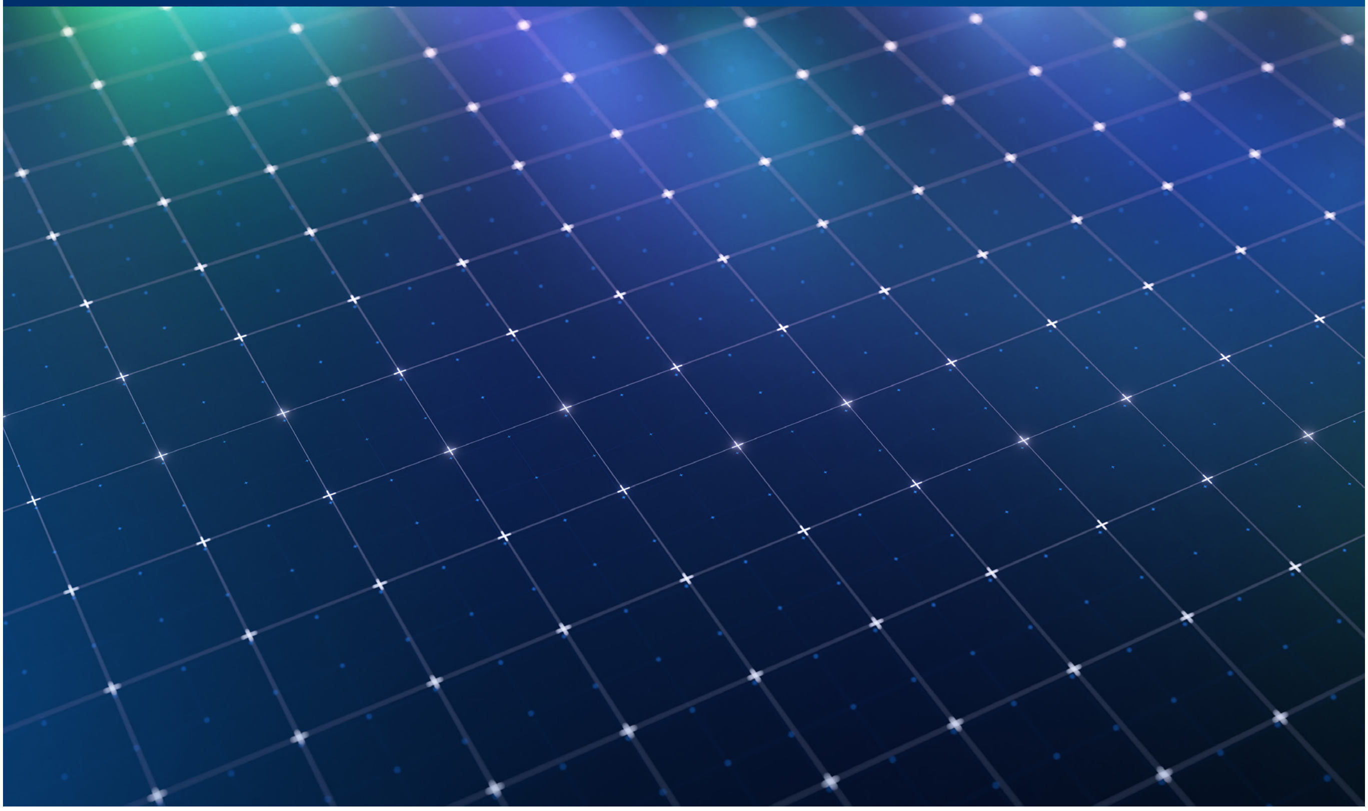
National Physical Laboratory

Lighting the way forward: Lightricity's LightBox makes indoor solar measurement possible

Lightricity's innovation is a highly efficient 'indoor solar panel', which can permanently power a wide range of Internet of Things (IoT) and other low-power devices. The stamp-sized device eliminates the need for batteries, which require regular changing and come with a large environmental footprint on disposal. Unsurprisingly, this has attracted interest from large facilities such as warehouses and manufacturing facilities with large suites of connected sensors, often in hard-to-reach areas.

As Lightricity advanced its product, it needed a way to reliably measure how effectively it converts different types of light into energy. "Doing this is vital for our Research and Development (R&D), and for our customers' IoT product development" says Matthias Kauer, Managing Director of Lightricity. "It lets us test different design improvements and setups to reach the most optimal product. But it is also critical for gathering performance data so that our customers know what they are getting and can see for themselves that our product outperforms the alternatives."



Challenge

Unlike outdoor solar cells, which have well-established standards and off-the-shelf solar simulators, there was no universally accepted standard or measurement technique for indoor lighting.

So Lightricity developed its own indoor light simulator, which it calls the 'LightBox'. This self-contained 'box' hosts a panel of LEDs at the top, which can create the full range of indoor lighting intensities in a highly controlled way. The product under test is placed in the box beneath the LEDs – like a sunbather on a sunbed –and an array of sensors measure how it responds under different lighting conditions, with the measurement data then analysed by software on a connected computer.

However, measuring and analysing light responses is complicated, since indoor light conditions and sources vary enormously, from a few lux (a very dimly lit room) to several thousand lux (a brightly lit workshop), and solar materials perform differently under different light levels. Lightricity needed to measure how light was converted to energy at indoor light levels. It needed to show how performance would be affected in a room where lighting levels regularly changed. All of that creates a lot of measurement uncertainties, many of which were beyond Lightricity's capabilities.

"We quickly realised that we needed to ensure all measurement uncertainties had been properly considered and accounted for, and that measurements could be compared to an independent standard" says Kauer, "so no one could think that we designed it to favour our own product". This led them to approach NPL through A4I.

Solution

Over three A4I projects, NPL helped Lightricity to understand the sources of measurement uncertainty in the Lightbox and provided recommendations for enhancements.

"Indoor light harvesting really is a whole new area, albeit one that is growing rapidly," says James Blakesley, Principal Scientist at NPL who led the A4I project. "So we didn't have a template to work from and didn't know what the sources of uncertainty were going to be. We had to bring all of our team's expertise to really get our heads around what needed improving and how to do it".

Amongst the key improvements that finally arose from the project were adjustments to the uniformity of the LED light source, and the angular light distribution, i.e. how the light spread throughout the lightbox. These changes created a more consistent and precise light source, which significantly improved the accuracy and repeatability of measurements. The project also improved accuracy by comparing performance against calibrated reference devices, which are matched to the light harvesting materials under test. This minimises angular and spectral errors over the typical approach of using photometers which "see" a different spectrum and angular distribution of light to the devices under test.

Impact

Although the Lightbox was initially designed to support Lightricity's R&D, it has become a popular product in its own right, especially with university researchers and commercial labs who need to assess a growing number of indoor solar products. "These are people who care very deeply about measurement accuracy, so our product – which has been thoroughly assessed by NPL – is very appealing," says Kauer. "I'd say that since the project we've seen a more than doubling of sales of the Lightbox, and most of that can be attributed to the A4I improvements."

For its own indoor solar products, the Lightbox serves Lightricity with highly accurate performance data for its light harvesting panels in a range of indoor lighting conditions, supporting research, and allowing it to prove long-stated claims that its technologies are up to six times more efficient than other light harvesting technologies. “What’s more, having an NPL seal of approval gives our customers confidence that the measurements behind these claims are valid”, says Kauer. “That has already led to an increase in the number of customer projects that use our core indoor solar products.”

“The A4I project hugely improved this valuable piece of test equipment, and most of it would not have been possible without NPL. We just don’t have the expertise or measurement setups to investigate uncertainties at this level” he adds.

Moreover, the advancements in indoor PV characterisation developed through this project have directly contributed to a new international standard for indoor PV measurement, which NPL was involved in developing. “This will really boost the nascent indoor light harvesting industry” says James Blakesley. “There are a wide range of exciting new ‘indoor solar’ technologies that are just now emerging. Each uses different materials with different properties – perovskites, organic printed cells and so on – so having a consistent way to compare them will spur innovation and support sales by providing clear comparable product data.”

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