Shining a Light on **Reflective Pavements and the Urban Heat Island Effect**

On a ski slope or a sandy beach, solar energy reflects off the ground, so skiers and beachgoers wear sunglasses and sunscreen to protect against damage from the sun's rays. In urban areas, the sun can reflect off of some buildings and pavements in the same way.

Typically, man-made objects in built-up areas, including buildings and pavements, tend to absorb and hold more solar energy than undeveloped areas, causing urban areas to become warmer than nearby rural areas, a phenomenon known as the urban heat island effect (UHI). UHI is a serious issue that affects many cities around the world. Strategies to mitigate the effects of UHI require an examination of the science behind mitigation strategies to ensure goals are met without unintended consequences.

A commonly proposed UHI mitigation strategy is to use reflective surfaces, including reflective pavements, to bounce solar energy back to the sky. This may be logical on a rooftop where there is a clear path for reflective energy to dissipate into the atmosphere. At the ground level, however, reflective surfaces bounce the rays into people, vegetation, and buildings.

Most of the research used by advocates of reflective pavements is based either on studies of reflective roofs or studies that do not separate the effects of reflective roofs from reflective pavements. In addition, several research reports have documented unintended consequences with the indiscriminate adoption of reflective surfaces at the ground/pavement level.

This type of strategy (known as albedo mitigation) has been associated with increased human discomfort from the reflected energy, raising the apparent temperature by between 5½ and 11°F,[1,2] which can increase the risk of heat stroke.

Reflected energy from pavements can become trapped between buildings and absorbed by building façades, increasing the energy and cost required to cool buildings.[1,3]

Widespread reflection of the sun's rays has raised environmental concerns including reduced precipitation[1] and increased nighttime light pollution.[1]

Increased glare from reflective pavements creates safety concerns for drivers and pedestrians.[1]

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Because the unintended consequences of reflective pavements have not been sufficiently studied, documented, or dealt with, the National Academies of Science's Committee on Geoengineering Climate cautions against adopting albedo modification as a UHI strategy without further research into the potential results and impacts.[4]

Similarly, a U.S. Department of Energy report on UHI research found:

"the challenges faced in measuring cool pavements as opposed to cool roofs are significant simply due to the complexity of measuring the pavement's influence upon building energy demand — this implies that there still remain significant challenges to be overcome in establishing such estimates."[5]

While using reflective pavements may seem a simple solution to the UHI problem, the science does not support their widespread adoption and the identified unintended consequences could end up creating additional problems as our urban areas seek to address climate change.

1 Yang, J., Z.-H. Wang, K.E. Kaloush (2015). Environmental impacts of reflective materials: Is high albedo a 'silver bullet' for mitigating urban heat island? Renewable and Sustainable Energy Reviews, Vol. 47, No. 2015, pp. 830–84. doi:10.1016/j.rser.2015.03.092

2 Lynn, B.H., T.N. Carlson, C. Rosenzweig, R. Goldberg, L. Druyan, J. Cox, S. Gaffin, L. Parshall, & K. Civerolo (2009). A Modification to the NOAH LSM to Simulate Heat Mitigation Strategies in the New York City Metropolitan Area. Journal of Applied Meteorology and Climatology, Vol. 48, No. 2, pp. 199–216. doi:10.1175/2008JAMC1774.1

3 Yaghoobian, N. & J. Kleissl (2012). Effect of Reflective Pavements on Building Energy Use. Urban Climate, Vol. 2, pp. 25–42. doi:10.1016/j.uclim.2012.09.002

4 Committee on Geoengineering Climate (2015). Climate Intervention: Reflecting Sunlight to Cool Earth. National Research Council of the National Academies of Science, Washington, D.C. doi:10.17226/18988

5 Navigant Consulting Inc. (2009). Assessment of International Urban Heat Island Research: Review and Critical Analysis of International UHI Studies. U.S. Department of Energy, Washington, D.C.

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