Photo courtesy of CertainTeed Commercial Roofing

Energy Efficient Roofs

Tony Matter

The issue is even more simple than black and white.

The days when heating and cooling costs were a relatively insignificant item on a school's budget are long gone. The prices of oil, natural gas, and coal are high, extremely unstable and have led to higher heating and cooling costs, driving school districts to utilize energy-efficient building materials.

It can be argued that energy efficiency has impacted the roofing industry more than other aspect of the construction industry. Codes have been developed, organizations formed, and regulations established – all addressing the issue of energy-efficient roofing. Over the past decade, energy efficiency within the roofing market has been focused on cool roofing, using light-colored materials such as polyvinyl chloride (PVC) and thermoplastic polyolefin (TPO) to reflect sunlight and solar energy.

The energy savings generated by the use of reflective roofing materials are most often realized in warm, southern climates where Cooling Degree Days (CDD) outnumber Heating Degree Days (HDD) and air conditioning is more prevalent than heating. In reducing heating-related energy demands, which are greater than air conditioning demands in northern regions, dark-colored materials such as EPDM membranes are often the most beneficial. In fact, if examined strictly from an energy-efficiency perspective, research and data prove that

materials like EPDM can provide equal or better energy savings than those created by light-colored materials.

Table 7.4 of the 2007 Buildings Energy Data Book, published by The Building Technologies Program within the U.S. Department of Energy (DOE) outlines energy use in various commercial building types, comparing heating and cooling as a percentage of total energy consumed. The results show that heating accounts for 33 percent of the energy consumed within an educational facility, while cooling totals a mere five percent. These numbers indicate that the move toward reflective roofing in many parts of the country may be ineffective in minimizing energy consumption. The numbers also suggest that there should be more focus on cutting heating costs, not cooling costs, making dark-colored membranes an important asset in the push for energy efficiency.

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The U.S. DOE, in conjunction with the Oak Ridge National Laboratory (ORNL), has developed a Cool Roof Calculator to help consultants, architects, roofing contractors, and building owners determine the most efficient, cost-effective roof system for any given project. Accessible through the DOE Website, the Cool Roof Calculator simulates building energy consumption based on the type of roofing membrane and amount of insulation installed.

Users can pinpoint the analysis based on the zip code of their project, resulting in direct comparisons of various roofing assemblies. In most instances, dark-colored membranes will provide more energy efficiency than light-colored materials for projects located in cooler climates.

The calculator was recently used to help the School Building Authority (SBA) of West Virginia develop its Quality and Performance Standards, which outlines specific products and minimum performance qualifications for state-funded school construction and renovation projects. The SBA had considered mandating the use of reflective roofing materials for all statewide roofing projects.

According to David Sneed, Chief of Architectural Services for the West Virginia SBA, reflective roofing materials were initially chosen because the board believed they would cut the school districts' annual energy costs. This perception is becoming fairly typical. When the standards were sent out for review, however, many local roofing professionals began to question the use of reflective materials.

Photo courtesy of Tremco Inc.

E.T. Wrenn Junior High School, San Antonio, TX.

Ed Smith, manufacturer's representative with North Coast Commercial Roofing Systems in Huntington, WV,

was one of the first to raise concerns over the use of reflective roofing materials in a state that features far more HDD than CDD.

"I've been in the roofing business in West Virginia for nearly 30 years," said Smith. "This state has a long and successful history with dark-colored membranes, especially EPDM. Reflective roofing doesn't produce the energy savings in West Virginia that many would expect."

Smith contacted Carlisle SynTec, which manufactures both white and black membranes, to help him show the SBA that they would actually lose money if they mandated reflective roofing on their state's schools. Carlisle turned to Randy Koller, a certified energy manager for 28 years. Koller simulated a number of scenarios at various locations throughout West Virginia using the DOE's Cool Roof Calculator. He compared 60-mil reinforced TPO and EPDM membranes to determine how both materials would affect energy costs and carbon emissions.

His scenarios included assemblies with R-values of 15, 20, and 30 for each membrane at every location. In every scenario, the EPDM roof system provided at least 10 percent more annual energy efficiency than the TPO. Smith presented those results to Sneed and the SBA board to show them what could happen if they mandated reflective roofing materials.

Upon reviewing the data, the board developed a new roofing specification that called for 60-mil EPDM and at least two layers of staggered polyiso insulation. Thomas Worlledge, area manager at the architectural firm McKinley & Associates in Charleston, WV, commended the SBA for changing its original specification.

"White roofing is simply not beneficial in West Virginia," said Worlledge. "Furthermore, most schools are closed during the summer months, when peak air conditioning demand is at its highest. Installing a white roof to cut air conditioning costs makes no sense if there is no need for air conditioning in the first place."

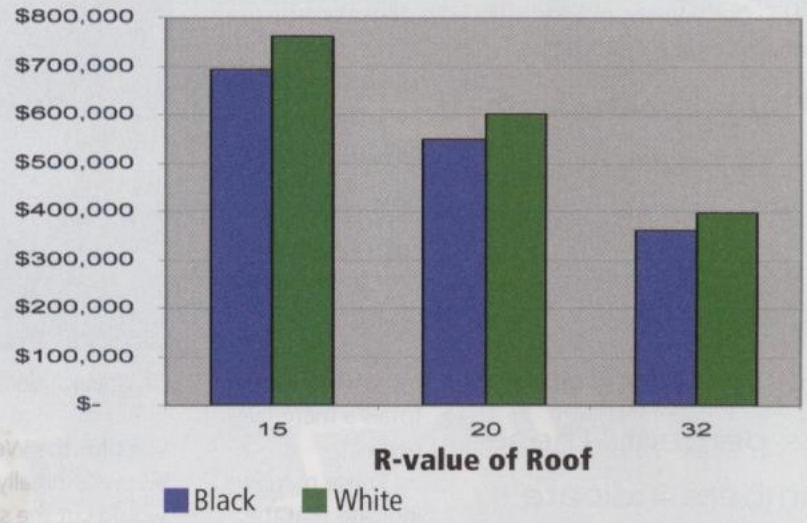
While Koller's findings proved the superior benefits of black membranes in cooler climates, they also demonstrated the importance of insulation in overall energy demand for all of his simulations, regardless of membrane color. When he ran the analysis on R-32 roofs, the energy savings attributable to membrane color were dramatically lower than those with an insulation value of R-15, and the difference in energy costs of the white and black roofs began to shrink as the R-value increased.

"Research shows that from an energy perspective, insulation often negates membrane color," said Andres Desjarlais, group leader for building envelope research at the ORNL. "Reflective roofing should not take the place of quality design, of which insulation is a key factor."

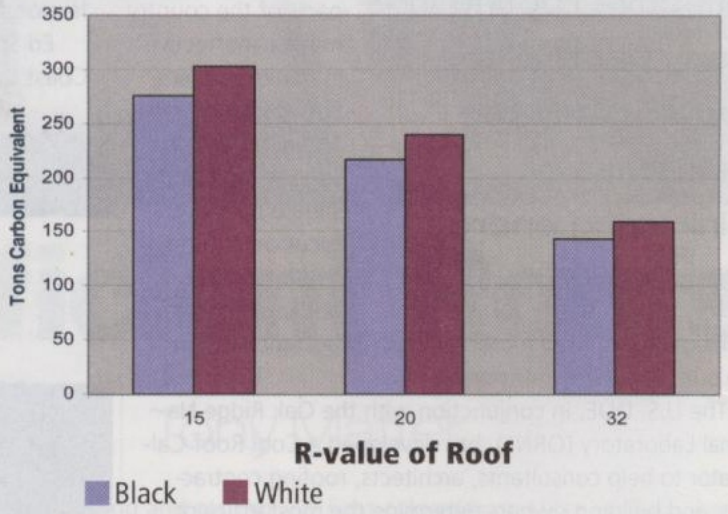
A superior option for any low-sloped roofing, white or black, is to utilize two layers of fully adhered

Energy Cost Comparison

20 Year Energy Costs Black vs. White



20 Year Carbon Potential Black vs. White



Based on data from Charleston, WV, with 4,632 heating degree days and 903 cooling degree days — from the DOE's cool roof calculator analyses.

insulation. This minimizes the affect of thermal escapes at the joints of the insulation and through the fasteners, resulting in a more airtight, efficient assembly.

"White membranes, throughout the northern part of the U.S., can address heat-island concerns, but they do not deliver energy savings nor contribute to lower carbon emissions," stated Carlisle SynTec's Director of Design Services Samir Ibrahim. "The key factor should always be the amount of insulation used in the assembly — the most influential component in achieving sustainability."

Even as more evidence that refutes the benefits of reflective roofing begins to surface, there is a large, influential movement that continues to push the agenda. Independent organizations and government agencies such as the Cool Roof Rating Council (CRRC), the Environmental Protection Agency's ENERGY STAR program, and LEED (Leadership in Energy and Environmental Design Green Building Rating System) are all recognizable within the roofing industry, and all promote reflective roofing without consideration of insulation or climate zone.

Worlledge, West Virginia's first LEED-accredited architect, said that LEED, while great in many ways, is part of what has caused the reflective roofing movement to infiltrate areas where it doesn't truly belong. "Just because a building receives LEED certification does not mean that it is a great building," said Worlledge. "Too many people do not understand the program's complexities and just use it as a checklist."

LEED is arguably the most prestigious and influential green building program in the United States. One LEED point is awarded to any building that utilizes a reflective roof system, regardless of location. So, while not required for LEED certification, reflective roofing is certainly promoted and used by designers as a way to garner one more point.

Ibrahim said that Koller's findings and the SBA's flip-flop were crucial in the validation of EPDM as an environmentally friendly, energy-efficient roofing material.

Photo courtesy of CertainTeed Commercial Roofing

In September 2002, the Cool Roof Rating Council (CRRC) launched its product rating program. The program provides for testing and labeling roofing products' surface radiative properties (solar reflectance and thermal emittance) using standardized methods that should prove useful for roofing professionals, architects, and planners.

"The design community has always emphasized sustainability and energy efficiency; however, the reflective roofing movement seems to have blurred many people's vision about reaching those goals," said Ibrahim. "EPDM has been an effective roofing solution for decades, and we always knew that it was more beneficial in colder regions. The energy analysis tools available today are helping us counteract some of the misconceptions that are out there."

Desjarlais knows a little about reflective roofing. He has been researching and testing its effects since 1988, when he published the industry's first report on the energy costs associated with white and black roofing materials. At the time, there was little interest in his paper because U.S. energy costs were low; however, he continued to study and he is now recognized as one of the foremost authorities on energy-efficient roofing.

"Cool roofing is the most contentious issue in the roofing industry since the introduction of single-ply membranes more than 40 years ago," said Desjarlais. "Just like when single plies were introduced, cool roofing has changed the landscape of the market, and whether it is perceived as positive or negative, people are getting excited."

Desjarlais is quick to point out the benefits of reflective roofing in warm, southern regions, but he does not believe they should be used in cooler climates in most instances. "There are many ways to make roofs energy efficient," he said. "Cool roofs are one of them, but they are not the only option."

It is highly unlikely that a consensus will ever be reached within the roofing industry of what constitutes the best system in any given location. Luckily, the emergence of energy and lifecycle analysis programs can help lead to informed decision making. One thing is certain: EPDM has proven to be a long-lasting and dependable roofing option for the past 45 years. It has lost share to reflective roofs over the past decade, notably in warmer, sunnier climates, but it is unlikely that its proponents will sit idly by and watch it lose out strictly because of its color. Reflective roofing materials have a place within the industry, but so too does EPDM.

Tony Matter *has been writing for the roofing industry for three years, and previously worked as a freelance reporter for* The Patriot News *in Harrisburg, PA. He earned a bachelor degree in Public Policy at The Pennsylvania State University. Matter has worked in the construction industry for nearly 10 years and currently serves as the marketing communications manager for Carlisle.*