An Optimized Analysis of Wind Flows in the Urban Environment and the Identification of Feasible Building Augmented Wind Turbine Sites

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Recent advancements in the development and availability of small-scale wind turbines fit for urban environments necessitate an accurate assessment of wind flows in complex urban settings. Previous research investigating wind patterns and trends in these environments have used simulation site models that do not accurately represent the complexity of building systems, and accordingly do not yield accurately complex wind flows. This research identified and assessed wind flow patterns in large-scale urban environments, and potential locations of turbine feasibility. Meteorological data of Hoboken, NJ, was extracted from the New York City Meteorological Network, a site model of a section of Hoboken was created using Google Earth Pro, and Autodesk Inventor Fusion and wind flow simulations were run using Autodesk Simulation CFD, which provided both visual and quantitative representations of the present wind flows. The concentration effect was identified to perpetuate with equal magnitude in both the small-scale and large-scale systems, with a statistically significant ($p<.05$) difference, and 1.5-2 times increase in wind speed between the source flow and canyon inlet flow. Additionally, the presence of the highest wind speeds located at the rooftop edges most near the source of the wind, perpetuated between both large-scale and small-scale systems. Furthermore, several previously unreported trends were identified, including a significant increase in wind speeds ($p<.05$) just outside of the inlet boundary of urban canyons in relation to the source speeds. This novel simulation provides essential wind characteristic data that will contribute to the information needed to install efficient and effective built-environment wind turbine technologies.