

**Introduction**

While the discussion over roof color has evolved into a more sophisticated conversation about holistic roof system design, sustainable roofing assemblies, and the risks of evaluating environmental benefits on a single attribute, the older “black vs. white” framing still influences policy and perception. Reviewing these early, simplistic arguments helps explain why some stakeholders continue to see the issue this way, despite advancements in research, materials, and building science (1,2,14,21,22). While the nickname for white roofs is cool roofs, it’s a very inaccurate nickname. Instead, we refer to these roofs as highly reflective white roofs (HRWR) which is a more accurate representation. Roof albedo refers to the level of reflectivity in the roof.

**History**

In the early 2000s manufacturers of highly reflective white roofs (like TPO, PVC, and coatings) used highly effective marketing campaigns promoting white, highly reflective membranes. At the same time, driven by a desire to slow global warming and the prevailing belief that lighter colors meant cooler temperatures, universities, federal laboratories, and environmental organizations began studying surface albedo impacts on ambient air temperature and energy efficiency. Research methods were new and inconsistent, and modeling was rudimentary compared to today’s standards. Some progressive cities adopted highly reflective highly reflective white roof (HRWR) mandates, and national model codes such as ASHRAE 90.1 and the IECC evaluated roof reflectivity and its impact on energy efficiency as a single criterion, without considering other performance factors (3,4,6,10,12,21).

At the time, there were few dissenting voices. The EPDM Roofing Association (ERA) and a small group of others urged policymakers not to base mandates solely on roof reflectivity. Early mandates focused only on potential energy efficiency (EE) or urban heat island (UHI) benefits, ignoring embodied carbon, landfill impact, resilience, and other sustainability factors (6,10,12,21,22).

These mandates were supported by early research that, while promising, relied on flawed assumptions, low insulation levels, and oversimplified climate modeling. Combined with HRWR’s lower first-cost installation and marketing momentum of some highly reflective white roof membranes, the result was a steady increase in HRWR market share and a decline in EPDM’s share (3,4,6,14,21,22).

**Limitations on the Existing Body of Research**

The ERA and Clemson University literature review in 2020 identified recurring limitations in cool roof studies published between 1985-2018. While these studies certainly add to the body of knowledge in some ways, their flaws mean they cannot justify broad mandates requiring HRWRs for entire climate zones or cities. Common limitations include:

* Modeling that oversimplifies real-world building conditions.
* Reliance on limited geographic data that does not account for climate diversity.
* Short-term monitoring that ignores seasonal or long-term effects.
* Low insulation baselines that inflate the apparent value of reflectivity.
* Inconsistent measurement methods for albedo and temperature.
* Limited consideration of winter heat penalties.
* Neglect of other environmental factors such as moisture, wind, and precipitation.

These limitations underscore the need for more nuanced, location-specific policy decisions (19,21,25).

**Unintended Consequences of Mandates for Highly Reflective White Roofs**

**Condensation, Moisture, and Potential for Mold**

In ASHRAE Climate Zones (CZ) 4 and north, HRWRs often require additional components like vapor retarders or air barriers to prevent condensation and moisture accumulation. Because codes do not require these additional components, many building owners opt out due to cost, leading to assemblies that trap moisture and do not dry out in summer. Over time, this can result in persistent dampness, reduced insulation performance, and mold growth. Without proper moisture control, the long-term performance of the roof assembly is compromised (14,19,21,22).

**Energy Efficiency**

In some cases in CZ 3 and in most cases in CZ 4 and north, increasing insulation provides a greater net energy benefit than increasing roof reflectivity. For example, adding insulation to raise a roof’s R-value from R-20 to R-30 can cut annual energy use by more than 10 percent in heating-dominated climates, whereas a reflective surface may yield negligible benefit in winter and limited benefit in summer. HRWRs can also increase heating demand in colder months, offsetting any summer cooling gains. Energy modeling consistently shows that in CZ 4 and north, investments in insulation outperform reflectivity in lifecycle savings (5,6,11,24,25).

**Urban Heat**

Urban heat islands are real and can be felt in any dense cityscape. However, the atmosphere does not behave like the simple experience of a shady spot under a tree. The current body of research lacks consistent, in-situ data demonstrating that HRWR mandates consistently reduce UHI. Cities such as Chicago and New York, which have had mandates for more than 15 years, have reported no measurable improvement in urban heat metrics. Without accounting for air movement, local climate, and other surface types, roof reflectivity alone cannot be assumed to mitigate UHI effectively (1,2,6,7,8,9,23). But increased urban tree canopy makes a big difference!

**Current Research**

Modern and more recent studies provide a more complete picture of the impacts of highly reflective white roofs. The ICF study on urban heat islands (UHI) found no clear correlation between HRWR mandates and UHI reduction in U.S. Climate Zones 3–5, emphasizing that real-world atmospheric conditions and mixed surface types reduce the measurable impact of roof albedo (23). The ICF energy efficiency study concluded that insulation improvements generate more consistent and significant savings than reflectivity north of Climate Zone 4 (24).

The Harvard 2024 “Unexpected Warming from Land Radiative Management” study found that widespread adoption of HRWRs can actually increase surrounding temperatures, reduce local precipitation, and worsen heat inequality between affluent and low-income neighborhoods (5). Tewari et al. (2019) found irrigated vegetative roofs were more effective for UHI mitigation than HRWRs (6). The Notre Dame study (Sharma et al., 2016) showed that HRWRs can slow air movement and reduce mixing, potentially leading to localized air quality concerns (7). Yang et al. (2015) concluded that high-albedo materials are not a “silver bullet” and that their benefits depend heavily on climate, urban design, and weather patterns (8). Georgescu et al. (2012) demonstrated that large-scale deployment of HRWRs can reduce rainfall by approximately 4% in some growing cities (9).

Taken together, these findings confirm that while HRWRs have valid uses, their large-scale mandated adoption can have unintended and inequitable environmental consequences. The evidence supports halting broad mandates in favor of a more flexible, performance-based approach that considers multiple criteria, including insulation, longevity, and resilience (1,5,6,7,8,9,23,24).

**Longevity of EPDM**

Multiple studies and field data show that EPDM roofs can last 40 years or more, far exceeding the typical 15–20-year service life of one particular HRWR, TPO. Longer service life translates into fewer tear-offs, reduced landfill waste, and lower embodied carbon from manufacturing and installation. If a single EPDM roof can perform for the same period as two or more TPO roofs, the sustainability advantages are significant—particularly in CZs 3-4 and north, where EPDM can also outperform on energy efficiency without exacerbating UHI concerns (15,21,22).

**Other Benefits of EPDM**

EPDM offers durability, resilience to extreme weather, UV resistance, and ease of repair. Its flexibility across a wide temperature range makes it less susceptible to cracking and splitting. Repairs are straightforward and cost-effective, often extending the roof’s useful life without full replacement. These attributes support both immediate performance and long-term sustainability goals (15,21,22).