Paint it White: One Way to Chill the Electric Bill

by Renee Cho - Jun 28th, 2009
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Could something as simple as white roofs actually make a dent in our carbon emissions and help curb global warming?

Physicist Steven Chu, our Nobel Prize-winning Secretary of Energy, thinks so. At the St. James's Palace Nobel Laureate Symposium in London last month, he pushed for a global initiative to lighten the color of roofs, roads and pavements to cut carbon emissions by the equivalent of taking all cars off the road for 11 years.

As residents of hot countries have known for centuries, buildings painted white stay cooler because they reflect the sun's heat. Light colored materials reflect more solar radiation, including visible, ultraviolet and infrared light (which accounts for most of the heat), than dark materials which absorb heat. Albedo, the gauge of solar reflectivity, is calculated from 0.0 to 1.0, with 1.0 being the highest measure of reflectivity.

Maximizing the number of high albedo surfaces around the world could significantly help cool the planet, said Chu, former director of the Lawrence Berkeley National Laboratory (LBNL).

Chu's ideas have been shaped by the work of Dr. Arthur Rosenfeld (formerly at LBNL, now on the California Energy Commission), and fellow LBNL scientists Hashem Akbari and Surabi Menon. In 1985, they began studying how light colored roofs and pavement could mitigate the urban heat island effect – when urban areas are 2˚F to 8˚F warmer than surrounding areas due to the heat absorbed by pavement and buildings.

In 2004, they realized that their research might also help curb climate change.

"When we did the calculations, initially we couldn't believe the results," Akbari said.

They figured that changing 100 square feet of dark roof area to white would have an effect equivalent to offsetting the emission of one ton of CO2. On a global scale, increasing the albedos of urban roofs and paved surfaces would be equivalent to offsetting about 44 billion tons of CO2 emissions.

White roofs and cool roofs, those made from other high albedo materials, result in less carbon emissions because they reflect the sun, and reduce the need for air conditioning and thus the energy from CO2 emitting power plants.

Cool roofs also curtail the heat island effect and its accompanying smog, make buildings more comfortable, ease stress on the energy grid, help buildings comply with energy efficiency codes, and extend the life of roofs because lower temperatures make for less wear and tear.

White roofs, however, are difficult to keep clean and may lose up to 1/3 of their reflectivity within a few years, so resistance to dirt accumulation is important for roof coatings. And some critics have questioned whether white roofs increase winter heating costs in cooler climates. But Michelle van Tijen from the Cool Roof Rating Council, explained,

"In areas with hot summer and cold winters, the energy savings during hot weather are still greater than the incremental loss of heat in the winter." This is because roofs do not absorb much heat from the sun in winter when days are shorter and cloudier, and the sun is less intense.

Proof Is in the Payoff

Several examples of shifting to dark to white roofs have shown the value.

In 1995, The Florida Solar Energy Center applied a white acrylic coating onto the 12,000-foot roof of Our Savior's Elementary School in Cocoa Beach, Fla. After a year, the school's energy consumption was down 13,000 kWh and its power usage had dropped 10 percent for an overall savings of $850.

The Heat Island Group, led by Akbari, tested light colored roofs on three commercial buildings in Davis, Gilroy and San Jose, Calif. The roofs' albedos increased from 0.20 to 0.60, roof surface temperatures on summer afternoons fell from 175 degrees Fahrenheit to 120, and average electricity use for air-conditioning dropped by 18 percent in the Davis building, 13 percent in the Gilroy building, and 2 percent in the San Jose store.

The Philadephia Cool Homes Project, which installed white roofs on approximately 340 low-income seniors' homes from 2001-2003, eliminated solar heat gain through the roofs, reduced ceiling temperatures by 4 to 5 degrees, and saved 560 kWh of air-conditioning electricity use per year.

White roofs also make good economic sense for cities. The 2006 report Mitigating New York City's Heat Island with Urban Forestry Living Roofs and Light Surfaces compared the effectiveness and cost-benefits of urban forestry, green roofs, light surfaces, and some combined strategies, in mitigating the heat island effect. For every 1 degree of temperature reduction, light roofs and surfaces cost less than green roofs or tree plantings.

What Makes a Roof Cool?

A roof's "coolness" is determined by its solar reflectance (albedo) and thermal emittance, the ability of the material to release absorbed heat.

The EPA and Department of Energy have established minimum solar reflectivity criteria for their Energy Star roofing materials.

Low slope roofs, usually commercial buildings, must have an initial solar reflectance of greater than or equal to 0.65 to qualify. Steep slope roofs, usually homes, must have an initial solar reflectance of greater than or equal to 0.25.

Currently, emittance criteria are not required for Energy Star qualification. Some materials, like metal, are highly reflective, but if their emittance is low they won't release absorbed heat effectively, so the best cool roofing materials have both high albedo and high emittance.

"Some roofing product types are more likely to be designed as cool (spray-on foam, single-ply, some metal products), while others are typically black (modified bitumen or built-up roofing)," said Molly Trobley-McCann of the Cool Roof Rating Council. "But anything can be coated white."

Though plain white paint can increase a roof's albedo, white roof coatings help prevent leaks and protect the roof better than simple paint. According to the Consumer Energy Center, the cost of cool roof and traditional roof products are generally comparable, but the advantage of cool roof coatings is that they can be applied every 10 to 15 years, reducing the need for expensive roof overhauls.

Because residential owners have been reluctant to put white roofs on their homes, mainly for aesthetic reasons, LBNL's Environmental Energies Technology Division is collaborating with Oak Ridge National Laboratory and pigment and roofing manufacturers to develop high albedo roofing products in a variety of colors and materials.

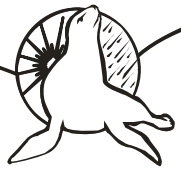
Cool Roof Rules and Standards

Since 2005, California has led the movement to adopt white roofs by requiring all flat roofs to be white. On August 1, its new Title 24 building standards will require both residential and nonresidential buildings to have cool roofs.

A number of other states and cities have also adopted cool roof standards and rebate programs, including Arizona, Arkansas, Florida, Georgia, Hawaii, Illinois, Louisiana, New Mexico, North Carolina, South Carolina and Texas. Still others promote voluntary programs and initiatives. Voluntary programs such as the Green Building Initiative's Green Globes and the U.S. Green Building Council's LEED rating systems give credit for cool roofs.

In January, the DOE ruled that all states must certify that their building codes meet the requirements in ANSI / ASHRAE / IESNA's 90.1-2004 Energy Standard for Buildings Except Low Rise Residential Buildings.

These standards, crafted by the American National Standards Institute, American Society of Heating, Refrigeration and Air Conditioning Engineers, and Illuminating Engineering Society of North America, provide minimum energy efficiency standards (including cool roof requirements) for new buildings, new parts of buildings, and new systems and equipment in existing buildings.



ASHRAE is currently developing standards for 2010 that will save 30 percent more energy, with a goal to have net-zero buildings by 2015.