Building Integrated Photovoltaic (PV) Systems – Energy production modelling in urban environment

Laboratory

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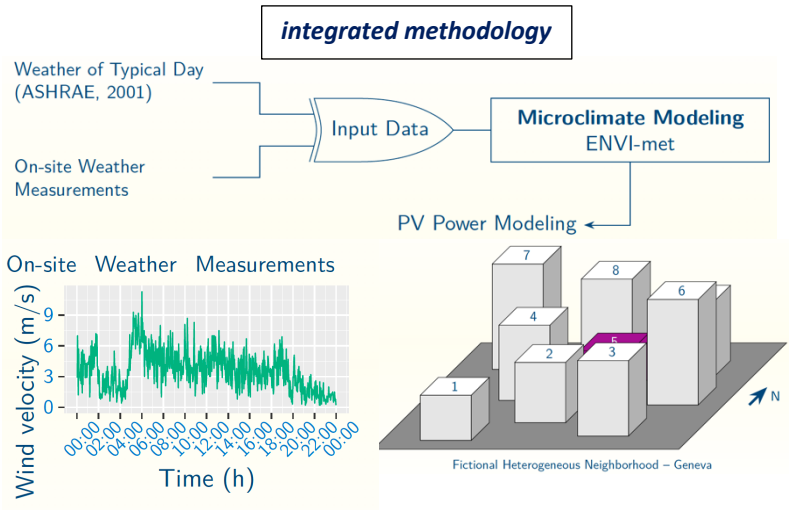
Key words : heat transfer, fluid mechanics, PV production, modeling, data processing

Context and objectives

The purpose of the PHD-thesis relies on the potential of photovoltaic (PV) energy production assessment of the buildings' facades in urban areas. The existing production models usually consider the buildings in isolation and take into consideration the close environment as masks.
However, several specific physical phenomena occur in urban areas. Some are due to natural weather conditions, such as the days/seasons cycle (time variability of the solar resource) or the cloud movement (intermittency of the solar radiation). Others are due to the built environment, such as the spatial heterogeneity due to the surrounding buildings, the interbuilding reflections or the wind channeling due to the narrow space between buildings in urban areas.
Considering an integrated methodology taking into consideration multi-physics (including solar radiation and airflow modeling) and multi-scales (evaluation of the spatial heterogeneity) features appears then as a crucial issue for the evaluation of the solar potential of buildings.



Using the methodology already developed at the laboratory, the work will focus on wind behavior close to buildings facades and PV panels. In particular, parts of convective / radiative fluxes will be assessed according to material properties (thermal, radiative, roughness) of the walls and typology of districts. Taking them as boundary conditions, PV power generation model will be tested.

The main tools are the software ENVI-met, an urban microclimate simulation software that includes an airflow model as well as a radiative model able to account for the inter-building reflections. Case studies will be based on fictional districts and on database of cities (Lyon, Geneva, Trondheim).

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