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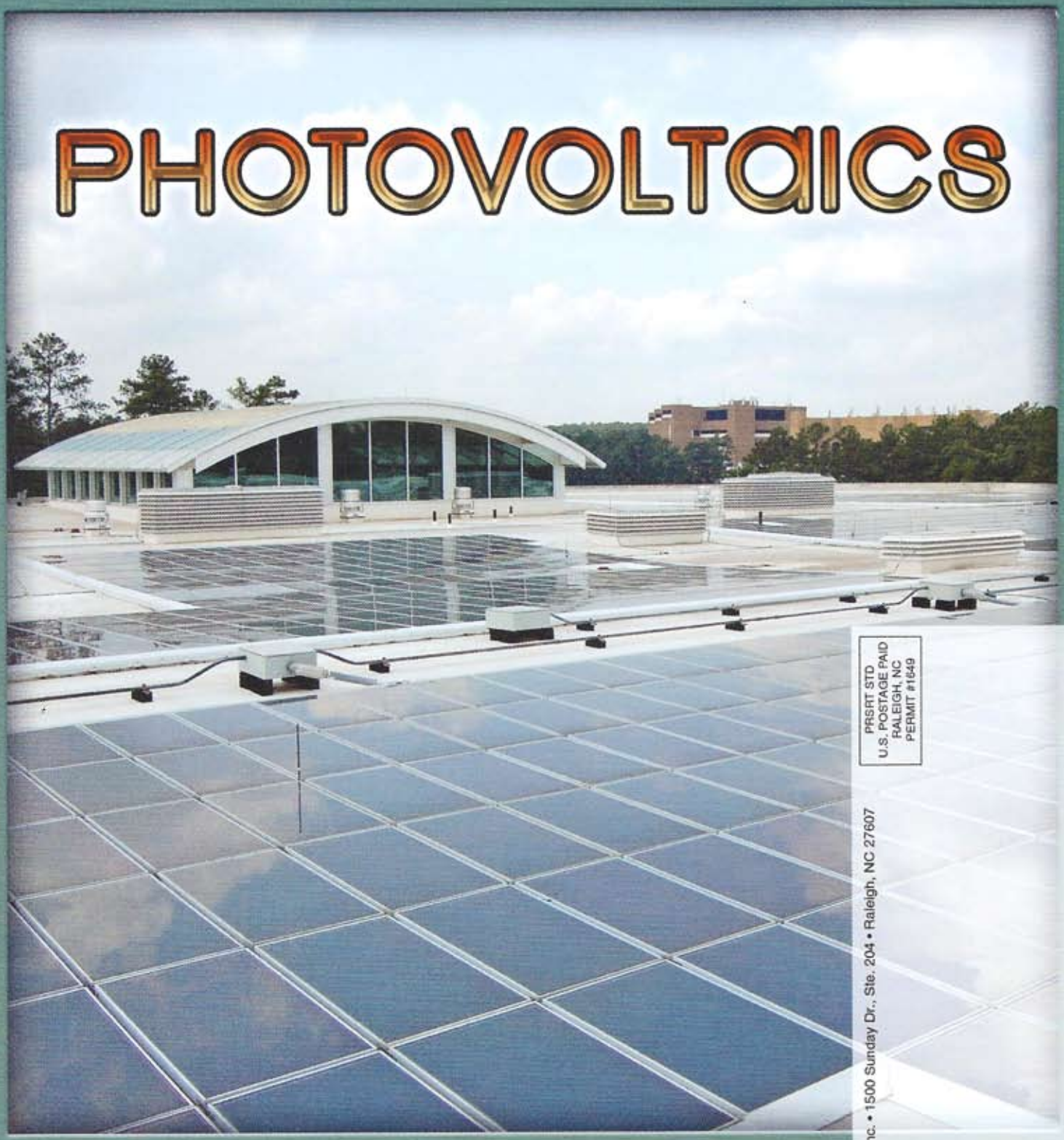
PHOTOVOLTAICS



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COOL ROOFS AND PHOTOVOLTAICS WORK TOGETHER TO ENHANCE GENERATION PERFORMANCE

By Michael Magallanes

It seems like a natural marriage of sustainable technologies: solar panels and cool roofs. Why not combine the energy-saving logic behind cool roofs with the energy-producing value of a rooftop solar system? One company reports that the output of its solar power system, when combined with a cool roof, increases 20% due to the improved collection of reflected and diffuse light.

Energy-efficient, cool roofing systems can significantly reduce roof temperatures, especially during the summer. Because of their lighter color, cool roofs reflect sunlight (i.e., "solar reflectance") and efficiently emit thermal radiation (i.e., "thermal emittance"). Although the actual benefits of a cool roof on a particular building will depend on many factors, including building type, load, season, and climate zone, cool roofs can significantly reduce summer electrical energy usage. A reasonable annual energy savings expectation for a typical low-rise retail or other commercial building is 10% to 30% of the electricity usage for air conditioning.

Along with cutting energy costs, the cool roof has many other benefits, including keeping attics and ducts cooler, improving occupant comfort, cutting maintenance costs, increasing the life cycle of the roof, and reducing urban heat islands, and along with them, associated smog. There are many types of sustainable roofs, including white, green, and those with solar photovoltaic (PV) panels and/or solar hot water systems. The performance of sustainable roof technology can often be optimized if it is integrated with a different, complementary sustainable technology.

How do cool roofs designed to reflect sunlight work with solar panels, which are designed to absorb it? Rather than working against the panels, the reflectivity of cool roofs sends more light to the panels from all directions—one of the reasons why these two sustainable technologies work in harmony. One solar installation company that has embraced the marriage is Advanced Powering Services, Inc., of Rancho Santa Margarita, CA. The company has installed a cool roof/solar panel beta test site on the roof of a local industrial building (see *Photo 1*). Tim Scharf, chief operating officer, said that although it's too soon for the beta system to generate any long-term data, he can report that the cool roof does seem to increase the energy output of the PV panels.

"Based on the system we are using, we expected the energy output to be 10.5 kWh,

Photo 1 – One solar installation company that has embraced the marriage of solar panels and cool roofs is Advanced Powering Services, Inc., of Rancho Santa Margarita, CA. The company has installed a cool roof/solar panel beta test site on the roof of an industrial building. Photo courtesy of Coat'N'Cool.

Photo 2 – A cool roof as an integral component of a solar installation enhances reflectivity and other benefits, such as cooling a building's interior and helping to improve the operation and efficiency of the photovoltaic system. Solar systems work best at temperatures below 90°F. If temperatures exceed 110°F, the solar power output can be reduced by as much as 50%. Photo courtesy of Coat'N'Cool.

Photo 3 – Energy-efficient cool roofing systems can significantly reduce roof temperatures during the summer, improving the performance of the photovoltaic system. Photo courtesy of Coat'N'Cool.

and, in fact, it is 11.8 kWh," Scharf notes. "We attribute this increase to the fact that the cool roof maintains a lower, more optimal roof temperature, which benefits the performance of the solar panels." Scharf, whose company is currently working with several multi-family property owners in Southern California to install cool roofs and PV systems, points out that solar systems work best at temperatures below 90°F, and that if temperatures exceed 110°F, the solar power output can be reduced by as much as 50% (*Photos 2* and *3*).

One of the more prominent buildings that combines a cool roof with solar panels is the Environmental Protection Agency's (EPA) 101,000-sq-ft National Computer Center in Research Triangle Park (RTP) outside of Raleigh, NC (*Photo 4*). The computer center, which achieved a LEED-NC 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 sq ft 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; in other words, a cool roof.

The solar power system consists of a 94-kilowatt (peak) PV array made up of 2,185 individual tiles. Each tile is a stacked composite made up 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% 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 (*Photo 5*).

Greg Eades, energy manager for the EPA RTP campus, says that while he has no specific data on the effect that the cool roof has

Photo 4 – One of the more prominent buildings that combines a cool roof with solar panels is the EPA's 101,000-sq-ft National Computer Center in RTP, near Raleigh, NC. Photo courtesy of the EPA.

on the performance of the PV system, it does appear that the roof is beneficial. Specifically, 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 has decreased. (Insolation is a measure of solar radiation energy received on a given surface area in a given time.)

"One would expect that if the solar output is increasing, the insolation is also increasing," Eades explains. "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 that the reason for the inverse relationship is the presence of the cool roof. If that is the case, then 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 by reducing energy waste. The EPA also took advantage of numerous opportunities to optimize the design for efficiency in its mechanical specifications.

The growing number of cool roof installations in California, and the potential for combining cool roofs with solar systems, have been helped by the support of the U.S. Department of Energy's ENERGY STAR® program and by the requirements of California's new Title 24 "Cal Green" Energy Standard, which prescribes cool roofs to be employed whenever low-slope commercial roofs are constructed or replaced.

Bill Conley, CFM, CFMJ, LEED AP, an Aliso Viejo, CA-based facility management and sustainability consultant who is a board member of the International Facilities Management Association, is a proponent of marrying cool roofs with solar. He points out that as a facilities 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 and its environment.

According to Conley, a cool roof combined with solar can improve the performance and economics of a PV system and at the same time be an important factor for California commercial property owners in complying with Title 24.

Echoing Conley, Ian McLaughlin with Lineside Electric, a San Juan Capistrano, CA, installer of solar systems, states, "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 photovoltaic system."

Getting down to basics, if a roof needs to be replaced or patched after solar technology has been deployed and operational, the lost revenue to the owner can be substantial. That's why, according to David Montross, president of Montross Roofing, an Orange County, CA, firm that specializes in roofing, decking, and construction services, a careful inspection of the roof system is not only necessary, but also critical. He points out that if the roof shows signs of weathering or wear and tear such as blistering and splitting, then it's probably best to replace with a cool roof before installing

Photo 5 – The EPA's Computer Center handles a massive quantity of data processing equipment. The output from the solar collectors offsets approximately 5% of the building's energy 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. Photo courtesy of the EPA.

the solar panels. For the optimum performance of the investment, a roof should be able to last at least 20 years from the time of the PV installation.

"If you are considering a new roof, you should seriously consider installing a cool roof, and if at all possible, a solar system on that roof, all at the same time," Montross explains. "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 air conditioning less or purchase smaller air conditioning units. A cool roof will also increase the life of a roof. By lowering the roof temperature, roofing products may last longer due to less thermal stress over time."

Combining photovoltaics with a cool roof has also attracted positive attention from the federal government, particularly the Internal Revenue Service (IRS). In a recently issued "private letter ruling" (P.L.R. 200947027) requested by solar tube manufacturer Solyndra, the IRS determined that the cost of a "highly reflective" roof installed in connection with a rooftop solar installation qualifies for the federal investment tax credit. The IRS ruled that the cost of improvements to a roof can qualify for the investment tax credit because the highly reflective roof surface "meaningfully increased" the amount of electricity generated by the PV panels.

An important note is that private letter rulings are solely addressed to the individual taxpayer requesting the ruling. Nonetheless, private letter rulings are generally accepted as a statement of the IRS's view of the law as applied to the facts in the ruling. However, each situation is different, and the contractor or the building owner should consult his or her own tax advisor concerning the federal tax implications of an investment in PV panels in connection with a cool roof.

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