

Wind Flow Modeling of Area Surrounding the Case Western Reserve University Wind Turbine

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Abstract

The Case Western Reserve University Wind Turbine (NorthWind®100kW) is a research turbine located in the heart of a large urban campus in Cleveland, Ohio. Due to the tall surrounding buildings, this location may create turbulence, resulting in a possible loss in energy generation. This research attempts to answer the question of whether the wind flow is affected by the buildings or not. Depending upon the direction of the wind, the surrounding buildings, which vary in height from 20 to 40 meters, may affect the wind patterns at the hub height of the turbine that is 37 meters from ground. In order to investigate this issue, a CFD (Computational Fluid Dynamics) model using COMSOL Multiphysics of the immediate area was generated. The analysis using a CFD model includes prevailing wind directions and analyzes the outcomes of the wind flow around the turbine. The model also takes into account building heights, locations, and dimensions. Reasonable agreement was found when the validity of the model was tested and compared against real wind measurements. These measurements were made by cup anemometers placed at three different locations and heights throughout the field, as well as a LiDAR placed at the center of the field near the turbine. Based on the agreeing results and visual model generated by COMSOL Multiphysics, the turbine is not affected by the buildings in most cases. However, in a very unlikely direction of the wind, the turbine is lightly affected by smoke stacks as seen in Figure 1.

Figures used in the abstract

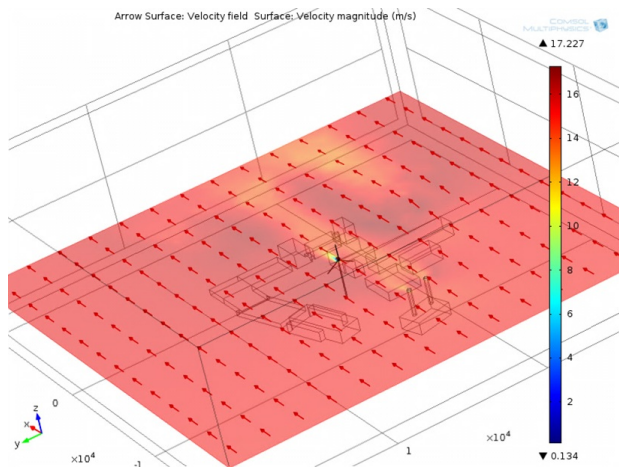


Figure 1: North East Wind affecting Turbine.