

## Overview of Literature Review Findings




To better understand the impact of roof membrane color on energy efficiency and its effect on urban heat islands, the ERA contracted with Clemson University researchers to conduct a thorough **review of published data and literature** with the intent to synthesize findings and identify any gaps in the existing research. After examining over 2,856 references, 178 articles and papers, and 102 original research studies ERA was able to recognize **key takeaways** and **areas for further exploration**, as identified in this summary document.



## Overview of Research on Energy Efficiency

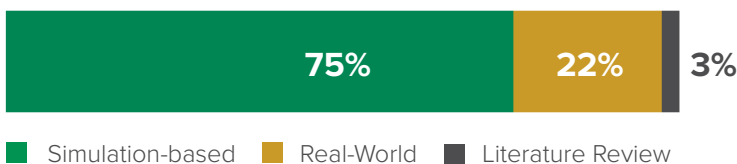
Studies and articles examining the impact of cool roofs on performance and energy efficiency yielded varied results, as its impact is influenced by a range of factors such as roof type, climate, location, and more. Additionally, studies varied greatly in methods of data capture and analysis.

### HOW DO COOL ROOFS IMPACT ROOF PERFORMANCE AND ENERGY EFFICIENCY?

ROOF TYPE AND MATERIAL:	PERFORMANCE FEATURE:	REFLECTANCE	ENERGY SAVINGS	INSULATION
				
ASPHALT SHINGLES	Does not allow dissipation of internal heat gains which increases demand for cooling	Slightly increases the % of energy savings but has little effect on energy consumption	Important in cold climates; Otherwise less impactful than other aspects such as reflectance	
BUILT-UP	Solar reflectance plays an important role in the effect of cooling demand	% reduction in temperature as a result of a change in the roofing membrane color leads to inconsistent results	Insulation plays a significant role in the effect of roofing membrane on heating demand	
CONCRETE	As albedo increases, efficiency increases; A white roof with no insulation gives max efficiency	Combining reflective roofing and thermal insulation is very effective in reducing the thermal load	Cool paint with insulation exhibits higher energy efficiency; Insulation isn't needed in cool climates	
EPDM / PVC / TPO	Increased levels of reflectivity increase the amount of annual energy savings	Life-cycle analysis is needed to evaluate the impact on energy efficiency, as life cycles are measured in decades	Annual energy savings achieved in all cities except for cities in cold climate zones	
METAL	Cool Roofs with high reflectivity are effective in equatorial climates but not sub-tropical climates	Temperate and cold climates have more percentage savings but less energy consumption reduction	Insulation increases the external surface temperature of the roof	

Legend: Impact of Cool Roofs on Performance ■ Positive ■ Minimal ■ Negative ■ Mixed ■ Additional Data Needed

### SNAPSHOT OF STUDIES EXAMINING COOL ROOFS AND ENERGY EFFICIENCY



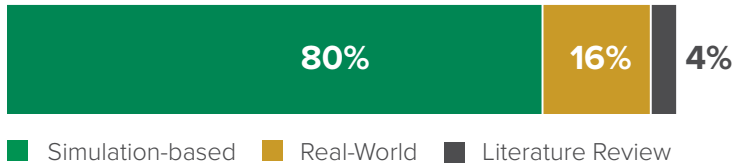
Individual roofs were included among the sample size of studies looking at energy efficiency

Different types of simulation models and measurement parameters were used in analyses

# Overview of Research on the Impact of Cool Roofs on UHI

Similar to the research on cool roofs and energy efficiency, studies examining the impact of cool roofs on urban heat islands yielded mixed results, as UHI is impacted by a range of factors such as urban landscape, density, geographic location and climate, as well as other factors.

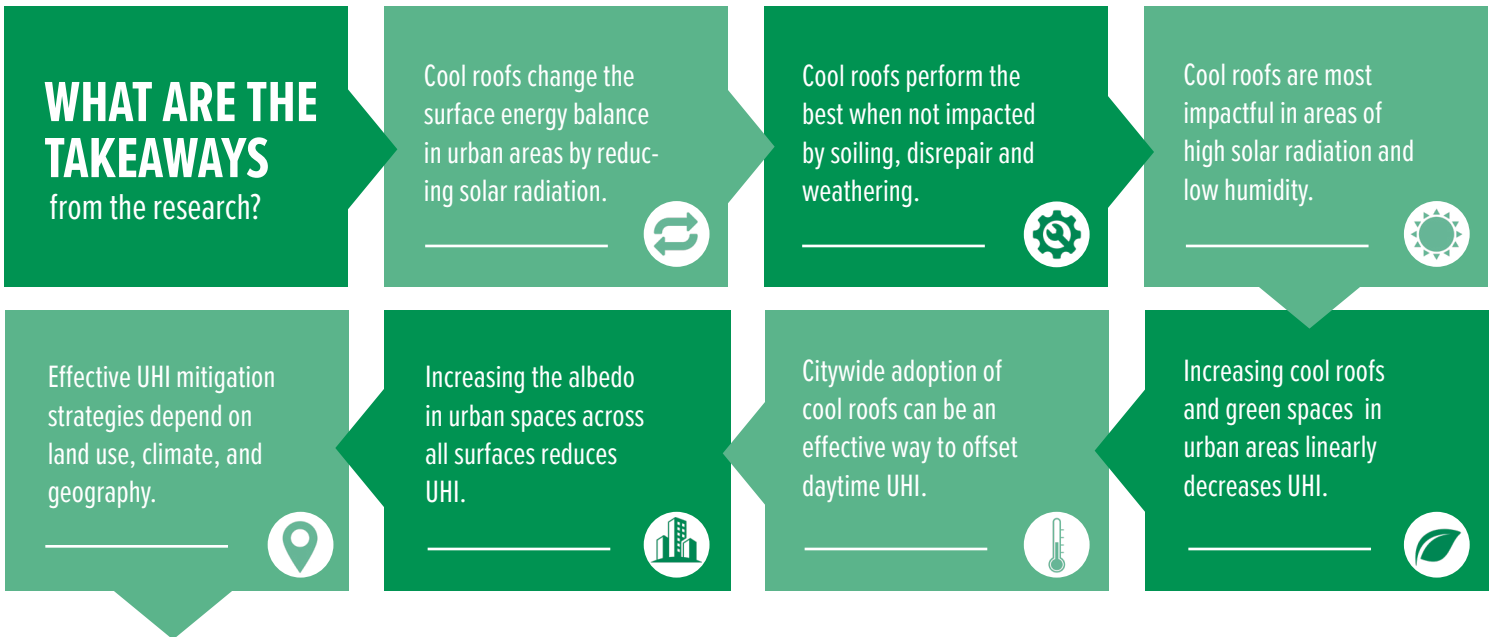
## STUDIES ON COOL ROOFS AND URBAN HEAT ISLANDS



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Urban Heat Island studies examined the impact of cool roofs on UHI effect across urban areas in 3 major global regions

Different types of simulation models and measurement parameters were used in analyses



## What Gaps in the Research Must be Addressed?

While there are a number of studies that examine the impact of cool roofs on energy efficiency and UHI in urban spaces, there are several areas that require further research to better understand the complexity of constructing efficient roof structures that yield a positive impact on UHI. Based on the critical review of current literature, **the following areas should be studied** to fully understand the implications of cool roofs.

- How do simulations compare to real-world studies?
- How does seasonality impact UHI and cool roof efficacy?
- What is the impact of green spaces and softscapes on UHI?
- How do different locations, roof types, and climate zones compare?
- What is the ratio of hardcapes to conventional roofs?
- Do cool roof implementation programs focus on roofs with the largest surface area?
- What results from expanding data beyond minimal capture?
- How do cool roofs impact cold and continental climates?
- How does degradation impact the effectiveness of cool roofs?
- How does UHI compare between different locations, climates, and roof types within a region?
- What are the economic and life cycle benefits of cool roofs?

## What does this Mean for Implementation?

While there is an abundance of research that currently examines the impact of cool roofs on building performance, energy efficiency, and UHI, there are several gaps and inconsistencies in research methodology which complicate their interpretation and application in real-world settings. Although viewed as a panacea for heat retention in urban environments, the effectiveness of installing cool roofs very much depends on a combination of factors which must be considered for each unique city and location. With the current widespread variability in methodology, areas of focus, and research samples, cooling mitigation strategies should avoid a one-size fits-all approach.

## About ERA

The EPDM Roofing Association (ERA) represents the manufacturers of many single-ply roofing products. Through ERA, the leading roofing industry manufacturers speak with a focused voice to provide technical and research support, offer sustainable and resilient roofing solutions, and communicate the longstanding attributes, consistency, and value of various single-ply roofing systems.