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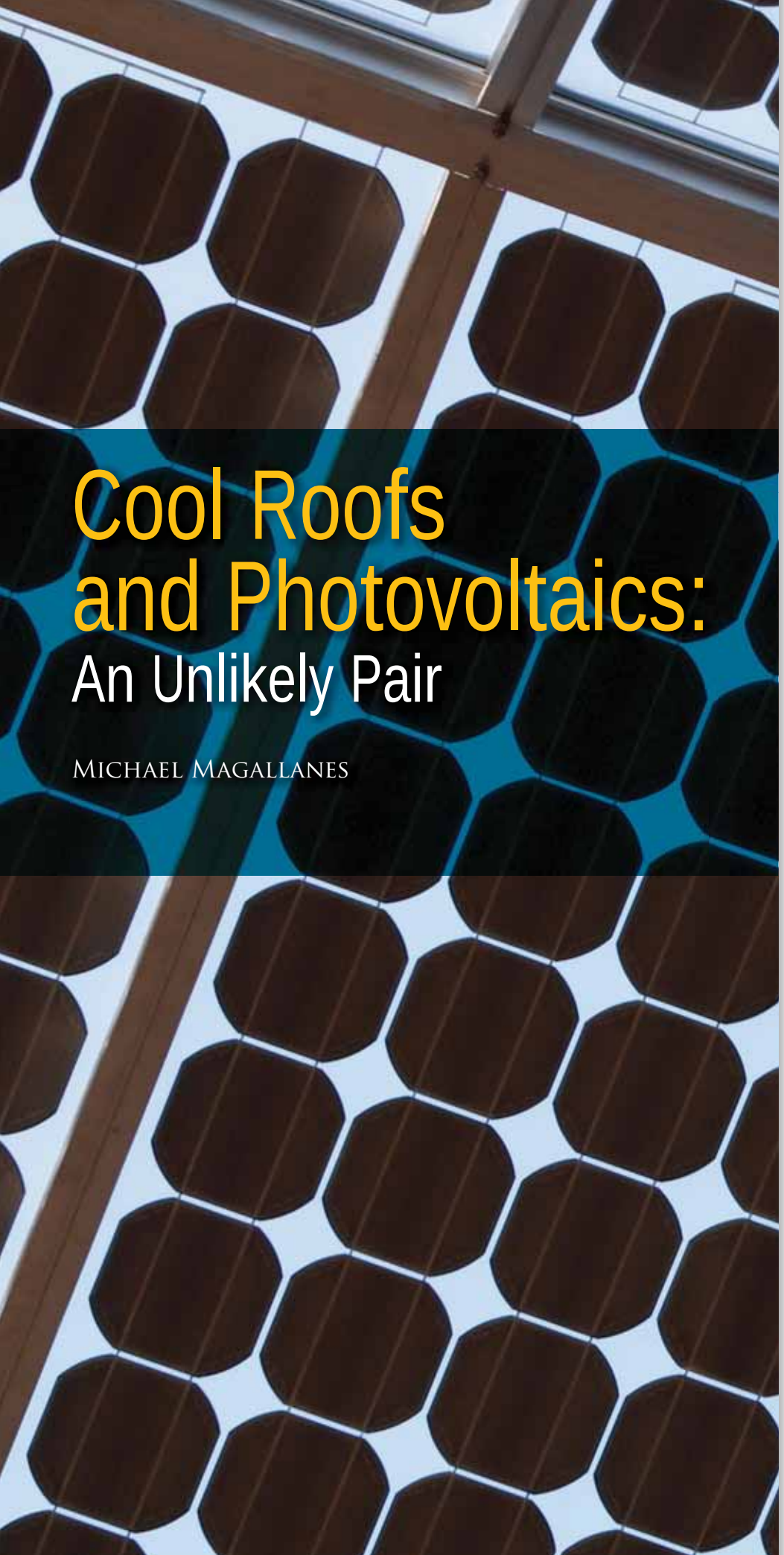


Cool Roofs and Photovoltaics: An Unlikely Pair

MICHAEL MAGALLANES

There are many types of sustainable roofs including white roofs, green roofs, and roofs with solar photovoltaic (PV) panels and solar hot water systems. The performance of sustainable roof technology often can be optimized if it is integrated with a different, complementary sustainable roof technology.

An example would be that the efficiency of a PV system frequently improves when it is placed above a cool roof. Because of their lighter color, cool roofs reflect sunlight (solar reflectance) and efficiently emit thermal radiation (thermal emittance). By cooling the roof and lessening heat transfer into the building, cool roofs reduce the cooling load of the air-conditioning system. This leads to both energy and financial savings while improving sustainability by minimizing greenhouse gas emissions.

Solar panels and cool roofs are a natural marriage of sustainable technologies. One solar installation company that has embraced this type of marriage is Advanced Powering Services of Rancho Santa Margarita, Calif., which installed a cool roof/solar panel beta test site on the roof of a local industrial building. Tim Scharf, chief operating officer, said that although it's too soon for the beta system to generate long-term data, the cool roof does seem to increase the energy output of the solar panels.

"Based on the system we are using, we expected the energy output to be 10.5 kilowatt hours (kWh) and, in fact, it is 11.8 kWh," Scharf said. "We attribute this increase to the fact that the cool roof maintains a lower, more optimal roof temperature that benefits the performance of the solar panels."

Scharf pointed out that solar systems work best at temperatures below 90 degrees Fahrenheit; if temperatures exceed 110 degrees Fahrenheit, the solar power output can be reduced by as much as 50 percent.

The importance of a cool roof

An energy efficient, cool roofing system significantly reduces roof temperatures during the summer while improving the performance of the PV system. Another benefit of a cool roof is that it can substantially enhance the performance of solar panels by lowering a building's interior temperature,

thus reducing the power load needed for air-conditioning. Other benefits include cutting energy costs by keeping attics and ducts cooler; improving occupant comfort; cutting maintenance costs; increasing the lifecycle of the roof; and reducing urban heat islands along with associated smog.

Solar reflectance and thermal emittance are the two measures used to determine the "coolness" of a roof. Solar Reflectance Index of a roofing product is a method for determining the radiative properties of roofing materials. SRI is defined by ASTM Standard E1980-01 Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces. The U.S. Environmental Protection Agency summarizes SRI as "the relative steady-state surface temperature with respect to the standard white (SRI=100) and standard black (SRI=0) under the standard solar and ambient conditions."

White reflective coatings contain transparent polymeric materials (such as acrylic) and white pigment (such as titanium dioxide or rutile) to make them opaque and reflective. These coatings typically reflect 70 percent to 80 percent of the sun's energy. Despite the white appearance, these pigments absorb the 5 percent of the sun's energy that falls in the ultraviolet spectrum. Thus, the pigments help protect the polymer material and the substrate underneath from ultraviolet damage. As long as the coating is white or light-colored, the roof will have high reflectance and emittance levels.

Many factors influence actual benefits

Although the actual benefits of a cool roof on a particular building are affected by many factors—including building type, load, season and climate zone—cool roofs can significantly reduce summer energy usage. A reasonable annual energy savings expectation for a typical low-rise retail or other commercial building is 10 percent to 30 percent of the electricity usage for air conditioning.

It has been found that a reflective roof coating can lower interior temperature of a commercial or industrial building by eight to 12 degrees Fahrenheit during the hottest four hours of a summer day. Not only does the lower interior temperature help reduce energy expenditures, but it also improves worker productivity, especially in non-air-conditioned space, by creating a more comfortable work environment.

A 2001 study by the Lawrence Berkeley National Laboratory in cooperation with the EPA underscores the value of cool roofs for reducing energy usage and related costs. The study focused on a 100,000-square-foot building owned by a major retailer in Austin, Texas, built with a traditional roofing system featuring an exposed black rubber EPDM membrane.

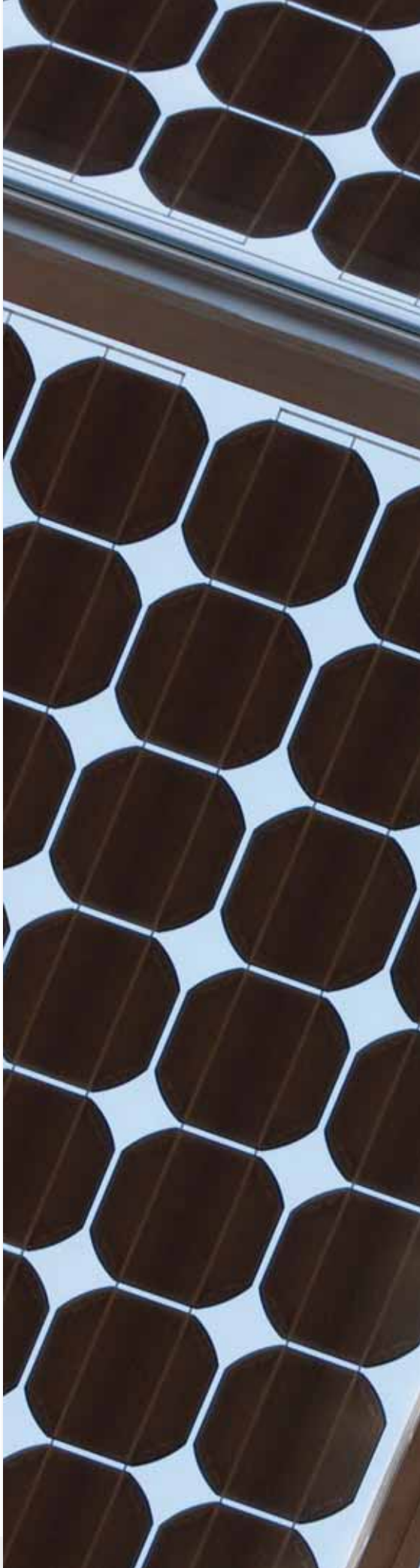
After 13 years of operation, the black roof was replaced with a white thermoplastic roofing system. Direct benefits of the new roof included daily savings from reduced demand for operation of the air-conditioning system as well as present value of future savings. These savings were coupled with benefits from energy conservation programs sponsored by the local utility as well as state and federal programs.

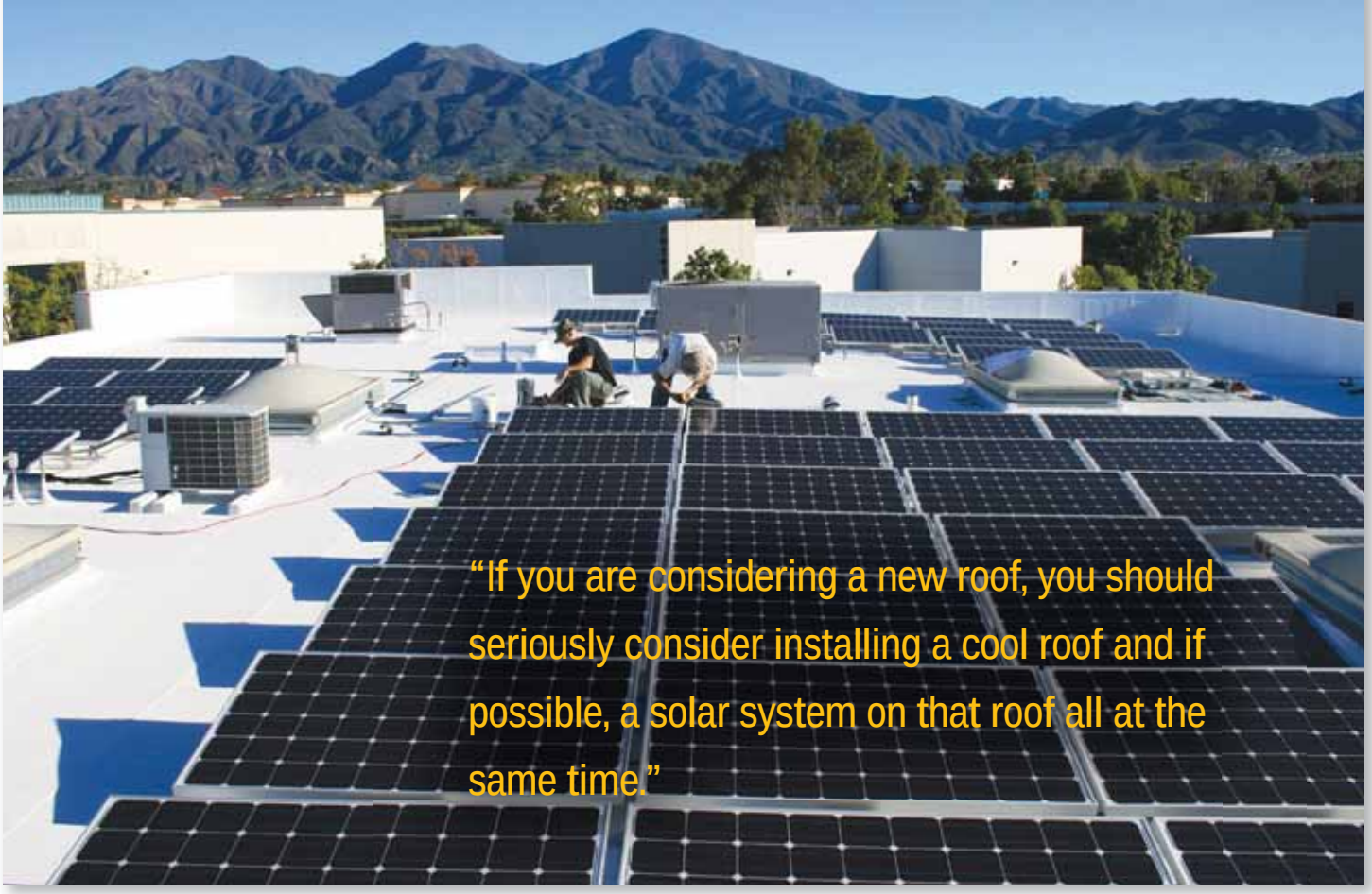
Specific benefits from the cool roof based on 2001 factors included the average summer temperature of the cool roof compared to the black roof was 42 percent less, dropping from 168 degrees Fahrenheit to 126 degrees Fahrenheit. This increased the useful life of the roof and reduced summer air-conditioning usage by 14 percent resulting in average monthly savings of US$490.

California's Title 24 cool roof requirement

Some of the factors that have led to a growing number of cool roof installations in California include the U.S. Department of Energy's ENERGY STAR® program and the California Code of Regulations, Title 24, also known as the California Building Standards Code, which prescribes cool roofs be employed whenever low-slope commercial roofs are constructed or replaced.

Bill Conley, CFM, CFMJ, LEED AP, IFMA Fellow, an Aliso Viejo, Calif.-based facility management and sustainability consultant, is a proponent of marrying cool roofs with solar. As a facility manager, his goal is to achieve the best possible operating configuration that saves money and energy, optimizes sustainability and ensures the longest possible usage of a building.





According to Conley, a long-time advocate of sustainability, a cool roof combined with solar can improve performance and economics of a PV system while also being an important factor for California commercial property owners complying with Title 24.

Echoing Conley, Ian McLaughlin with Lineside Electric, a San Juan Capistrano, Calif., installer of solar systems, stated, "A cool roof as an integral component of a solar installation enhances reflectivity and other benefits such as cooling a building's interior that can significantly improve the operation and efficiency of the PV system."

Willard Young with Solyndra Inc., a Fremont, Calif., producer of innovative photovoltaics for commercial rooftop installations, reported that based on his company's data, the output of its solar power system—which consists of cylindrical collectors instead of flat panels—when combined with a cool roof increases up to 20 percent due to the improved collection of reflected and diffuse light.

Solyndra is a major proponent of marrying solar power with a cool roof. Three companies that combine cool roofs with Solyndra's system are Public Service Electric and Gas Company, Norkus Foodtown and LPS Industries, all based in New Jersey. Six of Norkus' grocery stores have white, reflective roofs that significantly increase the energy power generation and reduce cooling costs by as much as 20 percent. LPS Industries, which manufactures flexible packaging that protects items such as food, medical devices and electronic products, has experienced a similar level of energy savings. PSE&G recently installed a 0.9-megawatt solar system/cool roof combination on its Central Division headquarters in Somerset, N.J., which should produce enough electricity to power 155 average-sized homes.

The EPA National Computer Center

The EPA's 101,000-square-foot National Computer Center in the Research Triangle of Raleigh-Durham, N.C., is one of the more prominent buildings that combines a cool roof with solar panels. The center, which achieved a LEED-NC (Leadership in Energy and Environmental Design - New Construction) Silver rating in early 2005, handles a massive quantity of data processing equipment. To achieve the Silver rating and reduce the building's substantial power load, 15,000 square feet of the roof is covered with solar panels on top of a highly reflective, ENERGY STAR compliant, white membrane (reinforced thermoplastic polyolefin) that reduces unwanted heat during the cooling season.

The solar power system consists of a 94-kWh (peak) PV array made up of 2,185 individual tiles. Each tile is a stacked composite made of a layer of rigid polystyrene foam insulation board, a wiring chase and airspace, and a PV module. Each tile interlocks with adjacent tiles and rests on top of the membrane-covered roof deck with no mechanical penetrations. The output of the PV array offsets approximately 5 percent of the building's electricity consumption, which is estimated to be approximately twice that of a conventional office building of equivalent size due to the large demand from data-processing equipment.

Greg Eades, energy manager for the EPA Research Triangle Park campus, said that while he has no specific data on the affect the cool roof has on the performance of the PV system, it does appear that the roof is beneficial. Specifically, he pointed out the energy output of the system has increased over the past three years from 85,000 kWh to 105,000 kWh while the "insolation" factor—a measure of solar radiation energy received on a given surface area in a given time—has decreased.

"One would expect that if the solar output is increasing, the insolation also is increasing," Eades explained. "However, for this system, the opposite is happening. The energy has increased while the insolation has decreased, which is counterintuitive. Although we don't have the data to prove it, one could surmise the reason for the inverse relationship is the presence of the cool roof. If that is the case, the cool roof is definitely beneficial."

To enhance the EPA building's energy efficiency, a digitally controlled, fully-automated building automation system (BAS) monitors and controls various aspects of the building, including temperature, pressure, humidity, electrical systems, computer room cooling units, cooling and heating equipment, maintenance indicators, lighting and security. Electronic sensors placed throughout the facility communicate to the BAS when temperature, humidity, fresh air ventilation rates and other environmental conditions need to be adjusted, further increasing the facility's energy efficiency. The EPA also took advantage of numerous opportunities to optimize the design for efficiency in its mechanical specifications.

The importance of roof condition

Getting down to basics, if a roof needs to be replaced or patched after solar panels has been deployed and operational, the lost revenue to the owner can be substantial.

According to David Montross, president of Montross Roofing—an Orange County, Calif., firm that specializes in roofing, decking and construction services—a careful inspection of the roof system before solar is employed not only is necessary but also critical. If the roof shows signs of weathering or wear and tear such as blistering and splitting, then it's probably best to re-roof with a cool roof before installing solar panels. For the optimum performance of the investment, a roof should be able to last at least 20 years from the time of PV installation.

"If you are considering a new roof, you should seriously consider installing a cool roof and if possible, a solar system on that roof all at the same time," Montross explained. "A cool roof reduces building cooling requirements by lowering the temperature of the roof and the building underneath. This means cooling equipment savings and, in many cases, the ability to run less air conditioning or purchase smaller air conditioning units. A cool roof also will increase the life of a roof. By lowering the roof temperature, roofing products may last longer due to less thermal stress over time." FMJ

Michael Magallanes is vice president of Coat'N'Cool (www.coatncool.com). Coat'N'Cool is a Yorba Linda, Calif., company that has created a proprietary cool roof product that is an easy-to-apply architectural coating specially engineered to reflect sun light in the UV, IR and Visible spectrum. Magallanes may be reached at mike@coatncool.com.