WRITTEN BY **RICK DUNCAN, PH.D., P.E.**

Spray Polyurethane Foam and Photovoltaic Roofing Systems

When Working with These Systems, You Must Consider Design, Safety, Maintenance and More

Spray polyurethane foam and photovoltaic systems are increasingly utilized together as a joint solution for energy savings. With the continued push toward sustainability and growing movements, like net-zero-energy construction, SPF and PV systems are a logical combined solution for the generation of renewable energy, the conservation of heating and cooling energy, and the elimination of the structure's dependence on fossil-fuel-consuming electricity sources.

Regardless of whether net-zero energy is the end goal, SPF and PV combined in roofing can be quite effective for many structures. Here are some considerations when looking to join these two powerful systems on the roof of a building.

ROOFTOP PV INSTALLATION TYPES FOR USE WITH SPF

Rooftop PV systems can vary significantly in size. Large-footprint buildings can employ PV systems rated from 50

PHOTOS: SPRAY POLYURETHANE FOAM ALLIANCE

Self-flashing of PV supports using SPF roofing systems.

kilowatts to 1,000 kW or larger while residential rooftop PV systems are commonly 3 kW to 5 kW.

Rooftop PV systems may be installed on racks or adhered directly to the roof surface. When looking to combine PV with SPF, it is generally not advised to adhere or place the PV panels directly onto the roof surface. Solar heat and water can accumulate between the PV and roof coating which could negatively impact coating performance. Moreover, panels applied directly to a low-slope roof will not be properly aligned with the sun to achieve optimal performance.

Non-penetrating rack systems may be placed directly on a rooftop and held in place with ballast. Racks may also be installed with penetrating supports that require flashings. Each type provides advantages and disadvantages. For example, ballasted racks may block water flow and affect drainage while penetrations require leak- and maintenance-prone flashings. SPF is unique in that it easily self-flashes around penetrating supports.

PV EXPLANATION

PV cells are the basic unit used to convert light to electricity. Many PV cells are bundled together to make a PV panel, or module. PV panels are grouped electrically to create a PV string. Depending on the system size, two or more strings are combined to create a PV array.

The dominant type of PV panel used with SPF roofing is cSi, or crystalline silicon. cSi is a typically rigid panel with a glass and metal frame and may be applied, unlike other dominant PV panel types, via rack installation methods.

Under no circumstances should SPF contractors ever disconnect or decommission a PV panel or system unless they are trained and qualified to do so.

A PV system includes many components in addition to the panels. Components include racks, rails, rooftop attachment devices, grounding systems, wiring and wiring harnesses, combiner boxes, inverter(s) and connection to the main electrical panel. Components may also include control modules and storage batteries for off-grid PV system installations.

ELECTRICAL SAFETY

Photovoltaic panels must be handled and maintained with caution. Electricity is produced when a single panel is exposed to light; however, because a panel is not part of a circuit, that electricity will not flow until the circuit is complete. A worker may complete the circuit by connecting the two wires from the backside of a PV panel.

When maintaining a PV system, it may become necessary at some point to disconnect or remove an individual panel from a string or an array. The whole system must be shutdown

SPF roofing systems self-flash around PV rack system supports, various types of skylights and roof-mounted HVAC equipment.

properly as a precautionary measure to prevent shocks from occurring to workers and arcing between electrical connections. This "shutdown" procedure must be followed with precision as part of a lock-out/tag-out program. This procedure is provided by the inverter manufacturer. Under no circumstances should SPF contractors ever disconnect or decommission a PV panel or system unless they are trained and qualified to do so.

Ideally, a roof system and the PV system should have the same expected service life.

HEAT BUILDUP

Photovoltaic panels convert approximately 15 to 20 percent of light to electricity, leaving the remaining unconverted energy to be released as heat. Additionally, PV panels are more effective when their temperature drops. It is for these reasons that the majority of rooftop PV systems are installed to encourage airflow under panels, which reduces the temperature of the panels, improves conversion efficiency and releases heat effectively. Photovoltaic panels installed 4 to 5 inches above the roof will not change the temperature of the roof and, instead, provide shade to the surface of that roof. This additional shade may extend the life of SPF roof coatings.

LOAD

PV panels add weight to a rooftop and this must be factored into the design and installation. Existing structures should be analyzed by a structural engineer to determine if the additional weight of the PV system is acceptable.

Rack-mounted arrays with penetrating attachments are fairly lightweight at 2 to 3 pounds per square foot, and ballasted arrays add 4 to 6 pounds per square foot. However, with the latter, more ballast is utilized at the perimeters and corners of a PV array. Thus, localized loading from ballast may reach as high as 12 to 17 pounds per square foot, which must be considered. Most SPF roofing systems have a compressive strength of 40 to 60 psi.

Additionally, roofs are required by codes to provide "live-load" capacity, a measurement that includes people, snow and other weight-bearing temporary scenarios that may occur. The

weight of a PV system is typically below the live-load capacity, however in the absence of a structural analysis, the live-load capacity will be reduced by the addition of the PV system.

A final consideration is whether a PV installation will create new locations for drifting snow, which may add considerable weight to a roof.

When determining key considerations for wind load and fire safety, best practices require deferral to the PV supplier.

EQUIVALENT SERVICE LIFE

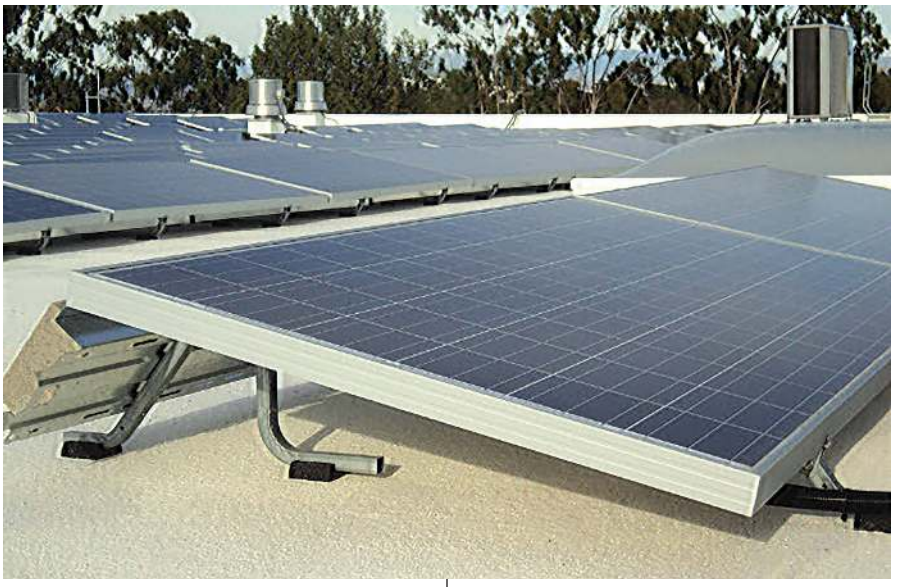
Ideally, a roof system and the PV system should have the same expected service life. Removal (decommissioning) and reinstallation (recommissioning) of a PV system is costly, and the cost should be weighed relative to the residual service life of the existing roof and cost of roof replacement at the time of PV installation. Ballasted, rack-mounted PV systems are difficult, if not impossible, to reroof (or recoat) under and around. Elevated racks with adequate space beneath may be able to be left in place when reroofing.

For example, a PV system that covers 10 percent of the rooftop will be easier to relocate during reroofing than a PV system that covers 75 percent of the rooftop. Building owners should be advised of future reroofing and maintenance costs with roof-mounted PV systems.

Drainage on rooftops is important for safety of the structure and longevity of the roof. PV arrays often have many points of contact with a roof, and these are possible locations that will block or slow drainage. PV racking should be positioned to minimize ponding water and/or include methods, such as notched pads, to allow drainage under points of contact, especially for ballasted systems.

Roof systems used as platforms for PV systems must be tough and durable, and generally speaking, SPF has greater compressive strength as density increases. Higher-density SPF systems may be preferred, especially when ballasted support systems are used.

An SPF system will be stressed during the installation of the PV system and



coatings and granules will help protect the roof during this time, as well as during scheduled maintenance. Because a roof surface below PV panels will likely not dry as fast as non-covered portions, coatings that stand up better to standing water and biological growth should be selected.

PV SYSTEM ACCESS

All roof-mounted PV systems should be inspected and maintained at least twice a year. Wiring, attachment points and flashings should be inspected, and cleaning of the top surface of the PV panels may be required.

To maintain and service the roof and PV system, workers must be able to access both. PV systems should not block access to drains, penetrations, flashings, mechanical units or other rooftop equipment. Similarly, PV systems should be installed so maintenance workers can access wiring, inspect panel-to-racking connections and properly clean top surfaces without stepping on PV panels.

Installation of PV systems on SPF roofing will inevitably create additional foot traffic. It is important to protect heavily trafficked areas with additional coating and granules or walk pads. The cost to do so is low and will protect the service life of the roof.

Although there are many additional considerations to the application of PV systems in combination with SPF roofs, the energy generation and conservation provided by the combined solution is well worth the extra effort. R