Understanding real life indoor lighting: towards a realistic spectrum simulator

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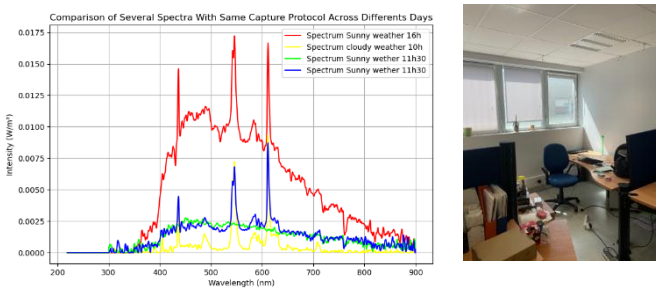
The emergence of indoor PV applications has opened a new field in device characterization and metrology. Whereas solar based applications have been framed by successive IEC standards, the artificial light-based characterization has been a wild field until July 2023 when IEC published a note (IEC TS 62607) proposing a unified standard of light source and measurement methodology. Nevertheless, the practicality of the standard is still discussed as the reality of the deployment of indoor PV is much more varied than for solar PV. Not only there is a wide range of light sources, but also the relative position of the device from the light source can vary a lot, both in distance and angle than the standard normal incidence. Therefore, the need to develop alternative tools besides the standard for testing the reliability of devices on real-life situations.

This work aims to propose the basis for the development of a protocol to assess indoor photovoltaic devices performances in a variety of real-like conditions. Two complementary axes are developed: (1) the constitution of a representative library of indoor light spectra under various types of sources and using conditions. (2) Development of a modular artificial light source able to replicate these spectrums in a lab environment. This combined approach is designed to ensure a robust and coherent reference for comparable measures between materials, technical architecture and deployment scenarios.

A series of spectral measurements was conducted with a calibrated spectrometer on commonly used indoor emission sources in representative conditions of real-life usage. Parameters such as source-sensor distance, orientation, surrounding surfaces colors and influence of natural light were systematically taken into account.

Simultaneously, a modular lightning system is developed. It combines a set of monochromatic and broad-spectrum LED, controlled by an internally developed spectral matching algorithm. This approach aims to dynamically optimize the relative output of each LED to minimize the spectral deviation between the target profile and the emitted spectrum. A feedback loop based on real-time measures provides accurate and finely tuned adjustment. This configuration will allow to recreate in a repeatable way indoor illumination condition, simplifying the testing of devices in a wide range of realistic conditions.



Measured spectra(left) at an office (Right) on different natural light conditions. Arrow indicates the position where spectra were collected.