SUMER - SimUlation du productible solaire en MiliEu uRbain/ *Simulation of Solar Production in Urban Environnement*

KEY WORDS:
Solar Power generation, Building Integrated Photovoltaic (BIPV), Urban Environment, Multi-scale, 3D building/city modeling, Numerical, Experiments

The research project is related to solar power generation potential in the context of energy transition and urban density. This including the potential on building facades that, even if they are non-optimally oriented and inclined surfaces, will also become economically attractive and necessary due to space limitations. The complexity of the urban environment as well as a multiple nature of the BIPV requires to develop an integrated simulation approach in order to quantify their benefit and ensure proper implementation and economic feasibility. An increasing number of cities are now modeled in 3D and recent progress in GPU accelerated process and cloud computing allow strong increase computational power that make possible to achieve acceptable accuracy in an annual daylight simulation method with significantly reduced simulation time and to consider to deal with larger spatial scales as is necessary for solar cadasters.
Starting from an existing tool, Archelios, developed by Cythelia in order to assess city and territory solar cadaster, the present study aims at completing through PV energy production on building rooftops and vertical facades based on a 3D city. In term of 3D building/city modeling accuracy, the standard Level of Detail will consist in modeling buildings as simple blocks with standard roof shapes (LOD2).
The work will highlighted in the framework of a new task of the International Energy Agency (AIE)- Solar Heating and Cooling program (SHC) dedicated to *Solar Neigbourhood Planing*. This task will also allow to compare the adopted approach with others and provide also provide real case studies (cities such as Grand Genève) in order to validate it.

Developped Approach
For such a complex environments that involve shadowing, building and ground inter-effects advanced computation models e.g. ray tracing have to be considered for accurately assessing solar irradiance on PV surface and consequently. PV yield.

Step 1- Geographical modeling of the urban landscape

To make a detailed estimate of the physical, temporal and geographical solar production potential in order to connect with the energy needs of buildings following steps are required: collection and constitution input data; modeling of physical phenomena (radiation taking into account inter-building and ground effects); interfacing and data analysis. This step requires a set of information concerning the relevant characteristics of the surfaces and their environment, that is to say a digital surface model (DEM). This type of data can be obtained using several techniques, such as simple aerial or satellite imagery or other techniques would bring an interesting degree of precision. In a first approach, the digital description will be grounded on the use of BD ORTHO provided by IGN.

Step 2- Shadow Casting and Solar Radiation

This phase will consist in modeling radiation in such a complex environment and especially incident on building façades. First, the Sky View Factor will allow to evaluate the reduction of the sky visibility from a roof or facade point due to obstacles in the surrounding environment. Then investigation and test will be led on several light transport or radiosity models with a good compromise between accuracy and computational time, including graphical approximations such as surface maps to define material textures, surface normal and occlusion. Comparison or couplings with existing tools such as Radiance would be investigated.

Step 3- Modeling of buildings and integrated solar components : prediction of economic potential

This phase will focus on evaluation of BIPV energy potential while considering more realistic operating conditions and time varying energy performance (aging). Moreover depending of the typology of buildings, several new indicators combining a potential for solar production, energy efficiency of buildings and potential for self-consumption would be established.

SKILLS AND KNOWLEDGE

Radiation modeling, Inter Building Effects, 3D GIS, Code Interoperability

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