Analysis of Reusable Wind Turbine Blades: Staying Ahead of the Renewable Energy Curve

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Data Science Capstone Project with Town + Gown: NYC

Motivation

By 2030, New York state targets to generate more than 70% of its electricity from renewable sources, thus increasingly siting wind farms across the state. However, this raises a large waste problem from turbine blades that are difficult to recycle. Inspired by the Re-Wind project, which challenges end-of-life management of non-biodegradable blades in a sustainable manner, we aim to develop a plan to support future reuse of decommissioned wind turbine blades and design a geographical model to minimize additional GHG emissions from transporting them.

Figure 1. A bike shelter (left) and park (right) in Denmark and Netherlands respectively, both made from decommissioned turbine blades.

Challenges

To optimize the repurpose of decommissioned turbine blades, we need to solve three main challenges. Firstly, it is essential to establish a GHG radius around wind farms to identify a boundary to transport these blades within. Secondly, we need to look for potential reuse locations within the GHG radius through the relevant geospatial data. Lastly, to estimate GHG emissions, it is necessary to account for turbine blade weights, for which there is little to no data.

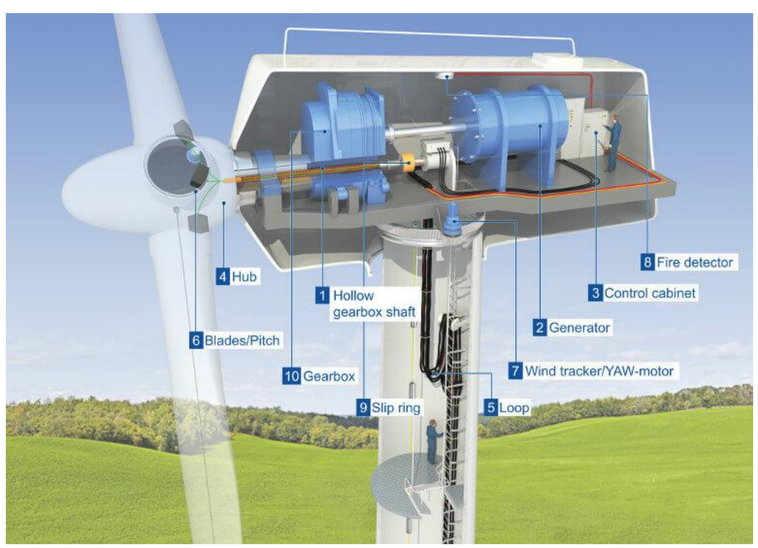

Figure 2. A detailed view of the rotor assembly in a wind turbine. Eggleston et al. establish the mass per blade is approximately one-sixth of the rotor assembly mass.

Modeling and Results

Assuming all landfills in New York state accept turbine blades, we determine GHG radius as the distance of the closest landfill to the wind farm using a greedy, exhaustive search.

Furthermore, leveraging a relevant dataset from TheWindPower Project, we can predict the rotor assembly mass for turbines in New York, which is then used to derive singular blade weight. After experimenting with various regressors, we find XGBoost achieved the best performance with median absolute error of 0.4 tons per turbine blade. (Error per turbine blade was established via error propagation analysis.)

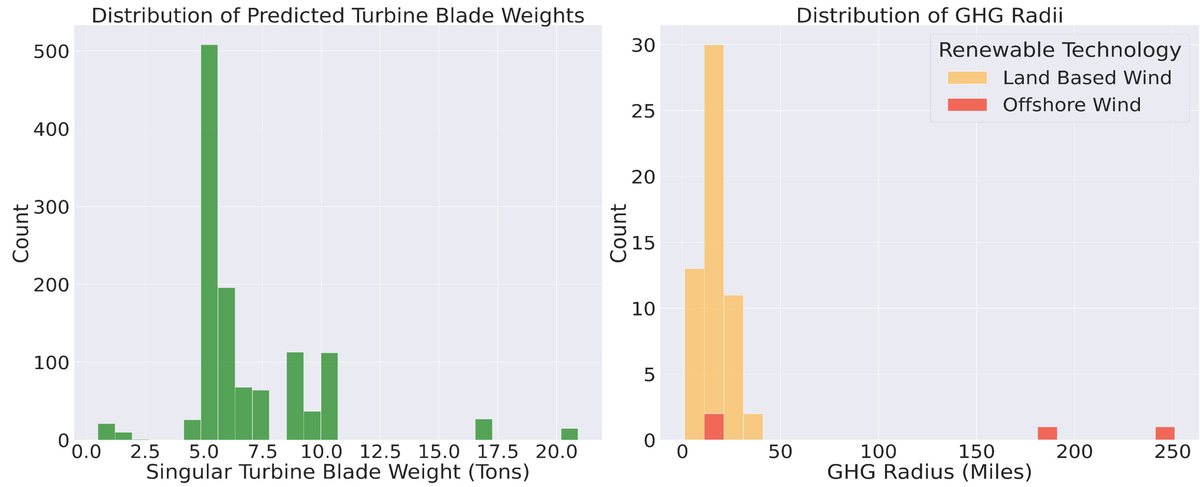

Figure 3. The histogram on the left shows the distribution of derived turbine blade weights in tons; on the right, we display the distribution of GHG radii in miles.

Future Impact

Our interactive map, which includes farm locations, their corresponding GHG radii, and potential repurpose locations (including New York State parks and New York State Thruways), along with the GHG emission estimation calculator can help stakeholders, including Town + Gown NYC, make informed decisions on where to send decommissioned blades.

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