Introduction

While offshore wind power has become commonplace in Europe, it is only beginning to be considered in the United States, predominantly along the southern coast of Cape Cod. In 2012, the National Renewable Energies Laboratory (NREL) carried out a study characterizing the feasibility of offshore wind power along the entirety of the United States coastline, except for Florida, Alabama, and Louisiana, for which there was insufficient data. This project’s aim is to supplement the 2012 study by determining suitable locations for an offshore wind farm along Florida’s Atlantic coastline. This project will focus on the state’s eastern (oceanside) coastline due to the predominant east-to-west wind currents. To carry out a study characterizing the feasibility of offshore wind power along Florida’s Atlantic coastline. This project was conducted in two phases. The first created an area over which power to be generated was determined using Equation 2 shown below (Map F). This assumed a 90-meter blade length, and a 45% turbine conversion efficiency, both of which are industry standard values. Then, the resulting raster was multiplied by the price of electricity per kWh in Florida (11.7 ¢/kWh), and extrapolated over a 20-year turbine life expectancy. This resulted in a raster of available profits per lifetime kW produced from each site.

Methodology

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Equation 1: Wind Speed Interpolation to 90m

For wind speed measurement, Uz at height z, this series of equations was applied twice: first where α = z and λ and again where α = 10 and λ = 90 to determine wind speed at 90m.

Equation 2: Estimating Power Output

To convert the interpolated wind speeds into a cost-based raster, the available power to be generated was determined using Equation 2 shown below (Map F). This assumed a 90-meter blade length, and a 45% turbine conversion efficiency, both of which are industry standard values. Then, the resulting raster was multiplied by the price of electricity per kWh in Florida (11.7 ¢/kWh), and extrapolated over a 20-year turbine life expectancy. This resulted in a raster of available profits per lifetime kW produced from each site.

To convert the bathymetry data set into a cost-based raster, a 2014 NREL Wind Cost Analysis was used to determine a cost per meter depth per kilowatt over the estimated turbine life of 20 years. An estimated cost of $136.7 per kW was multiplied by the bathymetry raster to result in a cost-by-depth raster per lifetime kW produced by the turbine.

To determine the feasible project area, a base area was first created using basic editing tools around the extent of the area being analyzed. Then, a 15-mile buffer around each deep water port, and one with a 5-mile radius from the coastline (Map A). These buffered areas were removed from the base area.

To determine the wave height data was used to build a rasterized wind speed model (Map B) covering much of the potential project area. The base area polygon was then cut to match the size of the available wind speed data.

A bathymetry raster for Florida’s dataset was obtained from NOAA (Map C). This raster was first used to limit the base area polygon; as offshore wind farms are currently only feasible within 60 meters of depth. After the base area had been determined, the bathymetry dataset would be used to apply a depth-based cost analysis to the final feasibility study.

The final data set that was considered is annual significant wave height, available from NREL (Map D). First, all areas with an annual wave height of over 2 meters were selected, and converted into a separate layer. Using the clip tool, these areas were removed from the base area. What remained of the base area polygon is the final area that would be analyzed for feasibility of a wind farm (Map E).

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