Université Claude Bernard Lyon 1

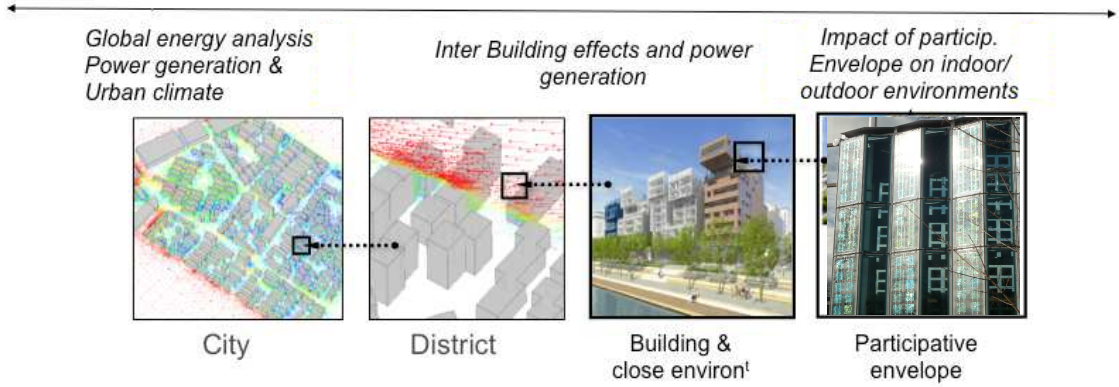
CETHIL

BUILDING INTEGRATED PHOTOVOLTAIC SYSTEMS – ENERGY PRODUCTION MODELLING IN URBAN ENVIRONMENT

KEY WORDS:
Heterogeneous and transient energy production, Photovoltaic or Hybrid Photovoltaïc-Thermal (PV/T) solar collectors, multifunctional building envelopes; urban environment, CFD modeling; multi-domain and multi-physics modeling; building physics

The whole energy management study at urban scale should afford in-site production, grid injection and energy storage. The reduction of variability and intermittency of the production could be provided by a multiplication and an aggregation of energy sources that at the large city scale can be more or less far away from the energy demand. In this context, PV integration on building envelopes (BIPV encompassing roof, façades) represents a mean to introduce local electricity production from solar resource at the scales of building, district and overall city. This branch of solution has a great potential according to large global surfaces implied and is an aesthetic concept that is prized by architects and useful for building energy engineering (stakeholders) as well as town planners.

Specifically on the BIPV sector, non-optimal orientation of the facades as well as inter building effects (IBE) dependent of local microclimate conditions (local air flow, shadings, multi-reflexions,) have to be taken into account since rigorous production assessment is targeted. If the close proximity of surroundings buildings is not considered for the prediction of the energy performance of a single building in an urban environment, it has been shown by recent research that the inaccuracies could be important. Discrepancies on the energy consumption predictions may reach 42% in summer, and up to 22% in winter. It is also the case for the prediction of building integrated solar PV systems for which the few existing studies do not take into account the effects induced, in one hand by the urban environment and on the other hand by the integration configurations (BIPV, BAPV, merged within a building envelope components, …).



The objective pursued in this PHD work is to develop an integrated methodology of production assessment using different numerical tools. As the scaling considered increases from the building to the neighborhood, the district, the city, this approach is intrinsically multi-physic and multi-scale. It will combined modelling of housing typology and areas morphology, microclimate simulations (CFD, solar radiation, multiple reflections and transfers) and building energy simulations (BES) including solar technologies. Interactions between buildings but also feedbacks of the buildings on the atmosphere will be taken into account to evaluate energy budget at the different scales. Studies will focus on the characterization of building operating boundary conditions that are strongly heterogeneous and transient and that remains actually poorly known. Cross scale analysis between models at building and district levels will be leading.

TOOLS

Semi-dynamical models (succession of steady states) of hybrid PV components are already implemented. Based on the fundamental physical laws, they have been derived and implemented in building simulation platform. These models will be improved to take into account thermal mass and transient behavior. Studies of buildings embedded in neighborhoods started six month ago through an ADEME project ORCHIDEE dedicated to tropical climates and the international research group (GDRI) between CNRS (France) and NTU (Singapore).

SKILLS AND KNOWLEDGE

Modelling, CFD, Building physics, fluid dynamic, heat transfer, energy balance

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