Prospectus

Offshore Floating Wind Substructure Development
(Technical Topic)

Framing of Offshore Wind Energy in the U.S.
(STS Topic)

By

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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

As the issue of climate change is becoming more and more serious, some groups are calling for the United States to lessen its environmental impact, since the country is one of the top producers of carbon emissions in the world. One avenue by which this can be achieved is exploring and investing in renewable energy sources to replace the burning of fossil fuels, which contributes to about seventy-five percent of carbon emissions (*Where Greenhouse Gases Come from - U.S. Energy Information Administration (EIA)*, n.d.). This includes not only expanding forms of renewable energy that are already more widely used, such as solar, hydroelectric, and onshore wind energy, but also using funds to develop newer forms of renewable energy, like offshore wind energy. Although wind turbines have been in use for decades in the United States, the field of offshore wind energy is still relatively unexplored, with only one functioning offshore wind farm in the country.

Both my technical and STS projects focus on offshore wind energy. The goal of my technical project is to improve upon the technology for substructures, or the structure on which the turbine floats, for offshore floating wind turbines. I am working in a group with four other mechanical engineering students to develop a substructure model that reduces environmental impact, cost, and maintenance. A model of the elected substructure will be 3D-modeled and printed, and tested in a wind tunnel. For my STS project, I will analyze how the portrayal of offshore wind energy by scientists and engineers frames both the public and policymakers' conceptions of and responses to offshore wind energy. I will be researching how the framing of offshore wind energy has affected its implementation in the United States, and what can be done in the future to support its implementation. I will use specific projects in the United States to explore and expand upon these ideas further.

Technical Topic

Although wind energy is one of the larger sources of renewable energy in the United States, "generat[ing] 6.5% of power delivered to U.S. consumers" (*Press Releases - Wind In The News | AWEA*, n.d.), there is still enormous untapped potential in the offshore wind energy industry. U.S. shores have a power potential of nearly double the country's energy use (*Computing America's Offshore Wind Energy Potential*, n.d.), but the United States has yet to take advantage of this new field. Most existing wind farms are placed on land, mainly in large, open fields to avoid the turbulence created by nearby infrastructure or trees. Other wind farms have been built offshore to also avoid turbulence and take advantage of the higher winds present at sea; however, they are not floating. These wind farms require extensive time, energy, and money to build because it is difficult to construct and secure these turbines while working in very deep waters. Floating wind turbines offer the compromise of utilizing the favorable wind conditions present in deep waters and not taking up valuable space on land, while being easier to construct on land and then float out to sea. Unfortunately, floating wind turbines are still expensive to construct since they are such a new technology that has not been researched and improved upon extensively. However, with more research and development, they could utilize modern construction technologies on land and then be brought out to sea and anchored for a relatively low cost. Also, since 80% of the U.S. population lives near the coast, offshore wind turbines would be in close proximity to the energy needs of the majority of the country. Since energy transportation can often be an obstacle and expensive, this is beneficial.

Throughout the academic year, I will be working in a capstone project team with Emily Fedroff, Kyle Dana, Cydnie Golson, and Ahmed Abdelnabi, four fellow mechanical engineering undergraduate students. Our capstone professor and technical advisor is Michael Momot in the

Department of Mechanical Engineering. The objective of our capstone course is to “develop something to increase the utility of wind turbines,” (Momot 2020). After researching wind energy in general, and exploring what areas could be improved upon, our team chose to focus on offshore wind energy. Because it is a lesser explored area, there is considerable potential for growth. More specifically, we are developing a prototype for a floating substructure that will improve upon existing technology. Because of testing, time and resource limitations, our model will be very small-scale. There are three main types of substructures that are currently in use or being developed: spar, semisubmersible or barge, and tension-leg platform. After deciding to focus on the semisubmersible substructure, we have used Principal Power’s WindFloat® as a basis for our research and design. After completing the processes of ideation, concept screening, and selection, we decided upon two designs to move forward with. Our first design consists of a semisubmersible based on the WindFloat® base design, and a weighted chain to provide more stability. Our second design uses a base which floats by a naturally pressurized system of drainage holes, with the option to include a ballast to improve stability. We are currently in the process of modeling and conducting analysis on our designs using software. Then, we will create final models of both designs using a combination of 3D-printed, store-bought, and hand-made parts. Once our prototypes are finalized, we will conduct testing using the department’s wind tunnel, and possibly some outdoor tests using a larger water basin and vacuum blower. Using all of our analysis and testing, we will conclude which of our designs is the best in terms of cost, stability, environmental impact, or what aspects of the models could be combined to create an even more effective design.

STS Topic

Although in general, long-term changes make for an easier transition, and would be less challenging to implement, the consequences of continuing with the current American energy sector do not allow for this time-frame (Hess, 2014). Scientist are estimating that the world has eleven years left before the damage done by climate change is irreversible (*Only 11 Years Left to Prevent Irreversible Damage from Climate Change, Speakers Warn during General Assembly High-Level Meeting | Meetings Coverage and Press Releases*, n.d.). Despite this looming threat, the United States has failed to take enough action to combat climate change in any real way. It is important to note how the United States differs from other countries, in that change could possibly be implemented faster and more effectively by state governments rather than the national government. Thus, it might be unfair to directly compare national requirements and regulations of the U.S. with those of other countries. In some states, such as Washington, Oregon, Idaho, and Maine, renewable energy production is well above the national average, with over eighty percent of energy coming from renewable sources (*Renewable Energy Production By State*, n.d.). However, in half of U.S. states, often dominated by the oil industry, renewable energy makes up less than twenty percent of energy production, which brings the national average down to only seventeen percent (*Renewable Energy*, 2017). Thus, national requirements and regulations might be necessary to motivate these states to implement renewable energy. Collaboration between states could also be useful in achieving implementation in certain cases (*Building an Offshore Wind Industry along the US East Coast: The Role of State Collaboration | McKinsey*, n.d.).

Despite the handful of states where renewable energy constitutes a majority of energy production, offshore wind energy makes up almost none of it. Although there are several offshore wind projects in development around the United States, there is only one that is currently operational and producing viable energy. One possibility why renewable energy has not gained traction in the United States is the pervasiveness of the fossil fuel industry, which is actively working to block sustainable transitions (Hess, 2014). The threat to this coalition's profit and existence by renewable energy has caused it to actively work against renewable energy in political spheres under the guise of maintaining the government's proper role (Hess, 2014). Virginia is one of a group of states that is currently working toward implementing offshore wind. This is a project of Dominion Power, an energy giant in Virginia, and is projected to be producing usable energy in the near future. Although this is only a pilot project, consisting of only two turbines, it is notable since it the first real attempt at offshore wind energy in the state of Virginia. This could be an instance in which state collaboration could prove useful, as this project is located in Southeastern Virginia, only about fifty miles from another offshore wind project off the coast of the Outer Banks in North Carolina, by Avangrid Renewables.

For my STS research, I will analyze how the framing of offshore wind by scientist and engineers has impacted its reception by the public and policymakers. I will also explore what changes could be made to these relationships to improve the reception of offshore wind energy in the United States. I will use Block Island Wine Farm as a case study in order to have a detailed example of how offshore wind was framed and perceived in that instance, and how it could be applied to projects in the future. It would be interesting to compare this working wind farm to one still in development, such as Dominion Energy's in Virginia, and see what the projects did differently, or how the politics of each state affected the projects' outcomes, and timelines of implementation.

Next Steps

Some of my next steps include finding more concrete details of the perception of offshore wind from the groups mentioned, including policymakers, and the public. I will need to conduct more research on Block Island Wind Farm, the only current operational wind farm in the United States, in order to use it as a case study. I want to find out what interests were at play in making the wind farm become operational, and how it was able to overcome pushback from political actors. I would also like to explore what could be done to make offshore wind energy more accepted in the country. Also, I will go more into depth into some of the resources used in the STS portion, including the article about political coalitions and collaboration between states, in order to consider the obstacles of expanding offshore wind, and what can be done to improve it, respectively. It would also be interesting to talk specifically about state collaboration, possibly in the case of Virginia and North Carolina as mentioned in the STS section above.

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