NREL NATIONAL RENEWABLE ENERGY LABORATORY

INNOVATION IMPACT | Solar Manufacturing

NREL Invention Speeds Solar Cell Quality Testing for Industry

A solid-state optical system, invented by the National Renewable Energy Laboratory (NREL), measures solar cell quantum efficiency (QE) in less than a second, enabling a suite of new capabilities for solar cell manufacturers. The system was developed with funding in part by the Office of Energy Efficiency and Renewable Energy within the U.S. Department of Energy.

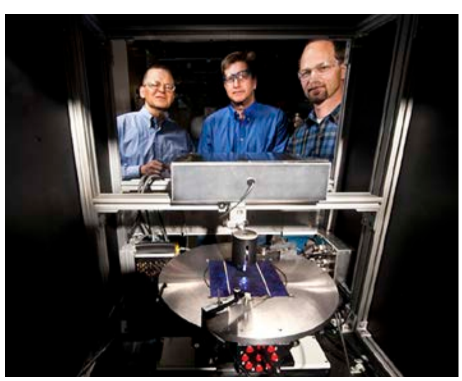
QE is a measurement of how cells respond to light across the solar spectrum, but traditional methods for measuring QE had been too slow, limiting its application to small samples pulled from the production line and analyzed in laboratories. NREL's technique, commercialized by Tau Science as the FlashQE™ system, uses a solid-state light source, synchronized electronics, and advanced mathematical analysis to parallel-process QE data in a tiny fraction of the time required by the current method, allowing its use on every solar cell passing through a production line.

The FlashQE system uses an array of light-emitting diodes (LEDs), each emitting a different wavelength of light. The LEDs illuminate the cell simultaneously, rather than the serial approach of the conventional system. The key to the technology is that all the LEDs are flashed on and off at different frequencies, thereby encoding their particular response in the solar cell. High-speed electronics and advanced mathematics cleverly extract the encoded information to reveal a full-spectrum QE graph of the cell. A wide variety of information is gathered in less than a second—information about the ability of the front surface of the cell to absorb high-frequency light, the quality of the thin-film surface coatings, the ability of the middle region of a cell to absorb a wide range of wavelengths, how well the back surface absorbs lower-energy light, and the ability of the back surface to collect electrons.

Some of this is new information for manufacturers. Solar cell manufacturing lines test each cell to determine useful cell parameters, such as how much current and voltage is generated. But conventional tests give no information about how the cell responds to each color of light in the solar spectrum.

Flash QE's ability to also test for each cell's response to color allows crucial extra information to be fed back into the production line. It does it so fast that cells of the same current and the same response to particular colors can be sorted into bins. From these sorted bins, spectrally matched modules can be made to optimize the energy produced throughout a day.

NREL's ingenious approach, in which parallel processing allows all of the QE data points to be measured simultaneously to produce a QE graph in 1 second, is more than 1,000 times faster than the industry's current state-of-the-art technique.



NREL scientists Pauls Stradins, Brian Egaas, and David Young take a look inside their instrument, the Real-Time QE, which quickly measures how a solar cell responds to different wavelengths of light.

Photo by Dennis Schroeder, NREL 18964

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Quick Facts

Real-time quantum efficiency (QE) measurements—licensed and commercialized by Tau Science Corp. of Beaverton, Oregon, as FlashQE™—use light-emitting diodes, high-speed electronics, and mathematical algorithms to measure the QE of solar cells up to 1,000 times faster than had been done before.

The FlashQE system is not just an incremental improvement over current QE measurement options. Its impressive increase in measurement speed is enabling numerous new capabilities for industry and laboratory researchers.

The shape of a QE curve helps scientists and manufacturers understand various characteristics of a solar cell—from how well it generates electricity from certain wavelengths of light, to which part of the cell needs improvement.

Flash QE is the quickest diagnostic tool for the quantum efficiency of solar cells, yielding a voltage/current curve, which shows the amount of power generated, while also diagnosing how the cells respond to different wavelengths of light.

Tau Science has made improvements to the instrument, patenting their own ideas for LED optics and handling the vast amount of parallel-processed data needed for the technique.

Tau Science's first shipment of a Flash QE system was in early 2011 to Oregon State University, which will use it in its pilot solar-cell production facility.

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NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

NREL/FS-6A42-59016 • August 2013