THE VIEW FROM THE ROOF

Building a Sustainable Future

A Report from the EPDM Roofing Association
February 2024

ERA
EPDM ROOFING ASSOCIATION

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TABLE OF CONTENTS

FOREWORD

A Letter from the ERA Executive Board

January 31, 2024

The EPDM Roofing Association (ERA) is dedicated to delivering science-based technical and research support, providing dependable roofing solutions and communicating the longstanding attributes of EPDM roofing materials to the construction industry.

Carlisle SynTec and Holcim Building Envelope (formerly Firestone Building Products) founded ERA in 2002, and were joined in 2012 by Johns Manville. Together, these companies have ensured that accurate information about the value of EPDM is being proactively provided to roofing decision makers from coast to coast and internationally.

Over the past 20 years, while EPDM membrane formulations have remained relatively constant, ERA members have continually delivered product innovations to the roofing community. Self-adhering components have increased roof system quality, highly puncture-resistant 90 mil EPDM membranes have been introduced offering the thickest layer of waterproof protection available, and white EPDM has been introduced for use in warmer climates.

During the same period that these advances were developed and introduced, long-standing challenges surrounding the roofing industry have intensified, and new issues have emerged. The increasing frequency of extreme weather events, including record-breaking heat worldwide, has increased demand for sustainable, energy-saving construction materials. Roofing membranes and roofing systems have become a focus of efforts to reduce the use of natural resources. For our ERA members, the commitment to sustainability has become the core value of our effort to create long-term value for our customers.

In a related development of critical importance to the roofing industry, when ERA was founded, regulations, codes and standards had little impact on the use of EPDM products. Now, ERA finds itself devoting significant time and resources to ensure that government and industry bodies, in their effort to require sustainable construction, do not take away choice from building owners, facility managers, architects and designers. As part of this effort, ERA provides code and regulation-setting bodies with science-based information to ensure that any changes in the regulatory environment are based on fact, not false assumptions.

Historic weather patterns can no longer be a guide for building codes and standards, since the past is not a reliable guide for what can be expected from future threats. Additionally, building decisions cannot be based on assumptions, but must objectively draw on sound science.

As part of that commitment to be guided by science, not assumptions, ERA has invested significant resources to studying the value of cool roof mandates when they are used as part of a climate action plan to mitigate the impact of Urban Heat Islands, or UHI. Our findings have revealed that well intentioned public policy decisions are being made on the basis of flawed science and inconsistent measurement data.

Given the urgency of preserving the resources that we use in our products for generations to come, and the critical role that roofing plays in sustainable construction, ERA has produced this first annual report on *Building a Sustainable Future*. This document is provided as a resource for the decision-makers of the roofing industry, and for the thought leaders who impact the trajectory of roofing science.

Our goal is to ensure that anyone interested in creating or investing in a sustainable roofing system has access to up-to-date information about best practices to be followed, as well as an understanding of the benefits of EPDM in a wide-ranging sustainable plan.

We want to be your partners as stewards of a dynamic present and builders of a sustainable future of the roofing industry.

THE GROWING COMMITMENT TO SUSTAINABLE BUILDING

Sustainability may seem like a relatively new concept, but awareness of the impact of human activities on the natural environment has been with us for hundreds of years. Prior to widespread urbanization, communities relied heavily on locally produced goods as well as the common management of critical resources. By the late 1980's, the concept of sustainable development was introduced by an international commission, and defined as "meeting the needs of the present generation without compromising the ability of future generations to meet their own needs."

These early efforts were driven primarily by concerns about degradation of the environment caused by pesticides and air pollution. More recently, the concern about the natural environment has been sharpened by the increasing frequency of cataclysmic and unprecedented weather events, as well as record setting heat and rising energy prices throughout the globe. The effort to achieve sustainability has moved front-and center as an essential guide to stabilize the use of resources without limiting innovation and economic growth.

The attributes of EPDM, which have made it a dominant choice in the construction industry, now deliver new value to a 21st century roofing system.

This report is designed to provide anyone who is making a decision about designing a new or replacement roof the facts you need about EPDM, and the sustainability it will deliver to your structure. As with all of the information ERA provides to the roofing community, the information in this report is based in firm science, as part of the commitment our members made to you when ERA was founded more than 20 years ago.

For the manufacturers of EPDM, this has meant taking a close look at a tried-and true product that has been in the marketplace for decades, and assessing its value against the rigorous standards of sustainability.

Sustainability: The Definition that Works

In our outreach materials and internal planning, ERA adheres to the definition of sustainability as an approach that "meets the needs of the current generation without compromising the ability of future generations to meet their own needs." As with many topics central to current building construction, there is wide debate, even disagreement, about whether that definition encompasses all that is meant by sustainability, as well as how to create a sustainable product.

While we are guided by our own definition of sustainability, the complexity of this issue requires that we remain aware of how others define sustainability, and what they see as essential components to achieve a sustainable future.

From the Association for the Advancement of Sustainability in Higher Education

"Sustainability is one of those big, complex concepts that defy easy definition or simple responses yet demand attention to our collective well-being. Some Native Americans would judge the worth of an idea by considering its potential impact on a seventh generation in the future. Some environmentalists want to reference the carrying capacity of the planet. Others insist that we factor in social well-being and economic fairness. If you accept all this, then teaching about sustainability can be truly transformative, challenging people of all ages and backgrounds to think and act in very new ways and healthy built environment."

aashe®

First Sustainable Roof?

Several millennia ago, early man — and the wife and kids — decided that life in a cave was a little dark, damp and confining, and started thinking about a better place to live. This led, eventually, to the need for a roof. Sod was the obvious first choice for a roofing material — abundant supply, close at hand, pretty simple to install, providing good insulation. Whether that caveman knew he had installed the first "sustainable roof" is unknown.

Fast-forward to the multiple choices that we now have to shelter ourselves and the structures where we work, learn, shop and perform hundreds of other activities. In some ways, the challenges are the same as they were thousands of years ago: keep the occupants dry and comfortable and protect the systems in the building, although those systems are vastly more complex than they were for our ancestor emerging from his cave.

A few other things have changed, as well, including the cost of energy for heating, cooling and running building systems, and an intensifying awareness that our planet cannot provide endless natural resources. Enter sustainability, and the critical considerations we face today as we strive to meet our societal needs, and — at the same time — preserve resources for the use of the next generations. The challenge today is still to keep a building and its occupants protected from the outside elements and ensure that they have access the quality of life that we enjoy today.

From the AIA

"Architects play a crucial role in mitigating and adapting to climate change through sustainable and resilient design. Energy efficiency and renewable energy, materials transparency, the protection of water resources, and other sustainability strategies support mitigation by conserving resources and reducing carbon emissions.

Resilient design helps communities adapt to evolving conditions, reduce harm and property damage, and more readily, effectively, and efficiently recover from adverse events. Architects can draw upon both sustainability and resilience to become a force of valuable change by transforming the day-to-day practice of architecture to achieve a zero-carbon, equitable, resilient,

AIA

SUSTAINABILITY

*AIA's **Framework for Design Excellence** promotes better outcomes through good design:*

RESILIENCE	HEALTH
EQUITY	ZERO-CARBON

From The Center for Environmental Innovation in Roofing

"The challenge of defining a sustainable roof is similar to the task of blind men describing an elephant. One man mistakes a massive leg for a pillar, another perceives the trunk to be a snake, while others mistake ears for giant fans and tusks for pointed spears. And just as each individual perception fails to grasp the grandeur of the entire elephant, first impressions about sustainable roofing tend to fall short of revealing the true potential of the world's rooftops.

Words that currently describe sustainable roofs create as much contradiction as clarity. Sustainable roofs may be described as "warm" and "cool." They may not only be "energy efficient" but also produce "clean energy." Frequently, sustainable roofs are described by a particular color they exhibit: "white" to reflect the sun, "blue" from captured storm water, "green" from a living carpet of plants, and "black" from the sheen of solar panels. But behind these descriptions lies the fact that modern roofs serve many functions and impact the environment in many different ways."

From the United States Department of Agriculture

"USDA Consensus Statement (2011): The U.S. Department of Agriculture is committed to working with partners and stakeholders toward sustainability of diverse agricultural, forest and range systems. USDA seeks to balance the goals of:

- Satisfying human needs;
- Enhancing environmental quality, the resource base, and ecosystem services;
- Sustaining the economic viability of agriculture;
- Enhancing the quality of life for farmers, ranchers, forest managers, workers and society as a whole.

USDA integrates these goals into its policies and programs, particularly through inter-agency collaboration, partnership and outreach at both domestic and international levels.

From The Environmental Protection Agency (EPA)

"Sustainability is based on a simple principle: Everything that we need for our survival and well-being depends, either directly or indirectly, on our natural environment. To pursue sustainability is to create and maintain the conditions under which humans and nature can exist in productive harmony to support present and future generations."

From the UCLA Sustainability Committee

"Sustainability is defined as: "the integration of environmental health, social equity and economic vitality in order to create thriving, healthy, diverse and resilient communities for this generation and generations to come. The practice of sustainability recognizes how these issues are interconnected and requires a systems approach and an acknowledgment of complexity."

Sustainable practices support ecological, human, and economic health and vitality. Sustainability presumes that resources are finite, and should be used conservatively and wisely with a view to long-term priorities and consequences of the ways in which resources are used. In simplest terms, sustainability is about our children and our grandchildren, and the world we will leave them.


THE ROLE OF THE ROOF IN SUSTAINABLE BUILDING

The roof has always played a critical role in building construction, serving several essential functions that contribute to the overall functionality, durability and safety of a structure. With sustainability now considered an essential attribute, these factors take on even greater significance in the overall value of the building:

Protection from the Elements: The primary function of a roof is to provide protection from various environmental elements, such as rain, snow, hail, wind, and sunlight. It prevents water from entering the building, which can cause damage to the interior and compromise structural integrity.

Thermal Insulation: Roofs help regulate the temperature inside a building by providing insulation. Properly designed and insulated roofs, regardless of the color, can reduce heat loss in cold weather and heat gain in hot weather, making the indoor environment more comfortable and energy-efficient.

Solar Energy Generation: EPDM roofs are ideal to support solar panels or solar collectors, allowing for the generation of renewable energy. These can help reduce a building's energy consumption and environmental impact.

Longevity and Durability: A well-constructed roof with high-quality materials can extend the lifespan of a building, reducing maintenance and replacement costs over time.

The roof in building construction is no longer just a protective cover but a multi-functional component that helps to define the buildings sustainability. Proper design, material selection, and construction techniques are crucial to ensuring the roof performs its various roles effectively with sustainability a dominant goal.

BUILDING THE SUSTAINABLE ROOF: THE UNIQUE VALUE OF EPDM

EPDM has gained industry-wide acceptance and respect by providing immediate and long-term roofing solutions. As more emphasis is placed on the sustainable performance of building materials, EPDM continues to be the roofing material that stands the test of time.

The Membrane

An EPDM membrane is one of the most sustainable roofing materials and environmentally responsible choices used today by the construction industry. EPDM rubber roofing membrane has been a dominant choice of the low-slope commercial roofing industry for over 40 years, and now, with its ability to meet 21st Century requirements, it continues to be a top choice of architects, roof consultants and contractors for both new construction and replacement roofing projects.

- Its successful track record of superior overall system performance results in low life cycle costs.
- Less frequent replacement results in decreased building disruptions and reduced impact on the environment.
- For those systems that have reached the end of their service lives, EPDM membranes can be recycled to become walkway pads or used for other purpose.
- The initial production of the membrane has a low-embodied energy number (the amount of energy required to produce and implement a product from material extraction, manufacturing and installation).

The greatest test of any construction material is how it performs under actual field conditions. Forty years of empirical experience in field applications has shown EPDM to have the roofing industry's longest average service life. Characteristics that contribute to this superior overall system performance include:

- Cyclical membrane fatigue resistance
- Proven hail resistance
- High resistance to ozone, weathering and abrasion
- Flexibility in low temperatures
- Superior resistance to extreme heat and fire
- Thermal shock durability
- Ultraviolet radiation resistance

LCA: Life Cycle Inventory and Assessment

A 2010 Life Cycle Inventory and Assessment study (LCA) showed that EPDM performs better than many other single-ply and bitumen-based membrane materials in key categories such as global warming, acidification and smog generation. International organizations such as the ATHENA® Institute, which evaluates the environmental impacts of new and existing buildings through life cycle assessment (LCA), reviewed the data and have incorporated it into its ATHENA Impact Estimator for Buildings.

The 2010 study was one of the first LCAs in the construction industry that looked at entire assemblies (not just the membrane or product) and was also one of the first to be peer reviewed at the American Center for Life Cycle Assessment (ACLCA) annual meeting.

EPDM roofing systems therefore provide outstanding performance in reducing environmental impact and the greatest economic value in the low-slope commercial roofing industry. Combine these factors with the product's ongoing performance in energy savings and protection against the elements, including extreme weather conditions, and the potential for recycling, and it's clear EPDM is the right choice for commercial roof systems.

Long Term Performance

A recent long-term weathering study completed on behalf of the EPDM Roofing Association shows that even 30-year roofs continue to perform well.

- All samples were performing like new—after up to three decades in the field.
- EPDM withstands the effects of various climates extremely well.
- Properly designed, installed, and maintained EPDM systems can successfully withstand extreme weather cycles.
- Indications that EPDM systems can approach or exceed 40 years of service life.

This study of roof systems provides tangible proof of the long-term performance capability of EPDM. The study examined five roof systems, ranging from 28 to 32 years of in-field service, and concluded that all of the systems examined were s till performing as intended. In fact, the study found that all of the samples were essentially performing *like new* with physical characteristic properties above or just below the minimum characteristics of newly manufactured 45-mil EPDM membrane. The roofs were first inspected in the field to get a good sense of their condition, and then samples were sent to Momentum Technologies, a testing facility for the roofing industry. The laboratory testing examined five critical performance characteristics of the EPDM membrane.

The Elongation Test Results showed that four of the five roof samples exceeded the minimum characteristics for aged EPDM, and one exceeded the minimum for new EPDM. For Tensile Strength, all five samples exceeded the minimum standard. For Thickness XD, three samples exceeded the manufacturer minimum, while the other two missed by one-thousandth of an inch. For Thickness MD, three achieved or exceeded the minimum, while one missed by one one-thousandth of an inch and another by four one-thousandths of an inch. For Factory Seam Strength (Figure 5), it was only possible to test two of the samples and both easily surpassed manufacturers' minimums.

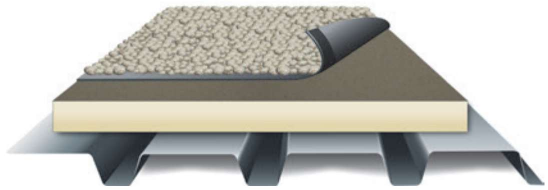
This is the fourth study conducted on EPDM that supports the long-term performance of the EPDM membrane. The first field studies of EPDM were done in the late 1980s, and the recent research supports a pattern that these roofs can really last a long time. By using today's advanced design techniques and proper roof maintenance, it is reasonable to expect that an EPDM roof will approach or exceed 40 years of service.

The Roofing Systems

EPDM Roofing systems each incorporate elements which, when combined, increased the overall sustainability of a roofing installation.

The Ballasted System

Ballasted systems account for approximately 35 percent of EPDM installations today. Using large panels measuring up to 50 feet by 200 feet, the ballasted system provides fast coverage at a relatively low cost. The EPDM panels are loose-laid over the insulation and held in place by smooth, river-washed stoned or concrete pavers.



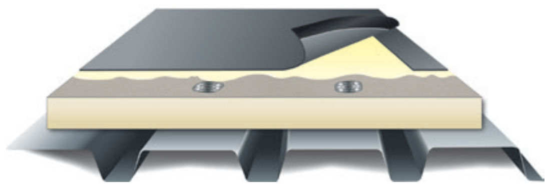
Ballasted Roof System

Ballasted systems are primarily used for large new construction projects, but can also be used on roof replacement or recovery projects where the existing structure can support the additional weight.

Ballasted roofs also have their place in sustainable building design. A ballasted system with a weight of 17 pounds per square foot saves as much energy as an ENERGY STAR-rated reflective roof. Additionally, stone and concrete are virtually fireproof, so ballasted roofs provide the highest fire rating available.

The Fully Adhered System

Fully adhered systems use panels measuring up to 30 feet by 100 feet. The membrane is bonded to the insulation, which has been physically attached, utilizing mechanical fasteners, stress plates and/or adhesives. Either non-reinforced or scrim reinforced membrane can be used, with the non-reinforced membrane making up most adhered installations.



Fully Adhered Roof System

Fully adhered systems are lightweight and ideal for a wide range of building sizes and geometric configurations, including high-slope applications. Because of recent technological advances in application, the fully adhered system is becoming the system of choice for roof replacement applications in many areas of the country.

Fully adhered EPDM roofs make ideal supports for PVC systems because of their durability and compatibility with solar panels.

The Mechanically Attached System

Mechanically attached systems can be installed using large panels attached through the membrane, or using narrow panels attached in the side laps. Non-reinforced or scrim reinforced membranes can be used, depending on the needs of the building owner. Mechanically attached systems are lightweight and are ideal for all building sizes and configurations.

Mechanically Fastened Roof System

While all three systems, when correctly installed, can provide sustainable service over decades, a fully-adhered membrane will prevent fluttering and the resulting energy loss.

A specific kind of energy loss is created by "air intrusion." This occurs when air that starts inside the building works its way through the roofing system but doesn't make it to the outside, instead looping back to the interior. This is likely to be a problem when single-ply membranes are mechanically attached. When wind flows over the surface of the roof and the membrane billows slightly, it creates a void, and that void needs to be filled. The air that fills the void is coming from the interior of the building. So as the roof flutters, it is pumping air into and out of the roofing system. The air can also be carrying moisture that can condense under the roofing membrane.

If you are in a cold climate, the warm air from the interior of the building is chilled by its contact with the cold roofing membrane; if it is summer, the air becomes warmer. Either way, the air needs to be reconditioned when it returns to the interior of the building, driving up energy costs.

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SOLAR ENERGY AND EPDM: A SUSTAINABLE SOLUTION

An EPDM membrane can work in partnership with a PV system to produce a supply of sustainable power. With strong government support, almost 70 years of technological advances, and growing concern over the use and expense of fossil fuels, conditions are now right to make solar power an economical and sustainable choice.

Legislation and Market Forces

The move to solar was jump started by the passage in 2009 of a stimulus package, legislation that earmarked more than $25 billion in funds for alternative energy subsidies. The price of solar cells began to decline as the technology became more efficient, setting the scene for exponential growth during the last decade.

Call it a tipping point, a perfect storm, a critical mass. In 2022, forces converged to capitalize on the progress of the last decades and respond to the concerns of the current business climate. Political instability worldwide has created major reservations about reliance on traditional sources of energy; as global warming intensifies, "clean energy" independence has become an attractive political agenda.

Focusing on the Roof: Before you Build

Buildings are now seen as part of the solution to climate change, reducing carbon in the atmosphere. The roof is rightly seen as essential to the function of the building. It is also an attractive platform for photo-voltaic systems. But the primary function of the roof needs to be considered and protected before any decisions about solar can be made. In a perfect world, the scope of the solar being attached to the roof would be part of the overall structural scope of the project.

Regardless of whether you are designing a new roof, or retrofitting an existing one, there are certain basic questions to be asked before any construction should proceed:

- First, can the proposed or existing roofing system support the weight of the photo-voltaic array, including the solar equipment and the racking system?
- Equally as important, how will the system get attached to the roof? A broad variety of building codes refer to standards for this stage of the construction. The codes provide a good starting point. But there's also an expectation that the structural performance of items as they are attached to the roof have to be calculated and designed by a professional to fit the unique challenges of the individual project.

Key Considerations

There are two basic choices for attaching a solar array to the roof: mechanically attached, or ballasted. In a ballasted system, the ballasting weight is attached to the bottom of the rack. That weight should be adequate to resist forces such as earthquakes or high winds.

Before you begin work, carefully determine whether the existing or proposed roofing membrane cam accommodate the heat generated by the PV system, and — conversely — will the solar panel be impacted by heat reflected upward by the membrane?

Conventional wisdom might point towards using a reflective roof with a PV system. Recent research suggests otherwise. According to Jason Wilen, a Chicago-based architect and roofing consultant, “There is research out there that would suggest that it would be advantageous to have a non-reflective or dark surface.” This research focused on the reflective heating generated by the roofing surface up towards the solar panels. While the roof itself may be kept at a cooler temperature by using “cool” roofing, the research suggests that up to a nine degree heating of mechanical items could be caused by heat thrown off by the reflective roof. The operating temperature of solar panels directly impacts their efficiency. In general, the cooler the panel, the more efficiently it is collecting and disseminating energy.

Ultimately, these choices will be driven by one basic question: “What will offer the biggest benefit to a building owner?” A PV system that generates significant clean energy, supported by a long-lasting roofing membrane that contributes to the smooth functioning of the solar panels, cutting costs and generating tax relief, is most likely an approach that will leave a business owner smiling. That’s the promise of solar power, a promise that seems sure to deliver long-anticipated and long-term results.

The challenge with ballasting equipment, however, is that the ballast needs to be secure enough so that the rack system will not move. Wind is the most obvious concern. Solar panels tend to be of a shape that has large surfaces that can exposed to the wind. Any sliding of the array or the rack on the roofing membrane can cause abrasion, potentially causing damage. The upside of a ballasted approach in a retrofit setting: fewer penetrations that you would have to accommodate in the roof system.

Another key consideration: will the service life of your photo-voltaic system be similar to the existing or intended roofing membrane? Solar panels are durable and can last up to three decades. A membrane that wears out before the solar panels are ready to be replaced can create and expensive and logistical challenge.

Assess how much heavy foot traffic will be needed to maintain the proposed panels. In order to maintain their peak efficiency, solar panels need to be cleaned frequently. Caked dust, debris, twigs and pollen can all reduce the yield of the PV system by preventing light from reaching electricity-generating cells.

Evolving Building Code Requirements

It's clearly important for anyone involved in repairing or creating new roofing systems to stay current on these evolving code requirements. In fact, a close examination of these updated codes, as tedious as it might be, can yield some surprises, not only in terms of what is required, but also what is allowed.

A Look Back at Building Codes
But first, a brief history of building codes. The International Building Code, or IBC, is actually a relatively new arrival to the construction world. Prior to 2000, building codes in the United States were developed by three regional bodies and then implemented in a somewhat piecemeal fashion throughout the country. Ultimately, spurred by increased globalization and the need to mesh with building codes in other countries, the construction industry in the United States pushed for unified, national

building codes that could be modified as needed by state and local governments. Essentially, the industry moved to a "top-down" approach to building codes, rather than trying to unify grass-roots efforts once they have been adopted.

The first iteration of the International Building Code was published in 2003. It has been revised every three years since its inception, and has also spawned an entire suite of related sub-codes, including the IECC, or International Energy Conservation Code. Despite the fact that the word "international" is prominent in the name of the code, the IECC is predominantly staffed by Americans, and inspired by prior American codes. But since several other countries, primarily in the Caribbean and Latin America, rely on codes developed in the United States, the name of the organization reflects its international impact.

The IECC, now preparing for its 2024 revision, has broadened its focus beyond the original mandate of ensuring safe and resilient structures. It now incorporates strategies to "support increased energy efficiency and reduced greenhouse gasses," strategies that, of course, include the utilization of solar installations. Here we come to the content of the IECC which might be easy to miss but essentially broadens the choice for roofing membrane color. To provide specifics, Table C402.3 of the IECC refers to "Low-sloped roofs directly above cool conditioned spaces in Climate Zones 1,2 and 3." The code states that these structures are exempt from installing reflective membranes if 75% or more of the supporting roof is covered by photo-voltaic systems or components, as well as other structural items such a skylights, roof gardens, or above-roof decks or walkways. In other words, this exemption allows a broad choice in building membranes for anyone planning a solar installation on a new or existing roof, even in many locales where reflective roofs are otherwise mandated.

Sunsetting ENERGY STAR

For those of us who have spent a lifetime in Washington observing, managing and explaining the intricacies of our rather messy democracy, it is a given that once a government agency gets a program in place to encourage specific activities among the private sector, it rarely abandons it. Just as rarely does an agency acknowledge that business leaders are perhaps the best people to make decisions about their businesses. But that is exactly what happened when the EPA "sunsetted" its ENERGY STAR specification for roofing products.

In 1992 the EPA launched the ENERGY STAR program. It offered participating companies the opportunity to put the familiar blue-and-white shooting star logo on their products, signifying their energy efficiency. According to the EPA website, "by 2020, more than 7 billion ENERGY STAR products across 75 different categories" had been purchased. In 1999, roofing products were added to that list, with a particular focus on encouraging the use of "cool" roofs.

Fast-forward to June 2018, and the EPA, recognizing that roofing systems have little in common with consumer products such as refrigerators and computers, circulated a request for comment on a proposal to "sunset" Energy Star specifications for roofing products. The letter acknowledged that the labeling program "has been surpassed in many cases by commercial building codes" and proposed a three-year phaseout period. It further noted that efficient commercial roofing "is now driven by codes and voluntary building standards, as well as standard design practices nationally."

The EPDM Roofing Association, or ERA, along with other leading members of the roofing industry, submitted comments on the proposed "sunset" plan, supporting its approach. We pointed out in our letter that the program brought the necessary attention to the long underappreciated role that roofs can have on overall building performance. But, 20 years after its inception, we pointed out that "it is clear that the program has been surpassed, in many instances, by commercial and residential building codes, high performance certification standards like LEED, and evolving building performance experience that allows building science to inform designers and architects on best product utilization for a particular climate and building." In other words, we urged, as we always have, that decision making about roofing choices be left in the hands of the experts and key stakeholders: architects, specifiers, and building owners.

One year later, in 2019, the EPA issued a subsequent letter, saying that it would finalize sunsetting of the ENERGY STAR specification for roofing products on June 1. Roofing companies were given ample time to phase out their investment in the program, including relabeling products and ending the use of any promotional materials focusing on the use of ENERGY STAR.

As the roofing industry embarks on 21st Century challenges to save energy, mitigate urban heat island, and perform at an increasingly higher level of resilience and sustainability, we are building on raised awareness that each building is different. And each individual building requires the design of knowledgeable roofing experts who can leverage the value of the broad variety of roofing products available today.

The architect, specifier or building owner — whoever is choosing the membrane — is not now restricted by the reflectivity of the membrane but has a wider spectrum to choose from. And often, the needs presented by the solar installation will point towards the qualities found in a dark membrane.

Low-Slope Roofing and Solar

There are certain basic questions that need to be answered before any construction of a solar installation should proceed. For instance, "Will the service life of your photo-voltaic system be similar to the existing or intended roofing membrane?" Solar panels can last up to three decades. A membrane that wears out before the solar panels are ready to be replaced can create an expensive and logistical challenge. Another key question is, "Can the supporting membrane withstand, and not be discolored by, the heavy foot traffic needed to maintain the proposed panels?"

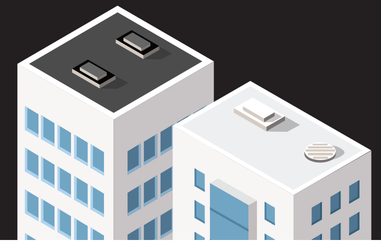
There are other advantages to using a dark membrane that might be less readily apparent. Solar panels can be impacted by the heat reflected upward from a roofing membrane. It's important to carefully assess whether the proposed roofing membrane can withstand the heat generated by the PV system, and — conversely — how the solar panel will be impacted by heat reflected upward by the membrane. While the roof itself might be kept cool by a reflective membrane, this reflective surface can add up to nine degrees onto the solar panel. Excessive heat of this type can impact the efficiency of the solar system, reducing the amount of energy it collects.

So — reflective or dark membrane to support a solar system? Given the latitude provided by the IECC, the choice is left with those who have greatest vested interest in the success of the project: the architect, specifier and building owner, who have the most to gain by making an informed, sustainable choice.

The EPDM Roofing Association offers a technical bulletin specifically designed to educate the construction community about the best approach to using solar with EPDM membranes. You can download a copy at _________.

It's impossible to imagine an architect, a specifier, or a contractor setting out to design or repair a roof without accurately measuring the components each step of the way.

TECHNICAL BULLETIN



EPDM ROOFING ASSOCIATION TECHNICAL BULLETIN #103

Rooftop Rack-mounted PV Systems and EPDM Roof Assemblies

Roof System Choice

EPDM roof systems are a common and established roof system type and are an ideal choice for use with rack-mounted PV systems due to their durability, east of installation, ease of flashing rack connection/bearing points, and roof system manufacturer acceptance of use with PV systems.

The Single Ply Roofing Industry (SPRI) Industry Bulletin 1-13, *A Summary of SPRI Membrane Manufacturer Photovoltaic (PV) Ready Roof Systems and Services* identifies EPDM as a rooftop-PV compatible material and indicates typical attributes that are often a part of roof system manufacturers' requirements when rack-mounted PV systems are planned including:

- An approved insulation board with a minimum thickness and compressive strength
- The addition of an approved cover board to enhance insulation protection
- An approved protection/separation sheet installed between the PV components and the roof membrane

The bulleted list above is not all inclusive. EPDM system manufacturers' often work with roof system designers and contractors to identify roof system components to include based on desired performance and warranty goals.

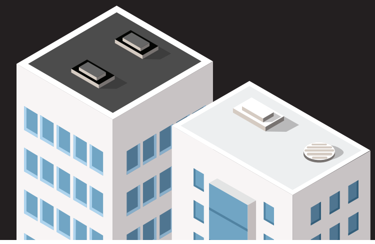
Roof System Color/Reflectivity/Thermal Resistance

In the past it was thought a roof system should be "cool" when used in conjunction with a PV system, the thinking being a cool roof would help prevent the air conditioning system from having to overcome added heat from the roof surface in the summertime. As most jurisdictions now have adopted modern energy conservation code requirements, low-slope roof systems are generally required to have a thermal resistance (R-value) considerably more robust than in the past. A reflective surface may not be beneficial as surface heating likely will not contribute to interior heating in a significant way due to the required insulation.

Roof system designers should also consider reflective heating where energy reflected from the roof raises the surface temperature of adjacent surfaces- in some cases up to 9 °F vs. a non-reflective surface. This is significant as the efficiency of rack-mounted PV systems are reduced at higher operating temperatures; the hotter panels get, the less power they generate. EPDM membranes are available with both reflective (white) and non-reflective (black) surfaces. For buildings with proper (energy-code mandated) insulation levels, a black membrane may be a better choice. In these cases, limiting reflective heating represents a larger benefit for building owners and energy conservation codes generally allow for roof system designers to take advantage of this benefit.

(continued)

TECHNICAL BULLETIN



EPDM ROOFING ASSOCIATION TECHNICAL BULLETIN #103

Energy Codes Generally Allow for Black EPDM in All Climate Zones with Rooftop PV

Most jurisdictions have adopted an energy conservation code based on the International Energy Conservation Code (IECC). While model energy codes require reflective roofing in climates zones 0-3, the current version of IECC, the 2021 Edition, contains provisions where reflective roof surfaces are not required when any of the following is installed on roofs:

- Photovoltaic systems or components are installed
- Solar air or water-heating systems or components
- Roof where not less than 75% of roof areas contain elements exempted from roof reflectivity requirements including: PV-related equipment; vegetative roofs; above-deck walkways; skylights; HVAC systems and components and other opaque objects mounted above the roof; rooftop ballast and pavers; and areas of roof meeting certain shading requirements.

The above provisions are found in IECC 2021, Section C402.3. Similar provisions are also found in earlier editions of IECC as well as ASHRAE 90.1, *Energy Standard for Buildings except Low-rise Residential Buildings*. Flexibility built into commonly adopted energy code allows for roof system designers to pick the right EPDM membrane for a particular project to provide the largest benefit to building owners.

EPDM — An Environmentally Responsive Choice for Rooftop PV

EPDM is a mainstream established product with a long track record of success, is easily recyclable when fastened or ballasted, and performs better than many other single-ply and bitumen-based membrane materials in key categories such as global warming, acidification and smog generation according to a peer reviewed Life Cycle Inventory and Assessment study (LCA). EPDM pairs favorably with rooftop PV for those looking for a strong sustainable option.

Selected References

Hart, Louisa ***Developing Roof Systems That Prevent Energy Loss*** Roofing Magazine. March 2019.

ERA Technical Committee ***Cool Roofs in Northern Climates*** January 2017.

Oak Ridge National Laboratory ***SPRI-ORNL Study Shows Ballast and Paver Systems Save as Much as a Cool Roof*** Interface. August 2008.

Case Study: Carlisle EPDM and PVC Unite Atop Colorado Hospital Carlisle-Syntec. June 2017.

SPRI Reinforced EPDM Environment Product Declaration Johns Manville. September 2016.

How Everyone Benefits From Resilient Roofing, Including Building Owners and Their Communities Firestone/Elevate. 2022.

Additional references are available on the ERA website at ***www.epdmroofs.org****.*

A SUSTAINABLE APPROACH: WHAT WILL REDUCE THE IMPACT OF THE URBAN HEAT ISLANDS?

It's this focus on measurement that has informed much of the EPDM Roofing Association, or ERA, for the past two decades. In fact, ERA's mission, beginning with its founding in 2003, has been to provide science-based information about our products, to ensure that they are appropriately used to deliver an optimized performance to our customers. With that goal in mind, we have supported research to investigate issues such as the life expectancy of EPDM, its resistance to hail, and its energy efficiency when installed with the recommended amount of insulation.

Based on this tradition of research to assess the performance of our products in a variety of situations, two years ago ERA embarked on a study focusing on one of

the most important challenges we face. Urban heat islands (UHI) are areas that experience higher temperatures than outlying suburban and rural areas. This past summer, the United States experienced some of the most extreme temperatures in its history, and more than four out of every five Americans live in cities that experienced this extreme heat. This concentrated heat threatens the wellbeing of those who experience it, especially individuals and communities that are more vulnerable due to health, social, economic, or other reasons.

Specifically, the ERA-funded research looked at the impact of “cool roof” mandates in urban areas, and the efficacy of these mandates in reducing the impact of urban heat islands. To conduct our study, we contracted with ICF, an independent consulting firm with experience in climate change, data analysis, and building science, to review and contribute to the research and analysis about cool roofs and UHI. ICF undertook a review of existing data and previous studies on UHI, and compared the temperature trends of similar cities within a pair. One of the cities in the pair had a cool roof mandate and one did not. In a later phase, ICF also looked at a dozen cities and compared the cities to themselves. ICF measured their temperatures over an extended period of time starting with when there were only a few cool roofs in the area and ending after there were more cool roofs.

Research Study Results

The results surprised us, but not for the reasons you might expect. ICF's analysis of temperature data for cities with cool roof mandates found no discernible correlation between the imposition of cool roof mandates and a reduction in UHI. The key words here are "no discernible correlation." ICF found that the data they reviewed showed that complex and inconsistent temperature assessment protocols are being utilized in virtually all UHI evaluations, making comparisons of efficacy problematic.

The two-year effort of ICF found that the presumed "real world behavior of urban temperatures and reflective roofs could not be verified due to the existing uncertainty in measuring the very factors that reflectivity allegedly help cure." Put another way, there is no consistent, universally used system of measurement to determine the value of a variety of efforts to mitigate urban heat island. This includes not only roofing, but also the potential mitigating effects of vegetation, cool pavements, and more effective planning.

Based on the findings of this study, or lack thereof due to lack of a consistent measuring system, ERA is recommending that we pause the emphasis on reflective roofing mandates as the preferred deterrent to the formation of UHI.

We are encouraging federal and state governments to conduct additional research to assess the relative value of all tactics that might diminish the impact of UHI. This will require a scope of study well beyond the abilities of any individual companies or academic institutions. And it will need a consistent, widely agreed-upon system to measure the efficacy of the variety of tactics currently being used. To ensure that we move forward to mitigate the impact of urban heat islands, we need to consider all potential mitigation tactics and accurately measure their relative efficacy.

If you can't measure it, you can't manage it, and — at this point — we can't measure it.

Overview of Critical Literature Review of Research on Cool Roofs

EPDM ROOFING ASSOCIATION

Summary of the Impact on Energy Efficiency and UHI

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.

FOR THIS REVIEW researchers examined:

- **2,856** ARTICLES AND PAPERS
- **178** LITERARY REFERENCES
- **102** ORIGINAL STUDIES

Overview of Research on Energy Efficiency

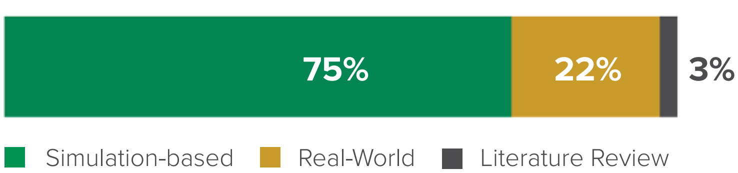
Studies and articles examining the impact of cool roofs on performance and energy efficiency yielded varied results, as its impact is influenced by a range of factors such as roof type, climate, location, and more. Additionally, studies varied greatly in methods of data capture and analysis.

HOW DO COOL ROOFS IMPACT ROOF PERFORMANCE AND ENERGY EFFICIENCY?

PERFORMANCE FEATURE: / ROOF TYPE AND MATERIAL:	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 excecpt 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



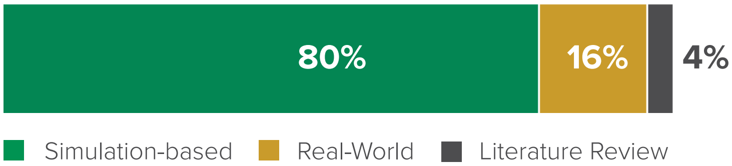
514 Individual roofs were included among the sample size of studies looking at energy efficiency

20 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



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

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

WHAT ARE THE TAKEAWAYS from the research?

- Cool roofs change the surface energy balance in urban areas by reducing solar radiation.
- Cool roofs perform the best when not impacted by soiling, disrepair and weathering.
- Cool roofs are most impactful in areas of high solar radiation and low humidity.
- Increasing cool roofs and green spaces in urban areas linearly decreases UHI.
- Citywide adoption of cool roofs can be an effective way to offset daytime UHI.
- Increasing the albedo in urban spaces across all surfaces reduces UHI.
- Effective UHI mitigation strategies depend on land use, climate, and geography.

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 hardscapes 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.

ERA

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