

Methods for Site Selection

The selection criteria for a site in western South Dakota is:

- Wind resource
- Terrain
- Landowners
- Vegetation
- Access to transmission lines
- Transportation access
- Environmental impact
- Community factors
- New development
- Energy potential

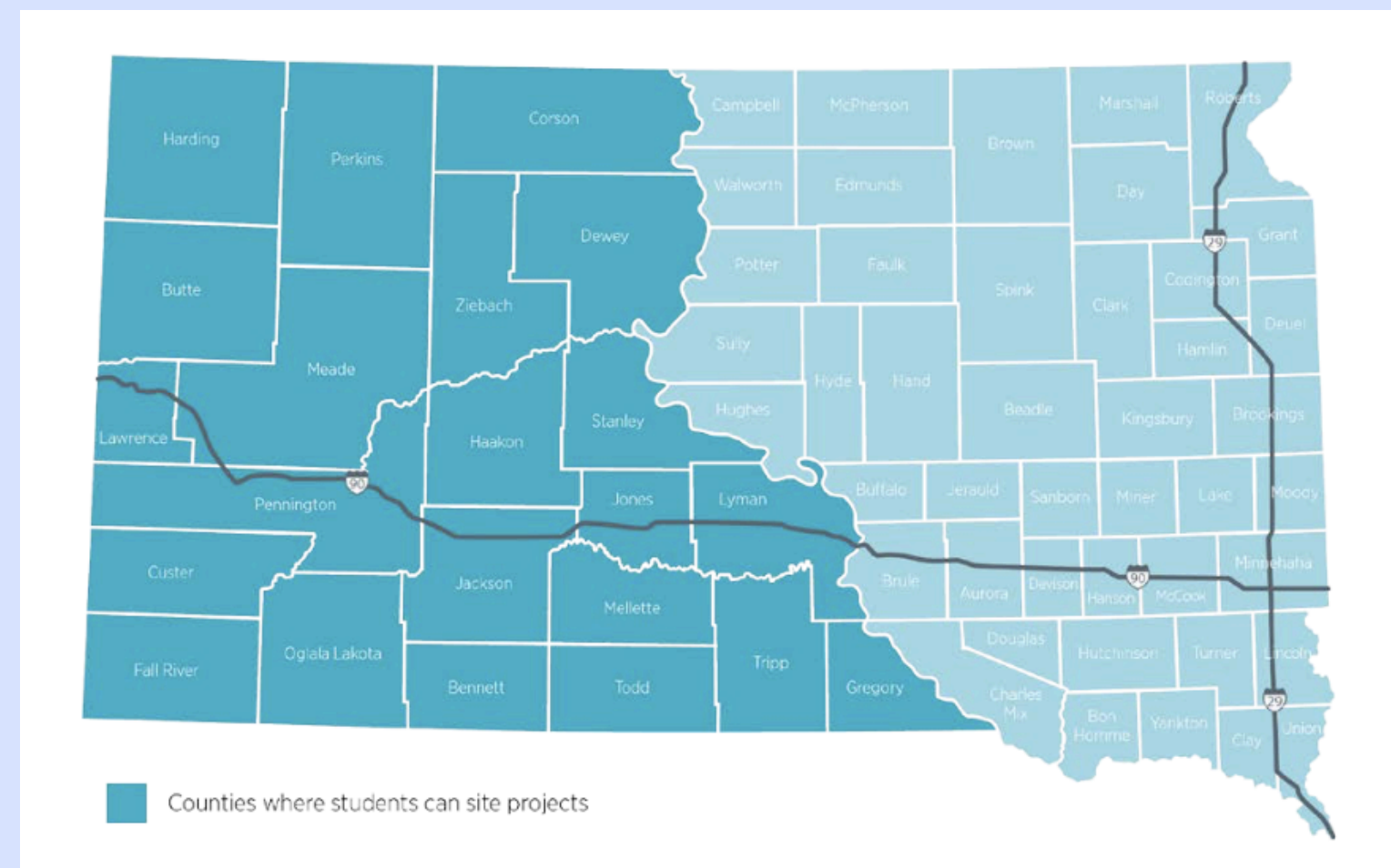


Figure 1: Potential Project Location [1]

These criteria were generated from the Rules and Regulations of the Collegiate Wind Competition 2021 and faculty advisors. Figure 1 shows the designated location the project development can be placed.

Site Selection

Two of the top sites within the designated project development location were then compared using the selection criteria listed in Methods for Site Selection. These sites were found using NREL's Wind Prospector Program and mapped using Google Earth.

Figure 2 shows the three locations the team considered.

Each site's characteristics are described in Table 1.

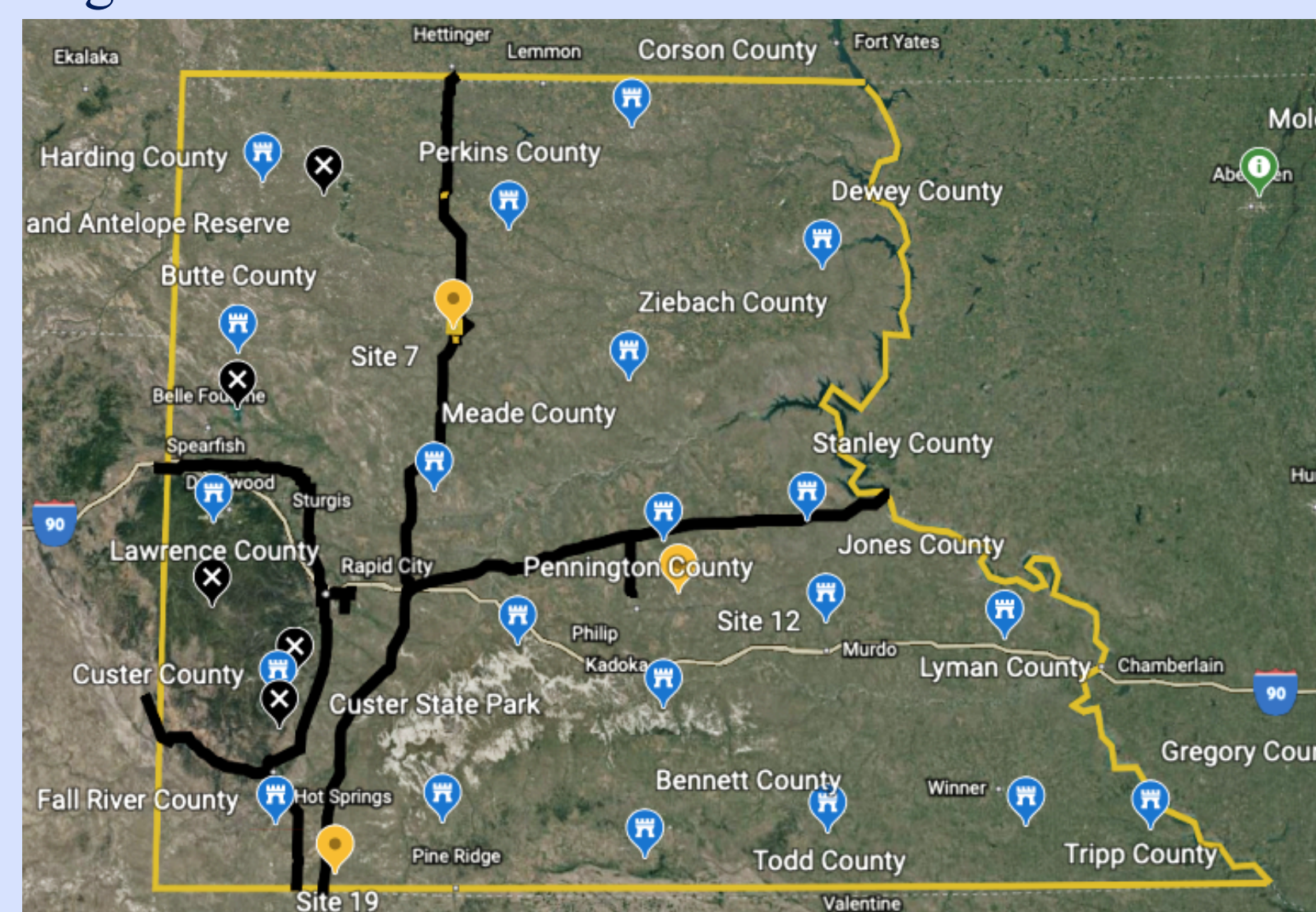


Figure 2: Sites Considered

Table 1: Site Comparison

	Site 7	Site 12	Site 19
Pros:	<ul style="list-style-type: none"> • 7.0-7.5 m/s avg. wind speeds. • Transmission lines within five miles of site. • Low density of vegetation. • Relatively flat terrain. • Located within two miles of a major highway 	<ul style="list-style-type: none"> • 7.0-8.4 m/s avg. wind speeds. • Transmission lines within two miles of site. 	<ul style="list-style-type: none"> • 7.0-7.5 m/s avg. wind speeds. • Transmission lines within five miles. • Less than five miles from major highway. • Relatively flat terrain.
Cons:	<ul style="list-style-type: none"> • State and privately owned land within site boundaries. • Site boundary near tribal lands. 	<ul style="list-style-type: none"> • High density of vegetation. • Known eagle migration area. • Major recreational area • National parks nearby. • Surrounded by multiple landowners. 	<ul style="list-style-type: none"> • Site boundary near National Forest. • Site is surrounded by different business. • Multiple different landowners.

Proposed Site

Site Overview:

From the results in Table 1, Site 7 was selected for further development. A maximum boundary area was then laid out. The proposed boundary is:

- Private owned land.
- Substation is going to be built on the new site to get energy into the grid easier .
- Around 20625295m².
- Turbines will be placed 500ft/1.1x height of turbine tower from property lines.
- No known interference with Native American Land.

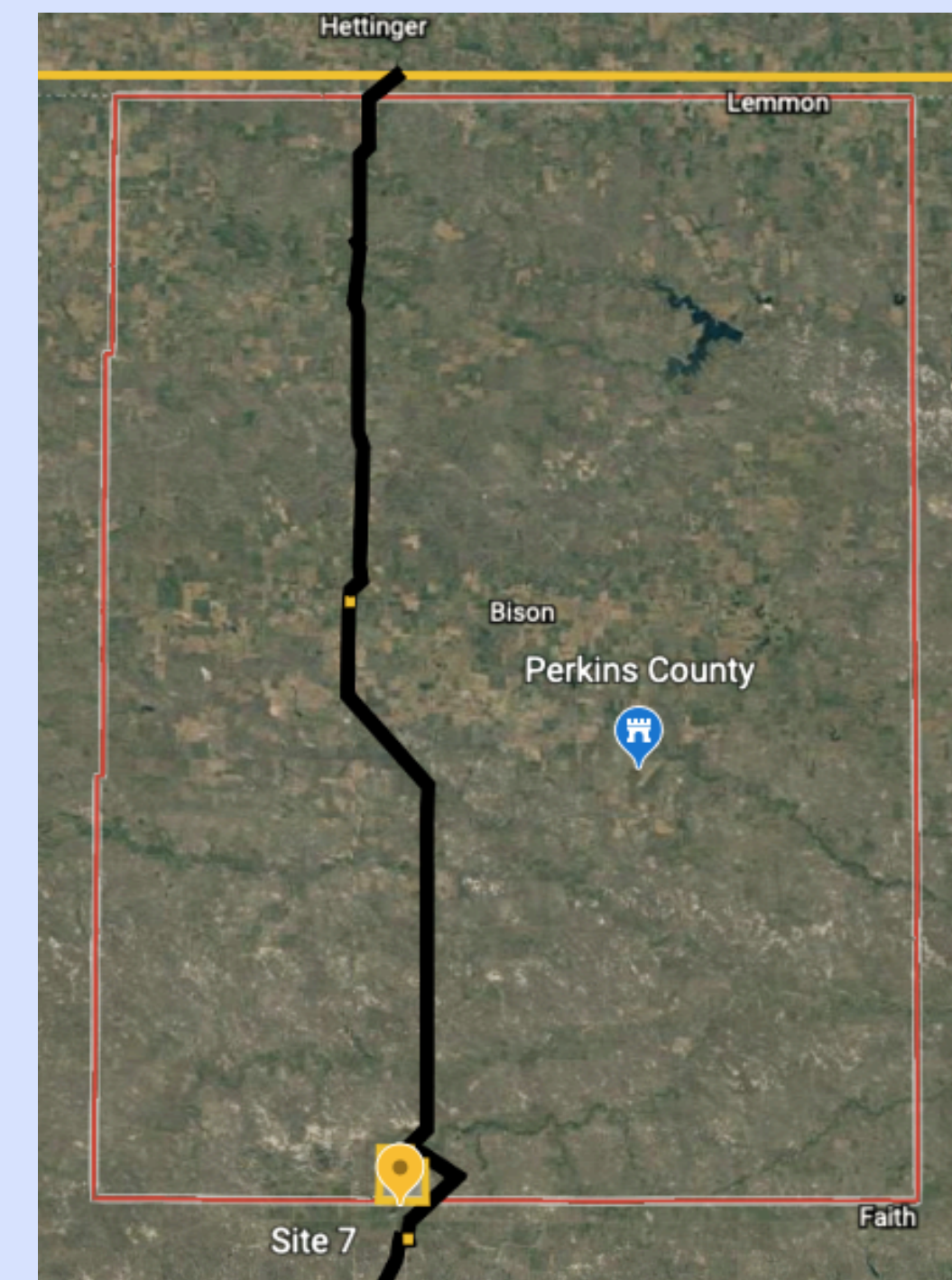


Figure 3: Proposed Site Boundary

Wind Resource

The team analyzed two anemometer wind data near the proposed wind farm from Windographer. This data was formatted and then modeled in Continuum, a project development software by NextEra. The average annual wind speed is 7 m/s and the Turbulence is 16%. Which means the site is rated for IEC Wind Class IA. Figures 4, 5, and 6 demonstrate the wind characteristics of the area. Figure 4 is the wind rose that is found at the different MET sites, Figure 5 represents the wind rose with wind direction and wind speed ratios, and Figure 6 is a wake loss map of the site. Through the wake loss map, the team plans to take advantage of the areas with the most wind.

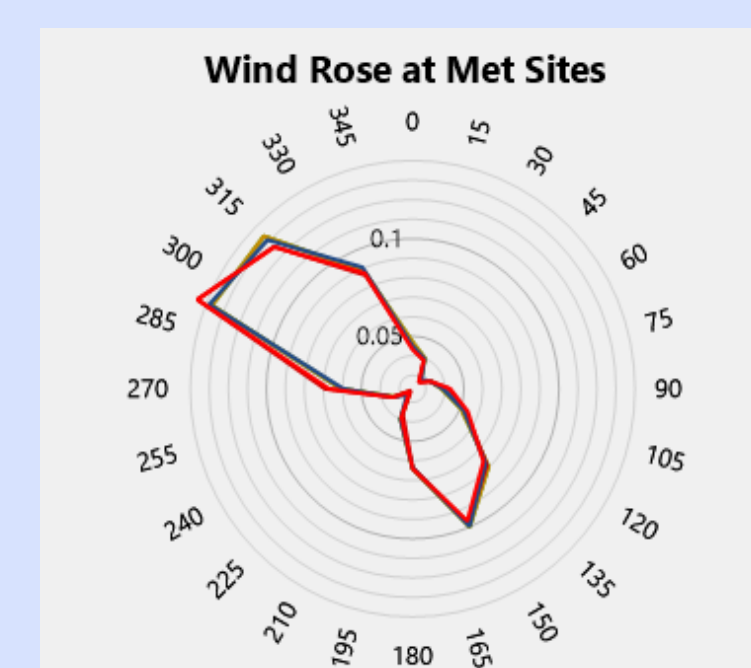


Figure 4: Wind Rose at Met Site

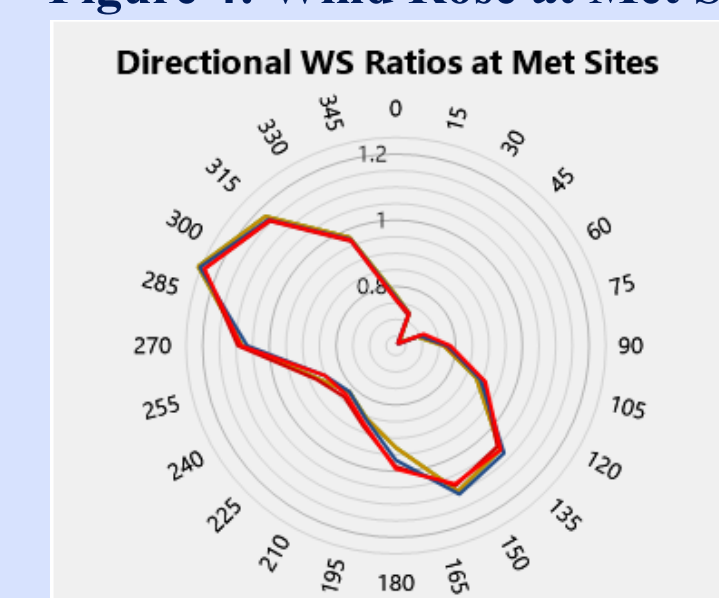


Figure 5: Wind Speed Ratio at Met Site

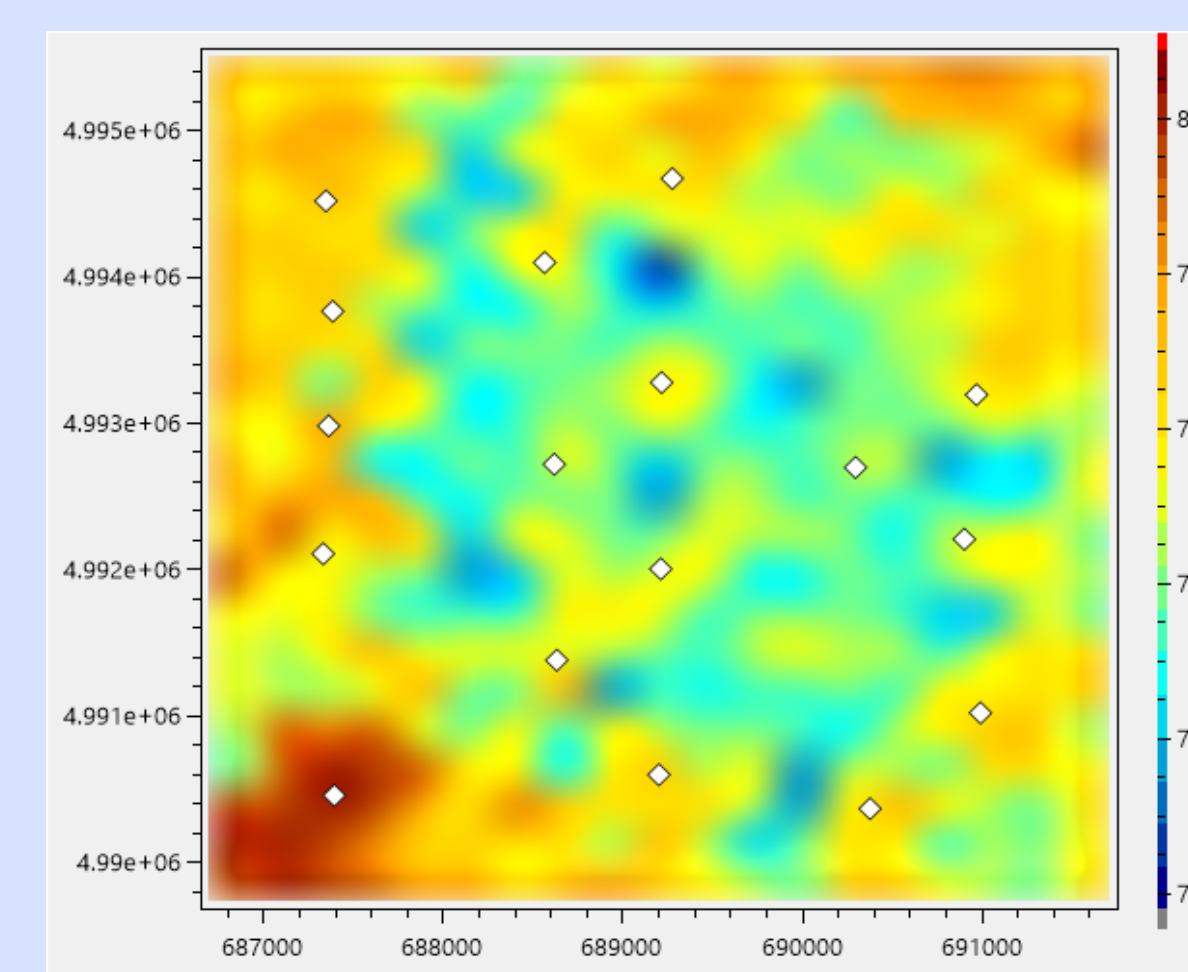


Figure 6: Wake Map

Community Factors

The teams plans to take the needed measures to be approved to build a wind farm in Perkins, South Dakota. The team is factoring in the noise, visual, vegetation, floodplains, wildlife, recreation, health and human safety, and possible Native American impacts that can be caused by the wind farm. Table 2 goes into more detail with this plan. The team also plans to contribute to the community by donating turbine parts to the local schools.

Table 2: Wind Farm Impacts and Mitigation

Impact	Mitigation
Noise	<ul style="list-style-type: none"> - Turbines will be placed 500ft/1.1x height of tower from property lines - Construction only during the day
Visual	<ul style="list-style-type: none"> - Turbines will be placed 500ft/1.1x height of tower from property lines - Aircraft Detection Lighting System in accordance with Federal Aviation Administration Wind Turbine Guidance Documentation
Vegetation	<ul style="list-style-type: none"> - No known species found in the area - Will still perform site screenings
Floodplains	<ul style="list-style-type: none"> - Perkins County GIS and FEMA Flood Insurance Maps - No major floodplains will be disturbed
Wildlife	<ul style="list-style-type: none"> - Permits, site screenings, impact assessment, monitor and a report plan will be established
Recreation	<ul style="list-style-type: none"> - No hunter access plan will be generated, nor will campgrounds be permitted due to the original land being nonrecreational farmland
Health and Human Safety	<ul style="list-style-type: none"> - Project will fund extra equipment to ensure fire protection within the project boundary, and insurance for the equipment being used
Native American Religious Concerns	<ul style="list-style-type: none"> - Full archaeology survey of proposed site will be performed - Project will work around any individual artifacts/sites of concern

Financial Analysis

Cost of energy and cash flow analysis for designed project development of a 20-year expected life. Project will be a Power Purchase Agreement (PPA) Partnership Flip with Debt. Values were calculated using the System Advisor Model. The project has a competitive PPA price with a flip year of 18. Due to a debt to equity ratio greater than one, the team will be using local companies in South Dakota for construction and donating used material to local schools.

Table 3: Financial Analysis

Metric	Value
Total Installed Cost	\$-151,470,000
Annual Operating Expenses	Average \$6,945,000 per year
Levelized Cost of Energy	5.71 cents/kWh
Purchase Price Allocation	7.20 cents/kW
Flip Year	18
Debt to Equity Ratio	1.38

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References

[1] National Renewable Energy Laboratory, "US Department of Energy Collegiate Wind Competition 2021," 2020

NAU's Team Website



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