

## Monitoring Green Roof Performance with Weather Stations

In the world of environmentally sensitive and sustainable building, green roofs are becoming more popular in new commercial building and renovation projects. The investment in covering a roof with soil and plants can pay off through mitigating stormwater runoff, lessening the heat island effect and offsetting interior heating and cooling costs.

*Whether the goal is LEED certification, measurement and verification of performance, pre-design data collection, research or all of the above, data logging weather stations can help construction executives make wise, money- and resource-saving decisions about design, materials and maintenance of green roofs.*

In order to verify that a green roof is indeed providing the benefits to justify the investment, it's important to monitor performance. For building projects participating in the Leadership in Energy and Environmental Design (LEED) Green Building Rating System, documentation of green roof performance is a requirement. Data logging weather stations are the ideal tools for the job.

A weather station can measure parameters such as rainfall, stormwater runoff, temperature, relative humidity, and many others 24 hours a day, 7 days a week. The information a weather station collects can help constructive executives make wise choices about designing, tuning and maintaining a green roof.

### **What is a Green Roof?**

A green roof is a roof covered with layers of synthetic and natural drainage layers, soil and growing plants. The roof's base structural support is typically covered with insulation, waterproofing, drainage space, a filter membrane, a root barrier and finally, soil and plants.

Most large green roof projects are installed on flat roofs.

Green roofs are broken into two categories by soil depth and plant type. Extensive green roofs are covered in soil 1-6 inches deep, and are planted with shallow-rooted, ground-hugging plants such as succulents or grasses. Such roofs may or may not be designed for pedestrian traffic.

Intensive roofs have a deeper soil layer, and can support large plants, shrubs, and even trees. Intensive roofs are often part of rooftop terraces or pleasure parks, and can require irrigation and dedicated landscape maintenance.

Green roofs can provide a number of benefits for commercial buildings. For example, they help in stormwater management by withholding water from drainage systems, thus lessening the burden on infrastructure and runoff treatment. They can also help moderate building interior heating and cooling costs. The roofs provide insulation from both sun and wind, and can make an impact on temperatures, especially for single-story buildings.

### **Green Roof Monitoring Application: Data Logging Weather Stations**



Data logging weather stations are ideally suited for monitoring a green roof's performance and operating conditions. These systems typically support sensors that monitor such parameters as temperature, wind speed, wind direction, rainfall soil moisture and others.

The weather station and its sensors are typically mounted on a metal tripod, and run on battery and/or solar power. All components are designed to withstand long-term outdoor weather conditions.

Data logging weather stations eliminate human error from data monitoring, and can be counted on to collect unattended readings 24/7, 365 days a year and store it into logger memory. Operators download data remotely or manually, and use data logging software to configure, deploy, retrieve and analyze information from the station.

Essentially, two types of data logging weather stations exist: standalone weather stations and weather stations with integrated remote communications.

Standalone systems require the user to visit the station to download data, adjust configurations and/or launch new sensors. Remote weather stations allow users to access collected data and perform system management and control functions over the Internet without having physically go to the site. These systems may feature similar sensors, hardware, and power options as their standalone counterparts, but provide the advantage of integrated remote communications technologies. *(See photo of a typical data logging station on a green roof in Seattle Washington, above, courtesy Magnusson Klemencic Associates.)*

## Working with the Data

Once data has been collected on a green roof, it typically needs to be plotted and analyzed. Most weather stations are equipped with accompanying graphing and analysis software that allows the user to set configuration parameters, designate launch times and offload data. The most sophisticated packages allow the user to combine graphs to compare data between systems, and quickly and easily export data with the click of a mouse.

Below are some approaches for using data logging weather stations to get the most out of green roof performance and investment. Some of these applications can help satisfy requirements for LEED certification credits. *(Caption for image at right: weather stations with plug-and-play architecture enable sensors to be easily plugged in without extensive user programming, wiring or calibration. Courtesy of [Onset Computer Corporation](#).)*



## Design

During the preliminary design process, it's prudent to collect environmental data in order to choose the best green roof design suited to the site. Rainfall, temperature, wind speed, wind direction and solar radiation all change seasonally, and can be affected by surrounding buildings and structures. It's best to measure some of these parameters at multiple points in the site. For retrofits, data collected before renovation can be a valuable measure of the new green roof's performance. The more data that is collected before making design decisions, the better.

## Stormwater Management

In order to verify that a green roof is helping to reduce the amount of stormwater released from a roof from a given rainfall event, it is important to know how much rain has fallen and how much has left the roof via downspouts and drains. In a green roof system, the roof runoff is equivalent to the total rainfall volume minus evapotranspiration and soil retention.

One technique for measuring runoff involves deploying a flow sensor at each downspout and/or drain. Evapotranspiration can be calculated from solar radiation, air temperature, relative humidity and wind velocity at the site. The remaining portion of rainfall volume is retained in the soil, and can be measured/monitored with soil moisture sensors in order to observe where and when the soil is holding water, and for how long.

## **Offset of Interior Heating and Cooling Costs**

A green roof acts as insulation from the sun and wind, and can affect a building's interior heating and cooling requirements. In the case of a renovation, it is possible to compare the before-and-after effects by deploying a weather station on the roof and indoor temperature loggers in the building's top floor for a period of time before construction. Rooftop measurements should include temperature, solar radiation, and wind speed.

Whether the goal is LEED certification, measurement and verification of performance, pre-design data collection, research or all of the above, data logging weather stations can help construction executives make wise, money- and resource-saving decisions about design, materials and maintenance of green roofs.

*Jessie Gunnard is a freelance science and technology writer based in Massachusetts. She writes about people, their work and their tools for organizations, businesses and publications nationwide. Trained as an environmental scientist, she's an "explainer," and gets excited about translating scientific and technical jargon for general audiences.*