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ADVANCED MODELLING OF ENVIRONMENT INTEGRATED PV SYSTEMS: FROM LOCATION TO LOAD

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Environment Integrated Photovoltaic (EIPV) systems are increasingly used for decentralized electricity generation. The concept of EIPV systems includes not only classical building-added PV (BAPV) and modern building integrated PV (BIPV) systems, but also those PV systems that are incorporated both aesthetically and functionally in the built or natural environment. To obtain the maximum energy yield from such systems, the optimal combination of all components is essential. In this contribution, we present a comprehensive software platform to remotely model arbitrary EIPV systems.

Our software platform allows the design of EIPV systems to be installed in any location. It considers the whole chain from the PV panels to the power electronics (from DC to AC side) to the load(s) [1]. We base our modelling efforts on a series of sub-models interconnected with each other. The only inputs needed are the specifications of the chosen PV module, the GPS coordinates of the installation site, its horizon, its geometry and its meteorological conditions (see Figure 1).

Time-resolved irradiance can be computed by integrating the product of sensitivity map from ray-tracing with the sky map, which is time-, location- and meteo-dependent [2]. This novel method is even accurate for curved surfaces. The effect of shadows can be included through horizon catching (horicatching), which is accomplished on-site with a fisheye camera and overlaying on the resulting image the yearly path of the sun at that location. In our remote approach, we use virtual horicatching based on a LiDAR height map of the surroundings. The albedo component, which plays a crucial role in modern cities with tall glass-covered buildings and/or in case of bi-facial PV modules, is also considered. Once the time-resolved irradiance distribution on the PV surface is known, the subsequent design of the EIPV system starts by estimating the temperature of the chosen PV module. The powerful fluid-dynamic model devised by Fuentes [3] turned out to be most accurate. Given a certain PV module, the hourly evolution of irradiance and module temperature finally allow to compute the hourly V_{OC} or V_{MPP} of the PV module/array. Based on this, the most suitable inverter(s) can be chosen, not only based on the installed peak power but also on the input voltage of the string(s). Finally, the power output at the AC-side is obtained. We validated the annual energy yield predicted by our software platform and the deviation from the experimentally obtained yield was less than 1%.

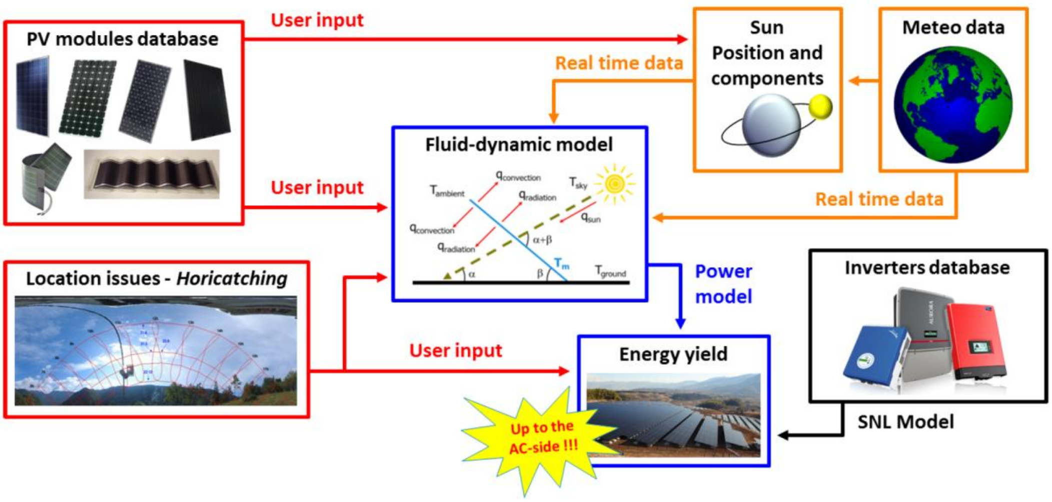

Figure 1: Schematic of our modelling platform. From the estimation of the PV module irradiance and temperature, the choice of the inverter, the time-dependent power model predicts the instantaneous power produced by the EIPV system at the AC side.

[1] O. Isabella, *Comprehensive modelling and sizing of PV systems*, MRS proceedings **1771** (2015), 17-23.
[2] R. Santbergen, *Calculation of irradiance distribution on PV modules,* Solar Energy **150** (2017), 49-54.
[3] M.K. Fuentes, *A simplified thermal model for flat-plate PV arrays,* Sandia National Laboratories (1987).