THESIS PROJECT PORTFOLIO

Active Stabilization of a Floating Wind Turbine Platform

(Technical Report)

The Means and Motives of Cape Wind Opposition

(STS Research Paper)

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The technical work and research case investigated in my portfolio both address the socio-technical challenge of a clean energy transition and primarily focus on the shortcomings of the growing offshore wind market. These shortcomings include instability and power deficiencies of the technology itself as well as social and political factors like public opposition and complicated permitting processes. Currently, offshore wind turbines are limited to "fixed-bottom" technologies, meaning they must be anchored to the seabed and placed close to shore. Additionally, the political culture of the US and failed projects like Cape Wind have induced distrust toward offshore wind and allowed other countries to largely surpass the US in offshore wind growth. By choosing a related technical project and research case, I set out to holistically propose a solution to these technical and social challenges while further accelerating the transition to clean energy. In what follows, I will briefly discuss the purposes of both projects and reflect on the benefits of exploring them simultaneously.

The goal of my technical project was to model an active stabilization system that could sense wave conditions and quickly react to provide balance for an offshore floating wind turbine. To select and design a working prototype, my group used an iterative ideation process to rank and improve dozens of ideas by certain criteria and ultimately select the best concept. The final design that my group implemented included a gyroscopic sensor to monitor the platform's tilt and three motors to adjust the tension in anchoring cables which provided a restoring force. A feedback control system was then coded into an Arduino microprocessor to calculate motor adjustments based on platform tilt and set the three motor positions. Although difficult to capture quantitative data, the final prototype worked well and stabilized itself from incoming waves in a majority of tests. This new technology would allow turbines to be placed in deeper waters where

there are higher wind resources and nominal impacts on beach views, which could limit possible opposition.

Furthermore, the goal of my research project was to investigate the failed Cape Wind project, an offshore wind project that was terminated due to heavy opposition and constant litigation. Using Actor-Network Theory, my research seeks to identify the motives and means of opposition groups in their efforts to dissolve the Cape Wind network. Evidence was collected from local articles, archived websites, and environmental impact statements to portray the intentions of two main opposition groups: The Alliance to Protect Nantucket Sound and the Wampanoag tribes. Although The Alliance publicly intended to preserve the beauty and marine life of Nantucket Sound, they also accepted major donations connected with the fossil fuel industry. The Wampanoag tribes, however, opposed Cape Wind on spiritual motivations of history and culture. Both opposition groups used the media, money, and litigation to support their fight against offshore wind development. Understanding the influence and motivations of opposing actors is crucial to ensuring that future meritorious offshore wind projects do not fail in the planning process. Prospective projects must realize that choice of location can have a major impact on the strength of the opposition, and developers should seek to include opposing voices early in the project timeline.

Working on a related technical and STS project concurrently provided me with a more unbiased and holistic perspective than if I had selected one over the other. For one, I found that researching both the design considerations of a wind turbine and the arguments of public opposition allowed me insight into the wants and needs of the engineer as well as local residents and landowners. Furthermore, I believe that some of this gained knowledge influenced and motivated the design of my technical project; by incorporating a stabilization system that favors

deeper-water turbines, the viewshed obstruction of Cape Wind could have been minimized or eliminated completely. This was one of the core complaints of many opposing stakeholder groups, and it became clear to me that technical developments similar to mine could one day lead to better public acceptance of wind farms. Overall, my work on both projects has led me to understand that the growth of offshore wind does not just require technical improvements, but also a cultural shift and restructuring of the existing networks in the wind energy project pipeline.