BY TED CUSHMAN

A Vegetated PV Roof

Developer-builders Jessica Pitts and John Miller of Flywheel Development had a goal and a problem. Their goal was to build affordable net-zero townhomes in suburban Washington, D.C. Their problem was stormwater management: Rules in Prince George's County, Md., required them to detain the runoff from heavy rainstorms on site, rather than divert it into municipal storm drains.

The poorly draining site soils and the tight site precluded traditional ground-based stormwater-management best practices, so they looked to a vegetated rain-detaining roof for a solution. But Pitts and Miller also had other plans for the roof: They needed solar power to meet their ambitious energy goals.

In the end, Pitts and Miller reached both of their objectives with an innovative combination: a vegetated roof whose growing medium captures significant amounts of rainfall, with solar arrays mixed in with the plants and supported by modular frameworks that are anchored and ballasted by the green-roof growing medium. Manufactured by German firm Optigrun (optigreen.com), the PV array support system is imported from Germany, and the pair say this is the first time it has been deployed commercially in the United States. But Miller says the idea is a "no-brainer" financially: "Because the solar racking is ballasted by the green-roof media and the plants that keep it there, the percentage of the green roof that is ballasting the panels is eligible for the federal tax credit for PV."

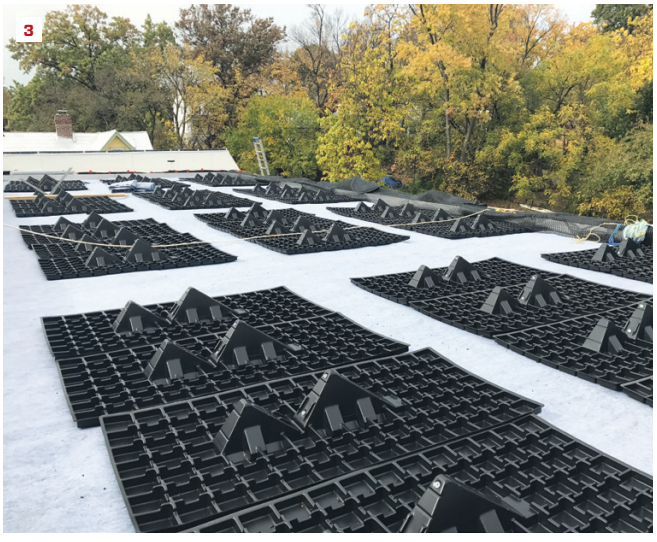
The roof is also effective as a stormwater management system. Says Pitts, "The solar green roof is designed to detain between 1.8 and 2.4 inches of rainfall. There is little to no runoff from a small storm of about 1.2 inches or less."

The process started during the design phase. Says Pitts, "This can go on any sort of deck. Our structures are wood framed. But you have to account for the load that you're going to be carrying with the engineering, so it's important if you do this, to have a mind to do it at the beginning."

"Wind uplift is a critical calculation on the solar," Pitts notes, "and the depth of the green-roof media is determined by wind-uplift calculations. We had a 3-foot parapet wall on three sides of the roof, and the PV

Photos courtesy Flywheel Development

An electronic leak-detection sensor verifies the watertightness of the EPDM roofing material before the green-roof membranes and growing media are installed **(1)**. A plastic protection mat and a geotextile mesh are the next layers to be applied to the roof **(2)**.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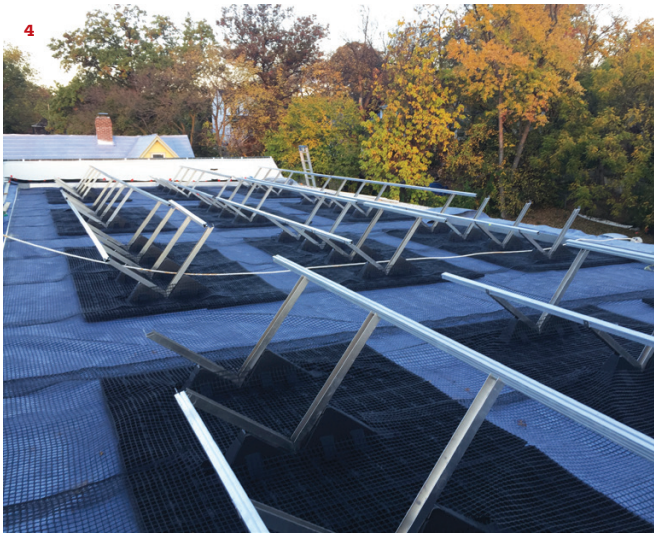
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Durable plastic rack bases are set in place on the roof **(3)**, then the geotextile mesh layer is rolled out, lapping over the plastic bases **(4)**. Metal racking for the PV panels is anchored to the plastic bases, which will be ballasted by the green-roof growing media.

system is down below that level and is protected from wind uplift on three sides, which reduced the depth of the green-roof media that we needed to install. So if you want to do this, at the beginning you need to think about the height of your parapet wall on your building and how you can protect solar panels from the wind."

The green-roof media would help to protect the building's EPDM roof from sunlight and weather. But the green roof and solar would also impede any needed repairs or maintenance down the road. So Pitts and Miller decided to install a leak-detection system before laying down the roofing. "We thought it was prudent to install a leak-detection layer," says Pitts. "It's a metal mesh that goes underneath the roof membrane. And what that allows you to do is that if you ever get a leak, you can identify the exact location of it."

The thin, stainless steel mesh comes in rolls and is installed directly to the roof deck before protection board and roofing are installed. "It looks like chicken wire," says Pitts. "There are two leads that you can run up the side of your parapet wall and hang out at the top. And you can test even before you put the green roof on. We had the people come out and test the membrane as soon as it was in place. They wet down the roof and apply an electrical charge and they look for places where you get a connection."

"They use a detector that looks like a push broom with metal bristles on it," says Miller. "They found five or six little pinprick holes that you never would have noticed, and we patched them. All you have to have is a roofer maybe bends over and maybe one of the metal brads on their jeans pokes a hole in the roof, or they drop their utility knife, and you would never know. The leak detection crew will circle this spot with a marker, and you're like, 'Wait a minute—that's a hole?' But this way you know on day one that your roof is leak-free. And if you have a future problem, then you can find it."

"So then you put in the layers of the green roof," says Pitts, integrated into the high-density plastic bases for the solar-array racks. "So you have your plastic protection layer, which keeps the roots from growing down into the actual roof itself. Then you have a protection mat, which is kind of like a felt material. And that's for protecting the roof membrane from the roughness of the growing medium. Then you have a geotextile mesh; the mesh that we were using has large holes in it—it's a loose weave—and that goes on top of the bases that the green roof ballasts down."

The mesh wraps under and around metal edging at the roof perimeter, and it runs over the PV rack bases. "And there's an L-shaped metal bar that is installed into each of those bases, and then the rack is accepted into those metal L bars," says Pitts. "And then each grouping of panels is also tied together. So you can do a long grouping of however many you would like, and we had four individual systems on top of each of the four individual homes. So each panel grouping becomes linked together, and then they all become linked together through the geotextile mesh."

Now it's time to place the growing medium. "We needed thick layers of media," says Pitts. "It's very common to have drainage trays and things of that nature to help reduce the depth of green roofs, but we wanted it to be thicker, because we are using the weight of it to hold down the solar. We had a green-roof-media company (Mulch Solutions of Falls Church, Va.) come and blow the media up onto the roof with its blower truck." There were two types of media: a larger, heavier drainage medium as a base layer, then a layer of growing

Green-roof mineral growing media is blown onto the roof, covering the geotextile mesh and plastic rack bases to a depth sufficient to ballast the racks against any wind pressure **(5)**. Small seedlings are then planted into the growing media **(6)**. After a single growing season, the plants have spread **(7, 8)** and will soon cover most of the rooftop area.

medium on top of that, separated by a layer of fabric. The entire placement with the blower truck took less than a day. Besides the efficiency, says Pitts, another advantage to the blower truck is that it avoids creating point loads on the roof during the application of the growing medium.

"And then the plants arrived," says Pitts. "There are two different types of green-roof plants: There are ones that grow in sun, and there are ones that grow in shade. So we had to demarcate the locations behind and beneath the panels and allocate the shade plants to those locations; and the sun plants went everywhere else. And then we got all the PV equipment, and the PV panels came up last."

The roof has been in place for more than a year now, says Pitts, and the plants are spreading nicely over the growing surface. "Green roofs require a lot of care and feeding in their first couple of years to get them to establishment," says Miller. "We're hoping that this year the growth is really explosive." Pitts adds, "We want it to get to the established point, and I think in this next year we should be reaching that, pretty close."

Ted Cushman is a senior editor at JLC.