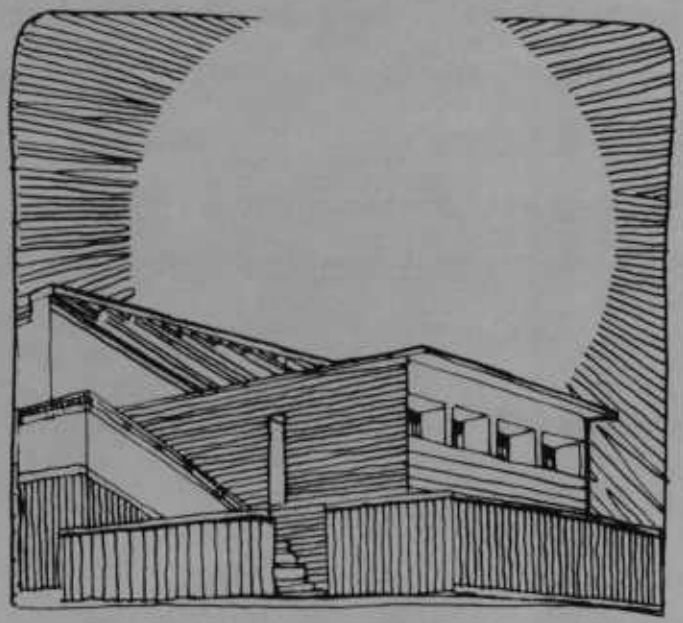
Costs: Initial costs for commercially built and installed systems range from $2,500 to $5,000. These costs break down into the following approximate categories: one-third for solar panels; one-third for other equipment; one-third for installation. Owner-built and installed systems range in cost from $800 to $2,000.

Tax credits: The State of Oregon allows an individual a 25 percent income tax credit on the initial cost of the solar system, with a maximum of $1,000 claimed as credit. The Federal government allows a 40 percent income tax credit on the initial cost of the system with a maximum of $4,000 claimed as credit. A tax credit, unlike a tax deduction, is an amount of money that is subtracted from the tax obligations. If both State and Federal credits are taken, an owner can estimate the final cost of the solar installation to be about one-third its initial cost. The State tax credit application must be made and approved by the Oregon Department of Energy *before* the solar installation.

Loans: Most lending institutions allow solar hot water systems to be included in home remodeling loans.

The Oregon Department of Energy (ODOE) administers the Small Scale Energy Loan Program. Any individual, small business, non-profit cooperative, or corporation may apply for a loan. Application forms are available by writing ODOE, 102 Labor and Industries Building, Salem, Oregon 97310 or by calling, toll-free, 1-800-452-7813, asking for the Oregon Department of Energy.

Your electric power or gas supplier may offer special water heater incentive programs. Interest-free loans and rebates are available. Contact the utility that supplies the energy used by your hot water heater.



Conserve Hot Water

Three hot water conservation measures should precede investment in a solar hot water system:

Measures	*Estimated annual savings Percent*
• Lower thermostat on hot water heater to deliver water at 120 degrees F. Dishwashers require a 140 degree F. setting.	10 to 20
• Install flow restrictors on shower heads and faucets.	10 to 14
• Insulate water heater (R-11) and pipes (R-4). (Your electric power supplier may provide a free water heater wrap service.)	10

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OREGON STATE UNIVERSITY EXTENSION SERVICE

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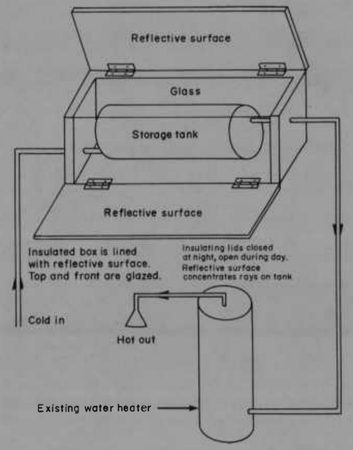
How Solar Hot Water Systems Work

Most households require hot water that is 120 to 140 degrees F. Consider solar hot water systems as *pre-heat systems*, with an auxiliary back-up heating unit. Depending on the water source and the time of year, the temperature of the water that supplies a household may vary from 45° to 60° F. A solar water heating system is designed to use available solar energy to pre-heat the water before it goes to the conventional water heater.

Solar water heating systems have three major components: (1) *Collection*—the solar energy needs to be collected and transferred to the water; (2) *Storage*—the heated water needs to be stored; and (3) *Controls*—there needs to be some means to move the water and to protect the entire system from freezing.

The simplest solar pre-heat system combines all three functional areas—collection, storage, and controls—into one unit called a batch or "breadbox" water heater. This system consists of a black water tank inside an insulated box with glazing on the sides orientated to receive solar energy.

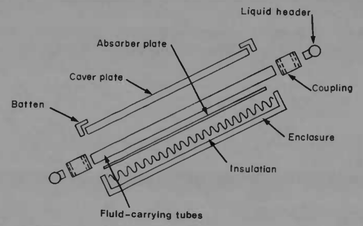


The cold water supplied to the tank is pre-heated by the sun (collection) where it remains (storage) until hot water is drawn from a household faucet (control). The pre-heated water moves to a conventional water heater where it is heated to the required temperature. The collection area of a "bread box" system is small when compared to more conventional solar heated water systems. The solar energy contribution to water heating is normally under 40 percent for most "breadbox" systems.

A more typical solar hot water system delivers pre-heated water to the conventional water heater like a breadbox design, but separates the three major functional areas.

Collection

The type of solar collection design best suited to heating water to the temperatures needed by most households is a "flat-plate collector." Flat-plate collectors are well-insulated boxes that contain a dark surface that absorbs solar radiation. This surface is usually called an absorber plate. The heat that is collected by the absorber plate is conducted to fluid-carrying tubes, attached to the absorber plate. The absorber plate and tubes are usually painted black for maximum solar collection. The insulated box and the absorber plate and tube construction are covered by either glass or special plastics so that heat is trapped within the box. Flat-plate collectors can collect some solar energy even during cloudy conditions.



Storage

Most homeowners who are considering a solar water heating system already have a conventional water heater, usually gas or electric. An effective solar system requires additional storage. The additional storage may be provided in either of two ways: (1) A second tank may be installed near the existing tank. The second tank would be the solar storage tank and would be connected to the collector panels and the existing water heater. (2) A single large tank may replace the existing water heater. This single tank would have an electric element in the top part of the tank only to act as the back-up heat source, while the bottom half of the tank would serve as solar storage.

Single-tank systems have less surface area than double-tank systems, which results in less storage heat loss.

Controls

One of the most crucial functions of a solar water heating system is its ability to move fluid between the solar storage and the collector panels *only* when solar energy is available to contribute heat to the water. In some solar water heating systems this control function is accomplished by a natural means called "thermosyphon." Hot water, like hot air, rises. If the solar storage tank is located higher than the collector panels, hot water will move through the panels to the storage tank and be replaced by cooler water. This movement of water will occur only when solar energy is available. A thermosyphon solar system can be called a *passive* solar water heating system.

If a pump is used to move water between the solar storage and the collector panels, the solar system is called *active*. In this type of system, temperature sensors are located in the storage tank and the panels to compare

water temperatures. These sensors relay information to a differential thermostat, which activates the pump only when sufficient solar energy is available.

Another function of the controls is to prevent freezing in the collector panels. Some solar systems use temperature sensors to activate drain-down valves, which allow all of the water in the panels to drain. This type of system is called a *direct* active solar system—the water that flows through the panels is the same water that comes out of the house faucet. The direct system is also referred to as an "open loop" system.

An alternative method of freeze protection involves an *indirect system* or "closed loop" system. In these systems the fluid that runs through the panel is not from the household water supply. The heat from the collector is transferred to the potable water in the solar storage tank through a heat exchanger. Most indirect systems use a non-freezing solution to transfer the heat from the panels to the potable water through a double-walled heat exchanger. Air is sometimes used as the heat transfer medium in indirect systems. When air is used, it is usually part of a combined solar space and water heating system. There are a few indirect systems which use "Freon," a phase change fluid, in a sealed system. The phase change system tends to be more expensive than the more conventional indirect systems.

Another indirect system uses distilled water instead of a non-freezing solution. In this drain-back system the distilled water drains from the panel into a non-pressurized tank whenever the pump is not running. Usually a second pump circulates the potable water from the conventional water heater through a single-walled heat exchanger in the non-pressurized solar storage tank.

The illustration on page 4 is a matrix of the four basic generic types of solar water heating systems, with the advantages and disadvantages listed for each system.

Maintenance

A properly installed solar system will require only a few maintenance chores. However, you should learn what is expected. For direct systems, you should check the drain-down valve in the fall to make sure it will operate properly. For indirect systems, you should check the non-freezing solution every year or two. The non-freezing solution can slowly oxidize into an acid which may harm the system. Wood-framed panels may need to be treated periodically.

Comparing Systems

Efficiency is a term often used when comparing one type of solar hot water system with another. The most *thermally* efficient system would be the one that delivered the most heat to the water under identical weather conditions. Design considerations that affect thermal efficiency in a solar hot water system include:

- Method of fluid circulation, active or passive
- Method of heat transfer, direct or indirect
- Solar panel efficiency and collector area
- Number and size of storage tanks
- Pipe and tank insulation

An important criterion is, which system will deliver the most heat to the water for the least cost? The Solar Energy Research Institute has made side-by-side comparisons of several different solar hot water systems. Passive solar water heating systems, due to their lower cost, were found to be more thermally efficient per dollar invested than active systems. Also, direct systems were slightly more efficient than indirect systems because of the inefficiency inherent in heat exchangers.

Thermal efficiency is not the only criterion used in selecting a solar hot water system. A buyer of a system also should look at external power requirements. From both an energy and cost standpoint, the external power required for *active* systems should be subtracted from the solar benefits of the system. Some other considerations in comparing one type of system with another are:

- How much will it cost to maintain the solar system over its expected life?
- Is there enough space for two tanks?
- Can downhill plumbing be accomplished for the drain-down or drain-back systems?
- Is the initial cost of the system manageable?

Sizing Solar Water Heating Systems

This table is used by the ODOE to determine the minimum collector area required to qualify for the Oregon solar tax credits:

Number of residents	Collector area needed *Square feet*
1	18
2	30
3	40
4	51
5	62
6	72

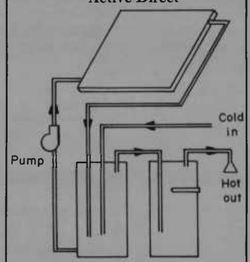
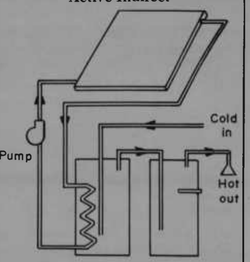
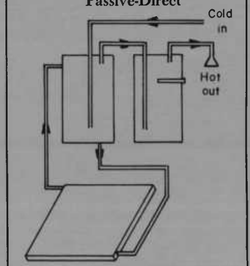
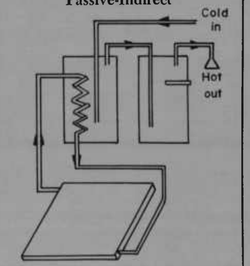
In many cases a homeowner will want to consider installing a solar system that meets more than 50 percent of the hot water needs.

The regional table (below) shows collector area necessary to provide various solar water heating percentages for four-person families in several Oregon cities.

Regional Table

Square feet of collector area	Percent of household water heating accomplished by solar energy						
	Astoria	Burns	Medford	North Bend	Portland	Redmond	Salem
40		54.4	50.3			55.2	
50		63.3	58.6	55.4		64.1	
70	54.1	76.5	71.2	68.4	57.3	77.5	60.5
90	62.7	83.2	77.7	77.5	65.8	84.4	69.0
110	69.1	87.4	81.8	83.6	71.6	88.5	74.1
130	74.1	90.3	84.6	87.0	75.7	91.2	77.9
150	78.0	93.1	87.0	90.0	78.9	93.5	81.0
170	81.9	95.5	89.4	92.5	82.0	95.7	84.2
190	85.7	97.7	91.9	93.9	85.0	97.7	87.8
210	89.5	99.0	93.6	95.8	88.8	99.2	89.9

Four Basic Generic Types of Solar Water Heating Systems

	Direct	Indirect
	Advantages • Thermally efficient • Normally cheaper *Disadvantages* • Requires reliable drain-down freeze protection • Higher external power consumption	*Advantages* • Freeze problems less likely *Disadvantages* • Lower thermal efficiencies: heat exchangers • Higher initial costs
Active *Advantages* • Good for retrofits • Higher panel efficiencies *Disadvantages* • Requires pumps and controls: increases initial maintenance, and energy costs	**Active-Direct**  	**Active-Indirect** 
Passive *Advantages* • Simplicity • High system efficiencies *Disadvantages* • Storage tank above panels: retrofit problems	**Passive-Direct**  	**Passive-Indirect** 

Buying Solar

• Ask for proof that the product will perform as advertised. Make sure the installer puts the system in operation and shows you, preferably by a tank thermometer, that solar heated water is being delivered to the solar storage tank.

• Get a written agreement of who will service the solar system if something goes wrong. Don't settle for a response that "any plumber or handyman will do."

• Ask what kinds of owner maintenance you should do.

• Examine all warranties carefully. Remember that according to the law, the manufacturer must state that the warranty is full or limited. If it is limited, know what the limitations are. How long does the warranty last? Are parts, service, and labor covered? Again, who will provide the service? Does equipment have to be sent back to the manufacturer for repairs? Ask the seller what financial arrangements, such as an escrow account, have been made to honor the warranties.

• If the seller makes verbal claims that are not reflected in the literature, ask the seller to write those

claims down and to sign them. Compare what is said with what is written. Save that statement.

• Don't forget your local Consumer Service office or Better Business Bureau. Both may be able to help you determine whether a seller is reputable or not.

• Make sure the installer has proper permits for installation.

Solar Hot Water Resources

Tax credit and general information

Oregon Department of Energy
102 Labor and Industries Building
Salem, Oregon 97310
378-4040 (Salem)
1-800-452-7813

Solar heating information

Oregon State University Extension Service (County offices are listed under County Government in the telephone directory.)

Conservation and Renewable Energy Inquiry and Referral Service (CAREIRS)
P.O. Box 1607, Rockville, MD 20850
1-800-523-2929

Western Sun/State Solar Office
102 Labor & Industries Bldg., Salem, OR 97310
378-4040 (Salem)
1-800-452-7813

Oregon Solar Energy Industries Association
P.O. Box 19183, Portland, OR 97219
244-2184 (Portland)

Manuals

Installation Guidelines for Solar DHW Systems
Superintendent of Documents
U.S. Government Printing Office
Washington, D.C. 20402
$4.00

Consumer complaints

Consumer Protection Division
500 Pacific Building, 520 SW Yamhill St.
Portland, OR 97204
1-800-452-7813 (in Portland call 229-5548)

Consumer Service Division
111 Labor & Industries Building
Salem, OR 97310
1-800-452-7813 (in Salem call 378-4320)

The Portland Better Business Bureau
Corbett Building
Portland, OR 97204
226-3981

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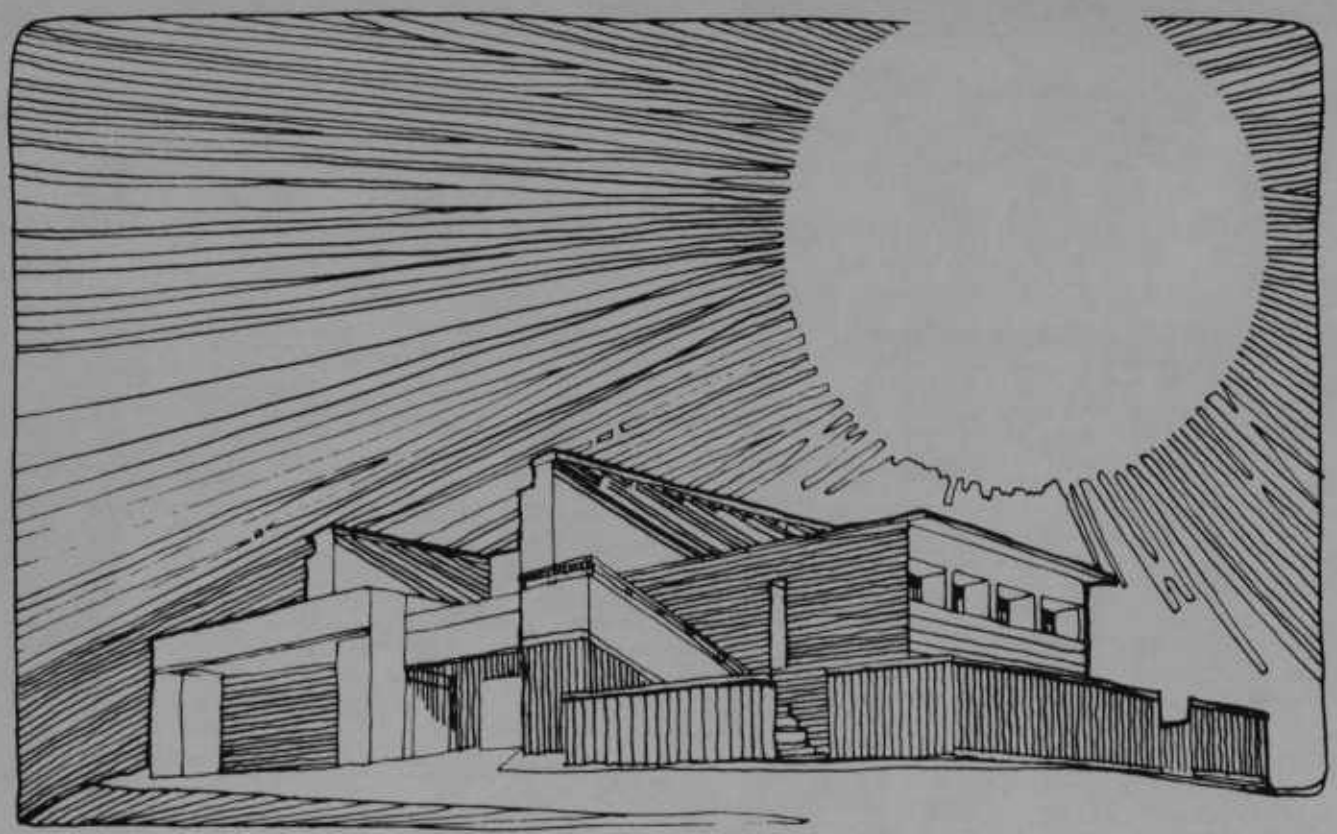

Recent Developments

Beginning in 1982, the Oregon Department of Energy (ODOE) will waive the requirement that you receive tax credit approval before installation if you purchase your system from a dealer who has received a dealer system certification from ODOE. If you are purchasing from a dealer without a dealer certificate or if you are building and installing your own system, you still must receive approval from ODOE before installation to qualify for a State tax credit.

Also beginning in 1982, ODOE is using a new table to determine minimum collector area necessary to qualify for a State tax credit.

The following table replaces the table on page 3 of this circular:

Number of residents	Collector area needed Square feet
1	30
2	47
3	63
4	79
5	94
6	110

The ODOE may allow exceptions to this table for systems that use high performance components or hot water conservation measures. Dealers may submit test data or other documentation if they want to use a different sizing table for the systems they install.

For further information, call the Oregon Department of Energy at 1-800-452-7813.