

Urban climate modeling for street-level connected wind turbines

Supervisor:

[Benjamin Luce \(Assistant professor\)](#)

Location:

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Duration:

6 mois, début en Mars/Avril 2024

Contact:

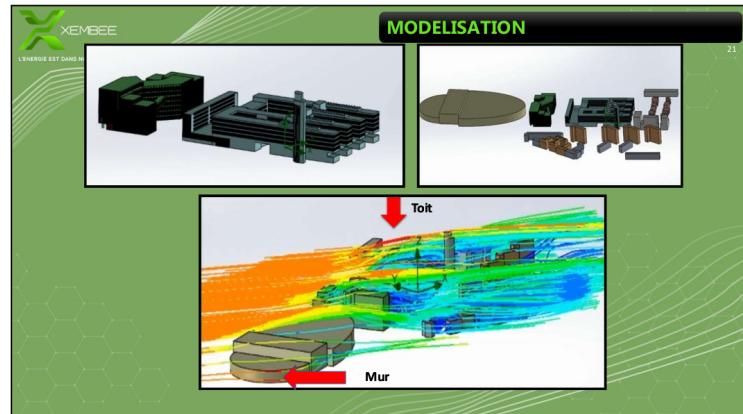
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Skills:

- Master level knowledge in fluid mechanics
- Applied knowledge in a programming language
- Knowledge on atmosphere sciences appreciated but not mandatory

Context:

The energy transition is a complex issue. One of the possible answers is the multiplicity of energy production sources. For historical reasons, France has chosen large-scale production centers, which allow for greater efficiency and a measured control of the productivity. Even renewable energies such as wind turbines and solar panels are based on large-scale facilities, often far from the places where the electricity is used.



Yet this energy, which is often small compared with combustion energy (or, even more impressively, nuclear energy), would benefit from being local. Solar panels are still reserved for a few roofs and, in urban environment, come up against the use of these same roofs for other applications (heat pumps, ventilation, etc.).



Xembee, a young start-up, offers an innovative solution for vertical wind turbines: compact, lightweight and robust, simple to install, design and maintain, they can be set on rooftops or building walls. They can even be discreetly integrated into the urban landscape, with the option of adding atmospheric sensors to transmit real-time data to city services.

This original creation now meets a technological challenge: while solar panels have sunlight maps, the equivalent in urban wind maps has yet to be created! The questions are numerous, both from the point of view of the fundamental research and the industrial application for a quality approach.

Organisation of the work:

Internship:

The student will begin with a bibliographical study of the relevant methods for simulating urban environments according to the company's needs.[1].They will familiarize themselves with the current processing chain, used to produce a wind map of a neighborhood. A method for automating the extraction of an urban map can be proposed[2].

One of the objectives of the internship will be to generate a database on a well-chosen test case. For this purpose, a coupling of CFD code and mesoscale atmospheric code is suggested.[3]. Two possibilities are considered: a WRF-PALM4U coupling[4] or a WRF-OpenFOAM one[5], [6], [7]. The student will then integrate this coupling into the processing chain to quantify the time saving/quality of results ratio, which will serve as the basis for a wider study to generalize the method.

Thesis:

The aim of the thesis is to guarantee a low-cost urban simulation (both in terms of time and computing resources) with an acceptable degree of fidelity.

The candidate will learn on mesoscale to microscale issues[8], [9], then run a series of high-fidelity urban simulations (LES) to compare with averaged (RANS) or hybrid (DES) simulations on OpenFOAM, possibly adding optimization techniques[10][11]. The study will be carried out in representative environments[12], [13] to then validate the wind speed prediction strategy and they will then suggest an estimate of the reliability of the results[14], [15].

Location:

The internship will take place at the LMFL (Laboratoire de Mécanique des Fluides de Lille) on the Cité Scientifique campus in Villeneuve d'Ascq. The LMFL is a CNRS research laboratory with 15 permanent staff and around 30 PhD and post-doctoral students. In close collaboration with ONERA, Arts et Métiers, Centrale Lille and the University of Lille, the LMFL offers recognized skills in a broad spectrum of fluid mechanics. From the theoretical study of turbulence to flight mechanics, rotating machines and atmospheric flows, this research benefits from state-of-the-art experimental facilities (wind tunnels, LASER instrumentation, etc.) and simulation tools of equal scope (high-performance computers, massively parallel numerical codes, etc.).

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