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Let the Sun Shine In

A novel idea for piping in sunlight where dreary fluorescent bulbs have long dominated

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A prototype rooftop collector focuses solar rays into a set of half-inch-wide polymer fibers that are capped in heat-resistant quartz.

The sunlight flows into a building through a network of exceptionally transparent fiber-optic cables.

Atop a three-story building at the east end of Oak Ridge National Laboratory in rural Tennessee, the warped image of researcher Jeff Muhs reflects off a silvery 46-inch-wide dish aimed at the afternoon sun. The slowly rotating mirror focuses sunlight into fiber-optic cables, which snake under the roof, past insulation and electrical wiring, and emerge in a light fixture one floor down. “It’s real impressive . . . on a sunny day,” Muhs says sheepishly. On overcast days like today, a video demonstration has to suffice. Sunlight piped from the roof blends with fluorescent light in the fixture down below, offering a warm glow that looks much more natural than the harshness of conventional fluorescents.

Bringing the sun into the mix not only cuts electricity use for indoor illumination by up to 50 percent, it also addresses a fundamental problem with office buildings—how to get daylight into the interior. Architectural studies show that, at best, light from windows penetrates only about 20 feet inside a structure. The solution came to Muhs 10 years ago during a business trip to Japan. There he found silicone gel fibers that transmitted light far more efficiently than any he had seen before. He realized that a network of those fibers could spread sunshine throughout a building.

The idea was simple, but execution was a problem because passing clouds can suddenly dim the sun; on overcast days, of course, there’s no sunlight to tap into at all. Muhs eventually hit on a hybrid fixture that combines an acrylic sunlight-diffusing rod with two fluorescent lamps attached to a dimmer. He then added a sensor that can read the brightness of the room and adjust the fluorescents as needed.

The prototype at Oak Ridge has been running for more than a year. A dish-shaped collector on the roof bounces sunlight to a smaller mirror, which concentrates the rays into a bundle of fiber-optic cables. At noon on a sunny day, the system can illuminate about 500 square feet of floor space for every square yard of dish. “I was skeptical,” says Paul Phillips, vice president of product development at LSI Industries in Cincinnati, which builds the prototype hybrid fixtures. “Then I saw the simplicity of it and the potential for reducing cost.”

The fibers transmit 40 to 45 percent of the incoming sunlight into a ceiling fixture containing two acrylic rods that are etched to scatter the light evenly; the adjacent fluorescent bulbs fill in when sunshine alone is too weak to illuminate the room. Researchers at Oak Ridge National Laboratory hope that piped-in sunlight will put a serious dent in the amount of energy used to light commercial buildings, which accounts for about 10 percent of all electricity consumption in the United States. Photovoltaic cells placed behind the collector's secondary mirror could augment the savings by converting the sun's invisible infrared rays into electricity.

By Muhs's estimate, an installed hybrid system would sell for about $4,000 per dish. A small 20,000-square-foot office building would require 40 prototype collectors, or a smaller number of the double-size ones Muhs's team intends to build. Such a setup could save $10,000 a year in electricity even compared with high-efficiency fluorescent lights. The Antares Group, renewable energy consultants, project that 3.5 million dishes could be in use by 2020, leading to a total savings of more than $1 billion.

Muhs believes retail spaces such as furniture stores are the best places to begin because they are open long hours and rely on inefficient halogen bulbs to bring out the same color and detail that sunlight does. A typical halogen light provides 14 lumens of illumination per watt. An energy-efficient fluorescent light yields 90 lumens per watt. On a sunny day, a hybrid fixture puts out the equivalent of two fluorescents while using no electricity at all. Hybrid lighting in an average-size store in the Southwest could pay for itself in four years, but Muhs expects that psychological factors will really seal the deal.

Companies have reported that skylights and windows enhance worker productivity and sales, and some studies suggest that daylight raises students' test scores. A 1999 study of 108 stores in a retail chain found that outlets with skylights had 30 to 50 percent higher sales, even though most shoppers interviewed were unaware of the lights. They said the stores felt cleaner, more spacious, and brighter. Researchers at Rensselaer Polytechnic Institute are testing to see whether hybrid solar illumination similarly elevates productivity and mood.

The Oak Ridge team will install finalized prototype fixtures in a Tennessee Valley Authority site in Alabama and in a Sacramento utility. Wal-Mart executives have expressed interest in trying out the system as well. Muhs is optimistic that hybrid lighting, like hybrid cars, will catch on as a prestige technology: "I think it could become a trendy thing to demand, 'I want sunlight inside my office.' "