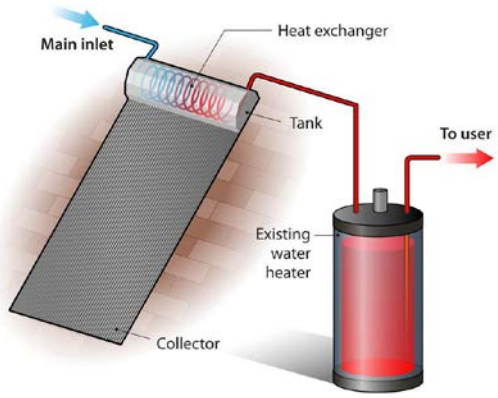
NREL
NATIONAL RENEWABLE ENERGY LABORATORY

NREL and Industry Advance Low-Cost Solar Water Heating R&D

Highlights in Research & Development

NREL and Rhotech develop cost-effective solar water heating prototype to rival natural gas water heaters.

Water heating energy use represents the second largest energy demand for homes nationwide, offering an opportunity for innovative solar water heating (SWH) technologies to offset energy use and costs. In the *Low-Cost Solar Water Heating Research and Development Roadmap*, researchers at the National Renewable Energy Laboratory (NREL) outlined a strategy to expand the SWH market. Recognizing that industry partnerships can boost R&D efforts, NREL and Rhotech Solar collaborated to develop a low-cost, polymer film SWH design that delivers high efficiency and long-term performance.



Conceptual SWH schematic. Illustration by Al Hicks, NREL

The roadmap provides a path forward to reduce SWH system costs and allow SWHs to be cost competitive in the U.S. natural gas water heater market. Based on NREL's analysis, a reduction in current SWH cost by a factor of 3 to 5, without compromising durability or performance, is needed to transform the water heating market. The roadmap set the following cost, performance, and reliability targets: installed system cost of $1,000–$3,000; 35%–40% source energy savings over conventional natural gas water heaters in cold climates; and 15–25 year product lifetime with high system and component reliability and performance.

In 2012, NREL and Rhotech Solar combined expertise in solar thermal design and testing to prove the feasibility of a low-cost polymer film prototype. Rhotech's SWH is constructed from thin-film polymers and uses natural convection to passively move heat to a storage tank located at the top. A polymer heat exchanger transmits the heat from the storage tank to the high-pressure water line (see figure). The complete system, including a heat exchanger, weighs less than 10 kilograms when empty, which will simplify installation and keep labor costs low.

Analysis, modeling, and field testing by NREL and Rhotech have shown that the system can be installed at a cost of approximately $1,200. Moreover, the polymer system has a target annual thermal efficiency of 32%, which is comparable to other more expensive polymer collector systems and slightly less than the 34%–38% thermal efficiency for state-of-the-art metal and glass SWHs that have an installed cost of $6,000–$10,000. The prototype will also undergo testing to show the polymer materials can withstand a 15-year lifetime.

Performance data are still being collected on the full-scale unglazed systems under test at NREL and on glazed and unglazed systems at Rhotech's California facility. The final step is to commercialize this product, which will require broader private-sector investments in developing successful low-cost SWH products.

Technical Contact: Tim Merrigan, *tim.merrigan@nrel.gov*

Reference: Hudon, K.; Merrigan, T.; Burch, J.; Maguire (2012). *Low-Cost Solar Water Heating Research and Development Roadmap*. NREL/TP-5500-54793. *www.nrel.gov/docs/fy12osti/54793.pdf.*

Key Research Results

Achievement

NREL and Rhotech Solar proved the feasibility of a polymeric film SWH prototype that delivers low cost and high thermal efficiency, and is applicable in cold climates.

Key Result

NREL researchers and consultants conducted modeling and analysis that resulted in an accurate model of the polymeric SWH configuration. Performance testing by Rhotech validated the simulation model; the thermal conversion efficiency of the glazed polymer system was determined to be in the range of 33%–37%, exceeding the annual efficiency goal of 32%.

Potential Impact

The success of this project will result in the development of a viable, low-cost SWH product that could make this technology cost competitive with natural gas water heaters in 3 years.

NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

15013 Denver West Parkway
Golden, CO 80401
303-275-3000 | www.nrel.gov

NREL/FS-5500-62107 | August 2014

NREL prints on paper that contains recycled content.