Turn Up the Heat

What lessons does a 25-year-old solar domestic water heater offer for building the market?

BY DREW GILLETT, with NICK PINE

DREW GILLETT

Gillett's "invisible" solar hot water system, nestled in the upper right corner of his roof-integrated air collector system.

The 80-gallon solar hot water system tank, with expansion tank and water meter.

Gillett tracks system performance using his system controller, timer and electric meter.

With faster paybacks and environmental benefits than photovoltaic (PV) systems, solar domestic hot water (SDHW) is recognized as a clean, economical solar technology. Worldwide growth in 2001 was 26 percent. Many states offer rebates. So what's behind lackluster growth of the U.S. market?

To examine this question, I offer my experience with my 25-year-old SDHW system.

Gillett's System Keeps Going

I installed my system in Bedford, N.H., in 1978. Since then, it has saved 3,000 kilowatt-hours (kWh) in empty-nest years and 6,000 kWh in my twin daughters' teen years. It comprises 80 square feet of Solar Alternative single-fiberglass glazed, flat black copper collector, an 80-gallon Sepco stone-lined tank and a 20-square-foot heat exchanger, with propylene glycol freeze protection and a Natural Power proportional controller and a 6-kilowatt backup electric heater. In 25 years, the system used about 800 kWh per year of backup electricity.

The system has supplied 80 percent of my family's hot water. The fiberglass required one recoating after 15 years. The system is on its third tank, because of New England's acid rain. The controller was hit twice by lightning and repaired. A sensor recently failed, but maintenance has been minimal—less than $2,000 (in 2004 dollars) over 25 years. The initial investment was $2,800, with a $400 HUD credit. System payback was less than 10 years.

In hindsight, what would I do differently? I might use a standard tank with an insertion fitting, a durable stainless-steel tank, a rubber-lined plywood box or an STSS flexible circular metal tank to avoid the cost and weight and replacement of the stone-lined tank. I might make the system larger and include radiant space heating, as in German combi-systems. But then I might use a selective coating or evacuated tubes to increase performance during non-summer months.

Above all, I would install the system again.

Table 1

Economics for Solar Water Heater Owners

	Gas/Oil Heating	Electric Heating
Average household hot water bill	$100-$400	$300-$700
Solar savings at 50% to 80% savings	$50-$320	$150-$560
Average simple payback, based on $5,000 system cost	27 years	14 years
Rate of return after taxes	3.7%	7.1%

For comparison, a CD must return 5% or 10% to be competitive (in a 28% income tax bracket). CD rates of return are now only 2% to 5%.

Note: For simplicity, calculations assume a zero fuel inflation rate, maintenance cost, salvage value and taxes. Individual savings will vary.

Are Economics the Obstacle?

As my experience demonstrates, SDHW offers tremendous benefits and value, even in places known for lack of sunlight. So what's stalling widespread adoption of these systems?

Is there a physics problem? I don't think so. After all, if we put something dark-colored in the sun, it gets warm almost anywhere.

Are the economics unattractive? Local, business and global economics suggest otherwise. Table 1 shows that an SDHW system can be a better investment than a certificate of deposit. Table 2 shows that these systems represent a potential annual market of $100 million in New Hampshire alone. Based on this estimate,

the U.S. market represents a potential $25 billion per year business, employing more than 30,000 people in installation and maintenance and another 30,000-plus in manufacturing and government.

Solar water heating economics works in Germany, China, Israel and Australia, where there are well-developed markets—and in the United States, for me. China has more than 100 manufacturers of evacuated tube systems alone.

Gillett's 1890s farmhouse with air collector, photovoltaic panels (lower right) and solar water-heating system (upper-right roof).

Lots of hot water and kWh savings over 25 years—even with teenagers!

According to a study by the International Energy Agency (IEA), market growth for flat-plate and evacuated-tube systems in 26 countries surveyed was 26 percent in 2001. The number of flat-plate and evacuated-tube systems installed in 2001 was 65 square meters per 1,000 occupants in Israel, 19.9 in Austria, 6.4 in China, 3.9 in Europe, 2.5 in Japan and—get this—only 0.08 square meters per 1,000 people in the United States and Canada. That amounts to 0.25 million square feet of U.S. systems, or about 5,000 installed systems. *(Download the report at www.iea-shc.org.)*

Electric water heater owners are prime candidates for SDHW systems because of high potential utility bill savings. Florida's Lakeland Electric utility actually installs systems for customers and bills them for the solar energy produced. Other utilities see SDHW as a "negawatt" producer. My utility gave me a reduced rate—7 cents per kilowatt-hour—to remain an electric water heater backup customer. My SDHW system savings were reduced, but the arrangement lowered my overall costs.

Each square foot of SDHW collector produces about 50 kWh of heat per year, or about 150,000 Btu. Even at the current low prices of fuel and electricity, that amounts to $2 to $7 per square foot per year, or $90,000 to $300,000 in annual revenue per acre. Talk about the highest and best use of land! Only dense urban areas have higher land costs.

Pricing is a concern. Our experience in the Northeast suggests an installed cost of $4,000 to $7,000. However, as production escalates, prices should decrease. Europe has experienced a decline of up to 30 percent in installed cost due to increased volume *(see www.ieatask24.org)*.

Are Attitudes the Problem?

Maybe SDHW adoption is stymied by politics. Politics affects economics, and oil companies affect politics. If we priced oil and electricity at their true costs to society (adding related costs for defense, the environment, health and so on), they might cost 10 times more and send clear conservation messages to consumers.

New Hampshire has no sales or income tax, but it has a modest local option town property tax exemption for solar systems. On my system, this exemption is about $120 per year—comparable to a typical system's $100 to $700 annual savings. On the other hand, the Million Solar Roofs program commitment for this state is 500 systems installed. Some goal!

That leaves aesthetics. If we could eliminate those pesky collectors on the roof, some say, SDHW would take off. Well, "invisible" solar is a hit; my SDHW system hides in a corner of a roof-integrated air collector. Companies like Dawn Solar Systems in Brentwood, N.H., and Zomeworks Corp. in Albuquerque, N.M., are developing systems that aren't visible from the curb.

Table 2

Economics for New Hampshire's Solar Hot Water Industry

Today's market comprises fewer than 10 systems per year, or about $50,000 in sales at an average installed cost of $5,000. The potential market in New Hampshire is $100 million per year or more:

State population: 1.2 million people
Dwelling units in state: 300,000 units
Assume 50% solar-capable: 150,000 units
Potential installations per year, based on 20-year system life: 7,500 systems
Installations in 200 working days per year: 40 systems per day
Jobs created with 2-plus-person crews installing one system per day: 100 continuous jobs
Potential installation market at $5,000 per system: $40 million per year
Potential maintenance market over 20-year life: $40 million per year and 100 direct jobs
Potential commercial market (hotels, car washes, businesses): $20 million+
Total potential market: $100 million per year

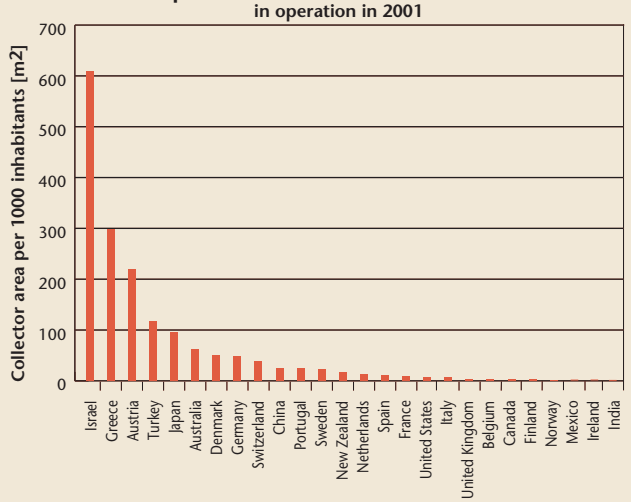
Editor's Note: This article is the third in the "Back to the Future" series examining lessons learned in the authors' 25 years of solar energy use. The most recent edition, on the solar town of Soldier's Grove, Wis., appeared in the November/December 2003 issue.

HELIODYNE INC.

Jurg Bieri (left), president of Heliodyne, and solar contractor M. Domich inspect solar water systems in a new Rancho Murieta, Calif., subdivision. Each home featurs a Gobi 408 or 410 flat-plate collector from Heliodyne, Richmond, Calif.

World Market Growth: Where is the U.S.?

Glazed flat plate and evacuated tube water collectors in operation in 2001



Source: IEA Solar Heating and Cooling Report, "Solar Heating Worldwide, Markets and Contribution to the Energy Supply 2001."

Note: Though not included in the IEA study, Cyprus is one of the leading countries in terms of installed solar collectors per capita, 0.86 square meters of solar collector per capita, or 860 square meters per 1,000. See www.sidsnet.org/successtories/32.html.

Jumpstarting the Market

I recommend several approaches to increase the U.S. market.

To begin, move away from costly, trouble-prone controllers and sensors to PV-powered pumps like the Helio-Pak from Heliodyne in Richmond, Calif. Move to thermosyphon vs. pumped heat exchangers or simpler drain-back systems. Reinvigorate batch heaters and integrated collector storage systems. They work in Israel and Australia. Why not here?

Next, focus on aesthetics. Invisible solar applications can integrate with conventional roof design and construction.

We could follow Ontario, Canada-based EnerWorks Inc., redesigning each piece to create new products. Eliminate the custom tank or use low-cost insertion heat exchangers like those made by Butler Sun Solutions in Solana Beach, Calif., to open up a vast retrofit market. Develop tanks and heat exchangers to improve performance and reduce the cost of integrating with oil and gas backup water heaters, since oil and gas systems have lower fuel costs than electric systems. Expand into combi-systems for space heating.

We could better promote double- or triple-play systems, like those of Zomeworks, which combine solar water heating with space heating and cooling.

On the economic and policy side, we need to ensure that SDHW stops falling through cracks because "it's not conservation,

BEIJING SUNDA

This Australian home features an evacuated-tube system from Beijing Sunda Solar Energy Technology Co.

since it produces energy" and "it's not electric production, since it produces heat." Hybrid PV-thermal systems, like those of SunWatt Corp. in Jonesport, Maine, which combine solar water heating with electricity generation, may bridge that gap.

Finally, innovative marketing can help. For instance, new subdivisions include standardized solar collectors on homes at minimal cost.

What can SDHW advocates do today?

The physics works fine in the United States (after all, we have more sun than Europe does). The economics are favorable. Local politics can be changed. New systems are addressing aesthetics. So maybe it's time to vote with our wallets. Visit the Solar Energy Industries Association site, www.seia.org, find a local dealer and request an installation quote.

When you receive the quote, consider that our use of fossil fuels may contribute to unrest in the Middle East. I have never regretted my decision to install SDHW through two oil shortages, two Gulf Wars, electric rates from 5 to 15 cents per kilowatt-hour, sunny and cloudy years, a smaller and larger family, and real estate booms and busts. The time for widespread U.S. adoption of SDHW systems is ripe. ●

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A SOLAR REALITY FABLE

How a solar thermal princess transformed from a no-frills drudge to a glamour queen.

By Howard Reichmuth, P.E., and Nick Pine

Long ago there lived a hard-working princess with a difficult name to pronounce. DHWerella went about her days doing useful work, with little excitement. She often felt eclipsed by her glamorous younger sisters: Aolia the wind princess, and PVeia the solar electric princess. All noted PVeia's promise, though she was not yet mature. The powerful sought Aolia, a statuesque Danish beauty.

Her stepsisters were supportive, but DHWerella felt slighted: She labored hard, but others got glory. Then again, it is difficult to build excitement with lukewarm water.

Extreme Makeover

One day the wily FOX sidled up to DHWerella. "Dee, honey, how about an extreme makeover, all expenses paid?"

She was confident of her worth, but perhaps she had focused too much on temperature and pressure ratings, and not enough on her wardrobe. "OK, fur-ball," she replied. "Do your thing." So the Fab Five did their magic. PVeia gave her fascination, and Aolia imparted grace.

DYNAMIC GRAPHICS INC.

DHWerella dazzled all at the Renewable Energy Ball, but none so much as the prince. Trained as an economist, he was enthralled with her cost-effectiveness and technical potential. But at the stroke of midnight she vanished. A tinkle arose as a pump housing struck the marble floor.

The prince trod the land with the pump housing, trying to fit any and all impellers. When he finally found his DHWerella, the kingdom rejoiced.

A New Solar Reality

Years later, we now conserve in serious ways. After the Building Code Wars, windowless houses are legal again. Single-wall graywater heat exchangers make 95 F water for fully enclosed showers. Water heating costs nothing compared to orthodontics. We have no heaters on roofs, less "mass and glass," and miniscule house heating bills. DHWerella takes comfort. ●