Developing 'indoor solar' to power the Internet of Things

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From Wi-Fi-connected home security systems to smart toilets, the so-called Internet of Things brings personalization and convenience to devices that help run homes. But with that comes tangled electrical cords or batteries that need to be replaced. Now, researchers reporting in *ACS Applied Energy Materials* have brought solar panel technology indoors to power smart devices. They show which photovoltaic (PV) systems work best under cool white LEDs, a common type of indoor lighting.

Indoor lighting differs from sunlight. Light bulbs are dimmer than the sun. Sunlight includes ultraviolet, infrared and visible light, whereas indoor lights typically shine light from a narrower region of the spectrum. Scientists have found ways to harness power from sunlight, using PV solar panels, but those panels are not optimized for converting indoor light into electrical energy.

Some next-generation PV materials, including perovskite minerals and organic films, have been tested with indoor light, but it's not clear which are the most efficient at converting non-natural light into electricity; many of the studies use various types of indoor lights to test PVs made from different materials. So, Uli Würfel and coworkers compared a range of different PV technologies under the same type of indoor lighting.

The researchers obtained eight types of PV devices, ranging from traditional amorphous silicon to thin-film technologies such as dye-sensitized solar cells. They measured each material's ability to convert light into electricity, first under simulated sunlight and then under a cool white LED light.

- Gallium indium phosphide PV cells showed the greatest efficiency under indoor light, converting nearly 40% of the light energy into electricity.
- As the researchers had expected, the gallium-containing material's performance under sunlight was modest relative to the other materials tested due to its large band gap.

- A material called crystalline silicon demonstrated the best efficiency under sunlight but was average under indoor light.

Gallium indium phosphide has not been used in commercially available PV cells yet, but this study points to its potential beyond solar power, the researchers say. However, they add that the gallium-containing materials are expensive and may not serve as a viable mass product to power smart home systems.

In contrast, perovskite mineral and organic film PV cells are less expensive and do not have stability issues under indoor lighting conditions. Additionally, in the study, the researchers identified that part of the indoor light energy produced heat instead of electricity—information that will help optimize future PVs to power indoor devices.

More information: David Müller et al, Indoor Photovoltaics for the Internet-of-Things—A Comparison of State-of-the-Art Devices from Different Photovoltaic Technologies, *ACS Applied Energy Materials* (2023). DOI: 10.1021/acsaem.3c01274

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