What's Happening from **BuildingGreen.com**
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## The First Practical Heliostat

The Boston company Practical Solar has introduced the first ready-to-go, practical heliostat system for reflecting sunlight into buildings. This sunlight can be used for daylighting of spaces that previously did not have direct solar access, such as rooms on the north side of a building, and for providing solar heat through a window or skylight. "We harvest sunlight," says inventor and company president Bruce Rohr. "We can deliver it where you want it."

This Practical Solar heliostat at the Tannery Mall in Newburyport, Massachusetts helps brighten several commercial spaces on the north side of the mall.

Rohr, who earlier founded the highly successful laser-scanning equipment manufacturer Cambridge Technology, had originally intended his heliostat system to be used for indirect space heating and water heating. After failing to raise money to develop advanced components for those applications, however, he shifted to simpler lighting and direct heating applications. The rest will come later, he says. While the heliostat relies on sophisticated engineering and software to make it work, the end product is extremely simple in its function, he told *EBN*.

A heliostat is a pedestal-mounted mirror that tracks the sun to focus light on a target. Practical Solar's heliostat consists of eight 12" x 12" (305 x 305 mm) flat glass mirrors mounted on an aluminum frame that is installed on a 2-3/8"-diameter (60 mm) galvanized steel pole. Low-voltage, twisted-wire cable, laid just below the ground surface, provides the heliostat with electricity needed to operate the motors and to transfer data for its control.

The Practical Solar heliostat, with eight square feet (0.74 $m^2$) of area, delivers 600 watts of heat (about the heat output of an electric space heater on a medium setting), according to Rohr, and the equivalent light of forty 100-watt incandescent light bulbs. Most commonly, the individual mirrors are kept in a plane so that the reflected light area is the same as the mirror area. The individual mirrors can also be adjusted to either concentrate or disperse the light.

Rohr, who has been working on heliostat design for 20 years, put up 12 early prototypes on his own property. After extensive refinement, the company now has 25 beta models installed for customers mostly in New England, but with a few as far away as Ireland. The production model, introduced in February 2009, looks virtually identical to the beta version, but there have been incremental improvements in nearly every part, according to Rohr. "We've learned an awful lot," said Rohr, who added extensive structural reinforcement after problems with the early prototype. The heliostat is rated to operate at wind speeds up to 50 mph (80 kph) and survive wind speeds up to 90 mph (150 kph).

Some have argued that heliostats only make sense in sunny climates, because diffuse sunlight cannot be reflected. Rohr admits that the ratio of direct-to-indirect sunlight is better in desert climates, but performance is good enough even in relatively cloudy Massachusetts. The average insolation in New England, according to Rohr, is 4.5 kWh/$m^2$/day, and even in the cloudiest period (from mid-December through mid-January) the average is 2.7 kWh/$m^2$/day. "We think we can make a living right here," he said from his South Boston manufacturing facility.

Another concern with the system and current application of reflecting sunlight onto windows is increased UV degradation or even melting of vinyl (PVC) materials. *Energy Design Update* reported in April 2007 on the mysterious melting of vinyl siding on homes. It turns out that reflected light, especially from low-e glass, is hot enough to distort or melt PVC; the problem can be exacerbated if the glass deflects when heated up, becoming concave. When asked about this concern with Practical Solar's heliostats, Rohr responded that in most applications the individual mirrors are kept in a plane, so the reflected sun is no more concentrated than normal sunlight. Rohr acknowledged, however, that in a concentrating mode, a heliostat could cause damage to some materials.

Customers *EBN* contacted all spoke enthusiastically about the system. David Hall, who manages the Tannery Mall in Newburyport, Massachusetts, has had a Practical Solar heliostat on the north side of the mall for the past six months. The control is programmed to deliver sunlight to different places at different times of day. In the morning, sunlight is directed through a window of a marketing firm located on the second floor; midday the light is shifted to a restaurant sign to increase visibility and aid in advertising; later in the afternoon the light is directed into a bar and grill. "It's terrific," he told *EBN*, noting that he hopes to buy one for his own home. Hall has had excellent experience with Practical Solar, he said. His only problem to date stemmed from the software requiring extremely accurate time to position the heliostat; the clock on his computer was slowly losing time, which threw off the heliostat. The problem was easily fixed by replacing the clock.

Bill Stroud has a Practical Solar heliostat at his home in Milton, Massachusetts. Sunlight is reflected through a north-facing window, and it has changed the home dramatically. "It's quite amazing, the impact that it's had on my home," he told *EBN*. "[The room] is now brighter, it has plants in it, it's warmer," he said, adding that "the mood of my family and myself is uplifted."

Probably the most unusual and diverse installation to date is on Jackson Madnick's home in Wayland, Massachusetts. Madnick has a single heliostat with eight different targets programmed into the software. At sunrise, the light warms up his wife's car. From there, a secondary mirror is used to bring light into their bathroom through a glass-block wall, then shifts to another mirror that brightens the kitchen and a bathroom below (through a translucent section of flooring). Madnick has even used the heliostat to warm an entry door so that he could varnish it late in the season (boosting its temperature from 30°F to 70°F) and to concentrate additional sunlight into his solar oven, doubling the cooking temperature from 200°F to 400°F. "I think it's incredible technology," an enthusiastic Madnick told *EBN*. "It's a cool, simple, revolutionary device," he said.

The Practical Solar heliostat sells for $995 and the control system with software adds $495. The control system can operate dozens of heliostats, and some discounting is available for multiple heliostats.

Rohr has lots of advances planned. "The future is completely wireless and self-powered," he told *EBN*. A tiny photovoltaic (PV) panel, just one inch square (650 $mm^2$), would provide all the power needed by the highly geared sun-tracking motors, and wireless controls would provide the data transfers.

Rohr is also anxious to implement his original vision for Practical Solar with indirect solar thermal applications, such as water heating, and solar electric applications. Indeed, he has worked with a customer in Rhode Island in which six heliostats are focused on a 20" by 20" (2,600 $cm^2$) target that transfers heat to a 600-gallon (2,300 l) water tank used for space and water heating.

To use Practical Solar heliostats for electricity generation, several different technologies could be used. The simplest approach would be to use the new generation of concentrating PV modules; one or more heliostats would focus sunlight onto specialized PV cells optimized for concentrated sunlight. More exotic approaches include using a thermoelectric (or *Peltier*) device that relies on a large difference in temperature to generate either electricity or cooling. Stirling engine technology could also be used to produce electricity, given the high-temperature heat source. Such development will have to await research funds, according to Rohr.

*– Alex Wilson*

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1. Photo: Practical Solar