Generation of Spectral Representations of Urban Wind Fields From LES and Experimental Databases for Aeroelastic Simulations of Wind Turbines

zEPHYR Marie Skłodowska-Curie project: towards a more efficient exploitation of on-shore and urban wind energy resources

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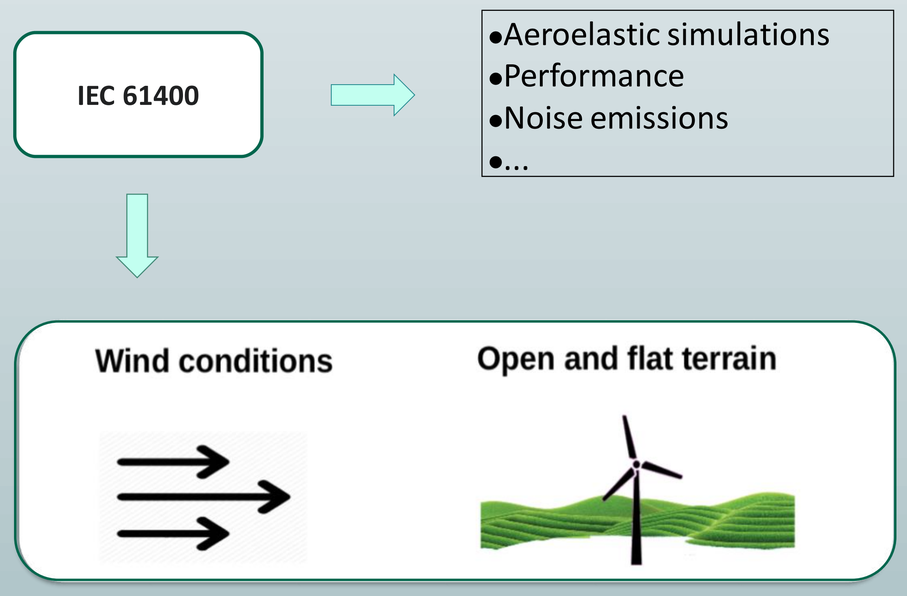
CONTEXT

Wind turbines are designed for safety, durability and performance according to the international standard IEC [1] (International Electrotechnical Commision) 61400-1 series. The system must be simulated for a set of load cases defined in the IEC standards and it is required to simulate the wind velocity fields required by the systematic aeroelastic simulations of wind turbines proposed in the IEC Standards.



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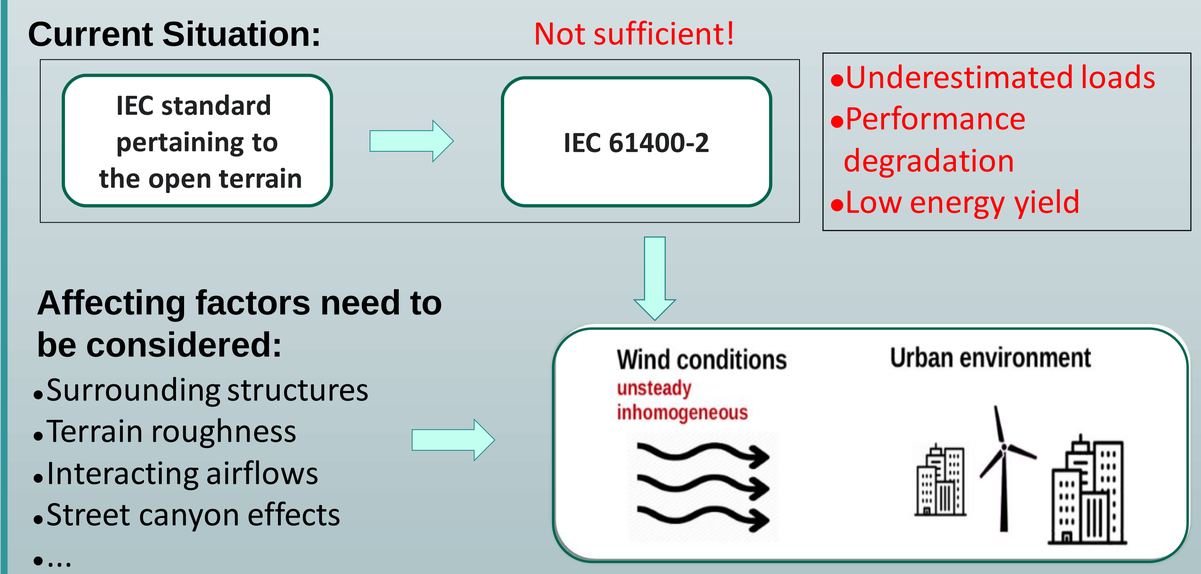
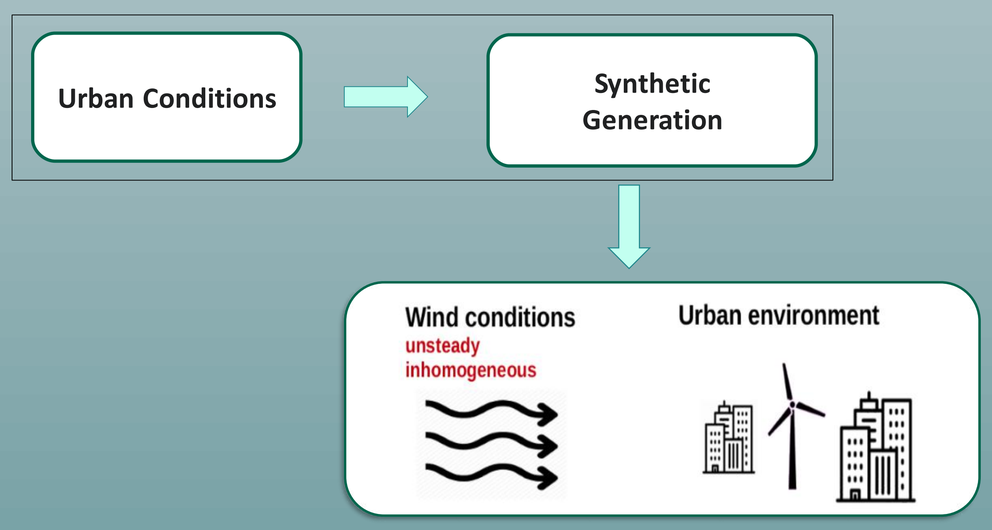
PROBLEM DEFINITION

As the range of installation sites expand from conventional open terrain to include the built environment, the small wind turbine design standard needs to be completed by including urban wind conditions. The current situation is that turbines are being designed as per the IEC standard pertaining to the open terrain but are then installed in the built environment, resulting in issues related to performance and safety. The results are underestimated loads, performance degradation.



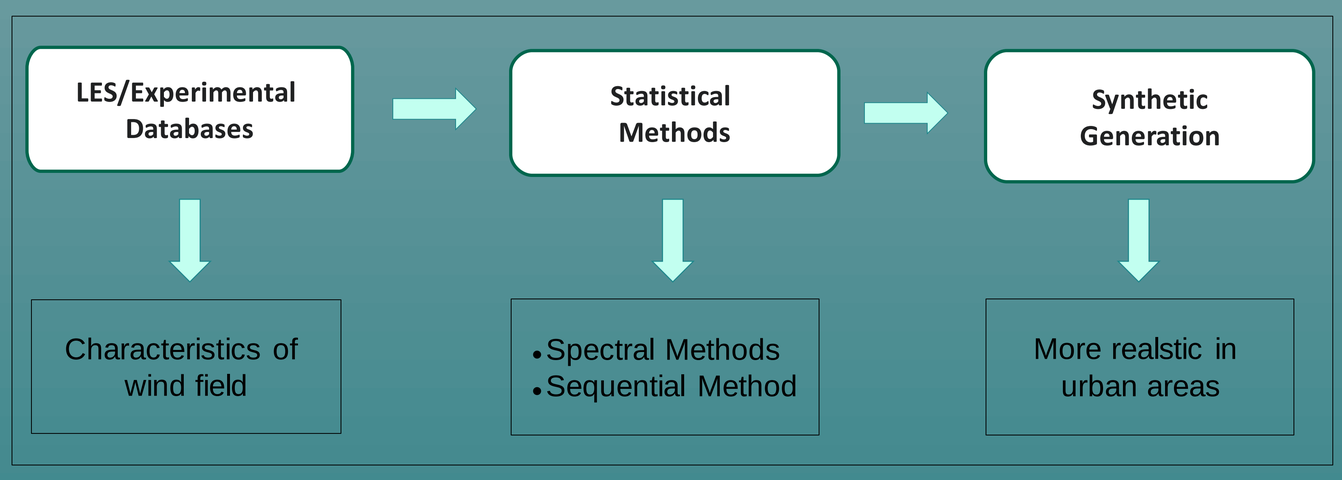
OBJECTIVES

The objective is to build efficient algorithms to generate synthetic wind fields representative of urban conditions. Conditions such as morphology of the urban location, low mean wind speed. Sudden change in wind direction, statistical non-stationarity and non-homogeneity of the wind velocity field, extreme wind speed fluctuations and wind events, change in atmospheric stability, … etc



METHODOLOGY

To build these models for the numerical generation of wind velocity fields that are representative of the urban environment, analyzing experimental database is done to understand the characteristic of wind fields. This database is used to provide statistical information required by numerical generation methods such those based in spectral representations of the wind velocity field such as the one proposed by Mann [2], or those based on time series techniques such the sequential method proposed by Krenk [3].



[1] IEC-61400-1. Part 1: Safety requirements. Wind Turbine Generator Systems IEC 61400-1, Edition 4, International Electrotechnical Commission, 2019.
[2] Mann, J. Wind field simulation. Probabilistic Engineering Mechanics, 1998.
[3] S. Krenk, R. Møller, Turbulent wind field representation and conditional mean-field simulation, Proceedings of the Royal Society A, February 2019.

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