SOLAR BUILDINGS

Solar Water Heaters
The Next Generation

THE U.S. DEPARTMENT OF ENERGY IS PURSUING AN AGGRESSIVE GOAL TO CUT THE COST OF SOLAR WATER-HEATING SYSTEMS IN HALF. REPLACING METAL AND GLASS COMPONENTS WITH LESS EXPENSIVE PLASTIC ONES IS A KEY STRATEGY FOR THAT GOAL.

Solar water heating is a well-established, highly effective, pollution-free technology for domestic water heating that can be used throughout the country. More than one million homes and businesses in the United States have been equipped to use water heated by the sun. Twenty-nine U. S. manufacturers shipped solar thermal collectors in 1997. Is there any reason why everyone is not installing solar collectors?

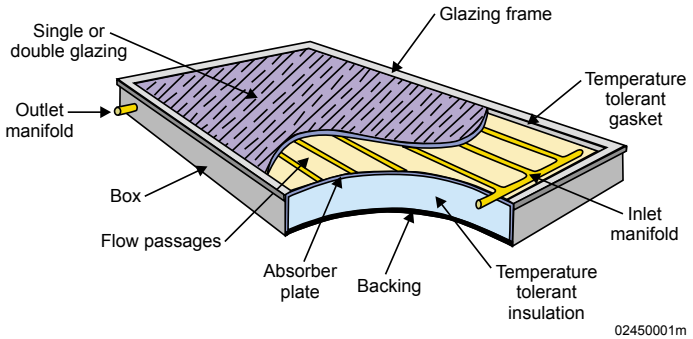
In most parts of the country, natural gas or other inexpensive water heating costs so little that it may take many years of solar water-heating savings to repay the initial solar water-heating system cost. Still, the need for clean energy for water heating remains strong. A significant amount of energy is used for water heating—indeed, water heating accounts for 18% of the energy used in the residential sector. And more and more systems are being installed as new buildings are constructed and as existing systems are replaced, underscoring the need for renewable options. Yet, solar collector sales in recent years have actually been dominated by less-expensive, lower-temperature systems used mostly for swimming pool heating.

Taking a page from the book of the pool-heating collectors—which are made almost totally from plastic—the U.S. Department of Energy's (DOE's) Solar Buildings Program is researching ways to replace with less expensive materials the metal and glass now used to make medium-temperature collectors for domestic water heating. During 1998, the National Renewable Energy Laboratory (NREL), DOE's renewable energy specialist, and Sandia National Laboratories began working on several studies on the use of plastics in solar water heaters. Laboratory researchers are also doing related research and testing.

Building with Polymers

Laboratory researchers and other experts see great potential for constructing solar water-heating systems with polymer materials (giant molecules formed from chains of simpler molecules). Polymers could replace or reduce the need for glass, copper, and steel in the collectors and the piping. The material and manufacturing cost per unit area is much lower for polymers, so manufacturing costs could be significantly reduced. They also weigh less, which reduces the cost of shipping, handling, and installation.

The successful use of polymers in solar applications requires overcoming two engineering challenges: (1) the thermal conductance of polymers is lower than that of metals, which can reduce water-heating performance; and (2) not all polymers weather well in



This typical flat-plate solar-collector design uses glass glazing, copper tubing, steel frame, and quality insulation. Substituting plastic for some of these components could lead to a new generation of low-cost solar water heaters.

"I HAVE JUST ONE WORD FOR YOU BENJAMIN—PLASTICS." THIS ADVICE FROM *THE GRADUATE* MAY BE CENTRAL TO MAKING SOLAR WATER HEATING A BIGGER PART OF OUR USE OF CLEAN, FREE, RENEWABLE ENERGY.

the sun—some early commercial and experimental solar systems built during the late 1970s and early 1980s experienced discoloration and failure due to exposure to ultraviolet solar radiation.

Lower thermal conductances can be largely accomodated with designs that place the heat transfer fluid in direct contact with the absorber—rather than indirectly, such as through the use of fins. In addition, the polymer industry is developing new polymer materials manufactured with chemical additives that result in higher thermal conductances and protection from ultraviolet radiation. In October 1997, program researchers held a workshop attended by members of both the polymer and solar industries to investigate the practicability of building solar systems with these new polymers. This led, during 1998, to the formation of a collaborative between representatives of DOE and these two industries to exchange information and to coordinate research and development.

Improving Subsystems

Based on feedback from the solar industry, program researchers began work on improving energy storage and freeze protection for piping. Currently they are working on new designs for energy storage and heat exchange within the collector itself. Better storage designs will help lower the overall cost of energy.

On the other hand, reliable freeze protection is a key component of long system lifetimes. Freeze protection is important for all designs, but especially for lower-cost passive systems. These systems currently can operate only in the South, where temperatures in the winter never go below -8°C (17.6°F). Better freeze protection would make passive systems competitive over a much larger geographic area. Researchers are testing outdoor freeze protection for both active and passive systems.

NREL/PIX 06436

This experimental integral collector-storage system is designed to use natural convection to draw heat from the inside of the building up through the exposed external pipes to keep them from freezing. Innovative freeze protection is a crucial challenge for reducing the cost of solar water-heating systems.

Molding the Future

NREL, Sandia, and their industry partners are exploring the use of plastic heat exchangers, thin-film plastic absorbers and glazings, plastic collectors, and plastic storage vessels. Laboratory researchers are also studying the durability of various polymers and developing nonpressurized integral collector-storage systems (storage in the collector). If results from the first phase of these studies are promising, the work will be continued toward product development. These studies will likely also suggest other ways that polymers could be used to lower the cost of solar water heater manufacture and installation.

Whether through the use of polymers, integral collector-storage systems, or some other means, the Solar Buildings Program aims to reduce by 50% the installation and hardware costs of solar water heaters by 2003. As the Solar Buildings Program meets the technological challenges necessary to achieve this goal, solar energy will play an increasing role in heating water in the buildings sector.

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