



Solar Energy - A Review

An Online Continuing Education Course for Engineers

Course Number: R-1009

Credit: 1 Hour / 1 PDH / 1 CPD

Solar Energy - A Review

Robert J. Scoff, P.E.

1. Introduction

In a sense, most, if not all, of the energy we use is “Solar Energy.” Energy from nuclear sources may or may not have come from the sun or other celestial sources. The sun is constantly emitting more energy into space than we, on this earth, can even imagine. The distance from the sun to the earth is about 93 million miles, and the radius of the earth is about 4000 miles. Using the area of a sphere ($\text{Area} = 4 * \pi * r^3$), the area that the sun sends energy to the earth’s orbit is about $109 * 10^{15}$ square miles. The area of the earth’s surface is about $197 * 10^6$ square miles, while the area of the earth facing the sun at any one time is about $98.5 * 10^6$ square miles. To get an idea of how much of the sun’s energy hits the earth, we can divide the area that the sun is sending energy out at the earth’s orbit by the area of the earth facing the sun at any one time. If we do that, we get $0.906 * 10^{-9}$. That’s about $90.6 * 10^{-9}$ % of the sun’s energy that hits the earth. The sun emits a lot of energy continuously. A very small percentage of that is used to support life on earth, including growing plants, and an even smaller percentage is used to generate solar energy for use by us. This course will give us some idea of how to capture that energy and use it in the electrical world and elsewhere.

2. Using the Sun to Heat Water and Homes

We don’t usually think of the sun as a heat source to heat water and our homes. Figure 2.1 shows a way to use solar energy to supplement a hot water heating system. The heating coils need to be protected from freezing. Swimming pools can be heated by eliminating the standard water heater and changing the piping to pump water from the swimming pool, and returning the heated water to the swimming pool. The controls would be very simple, and the system would operate whenever the sun was shining. This presents the big problem that allows the sun’s energy to be collected only when the sun is shining at that place on the earth.

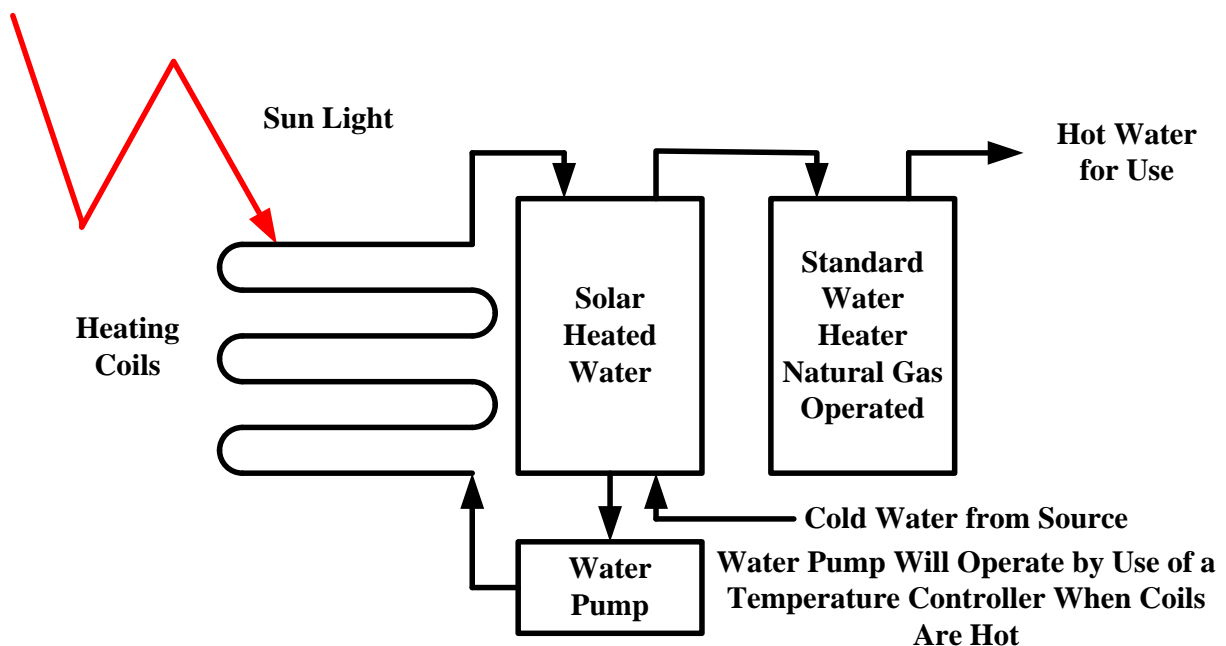


Figure 2.1 Drawing of a Way to Use Solar Energy to Heat Water

The energy available would depend on the area of the pipes exposed to the sun. As a matter of interest, the energy from the sun hitting the earth at any time is about 173,000 terawatts. In practical terms, the average energy from the sun is only about 63 watts per square foot. That figure comes from dividing 173,000 terawatts by the area of the earth facing the sun at any given time. The figure would be higher near noon at the equator. Solar panels are calibrated, assuming that about 93 watts per square foot are heating the earth. To get any amount of energy from the sun requires collecting devices with large areas.

This solar energy can also be used to directly heat living spaces. Clear glass windows and sky ports can allow solar energy to heat the interior spaces of buildings. Most of the time, solar energy needs to be supplemented by some other source of energy. This solar energy can be a detriment in areas where the sun heats up buildings too much.

Swimming pools are one place where solar energy can be and is put to good use. All that is required are some solar absorbing pipes on a rooftop and a small pump to circulate the water heated by the sun. Figure 2.2 shows how this is done, and Figure 2.1 shows how this system works.

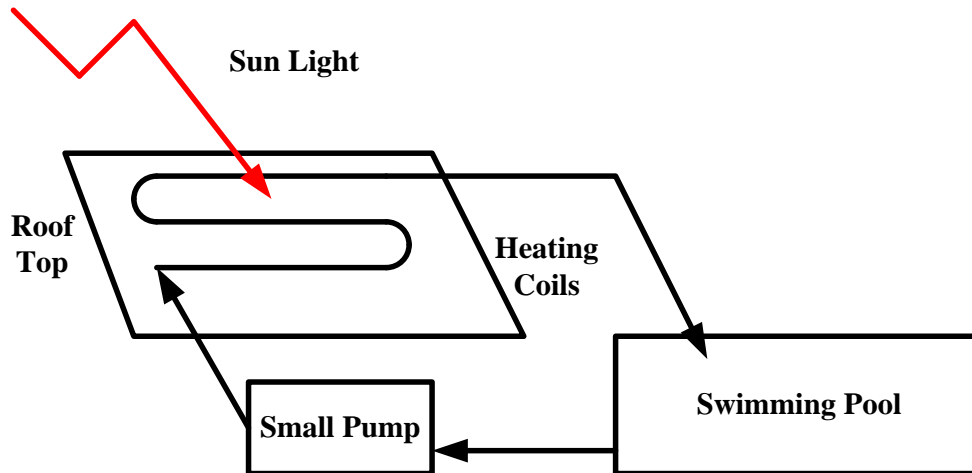


Figure 2.2 Small Solar System Used to Heat a Swimming Pool

Advantages are that the pool would be heated without outside intervention and with very little cost. Very little artificial energy input is needed, only enough to run a small water pump. Proper selection of the roof top heating coils would ensure that the pool would not get too hot. In freezing weather, the heating coils would need to be drained to prevent pipe breakage. Homes could also be heated in this manner.

In the case of heating a home, a heat exchanger would also be needed. Also, the pipes would need to be filled with antifreeze so that the system could operate in winter when the heat is most needed. Figure 2.3 is a diagram of how this system would work. This system would augment a standard natural gas or electric heating system, and the temperature control would only allow it to run when heat is needed. The air conditioner would be set up to not allow it to run when cold air is needed in the summertime. An added benefit is that the roof would be protected from the direct rays of the sun by the heating coils package. This seems like a sensible thing to do as very little additional infrastructure would be needed.

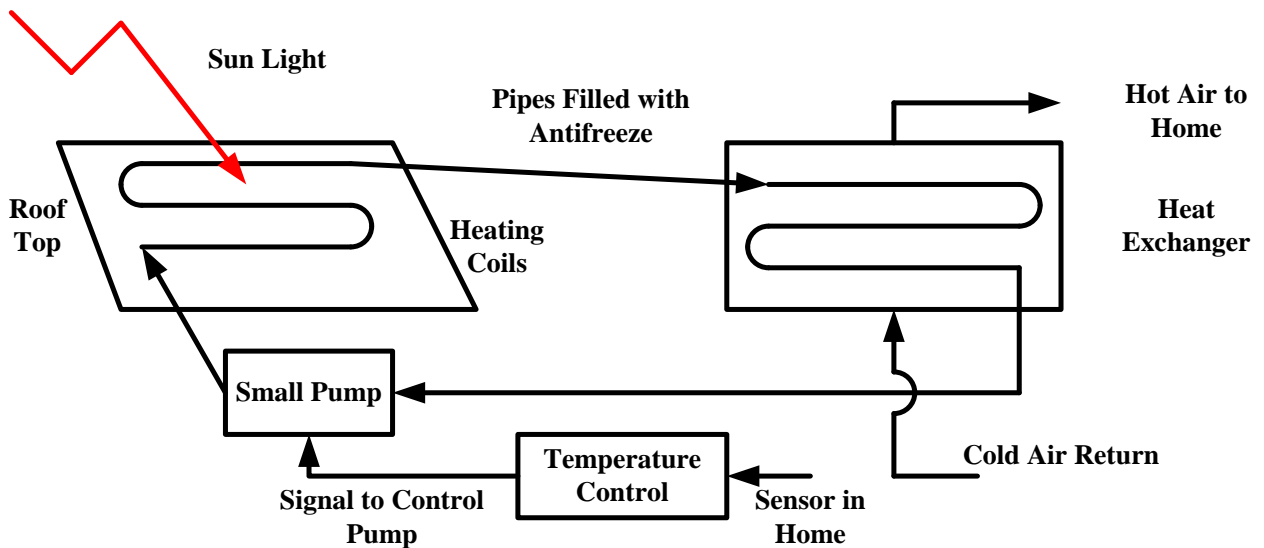


Figure 2.3 A Way to Augment a Home Heating System by Use of Solar Energy

So far, we have only shown ways to use solar energy on a small scale for individuals to use for their own comfort and convenience. Some capital expense is necessary, but it is not overwhelming. There are several ways to use large-scale infrastructure to utilize solar energy directly. We will now look at two of them, parabolic troughs and solar power towers.

Here's one added thought. A solar water heating system could be made completely passive by taking advantage that heated water would rise and cooler water would fall in as a completely closed system. Figure 2.4 shows how this would function.

Although I have never seen this idea implemented, there are no technical reasons why it would not work. In colder climates, the piping and water storage devices would have to be protected from freezing. The water would only be heated when the sun is shining, and enough of a temperature difference would have to exist to cause the water flow to happen. Since the heating of water is a significant part of the energy usage of a typical home, small-scale systems using this technique may have applications where the proper conditions exist. It would be interesting to see this idea made into a practical system. Someone with some practical plumbing skills could definitely do this. The elevations of the water tank and the heating coils would have to be correct to have the lighter and warmer water flow into the water tank, and the cooler water flows into the heating coils. The water tank would have to be higher in elevation than the heating coils. If this were not possible, a small water pump could be used to pump the water from the heating coils to the water tank when a certain temperature was reached.

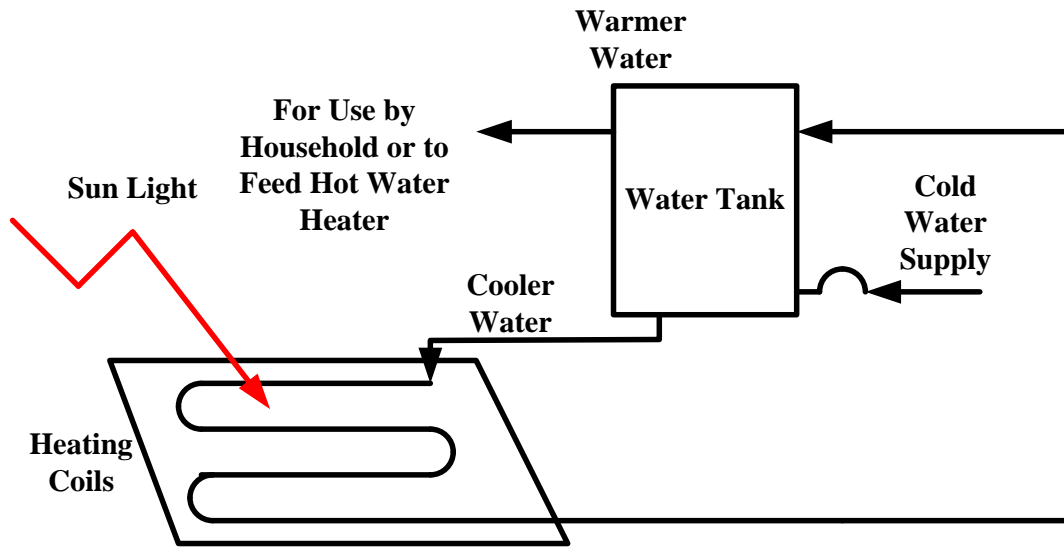


Figure 2.4 A Completely Passive Solar Water Heating System

3. Parabolic Troughs as Solar Energy Collectors.

On a larger scale, a parabolic trough can be used to concentrate solar energy to heat a pipe carrying oil that can heat water to generate steam and run a standard steam turbine. Figure 3.1 shows a picture of a typical parabolic trough solar energy accumulator.

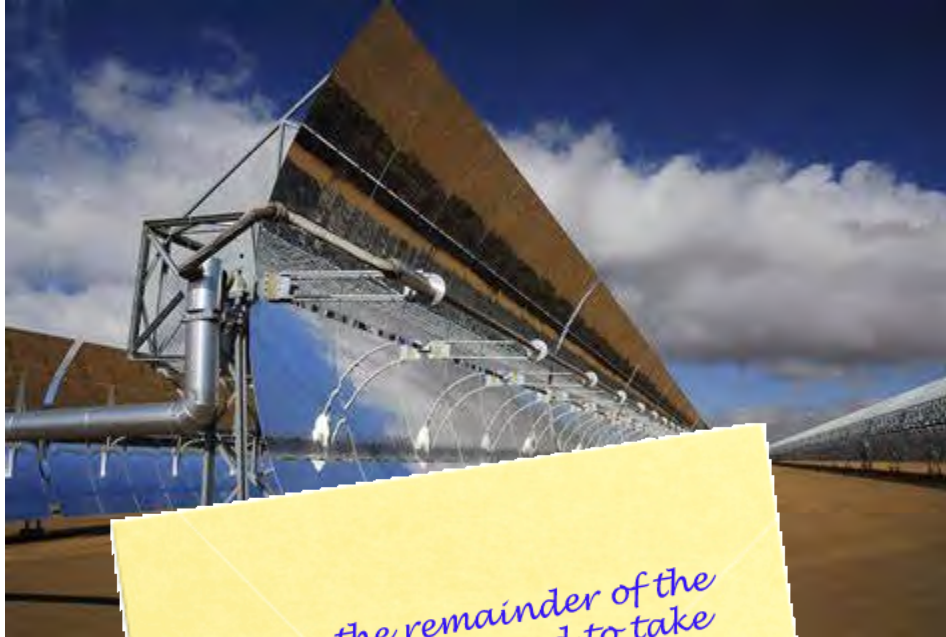


Figure 3.1 Parabolic Trough Solar Energy Accumulator

The parabolic trough would be oriented so that it could collect the maximum amount of solar energy. The collector is located so that they would be able to track the sun. The oil would be stored in a tank where it would be heated to generate steam to run a standard steam turbine. However, one of the best features of this system is that it allows the system to operate even when the sun goes down. This is because the hot oil would be used to heat the water in the tank, which would then be used to generate steam.

To view the remainder of the course material and to take the quiz for PDH credit, you must purchase the course.

Close this window and click "Add to cart" on the product page.

oriented so that it could collect the maximum amount of solar energy. The collector is located so that they would be able to track the sun. The oil would be stored in a tank where it would be heated to generate steam to run a standard steam turbine. However, one of the best features of this system is that it allows the system to operate even when the sun goes down. This is because the hot oil would be used to heat the water in the tank, which would then be used to generate steam.