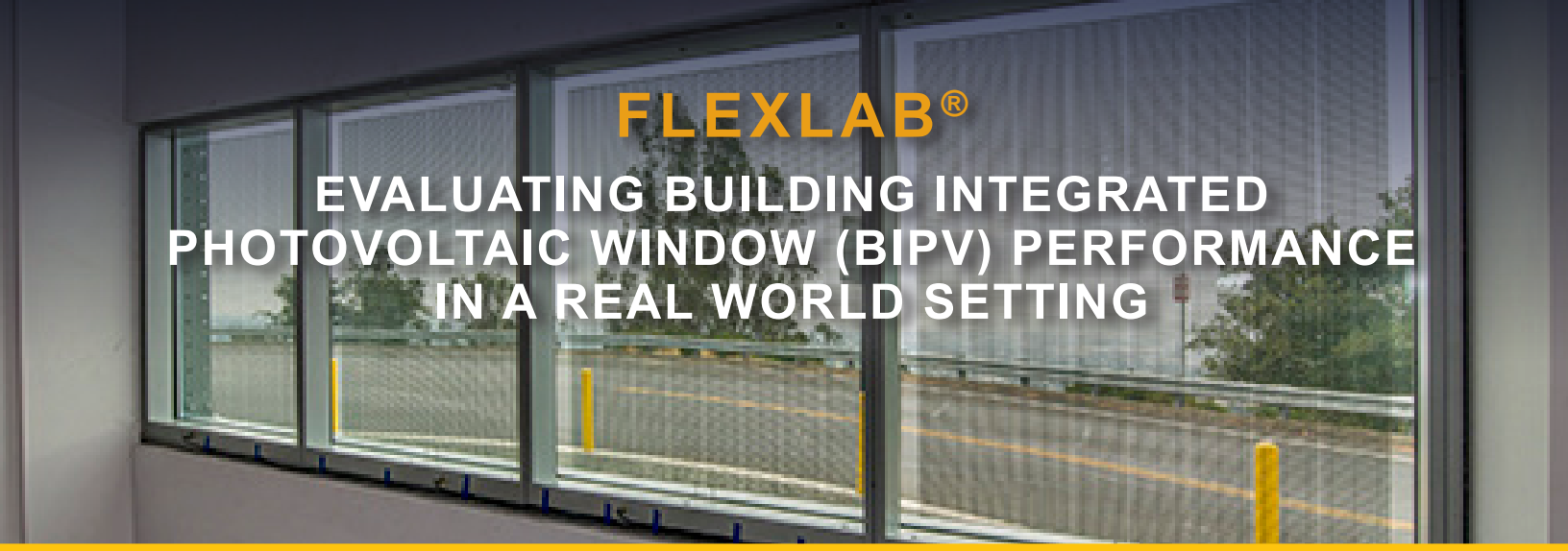

FLEXLAB®

EVALUATING BUILDING INTEGRATED PHOTOVOLTAIC WINDOW (BIPV) PERFORMANCE IN A REAL WORLD SETTING

New building integrated photovoltaic windows produce solar energy while reducing building energy consumption

THE CHALLENGE

Inform building owners of the advantages of a new window technology

The Department of Energy estimates that roughly 25% of the energy used to heat and cool U.S. buildings is lost through inefficient windows. In recent years, however, multi-lite glazing incorporating low-emissivity (low-e) coatings and inert gas fills, such as Argon, have reduced building energy consumption by increasing thermal resistance, reducing solar heat gain and increasing daylight utilization through lighting controls. However, a newer technology – building integrated photovoltaic windows (BIPV windows) – ups the ante by not only achieving those goals, but also by producing electric energy from solar radiation.

The key to a successful BIPV technology is to reduce solar heat gain and glare while achieving the best possible energy conversion efficiency – all while maintaining vision through the glazing. Solaria Corporation's semitransparent PV modules appeared to meet those needs, but to persuade designers and owners of the highrises that could benefit most to make that significant investment, they need to be assured of its claimed performance and economic viability.

THE SOLUTION

To evaluate the performance of Solaria's semitransparent PV modules and to identify their energy saving potential in comparison to code-level low-e windows, Solaria teamed with the U.S. Department of Energy's FLEXLAB® facility to conduct tests, with funding from DOE and the General Services Administration (GSA). The facility offered Solaria the unique ability to compare the two technologies at the same time and location, under the same conditions – as well as to change building orientation while keeping the windows and the monitoring equipment in place, to observe differences in the sun's angle on performance. FLEXLAB also enabled Solaria to evaluate shading options.

The tests measured energy consumption-related parameters such as heating, ventilation and air conditioning (HVAC) energy use, as well as BIPV window power generation.

> **Solaria's glazing-integrated PV product, exhibited a combination of improved solar control and electric power generation resulting in HVAC savings and net reduction in electricity use during the measurement period.**

Charlie Curcija, Berkeley Lab, Research Scientist

SOLARIA®

THE EXPERIMENT

- Testing took place September 30 to December 7, 2015.
- The XR testbed in FLEXLAB® allowed the windows to rotate from a southeastern to a northern facing direction, to test energy performance in different orientations.
- The test was conducted under southeast, south and southwest orientations; different HVAC set point temperatures; and different interior venetian blind shade positions.
- Both the BIPV insulated glass unit (IGU) and the reference IGU used an identical framing system, layout, and dimensions.
- The BIPV system's converter used dual maximum power point tracking, which handles two modules simultaneously.
- An energy communication unit collected module performance data, transferred it to a database in real time, and allowed for precise analysis of the performance of the microinverter and each BIPV array.

THE RESULTS

- Solaria's BIPV window has a relatively high energy conversion efficiency due to its high efficiency crystalline silicon (c-Si) solar cells. Its total conversion efficiency was close to 6%.
- Vertical glazing BIPV has relatively flat energy generation profile throughout the year, as opposed to roof- mounted PV collectors, which show much higher power generation in the Summer as opposed to Winter.
- South and southwest orientations are more favorable for increasing power generation.
- Compared to the reference IGU test cell, the BIPV IGU test cell had lower overall energy use. On average, the BIPV IGU showed a 15.9% total net energy saving potential (including power generation) during the test period.
- Discomfort glare is lower with the BIPV window compared to the reference window.
- The Solaria BIPV IGU has agreeable visual appearance, from indoors and outdoors.

THE BOTTOM LINE

Demonstrating a 15.9% energy savings

Solaria's comparison test at FLEXLAB demonstrated that the company's BIPV product can provide a 15.9% energy savings over a reference-insulated glass unit.

The ability to test both windows at different orientations to the sun revealed the best orientations for producing the most electricity. The tests also revealed opportunities for improvement: that using higher efficiency c-Si cells would further increase the energy yield, and that discomfort glare could be improved by using a lower transmittance glazing and/or suitable shading system.

The tests also identified future research opportunities on junction box and coating placement, exterior shading, daylighting performance and visual comfort, to further optimize the window and minimize impacts of shading from window mullions.

flexlab.lbl.gov
flexlab.lbl.gov/publications/measurement-verification-performance

BERKELEY LAB
ENERGY TECHNOLOGIES AREA