To: The Baltimore City Council April 12, 2022

From: The Smart Surfaces Coalition

Re: Concerns regarding Proposed Ordinance #21-0160 Building Code - Cool Roofs
"For the purpose of requiring newly constructed buildings and additions to existing buildings partly financed using City funds to adhere to specified roofing requirements; authorizing certain exceptions; and generally relating to the installation of Cool Roofs"

This document has been reviewed by Amber Wood and Jennifer Amann of the Buildings Program for the American Council for an Energy Efficient Economy (ACEEE) and by Cliff Majersik of the Institute for Market Transformation. This document is supported and endorsed by ACEEE and IMT.

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Summary

Under Council Bill 21-0160—also known as the cool roof ordinance—Baltimore would require roof coverings on low-slope roofs (roof slope < 2"12) on newly constructed buildings and upon replacement of old roofs beyond 50% to be reflective or meet other criteria such as having natural vegetation (green roof), and/or solar. It thus provides multiple ways for low-sloped roofs to comply including the use of reflective surfaces, greenery, and/or solar on part of the roof. The terms "cool roofs" and "reflective roofs" are used synonymously in this document.

The Smart Surfaces Coalition (SSC) strongly supports this bill. SSC, a 501(c)(3), is a coalition of 40+ industry leading organizations including the American Institute of Architects (AIA), the National League of Cities (NLC), the World Cement Association (WCA), the American Council for an Energy Efficient Economy (ACEEE), the Alliance to Save Energy, and other organizations that support cities in adopting green, porous, and reflective surfaces and solutions that contribute less to climate change.

This note is intended to address concerns raised about the impacts of the Baltimore City Council cool roof ordinance. Specifically, one commentary submitted to the Council regarding this bill was by two roofing materials industry groups: the Asphalt Roofing Manufacturers Association (ARMA) and the EPDM Roofing Association (ERA). These organizations are attempting to raise doubts and questions about increasing the use of reflective/cool surfaces in Baltimore.

The objections from these two groups have been made before and have been strongly rebutted by other roofing industry organizations. For example, according to a 2016 roofing industry review "lately, cool roofs have come under attack by the EPDM Roofing Association (ERA)." The author writes "they are making numerous, albeit erroneous, claims against cool roofs in spite of the science supporting their general benefits… The success of … cool roof technologies has created an anxiety among the manufacturers of 'non-cool' roofs. They have initiated a campaign through the ERA to discredit, or at least cast doubt, on the fundamental science behind cool roofing." The arguments posited in the ARMA/ERA document opposing cool roofing requirements proposed in Baltimore are incorrect and can be disproven by reviewing the literature. These claims are refuted below and again in the "Roof Details & Considerations" section.

According to the AMA/EPDM document, Baltimore is a "northern city", and requiring reflective roofs to cool buildings is not a good idea. The repeated characterization by the AMA/EPDM of Baltimore as a "northern city" is puzzling and would likely not make sense to anyone living in Baltimore.

The Baltimore cool roof ordinance is an important, well-proven, and cost-effective step to help make Baltimore a more livable, healthy, equitable, and competitive city. In doing so, Baltimore would follow the successful examples of many other major cities that require use of reflective surfaces, including Chicago, Dallas, Denver, Houston, Los Angeles, Miami Beach, New York City, Philadelphia, Los Angeles County and Washington, D.C. Many of the cities that have successfully adopted reflective roof mandates—such as Philadelphia, Chicago, and New York City—are all north of Baltimore and disprove the argument that reflective roofs would not be cost-effective for Baltimore as a "northern city".

A broad roofing and building industry consensus around the cost-effectiveness of reflective roofs is conveyed by the leading industry publication, Roofing Magazine, which summarizes that "decades of real-world examples from the marketplace indicate that reflective roofs are an effective net energy (and money) saver even in our coldest cities."

Roof Details & Considerations

Cool or reflective roofs reflect most sunlight back into the atmosphere and far more than a conventional, dark roof, which absorbs roughly 85%- 90% of incoming sunlight. Reflective roofs reduce heat in buildings and across the city, thereby reducing air conditioning demand and unwanted outside heat, smog, energy bills, and a range of health costs and risks.[1]

Asphalt and EPDM are lower-cost roofing options that are commonly characterized as being hot and dark, often absorbing at least 80% of incoming sunlight. These dark roofs

[1] "Cool Roofs", U.S Department of Energy, https://www.energy.gov/energysaver/cool-roofs.

heat up buildings, worsen city-wide urban heat, increase air conditioning demand, worsen smog and air pollution, and impose large economic and equity burdens. As a result of such costs, these types of dark roofs are increasingly being rejected by cities and by national and international energy codes in favor of reflective roofs. The US Cool Roof Rating Councils lists a variety of commercially available roofing products and paints that are highly reflective on their roof product directory.

Driven by rapidly rising market demand and the desire to respond to climate change, roofing manufactures are increasingly investing in more reflective roofing products. It is worth noting that these newer, higher value-added reflective roofs not only reduce unwanted heat and cut pollution, energy bills, smog, and global warming emissions, they also commonly command larger profit margins for roofing product companies. This dynamic makes cool roofs more desirable for both manufacturers and consumers, including most cities. Reflective roofs are being widely adopted by cities to cut energy bills, excess heat, and pollution and deliver other benefits.

Cool roofs in Baltimore are cost-effective and proven solutions to cut peak summer temperatures and lessen energy bills for residents. This is supported by the literature as briefly summarized below.

Baltimore's Climate Zone & Building Codes

Within building code, cool roofs are required in the Department of Energy's defined climate zones 1–3 (see figure 1) under ASHRAE 90.1, 90.2, and 189.1, and in the International Energy Conservation Code (IECC), and the International Green Construction Code (IGCC).[2]

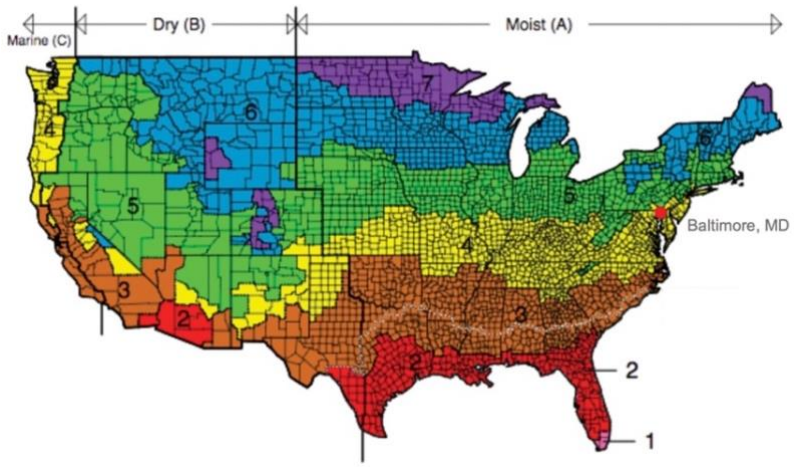

Figure 1: DOE climate zones with cool roof requirements are in zones1–3 (The red circle represents Baltimore, which is in zone 4)

[2] "Cool Roofs: Codes and Standards", CoolCalifornia.org, https://coolcalifornia.arb.ca.gov/sites/coolcalifornia.org/files/Cool%20Roofs_codechart_LBNL.pdf.

While cool roofs are not required in climate zones 4–8, it does not mean that they are not effective there. In fact, multiple cities in climate zones 4 and 5 have already adopted roof mandates and codes to require the use of cool, green, and/or solar PV roofs on new buildings. For example, New York City (2019) requires solar photovoltaic (PV) systems, a vegetated green roof, or both on all available roof area in "sustainable roofing zones." The policy also increases the prior threshold of solar reflectivity outlined in the Energy Conservation Codes. Another example is Washington, D.C, which implemented a code supplement in 2008 to require 75% of roof area not covered with solar, a green roof, or other roof penetrations to be cool roofs (have an initial Solar Reflectance Index or SRI of at least 78). For other cool roof codes and programs in different climate zones, see the CRRC code resource here.

In summary, a central EPDM/ERM argument that reflective surfaces would not work in Baltimore because Baltimore is in too northern a climate zone is incorrect. As noted above, many of the cities that have successfully adopted reflective roofing requirements—including Philadelphia, Chicago, and New York City—are well north of Baltimore.

Energy and Heat Reduction

For almost all the US, the cool roof summer cooling benefit far outweighs the winter heating penalty, even in climates north of Baltimore. For example, a Concordia University study to test the impact of reflective roofs on new and older commercial buildings in Anchorage, Milwaukee, Montreal, and Toronto when snow cover was factored in concluded that "cool roofs for the simulated buildings resulted in annual energy expenditure savings in all cold climates."[3] In most northern locations, winter solar irradiance—a major factor impacting energy savings—is only about 20% of what is experienced in summer months, because winter days are shorter, with lower angle sunlight (so the sun provides far less heat in the winter months).[4] Since days are shorter, sunlight is at a lower angle (reducing temperature), and there are more clouds, the winter heating penalty is small and shrinking. Global warming is making cities hotter and winters warmer, making reflective roofs even more cost-effective.[5] Also, many commercial buildings in warmer cities like Baltimore require space cooling all year due to heat from human activity and equipment, and so they generally don't benefit from heat from the sun.

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[3] M. Hosseini, H. Akbari, Effect of cool roofs on commercial buildings energy use in cold climates, Energy Buildings (2015), http://dx.doi.org/10.1016/j.enbuild.2015.05.050.

[4] "Solar Radiation Basics", Office of Energy Efficiency & Renewable Energy Solar Energy Technologies Office, https://www.energy.gov/eere/solar/solar-radiation-basics.

[5] "Climate Change Indicators; Heating and Cooling Degree Days", Environmental Protection Agency (EPA), https://www.epa.gov/climate-indicators/climate-change-indicators-heating-and-cooling-degree-days#:~:text=1958–2020).-,"Warmer"%20colors%20indicate%20an%20increase%20in%20temperatures%20between%20the%20two,is%2C%20fewer%20cooling%20degree%20days.

Given climate projections from the Intergovernmental Panel on Climate Change (IPCC) and statewide projections that Baltimore will experience about 47 days above 105°F by 2050,[6] city-wide cooling strategies like reflective roofs are moving from optional to essential to protect city livability.

Note that buildings in northern climates often have high levels of roof insulation. There is a common misconception that higher insulation levels reduce or negate the energy-saving impact of cool roofs. A study of black and white roof membranes over various levels of insulation by the Princeton Plasma Physics Lab for example, showed that the relationship between roof reflectivity and insulation were not tradeoffs, but in fact reciprocal. This means that for a building owner to have a roof that minimizes heat gain in the summer and heat loss in the winter, both insulation and reflectivity are necessary.[7]

It is worth correcting the mischaracterization of this bill in the AMA/EPDM document as pushing for a "one size fits all" approach, implying that under this bill buildings can only choose one roofing surface: reflective roofs. A reading of the bill, however, makes it clear that this is not the case. Council Bill 21-0160 requires that roof coverings on low slope roofs (roof slope < 2"12) on newly constructed buildings and replacement of old roofs beyond 50% to be reflective or meet other criteria such as having natural vegetation (green roof), and/or solar. It thus provides multiple ways for low sloped roofs to comply: including use of reflective, green, and/or of solar on part of the roof.

Moisture

Cool roofs in Baltimore reduce energy demand, cut energy bills, mitigate urban heat islands, and can be built without the presence of moisture. Moisture and condensation risks on cool roofs can be easily eliminated by using a variety of products or roof design. In cold climates, warm, humid air in a building travels upward during cold winter months and can infiltrate the roof assembly from the bottom. In a paper presented to the 2011 NRCA International Roofing Symposium, the Single Ply Roofing Industry (SPRI) reported on a field survey and modeling studies to verify whether cool roofs were susceptible to condensation build up. SPRI found that though moisture was observed on the underside of the membrane on three roofs, researchers noted "no detrimental effects due to moisture in any of the roofs."[8] In all cases, the minimal moisture build up detected in winter months dried up by the summer. Moreover, condensation risk for low-

[6] "Maryland", States at Risk, https://statesatrisk.org/maryland/all.

[7] Ranamurthy, P., T. Sun, K. Rule, and E. Bou-Zeid. 2015. "The Joint Influence of Albedo and Insulation on Roof Performance: A Modeling Study," Energy and Buildings 102:317-327. https://doi.org/10.1016/j.enbuild.2015.06.005; Ranamurthy, P., T. Sun, K. Rule, and E. Bou-Zeid. 2015. "The Joint Influence of Albedo and Insulation on Roof Performance: An Observational Study," Energy and Buildings 93: 249-258. https://doi.org/10.1016/j.enbuild.2015.02.040.

[8] Moghaddaszadeh, M. et al. 2013. "Hygrothermal Behavior of Flat Roof and Standard Roofs on Residential and commercial roofs in North America." Building and Environment 60, (February): 1-11. https://spectrum.library.concordia.ca/id/eprint/974482/.

slope roofs can be easily reduced by applying spray products or using a vapor retardant layer under the roof.[9] These design tactics and products are well understood and commonly used in the roofing community.

Conclusion

Groups like ARMA and ERA understandably advocate for continued deployment of their members' dark roofing products even as codes and cities increasingly prefer or require more reflective roofs because of the large range of resulting benefits. As noted above, other industry groups have vigorously rejected the arguments ARMA and ERA pose against the cool roof ordinance. A 2016 roofing industry review determined that "Lately, cool roofs have come under attack by the EPDM Roofing Association (ERA). They are making numerous, albeit erroneous, claims against cool roofs in spite of the science supporting their general benefits..."

ARMA/ERA correctly assert that insulation and tree planting are effective and critical solutions for reducing AC bills and urban cooling. But increasing city reflectivity is also needed for Baltimore to address the severity and breadth of climate change, equity, health and cooling cost burdens. In fact, Baltimore is one of the few cities in the country increasing tree canopy, but trees alone cannot provide the cooling, air quality, energy bill reduction, equity, and quality of life gains that Baltimore is seeking.[10] According to the Office of Sustainability for the city, Baltimoreans are already severely impacted by extreme heat, excessive demand for cooling power, and other challenges that urgently need to be addressed.[11]

Adoption of reflective roofs continues to spread as cities seek to cut heat, energy bills, pollution and other city-level risks. A roofing and building industry consensus around reflective roofs conveyed by the industry leading publication, Roofing Magazine summarizes that: "decades of real-world examples from the marketplace indicate that reflective roofs are an effective net energy (and money) saver even in our coldest cities."

In 2021, the Smart Surfaces Coalition conducted a 248 page analysis with/for the city of Baltimore and a range of partners such as AIA, the National League of Cities and the American Public Health Association to quantify the full costs and benefits of adopting Smart Surfaces—surfaces that more effectively manage sunlight and rainfall including reflective, green, and porous surfaces, trees, and rooftop solar. The report found that 12 individual surface solutions including reflective roofs would be cost-effective for

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[9] Karim Allana, "Avoiding Condensation In Low Slope Roofing Assemblies", 33rd RCI International Convention and Trade Show, 2018, https://www.abbae.com/wp-content/uploads/2020/04/RCI_33rd_Houston_TX_Trade-Show-AVOIDING-CONDENSATION-IN-LOW-SLOPED-ROOFING-ASSEMBLIES.pdf.

[10] Andrew Zaleski, "Urban Forests are dying. Baltimore shows us how to bring them back", Popular Science, June 5, 2019, https://www.popsci.com/urban-forests-trees-baltimore/.

[11] "Baltimore & Climate Change", Baltimore Office of Sustainability, https://www.baltimoresustainability.org/baltimore-climate-change/.

Baltimore (the benefit-cost ration was greater than 5:1 including for reflective low slope-roofs).

Additional points regarding why adopting strategies to cool Baltimore are so important:

Health

Dr. Georges Benjamin, M.D., former Secretary of Health for Maryland and current Executive Director of the American Public Health Association observes that; “Extreme heat in urban communities like Baltimore imposes enormous health and financial costs, including increased heat-related deaths. This is especially true in underserved and low-income minority neighborhoods. Adoption of Smart Surfaces city-wide is an essential strategy to address the devastating impacts of climate change and achieve a cooler and healthier city… Baltimore’s leaders, with state support, should move quickly to adopt Smart Surfaces.”

Employment

Manufacturers of dark roofs employ virtually no one in Baltimore. The job creation from development and broad adoption of reflective roofs and other Smart Surfaces—including green roofs, solar PV and trees—would create thousands of jobs for Baltimore.

Tourism

The importance of reflective surfaces in preventing further warming of Baltimore and protecting the critical summer tourism industry that already suffers for excess summer heat cannot be overstated. According to Visit Baltimore, 2018 data indicates that tourism sustained 86,414 jobs in Baltimore directly and indirectly.[12] In 2018, tourism also generated $10.7 billion in business sales and generated $734 million in state and city tax revenue.[13] Chris Riehl, then President of the Baltimore Tourism Association and owner of a local business Baltimore Rent-A-Tour, in 2021 commented, "Sustainable design features are something that the people of Baltimore are proud of. In the long term, incorporating Smart Surfaces in Baltimore will overall improve the livability and appeal of the city; allowing the city to market itself as a more sustainable, energy efficient, and desirable tourism destination.”

Baltimore’s climate action plan describes a vision for the city’s future that includes, protecting all communities from heat risk, ensuring environmental justice and equity, increasing employment and greater attractiveness for tourism, and reducing carbon emissions. By passing this legislation, the City Council and committing to climate reduction targets, Baltimore can accomplish these objectives cost-effectively.

[12] Visit Baltimore. “About Us”. https://baltimore.org/about-us/.
[13] Ibid.

Baltimore is getting hotter, and solutions are urgently necessary. Council Bill 21-0160 to rapidly expand city adoption of cool roofs reflect broad industry, government, and academic consensus of the large net benefits of reflective roofs for climates both north and south of Baltimore. This bill is an important, proven, and cost-effective step toward making Baltimore a more livable, healthy, equitable, and competitive city.

Some Resources

Most of the reports cited within the text submitted by ARMA/EPD appear to date from between 2006-2012. Older studies are commonly viewed as less current, less reliable, and less authoritative than more recent studies. More recent studies are therefore generally preferable in determining city policy. Below are a few generally more recent and useful industry resources/studies documenting that/why reflective/cool roofs are cost-effective. Note that nearly every study mentioned analyzes the impact of cool roofs in climates more north of Baltimore and mainly in climate zones 5 and 6 (Baltimore is in climate zone 4).

Study	Author(s)	Year
Cool Roofs in the US: The Impact of Roof Reflectivity, Insulation and Attachment Method on Annual Energy Cost	Athanasios Tzempelikos and Seungjae Lee	2021
Effect of cool roofs on commercial buildings energy use in cold climates	Mirata Hosseini and Hashem Akbari	2015
The joint influence of albedo and insulation on roof performance: An observational study	P. Ramamurthy, T. Sun, K. Rule, and E. Bou-Zeid	2015
Hygrothermal behavior of flat cool and standard roofs on residential and commercial buildings in North America	Moghaddaszadeh Ahrab, Mohammad Ali	2012
Cool Roofs and Thermal Insulation: Energy Savings and Peak Demand Reduction	Marcus Bianchi, Andre Desjarlais, William Miller, and Thomas Petrie	2007