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Preliminary Assessment of Potential for Wind Energy Technology on the Turtle Mountain Band of Chippewa Reservation

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ABSTRACT

Wind energy can provide renewable and sustainable electricity to Native American reservations, including rural homes, and power schools and businesses on reservations. It can also provide tribes with a source of income and economic development. The purpose of this paper is to determine the potential for deploying community and utility-scale wind renewable technologies on the Turtle Mountain Band of Chippewa tribal lands. Ideal areas for wind technology development were investigated based on annual wind resources, terrain, land usage, and other factors such as culturally sensitive sites. The result is a preliminary assessment of wind energy potential on Turtle Mountain lands, which can be used to justify further investigation and investment into determining the feasibility of future wind technology projects.

ACKNOWLEDGEMENTS

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ACRONYMS AND DEFINITIONS

Abbreviation	Definition
DOE	Department of Energy
GIS	geographic information system
kW	kilowatt
M	meters
Mi	miles
MW	megawatt
ND	North Dakota
NREL	National Renewable Energy Laboratory
OSPA	Oceti Sakowin Power Authority
REO	renewable energy objective
RES	renewable energy standard
RPS	renewable portfolio standard
TMCC	Turtle Mountain Community College
USGS	United States Geological Survey

1. OBJECTIVES & BACKGROUND

This report summarizes the work performed during the summer of 2019 at Sandia National Laboratories under the Indian Energy internship program.

1.1. Objectives

The purpose of this paper is to:

- Outline the potential benefits of renewable energy for the Turtle Mountain reservation
- Summarize the process for the early stages of wind energy planning and development
- Identify areas on Turtle Mountain tribal lands with high wind energy potential
- Propose and evaluate several conceptual projects, which can be used to justify further investigation and investment into determining the feasibility of future wind technology projects on the reservation

1.2. Renewable Wind Technology

Harnessing the power of the wind is not a new idea. Historically, wind systems have been used for applications such as pumping water or grinding grain. In the 20th century, wind chargers were used in rural areas to power radios and lights. Modern wind turbines capture the kinetic energy from the wind and convert it into electricity. Aerodynamic forces cause the turbine's rotor blades to spin, which produces electricity through a generator (Figure 1-1). Turbines come in a variety of sizes and are used for both small and large-scale applications, from offsetting electricity costs for a single home or community to supplying power in bulk to the utility grid [1].

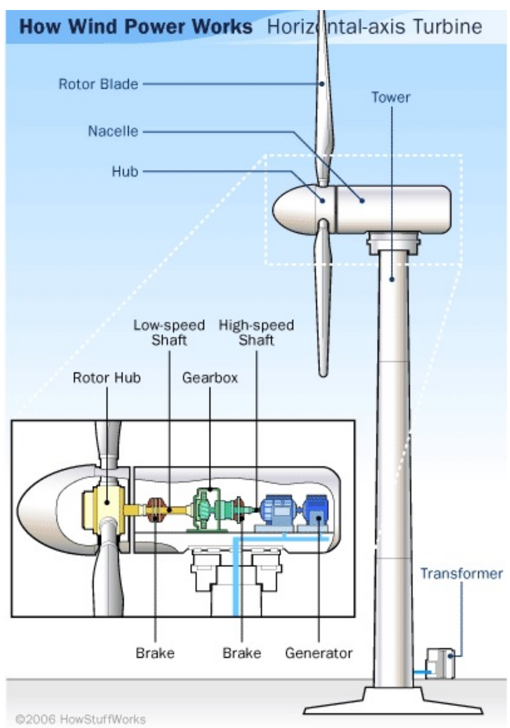

Figure 1-1. Components of a Wind Turbine (HowStuffWorks.com)

Small turbines are often used for residential or agricultural applications to help offset the cost of electricity for homeowners and farmers. These are known as distributed energy systems. They typically produce between 1 and 50 kilowatts (kW) of power. Mid-size turbines can be used for industrial purposes, as well as to help power schools or small communities. They generate between 100 kW and 1 megawatt (MW). Smaller wind technology projects such as these may either be connected to the existing utility service or operate off-grid. Due to their size, they can often be placed near the location at which the energy is to be consumed. This reduces the likelihood of the need for new transmission lines.

Some owners of grid connected distributed wind energy systems use net metering, which allows the user's electricity meter to run backward. This means that if the turbine produces more energy than can be used at the time, it provides the user with credit for energy used during times when the turbine cannot produce enough energy to power the entire load, reducing the overall electricity costs for the user. In North Dakota, net metering can be utilized by owners of renewable energy systems up to 100 kW served by investor-owned electric utilities [2].

Wind patterns vary throughout the year and even throughout the day, and do not always match peak electricity demands. If a grid connection is not possible or cost-effective, this poses a problem to homes or businesses relying solely on this variable energy source. There are several options to mitigate this problem. The energy can be stored in a battery to be used later, or the turbine can be coupled with another energy source to provide backup electricity even when the wind conditions are not favorable. Research is ongoing to develop better ways to efficiently store energy for later use [3].

Larger utility-scale turbines can produce over 1 MW and are usually grouped together to create wind farms that provide grid power. The footprint of wind farms generally only takes up 2% to 5% of the land on which they reside, allowing much of it to remain available for use in other purposes such as crop cultivation and ranching. They may reach a hub height of 80 meters or higher. The size and average power of utility-scale wind turbines has grown over the past two decades [4].

To promote renewable energy deployment, some states have a renewable energy standard (RES), otherwise known as a renewable portfolio standard (RPS). A RES/RPS sets a target for utilities and requires them to obtain some of their energy from a renewable source. A renewable energy objective (REO) is more of a voluntary target set to meet a certain renewable energy goal. North Dakota currently has a voluntary goal to have 10% of retail energy come from renewable sources [5].

1.3. Benefits of Renewable Energy for Native Communities

Some benefits tribes may experience by implementing their own renewable energy projects include:

- Increased access to electricity
- Ability to control energy decisions and natural resources to remain in line with tribal values
- Economic development
- Savings on electricity costs
- Increases energy sovereignty and resilience
- Makes connection to the outside world possible

Some villages, homes, farms, and businesses are located in remote areas where it is extremely expensive to extend utility lines to gain access to grid electricity. This is particularly true for many tribal communities, such as those on the Navajo Nation. Small-scale residential wind energy technologies, often coupled with other energy sources such as solar panels, can provide a cost-effective solution to this issue.

Preserving natural resources and taking care of the earth has always been important to many Native American peoples, and climate change has become an increasing concern in recent years. Many tribal peoples follow the seventh-generation principle, which says that responsible decisions must be made, including those concerning energy and natural resources in order to strive to make the world a better place for seven generations into the future. Wind energy technologies provide a clean source of energy without producing greenhouse gases. It consumes negligibly small amounts of water in comparison to other energy sources [6]. Implementing wind energy, as well as other forms of renewable energy, allows tribes to minimize negative impacts on the environment.

Wind energy can also provide tribes with opportunities for economic development. Utility-scale wind farms produce enough power to export and sell energy off the reservation, providing a source of income for the tribe. Wind farms also provide job opportunities, both during the development process, and after the project is complete. One example of a successful tribal utility-scale project is the Kumeyaay Wind Farm in California, a 50 MW wind farm that sells energy to San Diego Gas & Electric, enough to power 30,000 homes [7].

In 2015, six tribes (Cheyenne River, Flandreau Santee, Oglala, Rosebud, Standing Rock, and Yankton) banded together to form the Oceti Sakowin Power Authority (OSPA). They plan to combine their resources and create one of the largest utility-scale wind projects in the United States. Development of this is already underway. It has the potential to generate up to 570 MW of power and provide millions of dollars in revenue for the tribes through sales taxes and land leases [8]. This will then be reinvested back into the tribal communities. In addition, the tribes will experience economic development in the form of new jobs.

Community-scale wind technologies may not provide a significant means of direct economic growth for the tribe, but certainly have other benefits. They may be more cost-effective benefits to tribes looking only to offset their energy costs or provide power to a small community, as utility-scale projects are generally more difficult to fund and take longer to plan. Community-scale wind projects can provide both clean energy and revenue to tribes. In 2003 the Rosebud Sioux tribe installed a 750 kW turbine on their reservation to supply power to their casino and sell the excess electricity to the local electric cooperative [9].

Renewable energy increases tribal sovereignty and resilience, allowing tribes to become more self-reliant and make their own decisions on energy. It can provide backup power for essential functions, such as hospitals or tribal headquarters, in case of blackouts or emergencies. One example of this is the Spokane Tribe of Indians creating the Children of the Sun Solar Initiative after a 2016 wildfire cut off access to water and electricity. They are installing 650 kW of solar energy for their community, ensuring their energy security and ability to function during disasters.

There are many tribes throughout the country beginning to develop their own renewable energy projects to meet each of their individual needs and goals, and more are following their lead. Until recently, there were few examples for tribes to look to for guidance. Today, there are many more resources available to help tribes develop sustainable renewable energy projects for their communities.

1.4. Turtle Mountain Band of Chippewa

The Turtle Mountain Band of Chippewa (Ojibwe, Anishinabe) reservation is primarily located in Rolette County in North Dakota (ND). The main reservation land area is 12 miles long by 6 miles wide with allotments scattered throughout the surrounding region, totaling approximately 79,176 acres [10] as shown in Figure 1-2. The geography of the region is hilly with trees, lakes, and streams, as well as flatter open areas more suited for agriculture. Due to its location in ND, one of the areas with the best wind resource in the nation, the tribe has good opportunities to produce its own renewable energy.

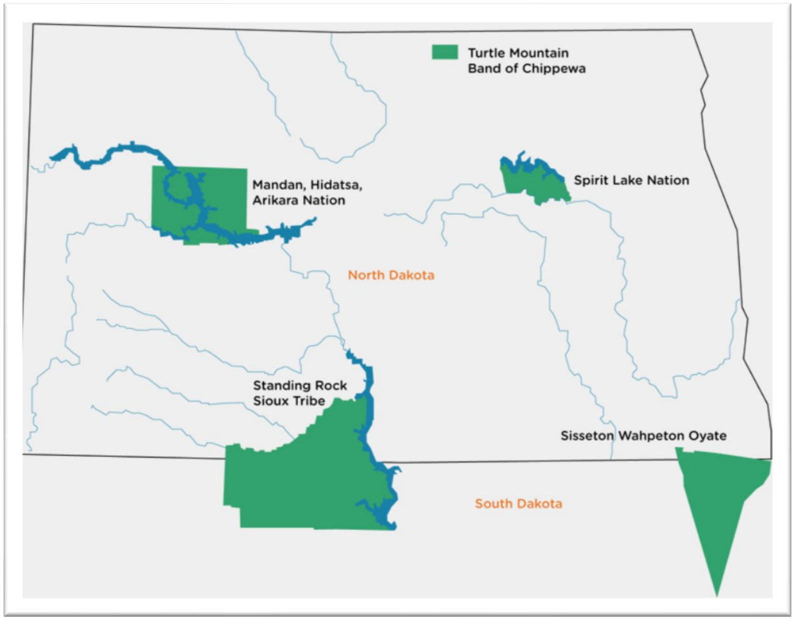

Figure 1-2. North Dakota Reservations (Bush Foundation)

One of the major issues the Turtle Mountain tribe experiences is a high rate of unemployment and poverty. As of 2016 unemployment on the reservation is at 59.45% [11]. The city of Belcourt, primarily made up of tribal members, is at 36% below the poverty line: 53% of children and 41% of tribal elders in Belcourt live below the poverty line [12]. This is over double that of North Dakota as a whole. On average, impoverished households must spend 25% of their annual income on energy [13], sometimes sacrificing other necessities to pay bills. Having electricity to heat homes is a necessity, especially during the long, sometimes brutally, cold North Dakota winters.

Renewable energy can provide the tribe with many different benefits. Development of a utility-scale wind farm on the Turtle Mountain reservation could help boost economic development and provide jobs to tribal members. Revenue from such a project could be reinvested back into the community. A community-scale wind energy project could help provide sustainable energy and reduce costs for schools, businesses, and communities. In November 2011, a ban on hydraulic fracturing (a method of oil drilling known for producing large quantities of contaminated wastewater and other material) was passed unanimously by the Turtle Mountain tribal council. This ban, one of the first on the continent, ensured that the tribe's water and natural resources would remain protected for years to come. Developing renewable energy would help Turtle Mountain continue to uphold their values of environmental stewardship.

There have been several instances of wind technology development on or near Turtle Mountain tribal lands in the past. In 1996, a 100 kW Micon-108 wind turbine was constructed on the reservation to give tribal members experience with operating and maintaining wind turbines. It provided power to the Belcourt Municipal Water Treatment Plant and was connected to the North Central Electric Cooperative utility grid [14].

Beginning in 1999, wind data was measured at a site near Turtle Mountain Community College (TMCC), north of Belcourt. It was discovered that this site sees an annual average wind speed of around 5.81 m/s (13 mph) at a height of 40 meters (m). In 2008 a 0.66 MW turbine was installed at TMCC for the purposes of supplying the campus with power, and to use as an educational tool for the college's proposed wind energy curriculum (Figure 1-3) [15]. During this same time period, a 30-50 MW wind farm in the southeast corner of the reservation was considered. This is a favorable location because of the proximity to a transmission line built adjacent to this area of the reservation. The G82R circuit was completed in 2002 and runs between Rugby, ND and Glenboro, Manitoba [16].

Figure 1-3. Turtle Mountain Community College (Credit: Blake Gumprecht)

In 2015, a utility-scale wind farm was constructed near St. John, ND (which is about 8.5 miles northeast from Belcourt). The wind farm is capable of producing up to 150 MW of power and is made up of 75 turbines, spanning approximately 25,000 acres of land [17]. Another wind farm was built in 2008 near Rugby, ND (which is around 45 miles southwest from Belcourt). Its 71 turbines produce 149 MW of power and take up about 9,554 acres of land. This is an example of how land used by wind farms can be multipurpose, since the surrounding land is still used for crop cultivation [18]. These examples also demonstrate how the turbine density of two different wind farms may vary due to constraints imposed on the project by siting considerations.

The existing wind farms both in the vicinity of the reservation and on other reservations have demonstrated that utility-scale wind energy is a possibility for the tribe. Construction of a wind farm on tribal lands could provide a significant source of economic development and revenue that could benefit and improve the well-being of the entire tribe.

The implementation of the TMCC turbine has shown that community-scale wind projects are also a possibility at Turtle Mountain. Many other locations on the reservation could also benefit from similar projects. Examples of locations include the Turtle Mountain casino, schools, tribal housing, and others. Wind projects in one or more of these locations could offset or even entirely cover electricity costs for the community involved.

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2. SITING CONSIDERATIONS FOR WIND ENERGY

This section expounds on the wind energy siting process. A few factors that should be considered include:

- Availability of wind resource
- Terrain and land use
- Cultural or historically protected areas
- Availability of transmission infrastructure

2.1. Wind Resource

Wind speeds and direction can vary widely across the U.S. The Great Plains are shown to have some of the best annual wind resource in the nation as highlighted by the purple regions in Figure 2-1. Wind maps, such as the one shown in Figure 2-1, are often used to make a rough estimate of wind resource, represented as annual averages, in the beginning planning stages of a wind energy project. This may then justify the expenses involved in the next step, which would involve hiring a professional to conduct a wind resource assessment at the specific project site. Often, this will take at least a year and can be quite costly, so it is important to use preliminary estimates to help determine the feasibility of a project at that location [19].

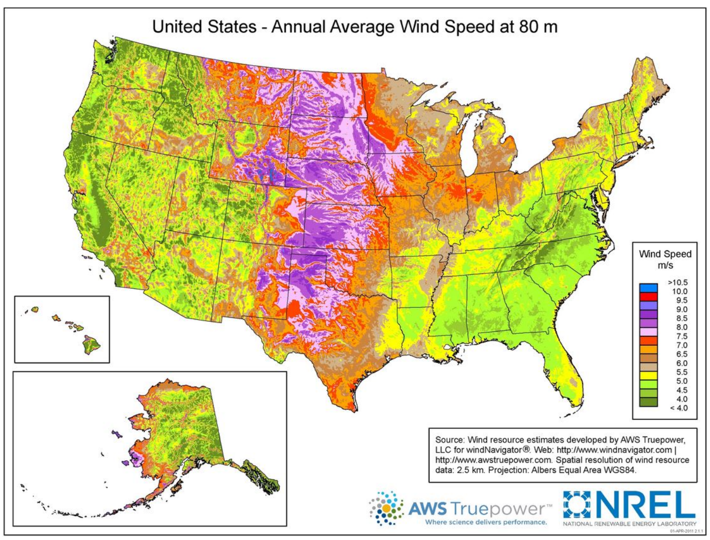

Figure 2-1. Annual Average Wind Speeds in the U.S. (80 meters) (National Renewable Energy Laboratory)

2.2. Terrain

Terrain is another important factor that should be investigated prior to investing in a wind energy project. When choosing a location for a turbine or set of turbines, it is important to note the topography and other nearby obstacles (such as trees or buildings) surrounding the site, which can greatly affect how the wind behaves, and by extension the amount of energy a turbine can output. A turbine placed at the top of a ridge will generally receive higher wind speeds. However, care must be taken when siting a turbine near an elevated landform such as a ridge or a bluff, since the wind behaves differently at various points and can become turbulent (Figure 2-2 and Figure 2-3) [20]. There are also certain types of land cover considered less likely to be developed on, such as non-ridge crest forested areas or wetlands [21].

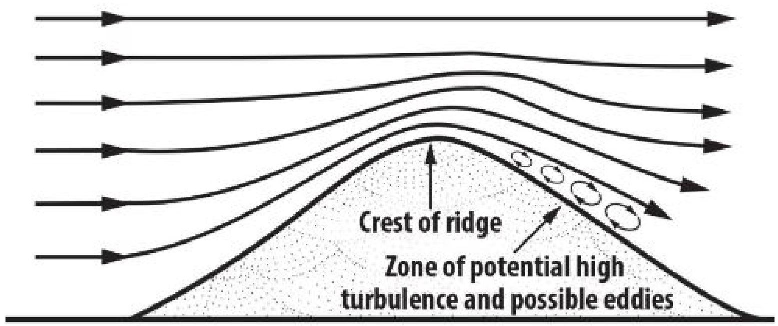

Figure 2-2. Behavior of wind over a ridge crest
(NREL Small Wind Site Assessment Guidelines)

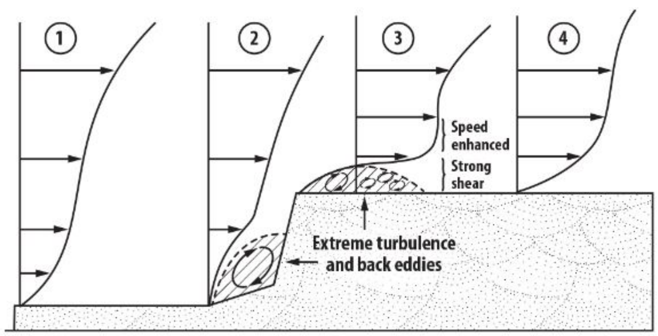

Figure 2-3. Behavior of wind over a bluff
(NREL Small Wind Site Assessment Guidelines)

2.3. Culturally Sensitive Areas

Protecting locations of cultural and historical significance should also be an important part of any development process on tribal lands. There are many instances of sacred Native American landmarks being exploited or misused without regard for the cultural importance of these sites. For example, Bear Butte near Sturgis, South Dakota, has faced controversy involving nearby development of bars, campgrounds, and music venues that disrupt the peace and serenity required for prayer and ceremonies [22]. Bear Lodge (Devils Tower National Monument) in Wyoming is another example. It is a popular spot for rock climbers, many of whom choose to ignore the voluntary ban on climbing in June, which is meant to be a time for ceremonies [23]. In many cases, these sacred sites have fallen out of the control of Native peoples, who must then fight to protect them. It is equally important to be aware of sites existing on tribal lands and adjust development plans to preserve them. Significant cultural sites and how they are determined may vary from tribe to tribe and may or may not be officially protected. In some cases, tribal elders might determine that a particular site is sacred, and in other cases professionals such as archaeologists or anthropologists might determine the sites based on oral history or the discovery of artifacts.

2.4. Transmission

Availability of electricity transmission infrastructure is extremely important to many wind energy projects, especially if they are larger-scale projects. Utility-scale projects are usually designed to export energy away from the wind farm, and transmission lines are what make transportation of this energy possible. Therefore, it is important to keep in mind proximity to transmission lines while selecting a site since transmission lines can be very expensive and time-consuming to construct. Prior to building a new wind energy project, transmission studies must be conducted to determine current capacity. This takes time, so it is important to communicate with the utility operator early in the development process.

2.5. Other Concerns

There have been concerns about the impact of wind turbines on surrounding wildlife that inhabit the same area, particularly birds and bats. Extensive research has been done on the impact of wind energy developments on birds, and while it is true that wind energy projects can and do cause fatalities, it has been shown that casualty rates are relatively lower than those caused by other man-made structures such as buildings and cars [24]. Some species that might be particularly sensitive to development in their habitat are prairie chickens and sage grouse; these species might avoid nesting or residing near turbines. Habitats for raptors, bats, and endangered species should also be properly assessed [3]. Eagles, in particular, are considered sacred to many Native American tribes, and preventative measures should be taken to avoid fatalities. This includes evaluating proposed sites prior to construction in order to determine the level of bird or bat usage, as well as their behavior. Siting projects away from sites where they habitat may help reduce fatalities. Modern wind turbines are larger than those used in older wind energy facilities, with fewer blade rotations per minute and slower blade tip speeds. Many wind turbines today are also mounted on monopole towers as opposed to older lattice-support towers used with older turbines. The lattice-support towers offer birds more places to land and perch, encouraging them to come close to the rotor swept area of the turbines.

Additional factors must be considered during the planning process, including local permitting and zoning laws, community support, and cost assessments. Detailed resources for learning about this process can be found in Appendix A.

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3. WIND ENERGY POTENTIAL AT TURTLE MOUNTAIN

To get an idea of where the best areas for wind energy on Turtle Mountain lands might be, the available land area was evaluated based on some of the siting considerations described in Section 2. Initially, only areas falling within the boundaries of the main reservation or off-reservation trust lands were considered. It should be noted, however, that in some cases (OSPA, for example) it may in fact be beneficial to collaborate with off-reservation private landowners.

3.1. Wind Resources

The National Renewable Energy Laboratory (NREL) Wind Prospector tool was used to evaluate wind resources on and around tribal lands. The Wind Prospector is a geographic information system (GIS) tool that helps in making a preliminary assessment of wind energy potential using data from AWS Truepower, LLC. Annual average wind speeds were measured at 80 m, which is a typical height for many modern wind turbines. These wind maps do not necessarily reflect wind on any given day at a given point. Rather, they are used to gauge available annual wind resource for a region and make preliminary estimates.

According to the Wind Prospector, wind speeds of at least 6.5 m/s (14.5 mph) at 80 m are suitable for wind technology development. Figure 3-1 shows that over half the tribal lands have a wind speed of 6.5 to 7 m/s (14.5 to 15.7 mph), with much of the rest having 7 m/s (15.7 mph) or higher winds. It appears that the southeastern corner of the reservation experiences the highest average annual wind speeds at 7.5 to 8 m/s (16.8 to 17.9 mph).

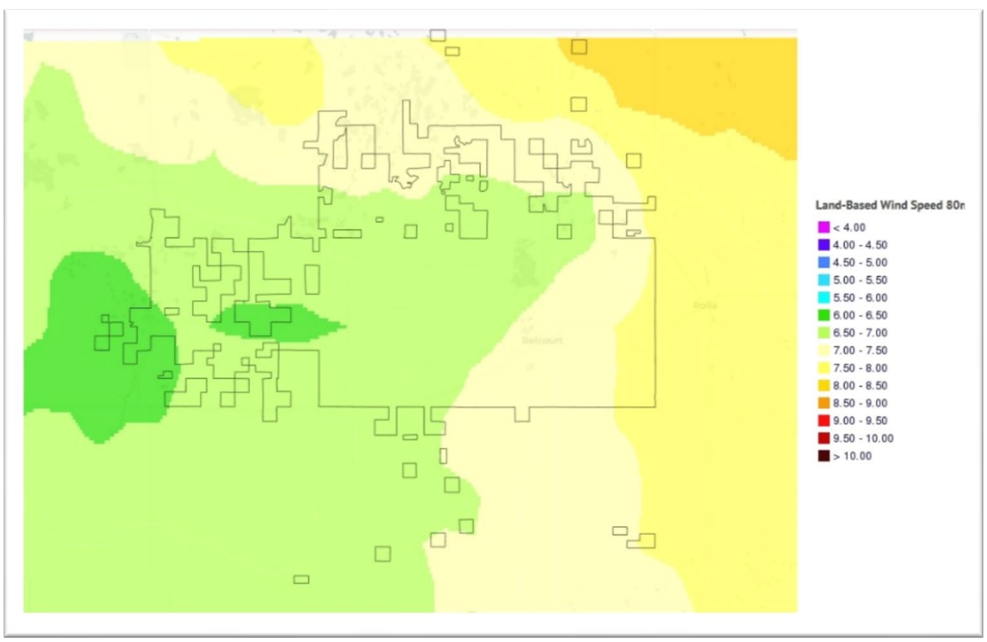

Figure 3-1. Land-Based Wind Speed (m/s) at 80 m over the Turtle Mountain reservation. (NREL Wind Prospector)

3.2. Terrain

To continue narrowing down the suitable land area for development, the following exclusions (based on those in the NREL study "Geospatial Analysis of Renewable Energy Technical Potential on Tribal Lands" [21]) were applied:

- Land with greater than 20% slope
- Incompatible land use areas
  - Forested areas
  - Developed areas (such as towns or cities)
  - Open waters
  - Wetlands

Land cover and topography maps were obtained from the Wind Prospector. The land cover data is based on the National Land Cover Database, which is created by the Multi-Resolution Land Cover Characteristics Consortium. The slope information is from U.S Geological Survey (USGS) National Elevation Dataset.

The Turtle Mountain reservation was shown not to have any areas of land with a slope of 20% or more, as depicted in Figure 3-2. The figure shows maximum percent slope at a 1 km spatial resolution and is a broad view of the region's topography. It does not show localized instances of steep topographic features that may affect the amount and quality of wind a turbine receives. This information would be found by having the area professionally sited using data collected on-location.

Figure 3-2. Maximum Percent Slope of Turtle Mountain Tribal Lands at 1 km Spatial Resolution (NREL Wind Prospector)

Figure 3-3 shows a simplified representation of the types of land cover in the Turtle Mountain region. Much of the northeastern part of the reservation is deciduous forest. There is only one major developed area (the city of Belcourt). Much of the rest of the tribal lands are classified as planted/cultivated areas, grassland, and shrubland. Of course, land cover types and location may vary much more than what is shown. In this instance, it is being used to make an estimate of where ideal land cover types will most likely be located. Choosing a specific site would require a more in-depth evaluation of the location in question (for example, by drone surveying).

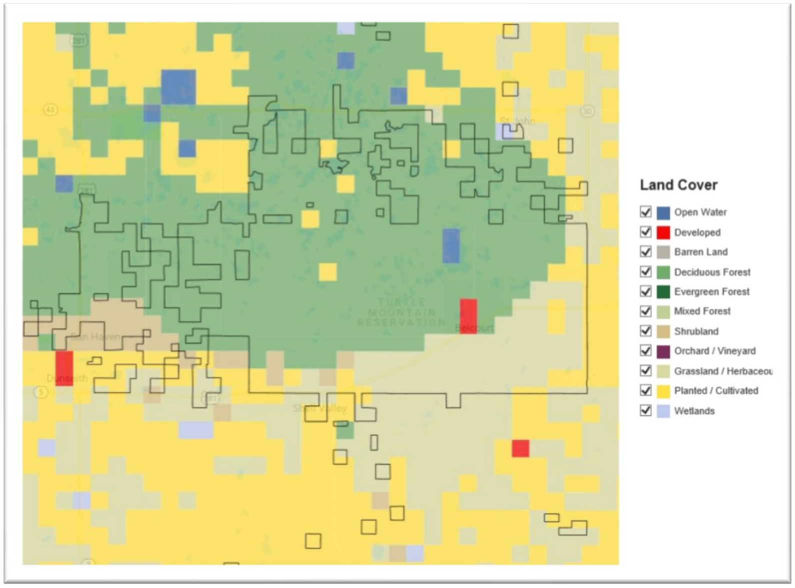

Figure 3-3. Types of Land Cover on Turtle Mountain Tribal Lands (NREL Wind Prospector)

3.3. Culturally Significant Areas

To find locations with cultural or historical significance to Turtle Mountain Band of Chippewa, a tribal member with extensive knowledge on the subject was consulted. Kade M. Ferris, an archaeologist and enrolled member at Turtle Mountain, has over 19 years of experience as a principle investigator and tribal historic preservation officer. He provided a map (Figure 3-4) of important locations on Turtle Mountain tribal lands, found through many archaeological surveys. Examples of these locations might be historical villages or archaeological sites. A 0.25-mile radius of suggested avoidance surrounds each point. These areas were then excluded from the remaining available land area.

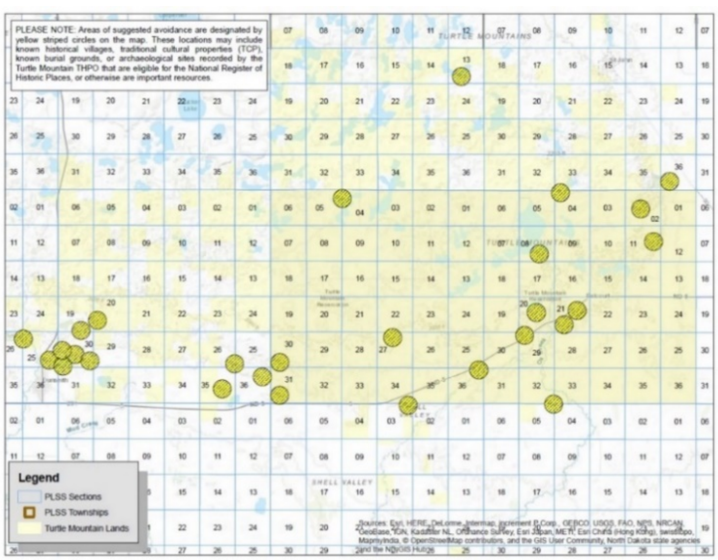

Figure 3-4. Map of Culturally Significant Areas on Turtle Mountain Tribal Lands (Kade Ferris, Tribal Anthropologist)

3.4. Transmission Lines

A shapefile containing major transmission line data was downloaded from the U.S. Department of Homeland Security Homeland Infrastructure Foundation-Level Data website. It was then imported into Google Earth and used to aid in determining which areas on the reservation are close to existing transmission lines. This map (Figure 3-5) may not show smaller or newer transmission lines, and communication with utility companies during the beginning stages of planning is essential to determine where usable transmission infrastructure is located. Having access to available transmission is particularly important for utility-scale wind developments, since a high amount of power will need to be transported.

The G82R line, a point of discussion in previous plans for a wind farm on Turtle Mountain, can clearly be seen near the southeastern corner of the reservation. Several others are shown near the city of Belcourt and along the southern and western boundaries of the reservation.

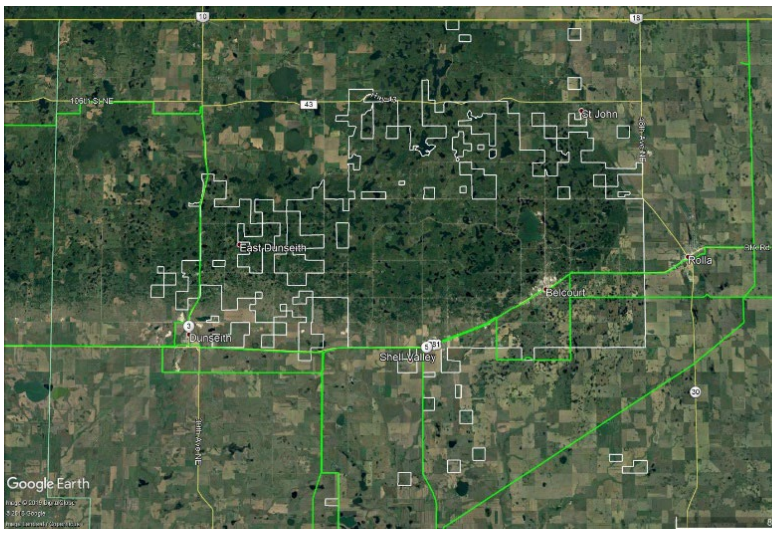

Figure 3-5. Existing Transmission Lines shown as green lines (U.S. Department of Homeland Security)

3.5. Overall Combined Filters

A map (Figure 3-6) was made highlighting remaining available land area after all exclusions are applied. This was done using USGS's The National Map. It seems that areas with a higher likelihood of both higher wind speeds and suitable land cover are located in the southeastern portion of the reservation. This region also has access to several transmission lines. There are many other locations that show promise as well, particularly in the southern parts of the reservation. However, this does not rule out wind energy projects in other regions, as the TMCC turbine has demonstrated. It just means that areas with good wind resource and ideal terrain are more likely to appear in the highlighted areas.

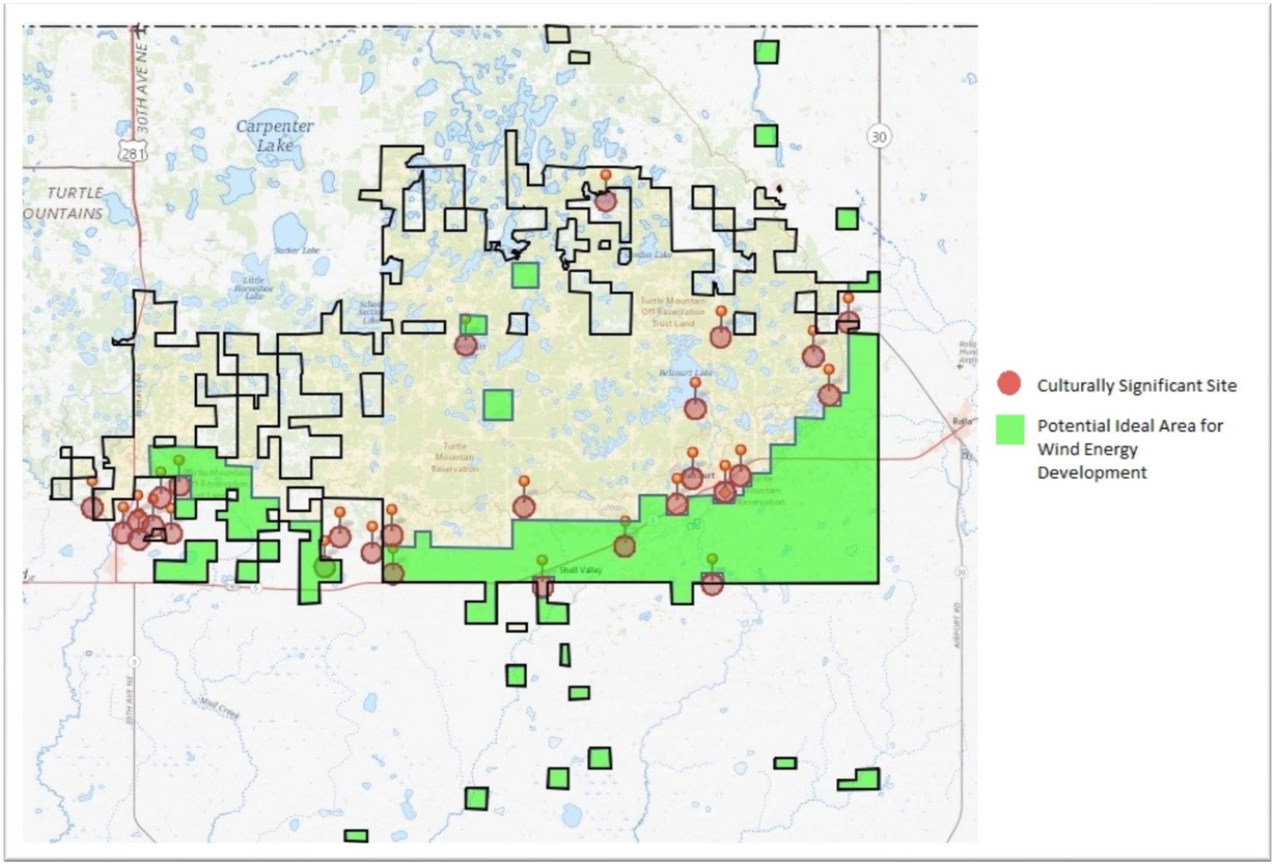

Figure 3-6. Possible Suitable Areas for Wind Energy Development (USGS The National Map)

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4. CONCEPTUAL PROJECTS

Using Figure 3-6, two different sites for conceptual projects (shown in Figure 4-1) were decided upon and the previously discussed siting considerations were applied to each project. Google Earth Pro was used to view each location at a higher resolution than the Wind Prospector maps. This made it easier to see precisely where obstacles such as dense trees and buildings lie. The National Map was used to view elevation contours that could help determine where larger topographical features such as ridges or bluffs might be. Coordinates of the culturally-significant areas were mapped, along with transmission lines. Road access for construction and transportation vehicles was also taken into consideration.

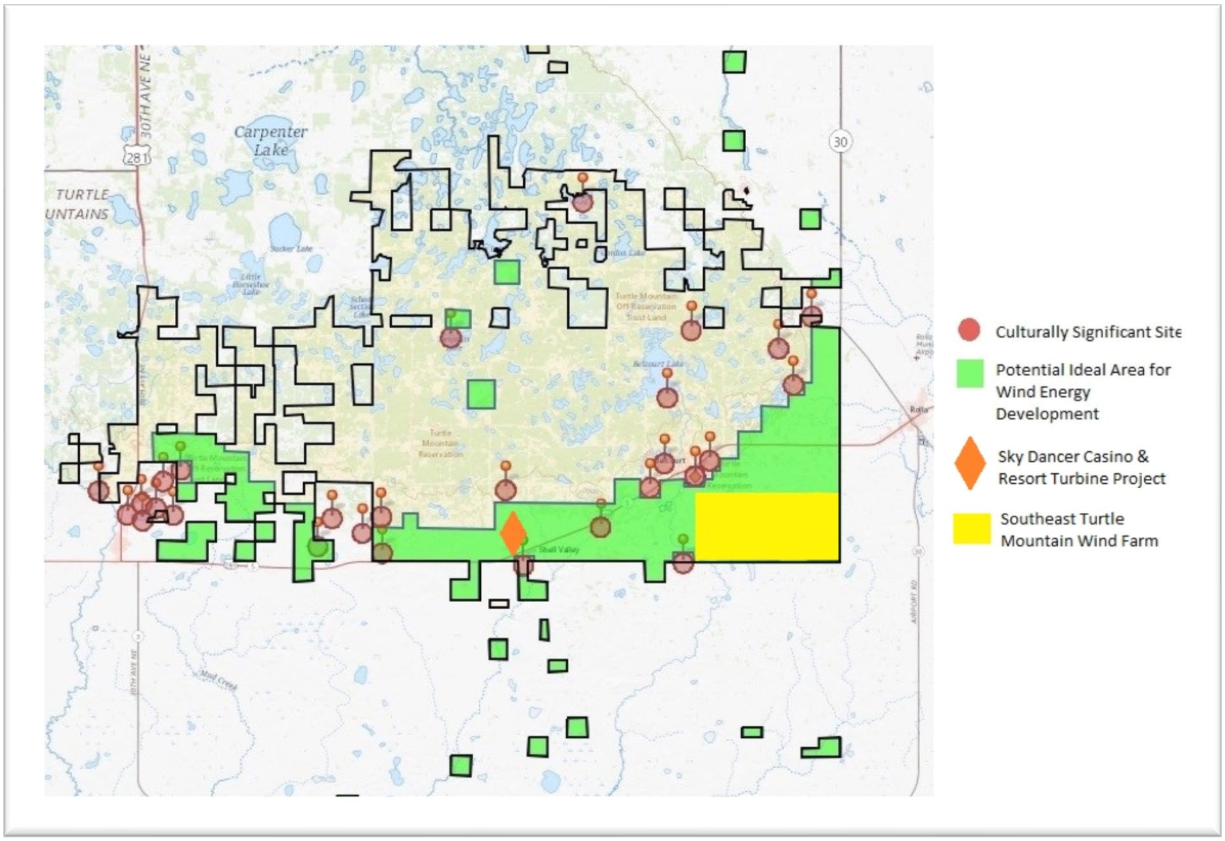

Figure 4-1. Conceptual Project Sites
(USGS The National Map)

4.1. Sky Dancer Casino & Resort Turbine Project

Figure 4-2. Sky Dancer Casino & Resort Turbine Project (Google Earth Pro)

Sky Dancer Casino & Resort Turbine Project (Figure 4-2) would be located at Sky Dancer Casino & Resort. The Sky Dancer is a major source of economic development for the reservation, attracting tourism and providing jobs for many tribal members. It recently underwent an expansion and renovation, with the construction of new hotel rooms, updated casino area, and an event center [25]. The Sky Dancer currently has 700 slot machines, a restaurant, snack bar, pool, and 194 guest rooms in the hotel. Based on this, combined with the fact that it is open 24 hours per day, the Sky Dancer is presumably a major energy consumer for the tribe.

This location falls within the 6.5-7 m/s (14.5-15.7 mph) region on the wind map, indicating that it has suitable wind resource for development. Much of the surrounding land appears to be open grassy areas or farmland. It is unclear precisely where the boundaries are for this parcel of land that the casino resides on. It is not within a 0.25-mile radius of a culturally or historically significant protected site. The site appears to sit near the top of an elevated landform (Figure 4-3), but more detailed surveying on-site would be required to pick a definitive location for wind turbine installations.

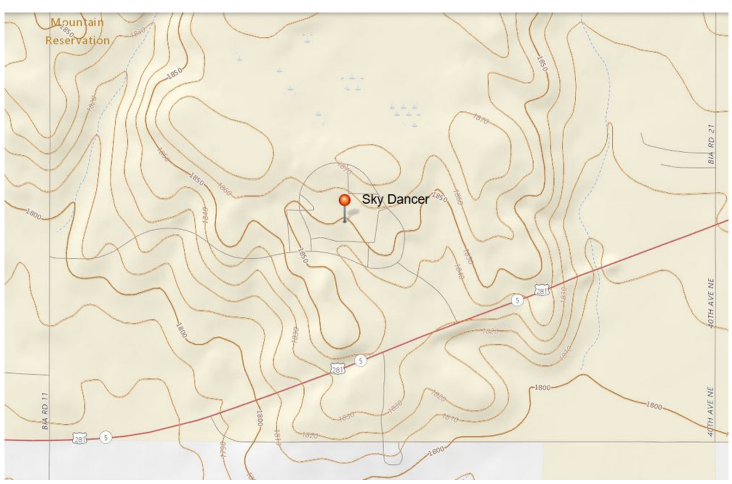

Figure 4-3. Contour Map Surrounding Sky Dancer Casino & Resort Turbine Project (USGS The National Map)

The Sky Dancer receives its energy from the Otter Tail Power Company, an investor-owned electric utility company. The utility company currently has 5.6 MW of distributed electricity from renewable energy sources on its system, serving 40 small customer-owned facilities. In Appendix K of its 2017-2031 resource plan [26], Otter Tail stated that they "will continue to analyze renewable distributed generation projects that are submitted for consideration. However, with its RES/REO obligations met in all three states, Otter Tail will only consider projects that are competitive with the Midcontinent ISO energy market or are needed to meet renewable objectives or the solar mandate in the service territory that it serves."

Information on the Sky Dancer's energy consumption was not found, so an estimate was made based on the energy usage of Northern Lights Casino, run by the Leech Lake Band of Ojibwe in Minnesota. Northern Lights is a similarly, if slightly larger, sized facility with 900 slot machines, a pool, hotel, and two restaurants. In 2003, it was found that its energy consumption totaled 6,427,320 kWh [27]. This was used as a rough estimate of energy consumption in calculations. Obtaining detailed information about the Sky Dancer's energy consumption would be an essential part of the project planning process.

Based on the estimated energy consumption of a facility of this size, and assuming a capacity factor of 0.4 (40%), this site would need a turbine with approximately 1.8 MW of capacity to be powered entirely by wind energy.

4.2. Southeast Turtle Mountain Wind Farm

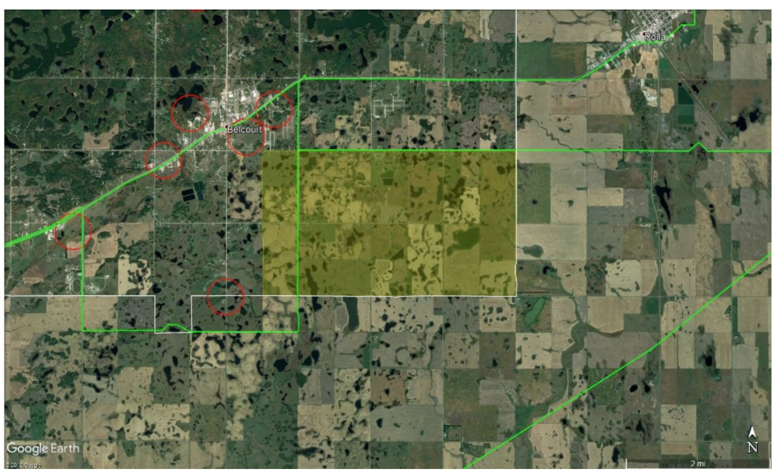

Figure 4-4. Proposed Area for Conceptual Wind Farm (Google Earth Pro)

Southeast Turtle Mountain Wind Farm can be implemented in the southeastern corner of the reservation, in or near the highlighted 20.6 km^2 area shown in Figure 4-4. Assuming a power density of 5 MW/km^2 [21], the capacity for this site would be about 103 MW if the entire land area is utilized for wind turbines. According to the NREL wind map, this spot receives annual average wind speeds between 7 and 8 m/s. The land here is primarily made up of agricultural fields and open areas of grass, though there are some scattered patches of trees/shrubs and small bodies of water. It is unknown what the land ownership is for this area. The proposed area avoids culturally sensitive locations. Figure 4-5 shows that the elevation of this area ranges from 560.8 m (1840 ft) up to 579.1 m (1900 ft) in some spots. An on-site assessment would be needed to place the individual turbines in optimal positions.

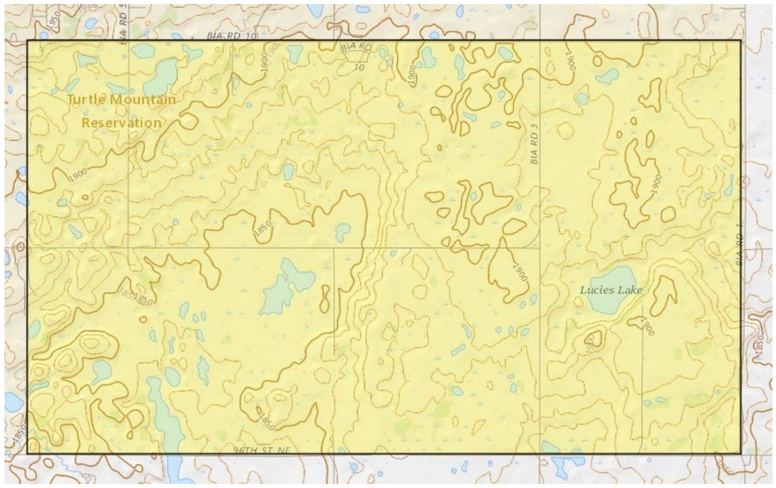

Figure 4-5. Contour Map of Southeast Turtle Mountain Wind Farm (USGS The National Map)

The fact that this location had already been a point of discussion when the turbine at TMCC was being planned supports this choice. It is close to transmission lines, and the number and density of residences in this region is also less, reducing potential negative impact on neighboring homes. Though this area appears quite large, the actual land taken up by the turbines is minimal. Landowners can still utilize the area for agricultural and other purposes.

5. CONCLUSIONS

Potential ideal areas for wind technology development on the Turtle Mountain Band of Chippewa reservation were investigated based on several siting considerations, including annual wind resources, terrain, land usage, and other factors such as culturally sensitive sites. Based on this information, two conceptual projects were chosen to investigate closer—one community-scale project and one utility-scale project. The end results were preliminary assessments of the potential for wind energy technology development on Turtle Mountain tribal lands, intended to justify further research into the feasibility of such projects.

5.1. Conceptual Projects

Based on the information gathered on the two conceptual sites, both show potential for wind energy development. Sky Dancer Casino & Resort Turbine Project would be located near one of the tribe's highest energy consumers, the casino. The surrounding land appears to be suitable for wind energy, and the wind resources are good. For the casino to be powered partly or entirely by renewable energy would add to its image of being a modern, state-of-the-art facility. The primary goal for this project would be to offset energy costs for the casino and hotel, saving money for the tribe that can then be utilized elsewhere to benefit tribal members.

Southeast Turtle Mountain Wind Farm can occupy one of the least developed areas of the reservation, containing mostly grassland and farmland. This makes it a possible area for a utility-scale wind farm, especially since there is nearby access to transmission. A wind farm could produce revenue that can then be used to benefit the community, like providing free or low-cost electricity to elders and low-income households. Alternatively, it can help fund other residential or community-scale renewable energy projects on the reservation.

The possibility of a wind project being viable would of course depend on a multitude of other factors not included in this paper. It must be determined whether the proposed project is economically feasible and beneficial for the tribe. Communication with local electric cooperatives in the early stages of planning would be essential. Environmental studies and the support and input of the community is also important. These were outside the scope of the work presented in this report.

5.2. Lessons Learned

There are many resources available to tribes interested in developing wind energy, including online courses and material from Department of Energy (DOE) Office of Indian Energy. Appendix A includes a list of some of these resources.

Tribal leaders can also contact other tribes who have experience with tribal energy projects, as they may have valuable insights into possible obstacles to wind technology development faced by Native communities. Many are very welcoming and willing to help other tribes and answer questions about their projects.

Learning from other tribes' experiences is crucial. During a summer internship, the author had the unique opportunity to travel to several different tribal communities and see firsthand what they have done to implement renewable energy and energy efficiency efforts. After listening to them, in addition to interviewing other professionals in the energy field, the author compiled these key points:

- Utility-scale wind projects do not necessarily have to be limited to tribal lands; having a mix of tribal, allotted, and privately-owned lands can be beneficial given the right circumstances
- Collaboration with people of differing backgrounds, perspectives, and level of technical or cultural expertise during the planning process is key
- It is important to ensure that energy goals are in line with the values of the community
- Practicing energy efficiency is very important, even when power is coming from a renewable source.
- Educating renewable energy users on the technology, how it works, and how to be energy efficient plays a major role in the success of a project, particularly with residential-scale technologies

5.3. Next Steps

While the conceptual sites might not reflect the size or locations of actual future projects, they demonstrate that Turtle Mountain lands show promise and that there is untapped potential for renewable energy development. These sites are only a couple possible areas that may be ideal, and further investigation into this topic may discover additional sites. If not already in progress, applying for funding for feasibility studies would be a good first step. It is also important to know the tribe's energy usage and costs to best assess where a project should go.

Renewable energy projects take a lot of time, dedication, and effort to plan and develop, often longer than any one tribal leader term. Creating a tribal renewable energy office or department could help the development process move along smoother and faster. Many young tribal members, including the author, are eager to attend college and bring back their experience to help their home communities, yet jobs are still very limited. Creating more opportunities would not only benefit them, but the tribe would also gain a wealth of knowledge and expertise to keep within the community.

There are many other steps that can be taken in the meantime, such as:

- Create a renewable energy standard for the tribe
- Hold workshops to educate tribal members about energy efficiency, renewable energy, and other related topics
- Implement energy efficient practices with any new homes or buildings being constructed on the reservation

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APPENDIX A. ADDITIONAL RESOURCES

The following are resources that may be helpful to anyone interested in planning a wind technology project:

A.1. Renewable Energy Basics and Planning Process

A very in-depth guide to planning

https://planning-org-uploaded-media.s3.amazonaws.com/legacy_resources/research/wind/pdf/pas566.pdf

DOE Office of Indian Energy Foundational Course, Very informative about wind renewable technologies

https://www.energy.gov/sites/prod/files/foundation_wind.swf

Community-Scale Planning Process

http://www.windustry.org/community_wind_toolbox-3-project-planning-and-management

https://www.energy.gov/indianenergy/past-webinars

A.2. Technical/Financial Assistance

https://www.energy.gov/indianenergy/technical-assistance
https://www.energy.gov/indianenergy/energy-development-assistance-tool

A.3. Maps and Visual Data

Shows wind maps and information for wind energy siting

https://maps.nrel.gov/wind-prospector/

Similar to wind prospector, more specific to tribes

https://maps.nrel.gov/tribal-energy-atlas/

The National Map, shows detailed land cover data

https://viewer.nationalmap.gov/advanced-viewer/

A.4. Examples of Other Tribal Wind Projects

Campo Kumeyaay Wind Farm
https://www.eastcountymagazine.org/images/documents/KumeyaayWindEnergyProjectCampoKumeyaayNation.pdf

Oceti Sakowin Power Authority Wind Farms
https://www.wind-watch.org/news/2019/01/24/wind-farms-planned-for-pine-ridge-cheyenne-river/
http://ospower.org/

Minnesota Tribal Coalition Tribal Utility Capacity Building Project
https://www.energy.gov/sites/prod/files/2016/01/f28/0711review_triplett.pdf

Fort Berthold
https://www.energy.gov/sites/prod/files/2016/02/f29/3tribes2005final.pdf
https://www.energy.gov/sites/prod/files/2016/02/f29/3tribes06final.pdf

Standing Rock
https://www.energy.gov/indianenergy/standing-rock-sioux-tribe-2012-project

Rosebud Community-Scale Wind Turbine
https://www.osti.gov/servlets/purl/951198

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