Begin forwarded message:

From: "Prindle, William" <William.Prindle@icf.com>
Date: October 29, 2021 at 2:21:47 PM EDT
To: Jared Blum - ERA <jared.blum@epdmroofs.org>
Cc: "Michalke, Travis" <Travis.Michalke@icf.com>
Subject: RE: ICF/ERA conclusions from UHI project

Jared, we've taken a shot at drafting a slightly broader framing of the ICF analysis, clarifying our findings, and adding some wider context and policy implications points.

I've circulated this internally, and we're comfortable with this way of presenting the results of our analysis.

Suggested Language for Framing ERA's ICF UHI study

Background and Context

ERA undertook an analysis of existing data and previous studies to add to the body of research on Urban Heat Islands (UHIs), with specific focus on the measurable impacts of commercial roofing surfaces. ERA contracted with ICF as an independent consulting firm with experience in climate change, data analysis, and building science to review and contribute to the research and analysis in this area. The goals of the study are to:

- Contextualize the causal factors and mitigation strategies for UHI effects.
- Estimate the relative size of commercial roofing as a causal factor.
- Conduct independent analysis, using methodologies from other studies, to test the hypothesis that cool roof mandates demonstrably reduce UHI effects.
- Describe resulting implications for public policy and further research.

The Multiple Causal Factors of UHI Effects

UHI effects can contribute to both the severity and the impacts of climate change. Urban areas tend to be warmer than their rural surrounds, for a number of reasons, with or without a changing global climate. Climate change can worsen UHI effects by increasing background temperatures, resulting in higher total heat impacts on urban residents. UHI effects can also accelerate climate change, by increasing solar radiation retention and by adding thermal energy to the local climate system.

UHI effects stem from multiple causes:

- **Reduced Natural Landscapes**. Trees, vegetation, and water bodies tend to cool the air by providing shade, transpiring water leaves, and evaporating surface water.
- **Urban Material Properties**. Human-made materials such as pavements or roofing tend to reflect less solar energy, absorbing and emitting more of the sun's heat to the local climate compared to trees, vegetation, and other natural surfaces.

- **Urban Geometry.** The size, dimensions and spacing of buildings and other structures influence wind flow and urban materials' ability to absorb and release solar energy.
- **Heat Generated from Human Activities.** Vehicles, air-conditioning units, fuel-burning systems in buildings, and industrial facilities all emit heat into the urban environment.
- **Weather and Geography**. Wind speed and direction, humidity conditions, and cloud cover strongly affect UHI intensity and duration. Local geography is also important, including the presence of water bodies, hills and mountains, and other features.

The Relative Contribution of Commercial Roofing to UHI Effects

The relative contribution of commercial building roofs to a given urban area's UHI effects depends on the percentage of total urban surface area accounted for by commercial roofing, and ability to demonstrate UHI impacts. While there is no comprehensive national data on this specific topic, one national laboratory study[1] of the city of Sacramento, California showed that about 19% of total surface area is accounted for by building roofs, compared to 39% for paved surfaces and 42% for vegetated, vacant, or other land. While the study did not break down the shares of residential vs. commercial roofing, national data from the Energy Information Administration (EIA)[2] shows that commercial roofing accounts for about 29% of total building roof area. The most recent EIA data also show that more than half of commercial roofing already has cool roof attributes; this further reduces the percentage of urban roofing area that could benefit from cool roof treatments. Applying these factors to the Sacramento data indicates that commercial roofing without cool roof characteristics accounts for less than 3% of total urban area.

Like their causes, strategies for reducing UHI effects also range widely, from increasing vegetation cover to cool roofs to cool pavements to smart growth. Since in the above example, both paved and vegetated or vacant land area account for more than 10 times the area of commercial roofing that could benefit from cool roof treatments, the data suggests that those strategies should be prioritized.

Testing the Hypothesis that Cool Roof Mandates Reduce UHI Effects

ICF conducted two analyses that studied localities with cool roof mandates and high penetration rates of cool roofs. Analyzing historical air temperature data from three urban and three surrounding rural areas, the analysis found that the studied cities' UHI effects were not linked to cool roof mandates: it found no discernable correlation between these cities' cool roof mandates and reductions in UHI, compared to analysis of comparable data from similar cities without such mandates. A second ICF analysis, that studied 10 localities using an earlier study's protocol for determining UHI, found that:

- daytime UHI was weak (when present) when compared to the earlier study's results;
- results varied significantly according to weather station selection; and
- daytime UHI varied according to the quantity of selected weather stations and the analysis timeframe.

These results suggest that the available data were not sufficient to repeatably determine the extent to which UHI exists in a given metropolitan area. They also indicate that the assertion that cool roof mandates significantly reduce UHI effects has not yet been established.

[1] https://www.sciencedirect.com/science/article/abs/pii/S0169204602001652?via%3Dihub
[2] https://www.eia.gov/consumption/data.php#rec

Implications for Policy Analysis and Further Research

This analysis leads to several implications:

- Commercial roof area that does not already have improved albedo characteristics accounts for a very small fraction of typical urban surface areas. Paved areas alone are likely to account for an order of magnitude (~10x) more of a typical urban surface area than low-albedo roofs.
- A broader, more rigorous, and consistent real-world analysis is needed to assess the value of cool roof mandates in a comprehensive climate action planning context.
- Cool roofs need to be compared to other strategies for reducing UHI effects, using a robust and consistent methodology, including increasing vegetation area and improving paved surface albedo, each of which accounts for many times the total area of low-albedo commercial roofs. Such rigorous analysis is needed to understand the relative benefits and costs of all UHI-reduction measures.

ERA is pleased to contribute to the research and analysis on this important topic, and looks forward to discussing these issues with policymakers, researchers, and other stakeholders in forging the best solutions to the climate change challenge.