Bright is the new black: New York roofs go cool

March 7 2012

On the hottest day of the New York City summer in 2011, a white roof covering was measured at 42 degrees Fahrenheit cooler than the traditional black roof it was being compared to, according to a study including NASA scientists that details the first scientific results from the city's unprecedented effort to brighten rooftops and reduce its "urban heat island" effect.

The dark, sunlight-absorbing surfaces of some New York City roofs reached 170 degrees Fahrenheit on July 22, 2011, a day that set a city record for electricity usage during the peak of a heat wave. But in the largest discrepancy of that day, a white roofing material was measured at about 42 degrees cooler. The white roof being tested was a low-cost covering promoted as part of Mayor Michael Bloomberg's effort to reduce the city's greenhouse gas emissions 30 percent by 2030.

On average through the summer of 2011, the pilot white roof surface reduced peak rooftop temperature compared to a typical black roof by 43 degrees Fahrenheit, according to the study, which was the first long-term effort in New York to test how specific white roof materials held up and performed over several years.

Widespread installation of white roofs, like New York City is attempting through the NYC CoolRoofs program, could reduce city temperatures while cutting down on energy usage and resulting greenhouse gas emissions, said Stuart Gaffin, a research scientist at Columbia University, and lead author on a paper detailing the roof study. The paper published online Mar. 7, 2012, in Environmental Research Letters.

The urban landscape of asphalt, metal, and dark buildings absorbs more energy from sunlight than forests, fields or snow- and ice-covered landscapes, which reflect more light. The absorption leads to what scientists call an "urban heat island," where a city experiences markedly warmer temperatures than surrounding regions. New York City's urban heat island has a more pronounced effect at night, typically raising nighttime temperatures between 5 and 7 degrees Fahrenheit relative to what they would be without the effect, according to Gaffin's previous research.

The problem leads to everything from spikes in electricity usage and greenhouse gas emissions to poorer air quality and increased risk of death during heat waves. In recent years, city planners worldwide have discussed cutting into this effect by converting dark roofs to either "living" roofs covered in plants or to white roofs, the far less expensive option. The options tested in this study included two synthetic membranes requiring professional installation and a do-it-yourself (DIY), white-paint coating that is being promoted by the city's white roof initiative.

"Cities have been progressively darkening the landscape for hundreds of years. This is the first effort in New York to reverse that. It's an ambitious effort with real potential to lower city temperatures and energy bills," said Gaffin. "City roofs are traditionally black because asphalt and tar are waterproof, tough, ductile and were easiest to apply to complex rooftop geometries. But from a climate and urban heat island standpoint, it makes a lot of sense to install bright, white roofs. That's why we say, 'Bright is the new black.'"

With climate change, the urban heat island problem will likely intensify in coming decades, said Cynthia Rosenzweig, a scientist at NASA's

Goddard Institute for Space Studies in New York City and a co-author on the paper.

"Right now, we average about 14 days each summer above 90 degrees in New York. In a couple decades, we could be experiencing 30 days or more," Rosenzweig said.

The study found similar temperature reduction when all the surfaces were first installed, but that the professionally installed membranes maintained their reflectivity better over multiple years.

The fraction of incoming solar radiation reflected skyward determines what is called a surface's albedo. The citywide program is in effect an "albedo enhancement" program. In addition to measuring rooftop surface temperature, the study also looked at how the reflectivity and emissivity of the white surfaces held up over time. Reflectivity measures how much light a surface immediately reflects skyward. Emissivity measures how much infrared radiation a surface emits after absorbing solar radiation.

Both the reflectivity and emissivity of the professionally installed white membrane coverings (which cost about $15 to $28 per square foot) held up remarkably well after even four years in use. These surfaces continued to meet Energy Star standards, set by the EPA's Energy Star Reflective Roof program. The effectiveness of the white coating (which only costs about 50 cents per square foot) was about cut in half after two years, ultimately falling below the Energy Star standard. However, Gaffin said, the low-cost surface improved albedo markedly over typical black, asphalt roofs.

"It's the lowest hanging fruit. It's very cheap to do; it's a retro-fit. You don't need a skilled labor force. And you don't have to wait for a roof to be retired," said Gaffin referring to the DIY acrylic method. "So if you really talk about ways in which you brighten urban albedo, this is the fastest, cheapest way to do it."

NASA studies the urban heat island effect to better understand and model how urban surfaces and expanding urbanization might impact regional and global climate, said Marc Imhoff, a biospheric scientist at NASA Goddard Space Flight Center, Greenbelt, Md.

"We're trying to build a capability where we can expand our knowledge with data on more locations, and ultimately develop computer models that would allow us to predict urban heat islands and urban temperatures on a town level," Imhoff said. "Eventually, we could incorporate our findings into large-scale, global climate models."

Provided by NASA's Goddard Space Flight Center