Stantec

Memo

To:	Katrina Managan City and County of Denver Environmental Quality Division Dept. of Public Health and Environment	From:	Stantec
File:	Cool Roofs Fact Sheet	Date:	August 14, 2018

GENERAL COMMENTS

The requirement for a cool roof is being introduced as part of a comprehensive proposal to change the existing green roof ordinance, which is limited to vegetated roofs. With the proposed changes, the City of Denver provides building owners a greater number of options for compliance with the ordinance, options which the Task Force evaluated for equivalent environmental benefits. These options include, but are not limited to, a cool roof. This fact sheet aims to describe key terms and concepts relating to cool roofs and their performance.

Urban Heat Island

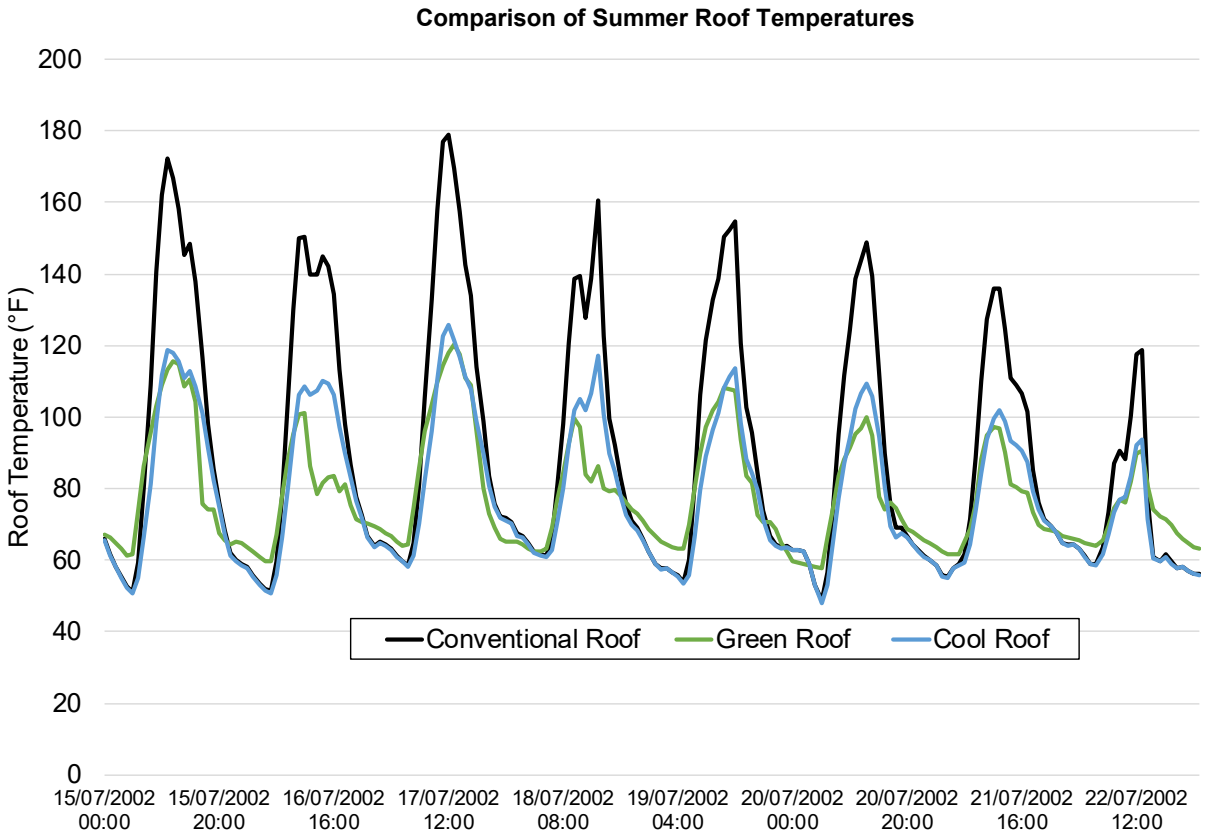
An urban heat island describes the condition where the ambient air temperature in a built up, urban area is higher than a nearby rural area, especially in calm weather. Urban heat islands are caused by a number of factors, most significant of which is that in our cities we have swapped out areas of vegetation for large areas of dark absorptive surfaces such as rooftops and roadways. Urban heat islands are the reason our cities are becoming hotter by day, and not cooling off as much by night. In addition to increasing the energy cost burden on households, these higher temperatures also contribute to increased air pollution, decreased water quality, and exacerbate existing health conditions such as respiratory illnesses.

Cool Roofs and Urban Heat Island

Cool roofs, also known as reflective roofs, are comprised of materials with a higher solar reflectance than conventional, dark roofing materials. Due to their reflectivity, cool roofs absorb less solar radiation, remain cooler during daytime, and therefore transfer less heat to the building structure below and the ambient air surrounding the roof. Studies have shown cool roofs stay up to 50–60°F (28–33°C) cooler than conventional (dark) roofs during peak summer conditions. When compared to conventional dark roofing materials, cool roofs mitigate urban heat island's by reducing the ambient air temperature in the vicinity of the roof surface.

Cool Roof Durability, Longevity

For any roof, proper installation and detailing is critical to longevity. As noted above, cool roofs absorb less solar radiation due to their reflectivity, therefore experience less thermal expansion and contraction than conventional roofs, increasing their life span. In addition, the maintenance requirements for cool roofs are typically similar to those of conventional roofs, resulting in little to no maintenance-related cost premium for cool roofs. To maintain their reflectivity, and associated thermal benefits, cool roofs may need to be washed periodically which has an associated cost. The frequency of washing is contingent on the air quality (dirt and particulate matter) of the building location.



Source: Stantec

Cool Roof Costs

Based on cost information provided to the Green Roofs Task Force by Denver-based roofing contractors, the cost premium for cool roofs as compared to conventional dark roofs was minimal. For the building types studied (office, retail, industrial, multi-family), the cost premium for new construction ranged from 0.003% - 0.03%; the cost premium at roof replacement for existing buildings ranged from 0.3 – 1.5%.

Condensation Risks

As for any high-performance envelope solution in a heating-dominated climate, good practice envelope design and application of building physics are necessary. Moisture damage is best prevented by the diligent application of building science and quality construction: appropriate amounts of roof insulation in multiple, stagger layers, and the usage of the appropriate membranes where required (vapour retardant, or even smart membranes such as Intello). This is a solvable problem and appropriate design support is readily available and accessible to building owners.

Reference: **Cool Roofs Peer Review Response**

Cool Roofs in Cold Climates

A key concern in Denver is the impact of cool roofs on heating loads during our cold winters. The most effective method of reducing heating energy in cold climates is highly insulating the building envelope, including not only the roof but also exterior walls and windows. The benefits of higher roof insulation by far outweigh relying on heat migrating into the building from a warm or hot roof surface. Any increase in winter heating energy use is typically smaller than the savings in summer cooling energy use, because heating loads typically peak in early morning when the sun is low and both cool roofs and dark roofs are approximately the same temperature. In addition, solar radiation in winter is impacted by low sun angles, shorter hours of daylight, increased potential for cloud coverage, snow accumulation on roofs (turning even dark roofs into reflective surfaces), roof insulation and orientation.

Resources

For more information on urban heat islands please refer to the following sources, referenced in the information above:

Heat Island Effects, United States Environmental Protection Agency
https://www.epa.gov/heat-islands

Heat Islands in Denver, Climate Central
http://www.climatecentral.org/wgts/UHI/index.html

Reducing Urban Heat Islands: Compendium of Strategies, United States Environmental Protection Agency
https://www.epa.gov/sites/production/files/2017-05/documents/reducing_urban_heat_islands_ch_4.pdf

Demonstration of Energy Savings of Cool Roofs, Lawrence Berkeley National Lab https://www.osti.gov/biblio/296885

Cool Roof Rating Council Brochure for Home and Building Owners, Contractors, Architects
https://coolroofs.org/documents/End_User.pdf

Delivering Urban Resilience, Greg Kats and Keith Glassbrook, USGBC https://www.usgbc.org/resources/delivering-urban-resilience

Economic Comparison of White, Green, and Black Flat Roofs in the United States. J Sproul et al.
https://www.sciencedirect.com/science/article/pii/S0378778813007652

Simulated Influence of Roof Reflectance on the Building Energy Balance in Two Northern Cities, Sebastian Freund, Daniel Dettmers and Douglas Reindl. file:///C:/Users/rbannongodfrey/Downloads/R&T%202008%20-%20Poster%20-%20White%20Roof%20-%20Dettmers.pdf

Cool Roof Use in Commercial Buildings in the United States: An Energy Cost Analysis, Thomas Taylor and Christian Hartwig
https://www.researchgate.net/publication/268148886_Preliminary_Analysis_of_Energy_Consumption_for_Cool_Roofing_Measures

Cool Roofs in Northern Climates, Kurt Shickman
http://www.roofingmagazine.com/evidence-cool-roofs-provide-benefits-buildings-climate-zones-4-8/