THESIS PROJECT PORTFOLIO

Active Stabilization of a Floating Wind Turbine Platform

(Technical Report)

The Struggle Over Offshore Wind Energy

(STS Research Paper)

An Undergraduate Thesis

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Rapid adoption of renewable energy sources can mitigate climate change that we are seeing today. In the U.S., 19.8 percent of electric power is generated from renewable energy sources; hydropower and wind account for most of the renewable share. The Center for Climate and Energy Solutions forecasts a 2.4 percent annual rate of growth of renewable energy, reaching 35 percent by 2030 (CCES, 2021). Most of the increase is expected to come from wind and solar energy. Yet turbine farms demand extensive land, and in densely populated areas, where grid capacity is most needed, available land is scarce. Offshore wind farms, however, do not compete for scarce land and do not subject local populations to noise pollution. The technical project involves creating an active stabilization system for a model of a wind turbine platform at sea. The sociotechnical research paper compares and explains why the Coastal Virginia Offshore Wind project has had a lack of opposition from local groups and why it continues to flourish.

An offshore wind turbine as opposed to one on land possesses the risk of swaying or tipping due to natural elements such as ocean waves, currents, and winds. To be most efficient, the wind turbine should be kept in a level, steady state position which proves to be difficult in the deep ocean. Having an efficient stabilization method for the turbine platform is essential for energy production from wind. The goal of our project was to design a scale-model of a floating wind turbine base which used active methods for maintaining its stability. Initially, we were given a passively damped design completed by a previous year's project group for use in this process. Introducing active stabilization to their design provides the unique ability to reliably counteract forces acting upon the structure from wind, waves, currents, and the movement of the wind turbine blades themselves. The active stabilization method had to be designed considering constraints of codes, constructability, cost, functionality, maintainability, sustainability, standards, and more. Following a meticulous design process, we were able to assemble a

physical prototype of an active stabilization method and test its effectiveness in water. The technical project involved a 3D printed floating platform model previously designed by a capstone group in the 2020-2021 school year which has been retrofitted with motors to pull and release tensioned anchors on the seafloor. Project goals included increasing buoyancy and floatability of the model, designing supporting elements for the motor systems, and programming the electrical components to actively sense and correct the platform's tilt. This experimentation occurred in a large tub of water deep enough to house the 3D printed model with its connected ropes. A gyro sensor was used to be able to track the angle of tilt that was occuring on the model.

The research question examined in the Sociotechnical research paper was why the Coastal Virginia Offshore Wind (CVOW) project off the coast of Virginia Beach has had a lack of opposition comparably to other, similar projects? The paper researches the steps that those in charge of the CVOW project have done to make the farm more favorable in the eyes of the public and groups located in the area such as fishermen, citizens, and advocacy groups. The main way that the project has done this is through years even before the project's commencement of reaching out to the local groups. An example of this which continues to be an example is "town hall" meetings with those involved. In these meetings, the project coordinators give updates on the project as well as updates on fishing in the area. The largest concern from the public was that the area would not be able to be fished in as well as harming marine life during the construction. The companies being so open to the public about this has led to a public support of the disruption of the area.

The technical project of stabilizing a model of a wind turbine platform was a success. We were able to attach the motors and gyro sensor to the top of the platform, and after many trials including the programming, the platform was able to stabilize itself under the influence of waves

in the test pool. I believe that the sociotechnical aspect of the thesis has also been a success in analyzing the CVOW and why it has been a success so far socially. Recommendations for further research would be to look at specifically when the CVOW project managers started reaching out to the public as well as if it was planned for in the project's conception.

References

CCES (2021, Oct. 27). Center for Climate and Energy Solutions. Renewable Energy. https://www.c2es.org/content/renewable-energy/