Group 21 - MR-TBD

To increase the share of sustainable energy production, over the next thirty years, the space dedicated to offshore wind energy is expected to rise exponentially. In hopes of lowering energy costs, wind turbines have grown substantially, recently reaching practical size limits. A multi-rotor vertical axis wind turbine (MR-VAWT) is a cost-effective alternative to the traditional horizontal wind turbine that mitigates upscaling disadvantages and can achieve a higher power density.

Mission Objective

The MR-TBD (Multi-Rotor Turbine Block Design) aims to reduce maintenance costs and increase the power density, dropping energy costs by 45% as a result. Its power density should be increased from the standard 5 MW/km^2 to 16 MW/km^2 to improve space efficiency. Compared to conventional wind turbines, the MR-TBD also aims to produce fewer lifetime emissions, utilize recyclable materials, and comprise of systems that could be made by many manufacturers, democratizing the design.

System Design

The 30 MW MR-VAWT system is to be installed in the Ijmuiden Ver wind farm zone. One wind turbine consists of 36 rotors divided into 6 shafts. The rotors are placed in a steel truss structure on top of a monopile foundation.

The rotors are 3-blade H-type vertical rotors, vertically stacked and rotating in different phases. This decreases the size of the systems needed and allows for torque smoothing to occur in the generators. This is a low-torque design that reduces the cost of individual drivetrain assemblies.

The truss structure is 280 m high, 280 m wide, and 25 m deep, housing the rotors, generators, and the wake management system. It allows for easy maintenance and installation, which conventionally are the most expensive procedures during the lifetime of a wind turbine. This is thanks to the ease of access to critical components and available space compared to a traditional wind turbine nacelle.

The wake management system consists of 4 sets of horizontal airfoils that span the structure width and re-energize the wake. This allows for closer packing of wind turbines with lower efficiency losses. During storms, the airfoils retract their High-Lift Devices (HLD) to reduce aerodynamic loads. Due to their large size, the HLDs also act as housing for shaft bearings and other systems.

The structure will predominantly be made of steel, including the blades and tower structure, avoiding non-recyclable composites as well as using generators that do not include rare earth metals. The manufacturing of the structure will occur in the Netherlands, minimizing transport costs. With the dimensions of the system, it can fit into two dry docks in Rotterdam, where it can be assembled.