# Energy Design Update®

The Monthly Newsletter on Energy-Efficient Housing

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## INDUSTRY NEWS

# A Near-Zero-Energy Development With an Innovative HVAC System

When the Massachusetts nonprofit Rural Development Incorporated (RDI) started planning a 20-unit residential development in the town of Greenfield, they took to heart the lessons learned in building a single net-zero home in Colrain, Massachusetts several years earlier (see "Net-Zero-Energy In New England," ***EDU***, June 2007). The single-family Colrain house featured double-stud walls insulated with cellulose, grid-connected PV arrays, and a solar thermal system for domestic hot water and space heating, with heat distribution by means of a radiant-slab floor.

The duplex units in the new Greenfield development make use of a similar building envelope system and retain the PV arrays and solar thermal systems for domestic hot water (though not for space heating). However, they are equipped with exceptionally simple ventilation and heat distribution systems that were inexpensive to install, and should also be economical to operate.

Figure 1. The 20 duplex units at Wisdom Way Solar Village are designed for low- and moderate-income buyers. Except for a box bay on the side of each unit, the shape is a simple rectangle, making for efficient framing and air sealing.

### Economy, Simplicity, Visitability

Because the Wisdom Way Solar Village, as the development is called, is aimed primarily at low- and moderate-income buyers, RDI sought to keep costs low wherever possible. The two-, three- and four-bedroom units are modest in size, ranging from about 1,100 to 1,800 square feet (see Figure 1). All models make use of a simple rectangular floor plan and pitched roof. Their compact size and shape, combined with the side-by-side duplex layout, simplifies air sealing and minimizes the buildings' surface area to reduce heat loss. Two of the units are fully wheelchair accessible, while all 20 of the units are designed to be "visitable" by wheelchair-using guests, meaning that they include a wheelchair-accessible downstairs bathroom and downstairs doorways wide enough to allow for wheelchair passage. The visitability feature also led the design team to make use of an unusual first-floor joist detail, which uses sill-hung joist hangers to keep the floor level low enough for a wheelchair to roll over the door threshold at a concrete porch (see Figure 2, page 2).

## In This Issue




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energy-efficient building technology, and feature high-density and mixed-use zoning. For the USGBC, which expects to launch the first public version of its LEED standard for neighborhood development sometime this summer, the Climate Positive program could provide an ideal real-world laboratory for gauging the effectiveness of the still-under-development standard.

### Quote Without Comment

"'Maximizing roof space and orienting buildings toward the south or southwest, for example, mean that even if photovoltaic cells are not installed immediately, a home will be able to accommodate them as they grow less costly and more sophisticated in the future,' said Mr. Willars, of the architects' institute … 'Solutions linking the power needs of whole neighborhoods work better than looking at one home in isolation,' Mr. Willars said. 'The days when we were striving to achieve an airtight box bristling with wind turbines are disappearing,' he said. 'Now we're trying to get to zero carbon in the most efficient, most effective manner.'" [Britain's Ideal: Green Homes, by Beth Gardiner, *The New York Times*, May 24, 2009.]

# NEW PRODUCTS

## Simple Solar Hot Water

Sunshine is proverbially free, but the hardware needed to convert photons into a hot shower is anything but. And the colder and cloudier the climate, the higher the system cost for a given solar fraction.

In northern areas, it's not at all difficult to spend $10,000 or more on a system that may provide less than one-half of a home's hot water needs; whether such a system will ever pay for the cost of installing it can be a difficult call (see "Why Solar Thermal Payback Calculations Are Tricky," ***EDU***, March 2008). But a number of manufacturers are producing solar water heaters aimed at improving that payback picture – not by increasing system efficiency, but by cutting installation costs. Depending on the situation, one of these simplified systems may offer more bang for the buck than a full-featured pumped glycol system with evacuated tube collectors and a separate solar storage tank.

Figure 10. The Globe Solar Energy IP-195 can be ground mounted or placed on a rooftop, as pictured here. The user-supplied insulated and heated unbilical can be seen leading from the unit at lower right.

### Globe Solar Energy IP-195

Integrated-tank solar thermal systems, in which a pressurized outdoor storage tank is mounted directly above a flat-plate collector, have long been popular in areas where freezing isn't a problem. However, a Canadian company called Globe Solar Energy (GSE) is marketing the IP-195, which is an integrated-tank system designed to work even where freezing temperatures are common (Figure 10). The unit's 24 evacuated tubes are not subject to freezing because they contain no household water, and the 150-liter (about 40-gallon) tank is well insulated with about two inches of closed-cell foam. According to the manufacturer, the overnight heat loss for the tank is 1 degree C for each 6.43-degree differential between the tank temperature and the outdoor air. Even under worst-case conditions of cold, cloudy winter weather and no water circulation between house and tank – a scenario that might easily arise during a homeowner's winter getaway to a warmer locale – the evacuated-tube array reportedly supplies enough heat to the tank to prevent any possibility of it freezing.

The supply and return lines leading to and from the tank are much more subject to freezing, and here the manufacturer relies on what could be described as a layered system of freeze protection. The tank fittings accept ½-inch PEX tubing, which can withstand repeated freeze-thaw cycles without damage. The freeze-tolerant PEX is then enclosed within two user-supplied insulated pipe assemblies, for which the manufacturer provides what are admittedly fairly sketchy specifications. In rooftop installations, the plumbing connection through the roofing can be waterproofed with a conventional vent-stack flashing boot. GSE also offers an optional electronic controller with an adjustable setpoint that activates a user-supplied trace heating element (electric resistance heat tape) placed between the insulated supply and return pipes. According to company spokesman Frank Wang, trace heating ele-

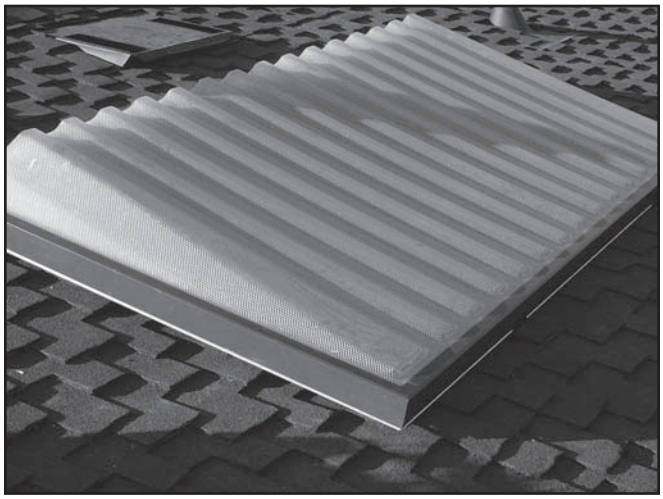

Figure 11. The Harpiris Energy SunCache is an open-loop collector that uses an innovative polyethylene heat-transfer tank.

Figure 12. The SunCache is not designed for cold-weather use, but can withstand occasional subfreezing temperatures, making it suitable for use over about one-third of the US.

ments in the Toronto area are typically switched on only during the two coldest months of the year, at an average electricity cost of about $7.50 per month.

Indoor plumbing connections to the existing hot water system are also simple, since the IP-195 functions as a preheater in series with a conventional tank-type or on-demand water heater. The hot water return line from the solar tank feeds the cold water inlet of the indoor gas or electric water heater; valves in the supply and return lines to the solar heater permit the homeowner to isolate it from the rest of the system for draining, maintenance, or in case of a temporary freeze in the exterior water lines.

The IP-195 is certified by the Canadian Solar Industries Association (CSA), and retails for about $3,000 Canadian; the manufacturer estimates the cost of plumbing supplies and installation labor at an additional $1,000.

### Harpiris Energy SunCache

Like the Globe Solar Energy IP-195, the Harpiris Energy SunCache is an open-loop integrated collector storage (ICS) system that's designed to by plumbed upstream of a conventional water heater (see Figure 11). However, rather than relying on a flat-plate or evacuated-tube collector, the SunCache makes use of a large wedge-shaped polyethylene tank as a collector. The approximately 4x8 foot tank is enclosed in an aluminum frame, and is covered with translucent acrylic glazing. After installation on a roof, the tank is filled with about 50 gallons of water through a garden hose fitting.

The unpressurized water in the tank, however, is not part of the household supply. Instead, it serves as a heat-transfer medium to the pressurized domestic water that flows through a 200-foot network of $^3/_8$-inch copper tubing molded into the open interior of the tank at the factory. The copper terminates outside the tank with Sharkbite fittings that allow for easy connection of PEX tubing.

According to Harpiris Energy president Eric Lee, the SunCache has several advantages over a conventional ICS heater. "A flat-plate collector in an open loop system is very vulnerable because of the black body effect," he says. "It can radiate so much heat to the night sky that it can freeze even when the air temperature is in the mid-thirties." The thermal mass of the SunCache's water-filled tank, by contrast, provides significant freeze protection to the copper tubing within. Even if a short, sharp freeze allows ice to form in the PEX tubing leading from the collector to the house, the unpressurized tank would be unlikely to freeze, unless temperatures dropped so low for so long that the entire 50-gallon tank froze solid. He notes that, although the unit would probably survive such a freeze without damage if the copper lines were empty, its long internal run of small-diameter tubing is not easily drained. Consequently, the SunCache is not designed for use much beyond the edges of the Sunbelt (see Figure 12). Within its working range, Lee estimates that one SunCache unit should have an annual solar fraction of about 40%.

The SunCache is also resistant to stagnation-induced overheating, Lee reports. The surface area and configuration of the tank are such that the water temperatures in the tank never exceed 170 degrees F. "At that point, heat losses are equivalent to the energy coming in," he says. As a result, there's no danger of exceeding the rated 180-degree maximum for PEX tubing. Open-loop flat plate collectors, by contrast, can stagnate at temperatures of 200 degrees F or more.

That resistance to overheating also reduces the scald hazard. Tests have reportedly shown that, when the SunCache is connected upstream of a conventional 30-gallon water heater with a thermostat setting of 110 degrees F, the maximum increase in output temperature is 15 degrees F once the solar-heated water has passed through the contents of the tank. With the thermostat of the conventional heater at 130, the maximum temperature increase was a mere 3 degrees F. With a larger-capacity tank heater, those increases would be even lower. Eventually, Lee hopes that the SunCache will receive a code exemption permitting it to be used without an anti-scald mixing valve, which would eliminate a common cause of failure. "Most mixing valves fail within five to ten years," he says. "They fail in the cold position, but they're still a pain to replace." (That proposed exemption would not, of course, apply to units used in conjunction with tankless water heaters.)

The $2,500 retail price of the SunCache includes shipping charges. All fittings needed to tie into the existing water heater are provided, including PEX tubing, pipe insulation, and a thermal mixing valve.

### Butler Sun Solutions Solar Wand

Closed-loop systems using propylene glycol as a heat-transfer fluid are much more costly than simple open-loop systems, and a sizeable chunk of that price difference can ordinarily be attributed to the cost of a solar storage tank and heat exchanger. The physical size of the storage tank may also be a deal-breaker, particularly in retrofit applications where space is at a premium. The Butler Solar Wand is an ingenious device that makes it possible to use a conventional tank-type gas or electric water heater as a closed-loop storage tank.

The Solar Wand is a tubular copper heat exchanger that is screwed into the tank's hot water outlet (see Figure 13). A ¾-inch male fitting in the wand is then plumbed into the existing domestic hot water line, while the supply and return lines to the closed collector loop are connected to a pair of $^3/_8$-inch compression fittings. In operation, the heated glycol from the solar collectors is pumped through the tank insert, which consists of three concentric tubes. As the hot fluid flows from the outlet of the device's innermost copper tube, near the bottom of the tank, it flows upward through a second, larger diameter tube that returns it to the collector. A sealed, helical copper jacket is tightly crimped to the outer surface of the return tube for efficient heat transfer to the potable water in the tank; the spiral-shaped air space between crimps is vented at the top of the wand. In the event of a defect in the return tube, leaking glycol would flow from the vent opening, indicating the need for repairs without contamination of the potable water.

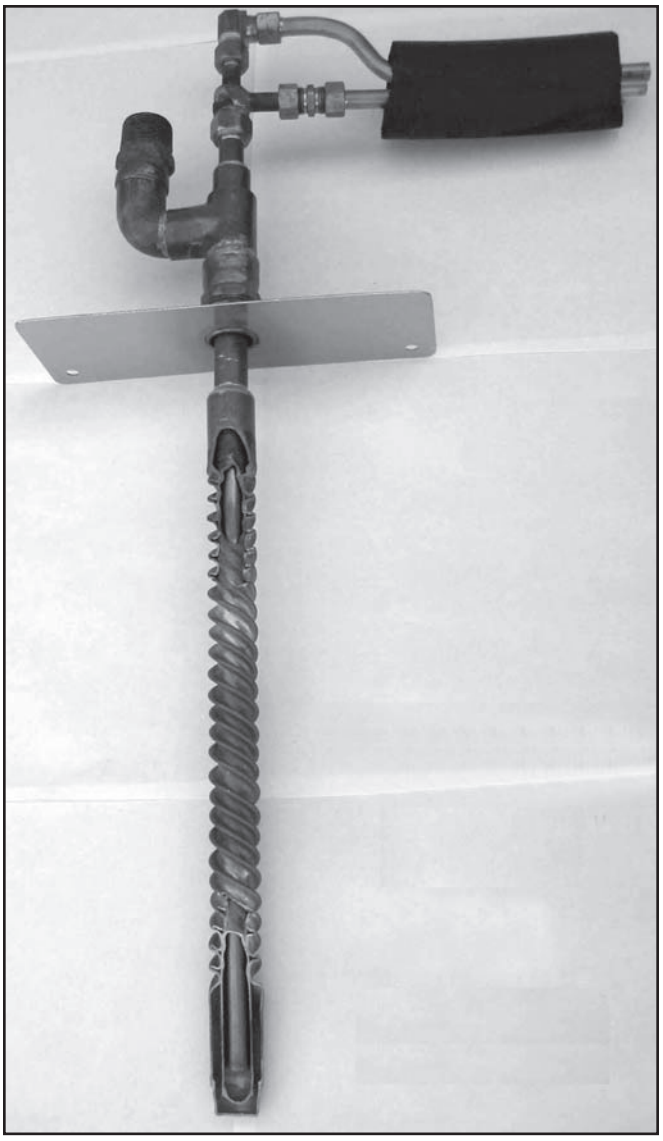

Figure 13. As shown in this cutaway view, the Butler Sun Solutions Solar Wand is a closed-loop heat exchanger designed to be inserted in the hot-water outlet of a conventional tank-type hot water heater, while still allowing water to be withdrawn through the same opening.

The Solar Wand is available in two lengths – a 46-inch version that extends nearly to the bottom of most 58-inch gas or electric water heaters, and a 36-inch model for 46-inch tanks. That ensures that the bottom of the wand, where the flow of hot fluid from the collector first makes contact with the conductive outer surface, is located in the coolest part of the tank to allow for efficient heat transfer.

That said, the heat-transfer ability of the Solar Wand is limited by its relatively small surface area, which, in turn, is a function of the largest tube that will fit through the outlet fitting of a standard water heater. To make the most of that limited surface area, the manufacturer recommends pumping the glycol from the collectors at the relatively slow rate of 0.5 gpm to keep the temperature

in the area of 200 degrees F. According to Solar Solutions owner Barry Butler, the Solar Wand can be used successfully with either flat plate or evacuated tube collectors. "Evacuated tube collectors lose less heat in cold weather, so they make the most of what winter sun there is in cold climates," Butler says. "In sunny areas, flat plate collectors are very cost-effective. If you want more output, it will usually be cheaper to increase the size of a flat plate collector than to go to evacuated tubes."

In addition to the Solar Wand heat exchanger itself, Butler also manufactures an integrated over-temperature/over-pressure device designed to be mounted on the roof above the collectors. In the event of system overheating – a possibility in a system designed to run at relatively high temperatures – it includes a fluid reservoir to capture and recover fluid vented to relieve system overpressure, and a finned copper radiator to discharge excess heat in the event of pump failure.

Complete system kits, including two 20-square-foot flat plate collectors, the Solar Wand itself, pump and controller, and most necessary small parts and fittings (but not the necessary tank-type water heater) sell for about $2,500.

### Energy Alternatives Greenward Ridge Vent System

Not yet on the market, but expected to be released sometime this summer, is an active closed-loop system from a New York State startup company called Energy Alternatives. Rather than making use of a flat plate or evacuated tube solar collector, as most active systems do, the company's Greenward Ridge Vent system is built around a ridge vent assembly that incorporates four parallel runs of PEX tubing, which collect heat from the warm air vented from an attic equipped with balanced eave vents. The heated glycol solution within the ridge is then circulated to a conventional solar storage tank with an internal heat exchanger as in any other closed-loop system.

The ridge assembly, manufactured for Energy Alternatives by Benjamin Obdyke, is a modified version of Obdyke's Roll Vent product. The PEX tubing is mounted at the vent center line, secured to the ridge assembly with clips that hold the tubing clear of the roof sheathing, the roof vent itself, and adjoining runs of tubing for maximum heat transmission by the exiting hot air (see Figure 14). According to Energy Alternatives president Kevin Scott, the system can heat domestic water to a maximum of 125 degrees F. Because the maximum possible temperature doesn't present a scald hazard, the system can be installed without a thermal mixing valve.

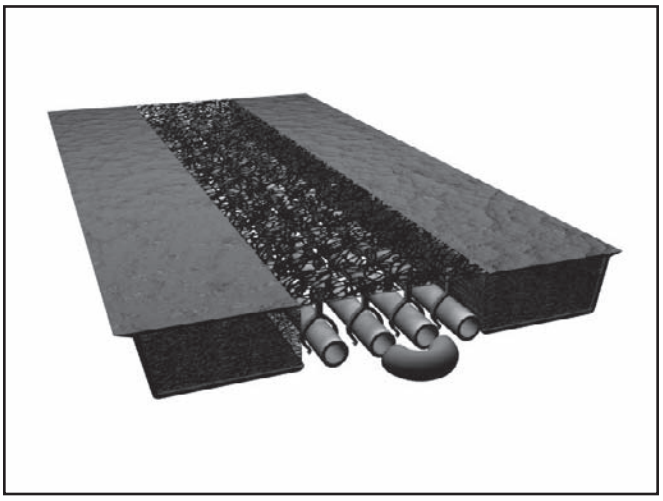

Figure 14. The Energy Alternatives Greenward Ridge Vent uses a pumped gycol loop to harvest heat from the air emerging from an attic ridge vent and transmit it to the domestic hot water supply.

Among other claimed benefits, the product performs as well as the standard Benjamin Obdyke ridge vent, whether it contains fluid or not, making it practical to install the Greenward Ridge Vent with an original or replacement roof to retain the option of installing the rest of the system at a later date. Scott also claims that the system is less dependent on direct sun than conventional solar collectors, since a vented attic may continue to exhaust stored heat well after sundown.

Energy Alternatives expects to sell a complete system kit for $3,100, including the ridge vent assembly, an 80-gallon Vaughn storage tank with heat exchanger, circulator pump, and all necessary fittings. The ridge vent will also be available separately, at a cost of about $300 for a 40-foot roll.

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