

Abstract: Engineering Design for an Offshore Wind Turbine Farm

This project centers on the engineering design for the construction of a 180-megawatt offshore wind turbine farm and operations facility in a south-central region of the USA. The purpose of the project is to provide low-cost, renewable energy to help utilities and their customers reach their carbon emission reduction goals and diversify their generation portfolio. Two lease blocks located 24.85 miles offshore have been selected, with further engineering analysis required to optimize the location of the wind turbines to minimize wake loss and cable length.

A university-based energy research institute, working with a wind energy student group, provided a Request for Proposals (RFP) to students in a senior engineering design course. The RFP included the following concepts:

- Approximately 12 wind turbines (enough to reach 180 MW).
- A collector system, transmission substation, and transmission line to connect and convert the electrical output of the wind turbines to the high-voltage transmission grid.
- A LEED Gold Certified local wind farm power monitoring and teaching facility.
- Site improvements for the new facility including walkways, driveways, parking, underground power and data lines, and other site amenities.

A team of five students responded with a formal engineering proposal. Study emphasis of the student team spanned construction management, structural engineering, geotechnical engineering, and environmental engineering. The students were mentored by five licensed engineers with expertise in the noted engineering areas. Additional guidance was provided by three class instructors, all of whom are licensed engineers.

Three alternative design concepts were developed by the team. All three designs included an operations and maintenance facility along with differing approaches for the offshore subsurface system. The first alternative used a gravity-based foundation consisting of precast concrete and reinforced steel for sites with depths of up to 30 meters. The second alternative was a steel monopile foundation designed for depths of 10 to 25 meters. The third alternative was a jacket foundation designed for depths of 30 to 35 meters.

The students presented a preliminary design report with the three alternatives to a panel of judges and mentors. The panel included licensed engineers, research scientists, and members of the public. An evaluation matrix was used to quantify the merits of each alternative. Factors evaluated included environmental sustainability, social sustainability, economic sustainability, project schedule, and the team's opinion of probable cost. The team recommended the second alternative, the monopile foundation, which will achieve the lowest estimated cost and a longer lifespan without having to sacrifice structural integrity.

With the client's approval, the team proceeded with the final design. Their work product includes a geotechnical report, verification of compliance with codes, structural calculations, drawings, and specifications. The specifications included bid forms, terms and conditions, and sections for key project elements. The student team presented a slideshow explaining the design details and considerations to the client and the panel of judges. A projected construction schedule, final opinion of probable cost, and copies of the project manual were included with the presentation materials.