

ENGINEERING GREEN BUILDINGS

BY GREG LUNA, LUNA & ASSOCIATES, MARYLAND HEIGHTS, MO.



The Myth of White Roofs in Northern Climates

White reflective roofs carry a significant heating penalty in northern urban centers

Over the last 10 years, white reflective roofs—widely touted in southern climates for their ability to help lower air-conditioning demand and, thus, energy bills, conserve natural resources, combat urban-heat-island effect, and reduce global warming—have been migrating north. There are mandates for their use in Chicago, New York, and Philadelphia. Yet contrary to news articles and politicians promoting the benefits of white reflective roofs, the fact is that most northern U.S. cities are wasting millions of dollars in energy, as well as precious natural resources, by buying into the belief white roofs are energy-efficient regardless of climate zone.

My company sells both white and darker-colored roofing materials. While we know white roofs reduce cooling costs, which are beneficial in warm southern climates, we also know they carry a significant heating penalty in northern urban centers, where heating costs outstrip cooling costs.

Following are two well-documented experiments, both of which support the finding that a dark-colored roof is more energy-efficient in heating-dominated climates:

- Ashley McGraw Architects and CDH Energy Corp. conducted an experiment on identical buildings. One building used a white thermoplastic-polyolefin (TPO) roof over 4 in. of insulation, while the other used a black ethylene-propylene-diene-monomer (EPDM) roof over 4 in. of insulation. A 30-percent heating penalty was documented with the white roof (http://bit.ly/Onondaga_report).

- Soprema Inc. conducted an energy-usage study at its facility in Canada, where it measured the energy impact of white, grey, and black modified bitumen membranes over identical layers of insulation. The black membrane was

City	Cooling benefit with white	Heating penalty with white	Net annual impact with white	Energy-efficient color	Electric cooling rate, cents per kWh	Gas heating rate, \$ per 1,000 cu ft
New York	\$159	(\$501)	(\$342)	Black	15.11	8.32
Chicago	\$111	(\$420)	(\$309)	Black	8.07	7.04
Philadelphia	\$161	(\$541)	(\$380)	Black	9.33	9.87
Indianapolis	\$129	(\$471)	(\$342)	Black	9.14	7.29
San Francisco	\$80	(\$723)	(\$643)	Black	16.94	8.46
Columbus, Ohio	\$148	(\$422)	(\$274)	Black	9.41	7.14
Charlotte, N.C.	\$226	(\$445)	(\$219)	Black	8.73	9.79
Detroit	\$119	(\$467)	(\$348)	Black	10.95	7.51
Boston	\$167	(\$657)	(\$490)	Black	14.14	11.44
Seattle	\$61	(\$498)	(\$437)	Black	7.69	9.11
Denver	\$168	(\$435)	(\$267)	Black	9.42	6.84
Washington, D.C.	\$217	(\$627)	(\$410)	Black	11.95	12.02
Nashville	\$257	(\$388)	(\$131)	Black	10.26	7.65
Baltimore	\$189	(\$485)	(\$296)	Black	10.43	9.30
Louisville, Ky.	\$197	(\$348)	(\$151)	Black	8.72	7.02
Portland, Ore.	\$81	(\$669)	(\$588)	Black	8.36	8.96
Milwaukee	\$85	(\$504)	(\$419)	Black	10.57	7.05
Kansas City, Mo.	\$181	(\$379)	(\$198)	Black	9.20	8.17
Virginia Beach, Va.	\$183	(\$394)	(\$211)	Black	8.06	8.21
Colorado Springs, Colo.	\$124	(\$508)	(\$384)	Black	9.42	6.84
Raleigh, N.C.	\$257	(\$459)	(\$202)	Black	8.73	9.79
Omaha, Neb.	\$122	(\$416)	(\$294)	Black	8.40	6.33
Oakland	\$80	(\$723)	(\$643)	Black	16.94	8.46
Minneapolis	\$76	(\$431)	(\$355)	Black	8.95	6.48
Cleveland	\$146	(\$376)	(\$230)	Black	9.41	7.14

Assumptions:

- 10,000-sq-ft building.
- One-floor building.
- 40 percent window-to-wall ratio.
- Post-1990 construction.
- Mid-efficiency heating equipment.
- Mid-efficiency cooling equipment.
- Aged reflectance: black EPDM = 9, white = 70.
- Aged emittance: black EPDM = 84, white = 86.

Roof Savings Calculator comparison of black vs. white roofs for major U.S. cities in colder climates, R-20 insulation with gas heat.

found to be more energy-efficient in heating-dominated climates.

White roofs are thought to reduce global warming. A study by Stanford University (http://bit.ly/Stanford_roofs), however, shows white roofs may actually increase the earth's temperature. The study suggests white roofs reflect heat upward into the atmosphere, where it

mixes with black and brown soot particles that retain heat.

Another study, by Arizona State University (ASU), indicates widespread adoption of highly reflective cool roofs could negatively impact rainfall patterns across the United States (http://bit.ly/ASU_roofs).

As noted by Matei Georgescu, an assistant professor in ASU's School of Geographical Sciences and Urban Planning, the study shows cool roofs shift rainfall patterns by reducing evapotranspiration, the process by which water evaporates from the ground and enters the atmosphere. In one case, cool roofs led to a 4-percent decline in rainfall. Georgescu concludes cool roofs may not be as appropriate in some regions as they are in others.

The U.S. Environmental Protection Agency is on record stating, "The energy savings that can be achieved with white reflective roofing is highly dependent on facility design, insulation used, climatic conditions, building location, and building-envelope efficiency." Meanwhile, the ENERGY STAR website cautions, "Before selecting a roofing product based on expected energy savings, consumers should explore the expected calculated results that

can be found on the Department of Energy's 'Roof Savings Calculator'" (http://bit.ly/DOE_RSC).

In the past year-and-a-half, two regulatory bodies—ASHRAE (ANSI/ASHRAE/USGBC/IES Standard 189.1, *Standard for the Design of High-Performance, Green Buildings Except Low-Rise Residential Buildings*) and the International Code Council (International Energy Conservation Code and International Green Construction

Code)—voted down proposals to mandate white reflective roofs in northern areas of the United States.

We are starting to expose the myth about white roofs in northern climates and counter a movement that has built momentum—and cost

cities millions of dollars in energy expenditures—over the last decade. The heating penalty associated with white roofs and the importance of geographic climate are important issues of which American building owners need to be aware.

Did you find this article useful? Send comments and suggestions to Executive Editor Scott Arnold at scott.arnold@penton.com.

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