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Conserving Energy and Heating Your Swimming Pool with Solar Energy

Swimming pools provide a great way to exercise and beat the summer heat. Building and maintaining a pool, however, also means relatively high costs added to your household's budget. There are several ways that you can reduce operating and maintenance costs, lower water consumption, and conserve heat if you heat your pool. Many people heat their pools to extend the swimming season and/or to keep it at a temperature that they are personally comfortable with. This lets them enjoy the full value from their pool. Solar pool heaters are an option to heat the pool with "clean" energy from the sun, and can reduce heating costs.

This fact sheet discusses options for reducing the costs for operating and heating your pool.

Photo courtesy of Aquatherm Industries, NREL/PIX07175

Roof-mounted solar collectors are used to heat the pool below, reducing energy costs.

Optimizing Water Filtration and Circulation Pumping

A study by the Center for Energy Conservation at Florida Atlantic University shows that pool owners can save energy and maintain a comfortably heated pool by using smaller and higher efficiency pumps, and operating pumps less each day. In this study of 120 pools, some pool owners saved as much as 75 percent of their original pumping bill when they used both conservation measures (see table on page 2).

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In a Florida study, most people who reduced pumping to less than 3 hours per day were still happy with the water's quality. On average, this saved them 60 percent of their electricity bill for pumping.

Savings from Pump Conservation Measures

Condition	Energy Use (kWh/year)	Cost of Energy ($/year)	Energy Savings
Original	3000	240	—
Pump replacement (downsizing)	1800	140	40%
Reduced time (60%)	1200	100	60%
Combination of above	720	60	75%

Table courtesy of Home Energy magazine. These savings represent a typical pool in Florida. The average pool pump energy bill is probably higher in Florida than in many other areas of the country because of the long swimming season. While the absolute savings here will be greater there than elsewhere, the percentage savings should apply nationwide. Note that the savings for the combination of measures are not simply the sum of savings for the individual measures. When both are implemented, the energy use is 60 percent of 40 percent of the original use—75 percent savings.

Sizing the Pump Right

When a pump wears out or can't be repaired, a pool owner typically installs a larger one, thinking that "bigger must be better." Instead, a larger pump may increase the costs of pumping and maintenance. To choose the right size pump, consult design charts that match the hydraulic characteristics of the pump to both the piping and the pool's flow characteristics. A local pool supply dealer should have access to these charts.

The Florida study shows that a 0.75 horsepower or smaller pump is generally sufficient for residential pools. Smaller pumps, which cost less, can be used if you decrease the pool circulation system's hydraulic resistance. This can be done through one or more of the following ways: substituting a large filter (rated to at least 50 percent higher than the pool's design flow rate), increasing the diameter or decreasing the length of the pipes, or replacing abrupt 90-degree elbows with 45-degree elbows or flexible pipe. These types of changes can slash up to 40 percent off the pump's use of electricity (see table above).

Circulating the Water

Another way to save energy is to reduce the pump's operating time. Pool pumps often run much longer than necessary. Pool owners need to understand the reasons behind circulating the pool's water. Circulating water keeps your pool's chemicals mixed. However, as long as the water circulates while chemicals are added, they should remain evenly mixed with minimal daily circulation. Secondly, circulating the water keeps the pool free of debris by drawing water out and through the filter. It is not necessary to recirculate the water completely every day to remove debris and clean the water. One complete circulation usually takes between 6 and 12 hours per day. But this may be longer than necessary since most debris either floats or sinks, and can be removed with a skimmer or vacuum. After about an hour, most of the pumping power is wasted by circulating clear water and does little to improve the water's quality.

Furthermore, longer circulation does not necessarily reduce the growth of algae. Instead, using chemicals in the water and scrubbing the walls are the best methods. In the Florida study, most people who reduced pumping to less than 3 hours per day were still happy with the water's quality. On average, this saved them 60 percent of their electricity bill for pumping. Combined with using a smaller size pump, pool owners saved up to 75 percent of their original electricity bill for pumping water (see table above).

One last simple measure for saving money is to use an accurate timer to control the pump's cycling. Use a clock that can activate the pump for many short periods each day if debris is a problem. Running the pump continuously for, say, 3 hours leaves the other 21 hours a day for the pool to collect debris. Several short cycles keep the pool cleaner all day.

Summary of Recommendations

Pool owners can save a great deal of money by:

- Choosing the smallest pump and the largest filter suitable for their pool
- Decreasing the hydraulic resistance of the pool's circulation system wherever possible
- Circulating the water with the pump for the shortest time possible (often fewer than 3 hours)
- Installing a timer.

Keep in mind, however, that all pools are different. Circumstances such as special cleaning and heating needs, climate, pool size, and usage all affect a pool's circulation, as well as the potential for saving money.

Reducing Water and Heat Loss

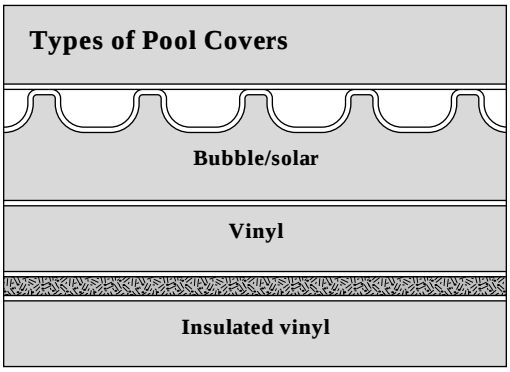
Almost all of a pool's heat loss—about 95 percent—occurs at the surface, mostly through evaporation to the air and radiation to the sky. A pool cover is an effective means to keep heat (and water) in a pool by reducing evaporation of water from the pool when it is not in use, and reduces radiant heat losses. A pool cover can reduce water loss by 30 to 50 percent. Each gallon of 80-degree water that evaporates removes around 8,000 Btu from the pool. Reducing water loss also reduces the amount of chemical water treatment required.

Outdoor pools can gain a significant amount of heat from the sun, absorbing 75 to 85 percent of the solar energy striking the pool surface.

Outdoor pools can gain a significant amount of heat from the sun, absorbing 75 to 85 percent of the solar energy striking the pool surface. A bubble cover (sometimes called a solar cover) is one of the least expensive covers made specifically for swimming pools. It's similar to bubble-packing material except it has a thicker grade of plastic and ultraviolet (UV) inhibitors. Vinyl covers are made of a heavier material, which extends their use. You can also get vinyl covers with a thin layer of flexible insulation sandwiched between two layers of vinyl.

A transparent bubble cover may reduce solar energy absorption by 5 to 15 percent, and an opaque cover may reduce it by 20 to 40 percent. However, the decrease in solar gain can be balanced or more than offset by the cover's retention of the pool's heat, which depends on the air temperature and humidity. Generally, the drier and cooler the air, the greater the heating benefit from covering the pool during the daytime. Of course, a cover should always be used at night to prevent losses when there is no solar gain.

A cover also helps you keep the pool clean and extend the life of the chemicals in your pool. At a cost of 20 to 60 cents per square foot, a pool cover may pay for itself in 1 year. Be aware, however, that UV radiation deteriorates the cover, requiring that you replace it every 3 to 5 years. Before you buy one, make sure the cover comes with at least a 2-year warranty. Also find out how easily you can place the cover over the pool, how to remove it, and how to store it. Systems are available that move the cover off and on the pool with a motor or hand crank.



Covers should always be installed and used according to the manufacturers' guidelines. Always consider that people could use the pool unauthorized or unsupervised.

A windbreak around the pool can also reduce evaporation, and make pool "lounging" more comfortable and private. A 7-mph wind at the pool surface can increase heat loss by 300 percent. A windbreak could include a fence or vegetation. It needs to be high and close enough to the pool so that it effectively blocks wind from moving across the pool surface, but doesn't block beneficial solar energy.

The easiest way to save energy is to lower the thermostat on your pool's heater so that it heats the pool no higher than the temperature that you feel comfortable with.

Heating the Pool Efficiently

If you are selecting a pool heater, ask for as energy-efficient model as you can afford. Several heat pump manufacturers make retrofit desuperheater coils for pool heating, and several make heat pumps for pool heating. These may be cost effective relative to natural gas heaters.

Besides that, the easiest way to save energy is to lower the thermostat on your pool's heater so that it heats the pool no higher than the temperature that you feel comfortable with. Every 1 degree reduction can cut your energy usage by between 5 and 10 percent. Once you have lowered the thermostat, keep the remaining heat from escaping by using a pool cover when the pool is not in use.

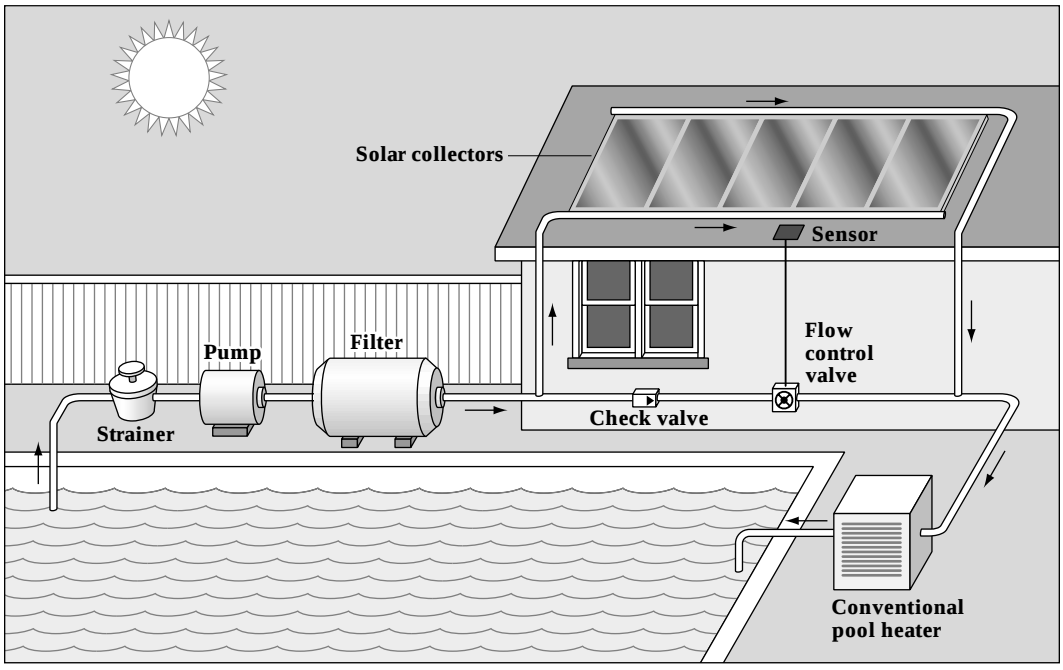
Solar Pool Heaters

If you have taken steps to retain your pool's heat but are still not happy with your heating bills, or if you plan to install a new pool, a solar pool heater may be a good investment. Such heating systems are one of the most cost-effective applications of solar energy. It is relatively simple to integrate a solar water heater since most pools require a pump, filter, and plumbing. With a solar energy system, the pool's water is pumped through the filter and then through a solar energy collector(s) instead of directly back to the pool. The sun heats the water in the collector(s) before it returns to the pool.

If you add a solar heater, you may need a pump larger than your present one, or a separate, smaller pump to pump the pool's water to and through the solar collectors. Adding any heater, solar or otherwise, will preclude selecting the smallest pump. Nevertheless, you also may reduce pumping time to help cut costs.

Unlike solar domestic water heating systems, which raise a small amount of water to a high temperature of about 140°F, pool heaters raise the temperature of several thousand gallons of water to about 80°F by circulating the water at a relatively fast rate through the collectors. This allows most of the solar energy falling on the collectors to transfer to the pool water.

Solar energy not only can be used for heating residential pools but also for larger commercial and public pools. One such application is the International Swim Center in Santa Clara, California. Heaters using solar energy heat three pools—a 50-meter racing pool, a 25-yard and 17-foot deep diving well, and a 25-yard training pool. Nearly 13,000 square feet of flat-plate collectors heat 1.2 million gallons of water. Since the project was completed in



A solar pool heating system.

February 1979, solar energy has been providing 60 percent of the energy required to heat the pools. The pool used for the 1996 Summer Olympics in Atlanta is heated with solar energy as well.

Solar collectors can also be used to cool the pool in hot climates or during peak summer months by circulating the water through the collectors at night. The collectors lose heat by radiation to the night sky.

Solar Pool Collectors

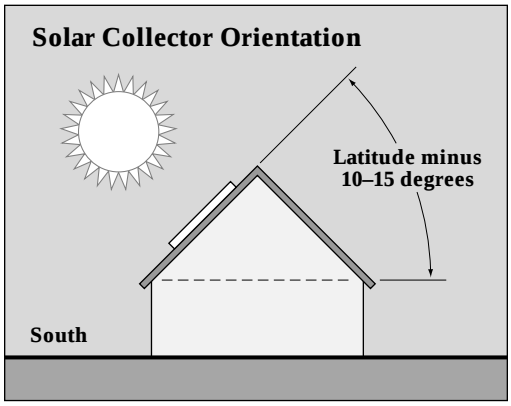
Collectors for heating a pool normally do not require glazing or insulation because they operate during warmer months when solar radiation and ambient temperatures are relatively high. This allows for a simpler design that is usually less expensive than collectors for domestic hot water. Many pool collectors are made of heavy-duty rubber or plastic treated with a UV light inhibitor to extend the life of the panels. The advantages of plastic collectors are that they're usually less expensive and weigh less than metal collectors.

It is relatively simple to integrate a solar water heater since most pools require a pump, filter, and plumbing.

Metal collectors generally are made of copper tubing mounted on an aluminum plate. The disadvantages of metal collectors are that they are more susceptible to corrosion and freeze damage, and the copper tubes may react with your pool's chlorine if the pH level falls below 7.2. Too many copper ions in pool water may form dark-colored precipitates, which can coat the pool's walls. This discoloration can only be removed by draining, cleaning, and repainting the pool. This problem can be reduced if the pH level is always kept above 7.2.

The area needed for collectors to heat your pool depends on many factors. A general rule of thumb is that the collector surface area should equal at least one half of the pool's surface area. In a relatively sunny climate, this additional heating helps extend the swimming season into spring and autumn. In cooler and cloudier areas, you may need to increase the collectors' surface area to equal the entire surface area of the pool.

Collectors can be mounted on roofs or anywhere near the pool that provides the proper exposure, orientation, and tilt toward the sun. The optimum collector orientation is south, but west-facing orientations are good if the collectors' surface area is increased to at least 75 percent of the pool's surface area. East-facing orientations are marginally good. The tilt of the collector is as important as the orientation. For heating primarily in the summer, the tilt should equal the latitude where the pool is located minus 10 to 15 degrees. Where optimizing the tilt is not possible, for example on an existing roof with a high slope or on a flat roof, increasing the collector area may be necessary to achieve the desired pool temperature.



For heating primarily in the summer, the tilt of a solar collector should equal the latitude where the pool is located minus 10 to 15 degrees.

One potential benefit of roof installation is that it may reduce the cooling load of the building that it's located on, since it puts the solar heat into the pool water and keeps it from radiating into the attic and the conditioned space below.

There is a company that makes a heat exchanger, which is placed in the attic, for heating pool water. This "collector" absorbs heat that builds up in the attic and transfers it to the pool water.

Because swimming pools include a pump and related plumbing, adding on a solar heater can be relatively simple. Unless you have experience with plumbing and electrical wiring, however, have a professional install your system. Often the pump circulates the pool water enough, but be sure it maintains a high flow rate to keep the panels operating at optimal efficiency. Your collector should require little maintenance if the pool's chemical balance and filtering system are checked regularly.

Resources

The following are sources of additional information on energy-efficient swimming pools:

Organizations

American Solar Energy Society, Inc. (ASES)
2400 Central Avenue, G-1
Boulder, CO 80301
Phone: (303) 443-3130; Fax: (303) 443-3212
Email: ases@ases.org
Web site: http://www.ases.org/

ASES is a nonprofit educational organization that encourages the use of solar energy technologies.

Florida Conservation Foundation (FCF)
1251 B Miller Ave.
Winter Park, FL 32789
Phone: (407) 644-5377
E-mail: florida@sundial.net
Web site: http://sundial.sundial.net/~florida/

It's mission is to provide accurate and authoritative information accessible to the public, and innovative ideas on solving environmental problems.

Florida Solar Energy Center (FSEC)
1679 Clearlake Road
Cocoa, FL 32922
Phone: (321) 638-1000; Fax: (321) 638-1010
Web site: http://www.fsec.ucf.edu/

FSEC researches and develops renewable energy and energy efficiency technologies, and educates the public on the results of its research.

National Spa & Pool Institute (NSPI)
1-800-323-3996
Web site: http://www.nspi.org/

NSPI is dedicated to the safe use and enjoyment of pools, spas, and hot tubs.

Solar Energy Industries Association (SEIA)
1616 H Street, NW, 8th Floor, Washington, DC 20006
Phone: (202) 628-7979; Fax: (202) 628-7779
Web site: http://www.seia.org

SEIA is the only trade association of solar energy system manufacturers and suppliers in the United States.

For more 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
1-800-DOE-EREC (1-800-363-3732)
E-mail: doe.erec@nciinc.com
Web site: http://www.eren.doe.gov/consumerinfo/

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

Web Sites

Pool & Spa News
Web site: http://www.poolspanews.com/

Reducing Swimming Pool Energy Costs (RSPEC!)
U.S. Department of Energy
Web site: http://www.eren.doe.gov/rspec/

Reading List

The list is not exhaustive, nor does the mention of any publication constitute a recommendation or endorsement.

Books and Pamphlets

Build Your Own Solar Water Heater, D. Root, FCF (see Resources), 1985, 25 pp.

Designing and Installing Commercial Pool Heating Systems, D. Root; FSEC (see Resources), 1984, c200 pp. Available for purchase from FSEC.

The Homeowners Handbook of Solar Water Heating Systems, B. Keisling; Rodale Press, 35 E. Minor St., Emmaus, PA 18049, 1983, 246 pp.

How to Design and Build a Solar Swimming Pool Heater, F. deWinter, Copper Development Association, 1975, 47 pp. Available from ASES (see Resources).

Solar Heat for Swimming Pools, D. Root; FCF (see Resources), 1982, 68 pp.

Solar Heating for Swimming Pools, FCF (see Resources), 1251 B Miller Ave., Winter Park, FL 32789, 1982, 68 pp.

Solar Heating of Swimming Pools: A Question and Answer Primer, C.J. Cromer; FSEC (see Resources), 1997, 4 pp.

Solar Water and Pool Heating Design and Installation Manual, D. Root; FSEC (see Resources), 1982, c500 pp. Available for purchase from FSEC.

Articles

"Efficient Design: Constructing an Energy-Efficient Pool Can Save Homeowners Plenty of Money," R. Messenger and S. Hayes; *Pool & Spa News* 26(3): 136, 142, 180, January 26, 1987.

"Running Pump Less Often is More Efficient," R. Messenger and S. Hayes; *Pool & Spa News* 25(21): 142, 144, 186, November 3, 1986.

"Solar Pool Heaters: The Simplest Use of Active Solar Energy." K. Sheinkopf; *Solar Today* 11(6): 22, November 1, 1997.

"Solar Pool Heating," A Question and Answer Primer," C. Cromer, *Solar Today* 9(3): pp 32-34, May/June, 1995.

"Swimming Pools Soak Up the Sun," D. Coughi, P. Hesse and T. Schiller, *Home Energy*, 13(3), pp. 37-42, May/June 1996.