Environmental Report

Goodhue Wind Project

In the Matter of the Application of AWA Goodhue, LLC for a Certificate of Need for a 78 MW Wind Project and Associated Facilities in Goodhue County

PUC Docket No. IP-6701/CN-09-1186

Energy Facilities Permitting
85 7th Place East, Suite 500
Saint Paul, MN 55101

June 2010

Responsible Governmental Unit	Project Proposer
Minnesota Office of Energy Security	**AWA Goodhue, LLC**
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Abstract

On October 15, 2009, AWA Goodhue, LLC (applicant), filed a certificate of need application with the Minnesota Public Utilities Commission (Commission) for the Goodhue Wind Project (project). The applicant is proposing to construct a 78 megawatt (MW) large wind energy conversion system in Goodhue County, Minnesota.

The proposed project is a large energy facility as defined by Minnesota Statutes, section 216B.2421. Such a facility requires a certificate of need from the Commission (Minn. Stat., section 216B.243). Additionally, the Minnesota Department of Commerce must prepare an environmental report (ER) for the project (Minn. Rules 7849.1200).

Office of Energy Security, Energy Facility Permitting (OES EFP) staff is responsible for preparing the environmental report (ER). This ER has been prepared as per Minnesota Rules 7849.1100-2100. The ER is part of the record which the Commission will consider in making a decision on a certificate of need for the project.

Information about this project can be found on the Commission's energy facilities permitting website: http://energyfacilities.puc.state.mn.us/Docket.html?Id=25631, or obtained by contacting Larry Hartman, Office of Energy Security, 85 7th Place East, Suite 500, St. Paul, Minnesota 55101, phone: (651) 296-5089, email: larry.hartman@state.mn.us.

Information about the Commission's certificate of need process can be obtained by contacting Tricia DeBleeckere, Minnesota Public Utilities Commission, 121 7th Place E., Suite 350, Saint Paul, MN 55101, phone: (651) 201-2254, email: tricia.debleeckere@state.mn.us.

The record for the certificate of need for this project can be found on the eDockets system at: https://www.eDockets.state.mn.us/EFiling/search.jsp; search on the year "**09**" and number "**1186**".

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1.0 Introduction

On October 15, 2009, AWA Goodhue, LLC (applicant), filed a certificate of need application with the Minnesota Public Utilities Commission (Commission) for the Goodhue Wind Project (project).[1] The applicant is proposing to construct a 78 megawatt (MW) large wind energy conversion system in Goodhue County, Minnesota.

A final decision on a turbine model has not be made, but the project will consist of turbines with a rated output of 1.5 or 1.6 MW in such number and combination as to yield 78 MW. Facilities associated with the project include gravel access roads, an electrical collection system, two project substations, a transmission line, up to two meteorological towers, and an operations and maintenance building.

The project would be located in Goodhue County, Minnesota, within a project area of approximately 32,700 acres. The project would be located just west of the city of Goodhue in the townships of Belle Creek, Goodhue, Vasa, Minneola, and Zumbrota. Electricity from the project's wind turbines would be collected at two project substations (north substation, south substation). These substations would connect to the electrical transmission grid via new and existing 69 kilovolt (kV) transmission lines.

In addition to a certificate of need (CON), the project requires a site permit from the Commission. The site permit is being considered by the Commission in a separate docket (WS-08-1233).

The proposed project is a large energy facility as defined by Minnesota Statutes, section 216B.2421. As a result, it requires the Minnesota Department of Commerce to prepare an environmental report (ER) for the project (Minn. Rules 7849.1200). Office of Energy Security, Energy Facility Permitting (OES EFP) staff has prepared this ER to fulfill this requirement. The ER is part of the record which the Commission will consider in making a decision on a CON for the project.

The proposed project is intended to produce renewable energy in furtherance of Minnesota's renewable energy objectives. Accordingly, alternatives examined in this ER are limited to "eligible energy technologies" that support these objectives (Minn. Stat., section 216B.1691). These alternatives include: (1) a generic 78 MW wind generation project sited elsewhere in Minnesota, (2) a 30 MW biomass plant, (3) a "no build" alternative, and (4) renewable energy technologies.

Section 2 of this ER outlines the regulatory framework governing the project. Section 3 describes the proposed project. Section 4 describes alternatives to the project and their feasibility and availability. Section 5 describes the potential impacts of the no build alternative. Section 6 discusses the potential human and environmental impacts of the project and

[1] The October 15, 2009, filing for a certificate of need was made by Goodhue Wind, LLC. On January 22, 2010, the filing was revised to reflect a new business structure for the project and to name AWA Goodhue, LLC, a Minnesota limited liability company, as the applicant.

alternatives, including possible mitigations. Section 7 describes the additional permits that may be required for this project.

Sources of Information

Information for this report is drawn from multiple sources, which are noted throughout. Primary sources include AWA Goodhue, LLC's applications to the Commission:

- Application for Certificate of Need, AWA Goodhue, LLC, October 15, 2009[2]
- Amended Site Permit Application for Large Wind Energy Conversion System, AWA Goodhue, LLC, October 19, 2009.[3]

Additional information has been incorporated from earlier, related Environmental Quality Board and Department of Commerce reports.

[2] Application of Goodhue Wind, LLC, for a Certificate of Need for a 78 MW Large Wind Energy Conversion System in Goodhue County, October 15, 2009; amended January 22, 2010 [hereafter CON Application], https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=viewDocument&documentId={0B931DF6-87C8-4B2C-A04B-36E85050698D}&documentTitle=200910-42906-03&userType=public.

[3] Amended Application to the Minnesota Public Utilities Commission, Site Permit Application for a Large Wind Energy Conversion System, October 19, 2009 [hereafter Site Permit Application], http://energyfacilities.puc.state.mn.us/resource.html?Id=25633.

2.0 Regulatory Framework

AWA Goodhue, LLC (applicant), is proposing to construct and operate the Goodhue Wind Project (project) in Goodhue County, Minnesota. The project is a large wind energy conversion system as defined in the Wind Siting Act (Minn. Stat. Chapter 216F). The project is designed to produce 78 megawatts (MW) of power and thus is a large energy facility per Minnesota Statutes, section 216B.2421.

In accordance with Minnesota Statutes, section 216B.243, no large energy facility may be sited or constructed in Minnesota without issuance of a certificate of need (CON) by the Minnesota Public Utilities Commission (Commission). Accordingly, on October 15, 2009, the applicant submitted a certificate of need application to the Commission. On December 30, 2009, the Commission issued an order accepting the application as complete and authorizing an informal review process.[4]

The informal review process includes several steps designed to develop a record upon which a CON decision can be made, including: (1) a notice and comment period, (2) analysis by Department of Commerce, Office of Energy Security, Energy Regulation and Planning (OES ERP) staff, (3) analysis by Office of Energy Security, Energy Facility Permitting (OES EFP) staff, and (4) a public hearing conducted by an administrative law judge (ALJ). Based on the ALJ's hearing report and entire record, Commission staff will make a recommendation to the Commission on issuance of the certificate of need. The Commission is the final decision-making body.

2.1 Environmental Report

Per Minnesota Rule 7849.1200, the analysis provided by OES EFP staff takes the form of an environmental report (ER). The ER provides an analysis of potential human and environmental impacts of the project, as well as alternatives to the project. To develop the ER, OES EFP staff is required to conduct at least one public meeting in the proposed project area. The purpose of the meeting is to advise the public of the project and to solicit public input into the scope of the ER. A "scope" is a determination of what needs to be assessed in the ER in order to fully inform decision-makers and the public about the possible impacts of the project and potential alternatives.

OES EFP staff held a public meeting on March 4, 2010, in Mazeppa, Minnesota. Approximately 200 people attended the meeting. A public comment period followed the meeting; the comment period closed on March 26, 2010. More than 110 written comments were received during the comment period. Concerns raised at the public meeting and in written comments included

[4] Order Finding Application Complete and Initiating Informal Review Process, December 30 2009, https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={02683040-2343-45AB-AFE9-75CD7418FD5A}&documentTitle=200912-45523-01.

potential impacts related to property values, aesthetics, public health and safety, wildlife, electronic communications, aviation, noise, and shadow flicker.[5]

Based on the scoping comments received and the rules governing the scope of an ER (Minn. Rules 7849.1500), the Director of the Office of Energy Security issued a scoping decision on May 27, 2010 (Appendix A). This environmental report has been developed in accordance with the scoping decision.

As noted above (and in the scoping decision), a public hearing conducted by an administrative law judge will be held in the project area to further develop the record for a Commission decision. This ER will be introduced into the hearing record by OES EFP staff.

2.2 Permits

Site Permit

In addition to a certificate of need, the proposed project requires a site permit (Minn. Stat., section 216F.04). This permit is issued by the Commission and is being considered by the Commission in a separate docket (WS-08-1233).[6] A site permit (authorizing the siting and constructing of the project) may not be issued before a certificate of need has been issued for the project (Minn. Stat., section 216B.243).

Additional Permits

In addition to approvals issued by the Commission, the project will require permits and approvals from federal agencies, additional state agencies, and local governments. These permits are discussed in Section 7.

Public Participation

The Commission relies on public participation in its certificate of need and permitting processes. Public participation enables the development of a thorough record. Citizens can ensure notice of these processes by placing their names on the appropriate OES project contact lists. Citizens can sign up for the Goodhue Wind project list on line: http://energyfacilities.puc.state.mn.us/Docket.html?Id=25631.

Citizens may also have their names placed on these project lists by contacting the OES state permit manger, Larry Hartman, phone: (651) 296-5089, email: larry.hartman@state.mn.us.

[5] See, e.g., Public Comments from AWA Goodhue, LLC Environmental Report Scoping Meeting on March 4, 2010, http://energyfacilities.puc.state.mn.us/documents/25631/030410%20PDF.pdf.
[6] See, Goodhue Wind Project, http://energyfacilities.puc.state.mn.us/Docket.html?Id=25631.

3.0 Description of the Proposed Project

AWA Goodhue, LLC (applicant, "AWA Goodhue"), is proposing to construct and operate the Goodhue Wind Project (project), a 78 MW wind farm in Goodhue County, Minnesota. AWA Goodhue is a limited liability company comprised of assets of GW Community Holdings, LLC and American Wind Alliance, LLC. The project is being managed by National Wind, LLC.[7] Electrical power from the project will be sold to Xcel Energy.[8] The project is intended to produce renewable energy in furtherance of Minnesota's renewable energy objectives (Minn. Stat., section 216B.1691).

3.1 Project Location

The project will be located in southeastern Minnesota near the city of Goodhue, Minn., within a project area of approximately 32,700 acres. The project would be located in Goodhue County in the townships of Belle Creek, Goodhue, Vasa, Minneola, and Zumbrota (Figure 1). The project area is predominantly rural and agricultural (Figure 2). Crops include corn, soybeans, small grains, and forages. Windbreaks are common around farmsteads; willows, grasses, and sedges are found near streams and ditches.[9]

The project area topography is relatively flat, but includes hills and ridges associated with water drainage (Figure 3). Elevations range from 929 to 1,243 feet above sea level.[10] Drainage is affected by agricultural ditches, drain tile, streams, and creeks.

The project area has a relatively low population density, with an estimated 17 persons per square mile.[11] The city of Goodhue, near the eastern edge of the project area, has a population of approximately 800 persons.[12] The city of Zumbrota, near the southern edge of the project area, has a population of approximately 2,800 persons.[13] The largest city in Goodhue County, the city of Red Wing, has a population of approximately 16,200 persons and is located about 15 miles northwest of the project area.

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[7] See the January 22, 2010 revision to the CON Application, https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={B5ACC18D-8111-4381-941F-DD9FFFA2CA8B}&documentTitle=20101-46288-01.

[8] AWA Goodhue has entered into power purchase agreements with Xcel Energy. See, Order Approving Power Purchase Agreements, Approving Contract Amendments, and Requiring Further Filings, April, 28, 2010, https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={097BAFD1-89FA-4E9C-9A4C-DEABF64758F1}&documentTitle=20104-49706-02.

[9] Site Permit Application, Section 4.4.1.

[10] Id.

[11] Site Permit Application, Section 4.2. The average population density for the State of Minnesota is 61.8 persons per square mile; the population density for Goodhue County is 58.2 persons per square mile. See Population Density, http://www.demography.state.mn.us/resource.html?Id=5238. Population densities for counties along the Buffalo Ridge in Southwestern Minnesota are in the range of 12-30 persons per square mile. Id.

[12] The 2000 census indicates a population of 778 persons, http://www.demography.state.mn.us/resource.html?Id=5238. The city of Goodhue website indicates a population of "just under 1,000," http://www.cityofgoodhue.com/.

[13] Population Density, http://www.demography.state.mn.us/resource.html?Id=5238.

3.2 Project Description

The Goodhue Wind Project will have a nameplate capacity of 78 MW. A final decision on a turbine model has not been made, but the project will consist of General Electric turbines with a rated output of 1.5 or 1.6 MW in such number and combination as to produce 78 MW.[14] Characteristics of turbine models considered for use in the project are shown in Table 1. Turbines would be placed on towers 80 meters (262 ft) in height.

Some site permit conditions for large wind energy conversion systems (LWECS) are based on criteria which are dependent on turbine size.[15] Turbines must be placed within the project boundary and meet all permit conditions. Accordingly, the final siting ("micro-siting") of wind turbines for the project will depend on, among other factors, the size of the turbines chosen for the project. A preliminary turbine layout using 1.5 MW turbines is shown in Figure 4.

Table 1. Wind Turbine Specifications[16]

Characteristic	General Electric 1.5 MW	General Electric 1.6 MW[17]
Hub Height	80 m (262 ft)	80 m (262 ft)
Rotor Diameter	82.5 m (271 ft)	82.5 m (271 ft)
Total Height	121 m (398 ft)	121 m (398 ft)
Cut-in Wind Speed	3.5 m/s (7.8 mph)	3.5 m/s (7.8 mph)
Cut-out Wind Speed	25 m/s (55.9 mph)	25 m/s (55.9 mph)
Rotor Speed	10 to 22 rpm	10 to 22 rpm
Distance to 50 dB(A) Noise Level	221 m (725 ft)	221 m (725 ft)
3 Rotor Diameters	247.5 m (812 ft)	247.5 m (812 ft)
5 Rotor Diameters	412.5 m (1,353 ft)	412.5 m (1,353 ft)

m = meters, ft = feet, m/s = meters per second, mph = miles per hour, rpm = revolutions per minute

[14] Site Permit Application, Section 1.0, Section 3.2. Subsequent to the application, the applicant eliminated the REpower 2.0 MW turbine from consideration for the project.
[15] For example, turbine setbacks from the project boundary and all non-participating lands are expressed in rotor diameters (RD). Rotor diameters vary with turbine size.
[16] Adapted from Site Permit Application, Section 3.2, Table 3-1.
[17] The General Electric (GE) 1.6 MW turbine is an upgraded version of the GE 1.5 MW turbine; see New GE Technology Boosts Wind Turbine Output, http://www.gepower.com/about/press/en/2009_press/050409d.htm.

Turbine towers will be secured by concrete foundations that vary in size and design depending on soil and substrate conditions. A control panel inside the base of each turbine tower houses communication and electronic circuitry. Each turbine will be connected to a supervisory control and data acquisition (SCADA) system. The SCADA system allows for real-time monitoring and control of turbine operation.

Facilities associated with the project include gravel access roads, an electrical collection system, two project substations, a transmission line, up to two permanent meteorological towers, and an operations and maintenance building. Electricity from the project's wind turbines would be collected at two project substations. These substations would connect to the electrical transmission grid via new and existing 69 kilovolt (kV) transmission lines. The area of permanent, direct land use for the project will be between 38 and 47 acres.[18]

Electricity generated by each turbine will be stepped up by a pad-mounted transformer at the base of each turbine to a collection line voltage (34.5 kV). The collection lines and SCADA fiber optic cable will be buried.[19] The collection lines will carry power from the turbines to two collection substations – a "Goodhue North" substation and a "Goodhue South" substation. Substations will require 1-4 acres of land and will include transformers, breakers, and relays.

Collection substations will transform the power to a voltage of 69 kV for connection to the electrical grid. The Goodhue North substation will be located near the community of Ryan, Minn. Power from the substation will be transmitted by a new 69 kV transmission line to the existing Vasa substation, approximately 4 miles north of the project area.[20] The Goodhue South substation will be located next to an existing 69 kV transmission line that crosses the project area. The substation will connect with this line.[21]

Once operational, the project will produce between 230 and 270 megawatt-hours (MWh) of electrical energy annually.[22] The net capacity factor is estimated to be between 34 and 39 percent.[23]

Service roads will provide access to turbine sites for construction, maintenance, and eventual decommissioning. Roads will be graded, overlaid with geotechnical fabric (as needed), and covered with gravel.[24] The extent of service roads depends on the turbines used for the project and the project layout. Permanent service roads will be approximately 16 ft. wide; temporary service roads (for construction) will be up to 45 ft. wide.[25] Temporary roads and construction

[18] CON Application, Section 2.1. The area of permanent land use depends on the type of number of turbines used for the project.
[19] A wireless SCADA system may be used for the project; see Site Permit Application, Section 3.3.2.
[20] CON Application, Section 2.1, Site Permit Application, Section 3.1. The Vasa substation is operated by Great River Energy and is located at the intersection of County Rd. 19 and County Road 51 in Vasa Township.
[21] Id.
[22] Site Permit Application, Section 3.8.
[23] Id. Capacity factor is the ratio of the actual power produced by a power plant (wind turbine) over a period of time versus its output if it had operated at nameplate capacity over the same time period.
[24] Site Permit Application, Section 3.3.4.
[25] Id.

areas will be restored after construction; permanent service roads will be maintained for project operations.

The location of the operations and maintenance (O&M) building has not yet been determined. The O&M building will house electrical switchgear for the project and thus will likely be located near a project substation.[26] The O&M building will measure approximately 3,000 to 5,000 square feet and will have a gravel parking lot.

After construction of the wind farm, up to two meteorological towers will be installed in the project area to monitor wind resources. Towers are 80 m (262 ft.) in height, free standing, and require approximately 3 acres at their base for installation.[27] Towers must comply with all Federal Aviation Administration lighting requirements.

3.3 Project Cost and Schedule

The cost of developing and constructing the Goodhue Wind Project is estimated to be $179 million dollars.[28] Operating costs for the project are estimated to range from $4 million to $5 million dollars per year.[29] Project construction would begin once all necessary permits are obtained; construction would take approximately six months. The applicant projected commercial operation of the project in December 2010.[30] The date of commercial operation depends on interconnection, permitting, and other project development activities.

[26] Site Permit Application, Section 3.3.1.
[27] Site Permit Application, Section 3.3.5.
[28] Site Permit Application, Section 3.6. The applicant estimates capital costs to be $2.3 million dollars per installed MW of nameplate capacity. Thus, 78 MW x $2.3 M/MW = $179 million dollars.
[29] Id.
[30] Site Permit Application, Section 3.7.

4.0 Project Alternatives

This section describes alternatives to the Goodhue Wind Project. Typically, alternatives to the project would include generation facilities of all types, including plants that use coal, natural gas, fuel oil, or similar non-renewable fuels. Alternatives would also include constructing transmission facilities (to import energy) in lieu of generation. However, the proposed project is intended to produce renewable energy in furtherance of Minnesota's renewable energy objectives. Accordingly, alternatives considered here are technologies eligible to be counted toward these objectives.[31]

Alternatives to the Goodhue Wind Project examined in this ER include: (1) a generic 78 MW wind generation plant (LWECS) sited elsewhere in Minnesota, (2) a 30 MW biomass plant, (3) a "no build" alternative, and (4) renewable energy technologies. The generic 78 MW LWECS and 30 MW biomass plant are discussed further in Section 6. The "no build" alternative is discussed further in Section 5. Renewable energy technologies, because none are feasible and available alternatives to the proposed project, are discussed solely in this section.

4.1 78 MW LWECS

An alternative to the proposed project, which would utilize an eligible renewable energy (wind), is a large wind energy conversion system (LWECS) sited elsewhere in Minnesota. Such a project could, theoretically, be a 78 MW project or a combination of smaller dispersed projects. The analysis in this ER will attempt to describe differences in the impacts associated with a generic 78 MW wind project sited in Minnesota and the Goodhue Wind Project, sited in Goodhue County.

4.2 30 MW Biomass Plant

A biomass alternative to the proposed project would be an eligible renewable energy technology. There are various possible sources of biomass fuel that could be used. St. Paul District Energy, a combined heat and power facility in downtown St. Paul, is fueled primarily by waste wood and has an electric generation capacity of 25 MW. The 55 MW Fibrominn plant in Benson, Minn., burns turkey litter. The Laurentian Energy Authority operates facilities in Hibbing and Virginia, Minn., with a combined capacity of 35 MW that convert wood, wood wastes, and agricultural biomass into electricity.

The biomass alternative analyzed in this ER is one that would burn a combination of hybrid willows, poplars, and corn stover, with natural gas as a backup fuel. This alternative is considered because such a plant, the NGPP Minnesota Biomass, LLC, electric generation facility, has already undergone environmental review in Minnesota, and data regarding potential environmental impacts associated with such a plant are available. Additionally, given the potential available feedstock in the project area, such a biomass plant is feasible.

[31] Minn. Stat. § 216B.1691, Subd. 1. Eligible energy technologies include technologies that generate electricity from solar, wind, hydroelectric, hydrogen, or biomass.

The NGPP project was reviewed by the Environmental Quality Board (Board) in 2003 when it prepared an environmental assessment worksheet (EAW) on the proposed facility.[32] At the time that it was reviewed by the Board, the NGPP project was a 38.5 MW project. The analysis that was conducted on that facility by the Board is valid for use as an alternative analysis in this ER. The Goodhue Wind Project will have a capacity of 78 MW, with an estimated capacity factor between 34 and 39 percent. The 30 MW biomass alternative examined in this ER is an appropriately-sized generation alternative.[33]

4.3 No Build Alternative

The no build alternative means that no wind project is constructed. Analysis for this alternative will consider the potential benefits and drawbacks of not constructing the proposed project (see Section 5).

4.4 Renewable Energy Technologies

Solar

Technologies for converting solar energy to electricity include thermal conversion (typically using sunlight to generate steam to turn a turbine) and photovoltaic cells (direct conversion of sunlight to electricity). Thermal systems convert sunlight into heat by concentrating sunlight with mirrors and transferring the resultant energy to a fluid medium (e.g., water, brine).[34] The energy is transferred via a heat exchanger to produce steam, and electricity is produced in steam turbine generators. Photovoltaic cells convert sunlight into electricity through semiconductor modules, typically installed in arrays.[35]

Solar technologies are more commonly employed in areas of the United States with relatively greater solar resources, i.e., the southwestern United States.[36] As an example, utility-scale thermal conversion systems (100 to 1000 MW) are being developed in California.[37] Large scale PV systems are more prevalent in Europe; however several large PV systems (230 to 600 MW) are being developed in California.[38]

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[32] EQB Docket No. 03-67-EAW-NGP Biomass [hereafter Minnesota Biomass EAW] ; see http://energyfacilities.puc.state.mn.us/Docket.html?Id=4452

[33] 78 MW x 0.39 = 30 MW. The biomass alternative, because it has natural gas backup, is assumed for analysis purposes to have a capacity factor of 1.0. Scheduled and unscheduled maintenance would make the effective capacity factor slightly less than 1.0.

[34] Concentrating Solar Power, http://www1.eere.energy.gov/solar/csp_program.html.

[35] Photovoltaics, http://www1.eere.energy.gov/solar/photovoltaics.html.

[36] Concentrated Solar Power Resource Potential, http://www.eia.doe.gov/cneaf/solar.renewables/ilands/fig12.html; Solar Photovoltaic Resource Potential, http://www.eia.doe.gov/cneaf/solar.renewables/ilands/fig11.html.

[37] Large Solar Energy Projects, http://www.energy.ca.gov/siting/solar/index.html. In order to meet California's renewable portfolio standard, large solar energy projects are being proposed in California deserts on federal Bureau of Land Management (BLM) land.

[38] List of Photovoltaic Power Stations, http://en.wikipedia.org/wiki/List_of_photovoltaic_power_stations#Large_systems_in_planning_or_under_construction.

Hydropower

Hydroelectric power plants convert the potential energy of water into electricity by passing the water through a turbine; the water turns the turbine and connected electric generator, thus producing electrical energy. The electrical generating capacity of a hydropower plant is primarily a function of two variables: (1) flow rate and (2) hydraulic head, which is the pressure created by water flowing from a higher to a lower elevation. Depending on the particular waterway being considered, project design may concentrate on either of these variables.

There are undeveloped hydropower resources in Minnesota; the estimated total electrical generation capacity of these resources is 136 MW.[39] This capacity is spread across 40 potential hydropower sites.[40] The nation's first ever commercial hydrokinetic power station is scheduled to come on-line in 2009 near the city of Hastings, Minn.[41] The city is installing the project at its 4.4-megawatt hydropower plant on the Army Corps of Engineers' Lock & Dam No. 2. The power generated by the two hydrokinetic units, each with a nameplate capacity of 100 kilowatts (0.1 MW), will be placed on the electric power grid through the city's existing electrical infrastructure.

Fuel Cells

A fuel cell is an electrochemical device that, without combustion, combines hydrogen and oxygen to produce water, electricity, and heat. Fuel cells require a hydrogen source for operation. This source can be pure hydrogen (hydrogen) or a hydrocarbon (e.g., methanol, natural gas). There are a number of fuel cell designs, with names derived primarily from the electrolyte used to direct electrical charges within the cell.

Fuel cell generation capacities are in the range of 100 kW to 100 MW.[42] Fuel cells are typically used as backup or additional electrical generation capacity for a specific end user. Accordingly, they are usually placed at the point of energy use, e.g., at a specific business location.[43]

Anaerobic Digestion

Anaerobic digestion is the decay of organic manner in the absence of oxygen. This decay produces hydrocarbon gases (e.g. methane) whose combustion can used to turn a turbine and electrical generator. There are two primary anaerobic digestion processes used to produce electricity: (1) anaerobic digestion of animal manures creating biogas and (2) anaerobic digestion of municipal solid waste creating landfill gas (LFG).[44] On-farm production of biogas is typically

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[39] U.S. Hydropower Resource Assessment for Minnesota, July 1996, U.S. Department of Energy (DOE), http://hydropower.inel.gov/resourceassessment/pdfs/states/mn.pdf.
[40] Id.
[41] Hastings Hydrokinetic Power Station USA, http://www.power-technology.com/projects/hastingshydrokinetic/.
[42] Fuel Cell, http://en.wikipedia.org/wiki/Fuel_cell.
[43] Fuel Cells in Backup Power Application, http://www1.eere.energy.gov/femp/pdfs/hydrogenfc_tir.pdf; Bloom Energy Claims a New Fuel Cell Technology, New York Times, February 23, 2010, http://www.nytimes.com/2010/02/24/business/energy-environment/24bloom.html. The article indicates that Google, Bank of America, and Wal Mart are testing fuel cells at their business locations
[44]Energy Policy and Conservation Report, 2008, Minnesota Office of Energy Security, p. 25-27, [hereafter Quad Report 2008], http://www.state.mn.us/mn/externalDocs/Commerce/Quadrennial_Report__2008_091509012935_2008-QuadReport.pdf.

limited to dairy farms with more than 400 cows, though small farms can utilize the technology for heating instead of electrical generation. Electrical generation capacity for biogas facilities ranges from kilowatts to over 13 MW.[45]

There are currently seven landfill gas projects in Minnesota, generating a total of 26 MW.[46] The largest facility generates 12 MW. The estimated potential electrical generation capacity of all landfills in Minnesota is 45 MW.[47]

4.5 Feasibility and Availability of Alternatives

The feasibility and availability of alternatives to the Goodhue Wind Project depend on a number of factors. In general, an alternative is feasible and available if (1) the technology is commercially available at a scale similar to the proposed project and (2) natural resources are available in Minnesota similar to those where commercial development is taking place.

78 MW LWECS

A generic 78 MW LWECS is feasible and likely available. Wind farms are in development across the state and Minnesota's wind resources are sufficient to facilitate a 78 MW project. Feasibility and availably are dependent on the ease of interconnection to the electrical transmission grid. In some parts of the state, the transmission grid is very near capacity and the connection of additional generating capacity is not easily achieved.

30 MW Biomass Plant

A 30 MW biomass plant is feasible and likely available. There are biomass plants of this size operating in Minnesota.

No Build Alternative

The no build alternative is feasible and available, but would not further Minnesota's renewable energy objectives.

Solar

A solar facility is not a feasible alterative to the Goodhue Wind Project. There are thermal and photovoltaic systems in development that are similar in scale to the proposed project. However, most systems are substantially smaller. The output of all photovoltaic systems in Minnesota is just over one megawatt (1 MW).[48] A photovoltaic system designed to replace the Goodhue Wind Project would be among the largest proposed worldwide.[49] Additionally, these systems

[45] Id.
[46] Id.
[47] Id.
[48] Quad Report 2008, p. 28.
[49] Capacity factors for photovoltaic systems are in the range of 0.20 - 0.30. Thus, an appropriately-sized alternative to the proposed project would be approximately 122 MW (78 MW x 0.39/0.25 = 122 MW). The largest proposed solar farm in the United States is the Rancho Cielo Solar Farm, with a project output of 600 MW. See the List of Photovoltaic Power Stations, http://en.wikipedia.org/wiki/List_of_photovoltaic_power_stations#Large_systems_in_planning_or_under_construction.

rely on solar resources which are not available in Minnesota. Solar resources in Minnesota are approximately 40-60 percent of those of the southwestern United States.[50] Of the two solar technologies (thermal and photovoltaic), photovoltaic is likely the better long term fit for Minnesota's solar resources. Implementation of distributed photovoltaic generation on a scale sufficient to serve as an alternative to the Goodhue Wind Project will likely require supporting public policy, e.g., feed-in tariff.[51]

Hydropower

Hydropower is not feasible or available. To produce the electrical energy equivalent of the Goodhue Wind Project would require developing approximately 50 percent of Minnesota's hydropower resources simultaneously and providing appropriate connections with the electrical transmission grid.[52]

Fuel Cells

Fuel cells are commercially available but typically not at scale similar to the Goodhue Wind Project. Additionally, to date, fuel cells have been used solely as an electrical supply for a specific end user. They have not been used as part of utility's generation portfolio. Finally, current commercial fuel cells are likely not an eligible energy technology such that their implementation would further Minnesota' renewable energy objective. Eligible technologies include those which produce electricity from hydrogen.[53] However, if the hydrogen source for a fuel cell is a geologic hydrocarbon (e.g., natural gas), then the fuel cell would not qualify as an eligible energy technology.[54]

Anaerobic Digestion

Anaerobic digestion is not feasible or available at a scale similar to the Goodhue Wind Project. The largest biogas and LFG facilities in Minnesota are substantially smaller than the proposed project. The current electrical generation capacity of all landfills in Minnesota is 26 MW.

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[50] Concentrated Solar Power Resource Potential, http://www.eia.doe.gov/cneaf/solar.renewables/ilands/fig12.html; Solar Photovoltaic Resource Potential, http://www.eia.doe.gov/cneaf/solar.renewables/ilands/fig11.html.

[51] New Oregon Feed-In Tariff Could Make Solar a Paying Proposition, http://sunpluggers.com/stories/new-oregon-feed-in-tariff-makes-solar-paying-proposition-0555.

[52] The average annual capacity factor for hydroelectric power is approximately 45 percent. Thus, an appropriately-sized hydropower project would be 68 MW (78 MW x 0.39/0.45 = 68 MW). This is half of Minnesota's hydropower potential (68 MW / 136 MW = 0.5). See, Hydropower Program Assumptions, p. L-7, http://www1.eere.energy.gov/ba/pba/pdfs/gpra_fy05_appendix_l.pdf.

[53] Minn. Stat. § 216B.1691, Subd. 1. Eligible energy technologies include technologies that generate electricity from solar, wind, hydroelectric, hydrogen, or biomass.

[54] Id. The statute notes that hydrogen is an eligible energy technology only if the hydrogen is generated by a renewable energy source, i.e., solar, wind, hydroelectric, biomass.

5.0 The No Build Alternative

Analysis of the no build alternative involves a discussion of the environmental impacts of continuing the status quo. For example, with a proposed highway project, the no build alternative would take into account the impacts associated with continuing to have traffic increase along existing roads and highways and for development to occur along these existing arteries. Potential impacts and benefits of the no build alternative for the Goodhue Wind Project are discussed here

5.1 Impacts

At least three categories of impacts can be identified if the Goodhue Wind Project is not built – (1) a hampering of the state's ability to meet its renewable energy objectives, (2) the loss of economic benefits in the project area, and (3) the likely negative impact of providing replacement electricity from a non-renewable energy source.

Renewable Energy Objectives

Minnesota has committed to a renewable energy objective of generating 25 percent of its electricity from eligible renewable sources by the year 2025.[55] Minnesota utilities forecast the need for an additional 2,600 MW of renewable generation to meet this renewable energy objective and an additional 1,500 MW to meet the objectives of neighboring states by the year 2025.[56] If the Goodhue Wind Project is not built, it could hinder the ability of the state to meet its renewable energy objective. There are wind resources in other parts of the state and wind farms could be placed in these areas (Figure 5). However, the wind resources of the state are finite. The wind resource in the project area is very good, and, if untapped, could hinder the state's ability to meet its renewable energy objective.

Loss of Economic Benefits

If the Goodhue Wind Project is not built, there will be a loss of economic benefits in the project area. Landowners would lose wind easement payments over the life of the project. Payments to landowners over the first twenty years of the project will be approximately $18 million dollars.[57] Local governments would lose wind energy production tax revenues; these revenues are estimated at $275,000 to $325,000 annually.[58] The Goodhue Wind Project is expected to generate approximately 200 temporary construction jobs for local contractors and 8 permanent jobs.[59] These employment opportunities and their associated income would be lost if the project is not built.

[55] Minn. Stat. § 216B.1691, Subd. 2a.
[56] 2009 Minnesota Biennial Transmission Projects Report, Section 8.4, Docket No. E999/M-09-602, https://www.edockets.state.mn.us/EFiling/edockets/searchDocuments.do?method=showPoup&documentId={00D61C53-85D2-4052-93E4-95D03AFE5532}&documentTitle=200911-43520-01.
[57] CON Application, Section 4.3.
[58] Id.
[59] Site Permit Application, Section 4.2.2.

Replacement with a Non-Renewable Resource

If the Goodhue Wind Project is not built, the electrical power it would have produced would need to be replaced, likely with a non-renewable energy resource.[60] Though the impacts associated with non-renewable sources vary, it is possible to estimate, as an example, the impact of replacing the Goodhue Wind Project with coal energy. The Goodhue Wind Project will produce approximately 266 gigawatt-hours annually (GWh/yr).[61] If this energy were produced by Xcel Energy's Sherco plant (a coal-fired plant), the plant would emit pollutants, including approximately:

- 399 tons/yr of nitrous oxides (NO_x)
- 399 tons/yr of sulfur dioxide (SO_2)
- 317,870 tons/yr of carbon dioxide (CO_2) [62]

Nitrous oxides (NO_x) are greenhouse gases that cause ozone and related respiratory illnesses.[63] Sulfur oxides (SO_x) can cause acid rain and human respiratory illness.[64] Carbon dioxide (CO_2) is the most important greenhouse gas and is responsible for global warming and associated impacts including significant changes to world weather systems and ecosystems.[65]

5.2 Benefits

Benefits of not building the Goodhue Wind Project would include avoidance of potential human and environmental impacts associated with the project. These impacts are discussed in Section 6 of this report.

[60] In 2008, non-renewable energy sources accounted for approximately 92 percent of Minnesota's electrical energy supply; Quad Report 2008.
[61] 78 MW x (1 GW/1000 MW) x (0.39) x (24 hours/day) x (365 days/yr) = 266 GWh/yr.
[62] Minnesota Energy Planning Report, 2001, http://www.state.mn.us/mn/externalDocs/Commerce/Energy_Planning_Report_121602022402_2002PlanningRpt.pdf. Emission rates per unit of electricity estimated at 0.003 lbs/kWh (NO_x, SO_2) and 2.39 lbs/kWh (CO_2).
[63] Health and Environmental Impacts of NO_x, http://www.epa.gov/air/nitrogenoxides/.
[64] Health and Environmental Impacts of SO_2, http://www.epa.gov/air/urbanair/so2/.
[65] Climate Change 2007: Synthesis Report, Summary for Policymakers, An Assessment of the Intergovernmental Panel on Climate Change (IPCC), http://www.ipcc.ch/.

6.0 Human and Environmental Impacts

This section discusses the potential human and environmental impacts of the Goodhue Wind Project and project alternatives. The alternatives include: (1) a generic 78 wind energy conversion system (LWECS) sited elsewhere in Minnesota, and (2) a 30 MW biomass plant. The potential impacts of the no build alternative are discussed in Section 5. Additionally, this section discusses mitigation strategies for potential impacts.

6.1 Air Emissions – Criteria Pollutants

Electric generation facilities have the potential to emit air pollutants during construction and operation. Minnesota Rule 7849.1500 requires this ER to examine emissions of the following pollutants: sulfur dioxide (SO_2), nitrogen oxides (NO_x), carbon dioxide (CO_2), mercury (Hg), and particulate matter (PM). These common pollutants (other than mercury) are known as criteria pollutants.[66]

Goodhue Wind Project

The Goodhue Wind Project will emit no criteria pollutants during operation. A minimal amount of these pollutants will be produced during construction, e.g., due to the operation of heavy machinery. Transmission lines, under certain conditions, produce limited amounts of ozone and nitrogen oxide emissions. Emissions and impacts of these pollutants are anticipated to be minimal.

Generic 78 MW LWECS

A generic 78 MW LWECS would emit no criteria pollutants during operation, and would have ancillary emissions (construction, transmission line) similar to those from the Goodhue Wind Project.

30 MW Biomass Plant

A 30 MW biomass plant would emit criteria pollutants (Table 2). These pollutants are based on a plant similar to the NGPP Minnesota Biomass plant (see Section 4.2). Each of these pollutants has potential to cause to human and environmental health impacts. Sulfur oxides (SO_x) cause acid rain and human respiratory illness.[67] Nitrous oxides (NO_x) are greenhouse gases that cause ozone and related respiratory illnesses.[68] Carbon dioxide (CO_2) is a greenhouse gas that is, in part, responsible for global warming and associated impacts including significant changes to world ecosystems.[69] Mercury can cause impaired neurological development in children.[70] Inhalation of particulate matter causes human respiratory illness.[71]

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[66] What Are the Six Common Air Pollutants?, http://www.epa.gov/air/urbanair/.
[67] Health and Environmental Impacts of SO_2, http://www.epa.gov/air/urbanair/so2/.
[68] Health and Environmental Impacts of NO_x, http://www.epa.gov/air/nitrogenoxides/.
[69] Climate Change 2007: Synthesis Report, Summary for Policymakers, An Assessment of the Intergovernmental Panel on Climate Change (IPCC), http://www.ipcc.ch/.
[70] Health Effects, http://www.epa.gov/mercury/effects.htm.
[71] Health and Environment, http://www.epa.gov/air/particlepollution/health.html.

Table 2. Biomass Plant Emissions, Criteria Pollutants[72]

Pollutant	**Emissions Rate** (lbs/kWh)*	**Annual Emissions** (tons/year)
Sulfur Dioxide (SO_2)	3.46 E-04	47.3
Nitrogen Oxides (NO_x)	1.98 E-03	260.2
Carbon Dioxide (CO_2)	0.66[73]	8.67 E04[74]
Mercury (Hg)	1.19 E-08	1.6 E-03
Particulate Matter (PM)	7.18 E-04	94.2

*lbs/kWh = pounds per kilowatt-hour

Because these pollutants are diffused into a global atmosphere, regional impacts are difficult to quantify. However, impacts due to particulate matter and ground-level ozone can be localized. Particulate matter and ozone are the pollutants of most concern in Minnesota, and they are tracked regionally by the Minnesota Pollution Control Agency.[75] Because the plant is fired primarily with biomass, net impacts from carbon dioxide will be minimal. Carbon dioxide released by the plant will be incorporated into plant matter which, in time, will serve as fuel for the plant. The plant will operate, to a great extent, as a closed carbon dioxide loop.[76]

Mercury exists throughout the environment; however, the primary source of mercury in air emissions is coal, i.e., the burning of coal in a coal-fired power plant. The biomass plant considered here would use biomass as a primary fuel and natural gas as a backup fuel. Thus, emissions of mercury, and related impacts, are anticipated to be minimal.

Mitigation

Emissions of some criteria air pollutants can be mitigated through control technologies. Nitrous oxides emissions could be reduced by approximately 75 percent through use of a selective non-

[72] Adapted from Minnesota Biomass EAW, http://energyfacilities.puc.state.mn.us/Docket.html?Id=4452.
[73] AP-42, Fifth Edition, Volume 1, Chapter 1 External Combustion Sources, Section 1.6 Wood Residue Combustion in Boilers, http://www.epa.gov/ttn/chief/ap42/ch01/final/c01s06.pdf.
[74] Because the plant is fired with biomass (excepting natural gas backup) net carbon dioxide emissions from the plant would be minimal. Carbon dioxide released from the plant would be integrated into new biomass materials which, in time, would be harvested and used to fire the plant. There would be carbon dioxide emissions related to transport of biomass and plant operations.
[75] Air Quality Index for Minnesota, http://aqi.pca.state.mn.us/.
[76] Fuels used to collect and transport biomass would likely not be carbon neutral and would create carbon dioxide emissions.

catalytic reduction (SNCR) system on the biomass boiler.[77] Particulate matter emissions could be reduced by 90 percent with add-on devices such as a multi-cyclone and dust collector.[78]

In addition to the use of control equipment to mitigate pollutant impacts, a 30 MW biomass plant would conduct a best available control technology (BACT) analysis. The BACT analysis is a requirement of new facilities under federal new source review prevention of significant deterioration (PSD). A BACT analysis and implementation could limit emissions from the plant to less than those presented in Table 2.

6.2 Air Emissions – Hazardous Air Pollutants and Volatile Organic Compounds

Electric generation facilities have to potential to emit air pollutants during construction and operation. Minnesota Rule 7849.1500 requires this ER to examine emissions of hazardous air pollutants (HAP) and volatile organic compounds (VOC). These classes of pollutants are known or suspected of causing cancer and other serious health effects.[79]

Goodhue Wind Project

The Goodhue Wind Project will not emit HAPs or VOCs during operation. There are petroleum-based fluids used in the operation of wind turbines. These fluids include: gear box oil, hydraulic fluid, and gear grease.[80] These fluids have a low vapor pressure and thus release of VOCs will be minimal. A minimal amount of HAPs and VOCs will be produced during construction, due to the use of diesel fuel in heavy machinery.

Generic 78 MW LWECS

A generic 78 MW LWECS would have HAP and VOC emissions similar to the Goodhue Wind Project.

30 MW Biomass Plant

A 30 MW biomass plant would emit HAPs and VOCs (Table 3). These pollutants are based on a plant similar to the NGPP Minnesota Biomass plant (see Section 4.2). Because these pollutants are diffused into a global atmosphere, regional impacts are difficult to quantify. The only area in Minnesota with a cancer risk due to HAPs greater than 100 in a million is the Minneapolis - Saint Paul metro area.[81] The emissions from the biomass plant are, compared with other sources, relatively small.

Mitigation

It is possible to mitigate HAP and VOC emissions with control technologies. However, given the relatively small amounts of HAP and VOC emissions compared with the costs of control equipment, it is likely that control technologies will not be employed.

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[77] Minnesota Biomass EAW.
[78] Id.
[79] About Air Toxics, http://www.epa.gov/ttn/atw/allabout.html;
[80] Site Permit Application, Section 4.9.
[81] Summary of Results for the 2002 National-Scale Assessment, http://www.epa.gov/ttn/atw/nata2002/risksum.html.

Table 3. Biomass Plant Emissions, Hazardous Air Pollutants and Volatile Organic Compounds[82]

Pollutant	**Emissions Rate** (lbs/kWh)*	**Annual Emissions** (tons/year)
Hazardous Air Pollutants (HAPs)	1.80 E-04	23.6
Volatile Organic Compounds (VOCs)	5.55 E-04	72.9

*lbs/kWh = pounds per kilowatt-hour

6.3 Light and Visibility Impairment

Wind turbines are tall towers with large, rotating blades. Consequently, they can impair visibility or otherwise impact the visible environment. This section discusses potential impacts related to visibility including shadow flicker, impacts on the viewshed, and the lighting of turbines.

6.3.1 Shadow Flicker

Goodhue Wind Project

Shadow flicker is the intermittent change in light intensity due to rotating wind turbine blades casting shadows on the ground. This change in light intensity can cause annoyance.[83] Shadow intensity, or how "light" or "dark" a shadow appears at a specific receptor, will vary with the distance from the turbine. Closer to a turbine, the turbine blades will block out a larger portion of the sun's rays and shadows will be wider and darker. Receptors located farther away from a turbine will experience thinner and less distinct shadows.

Shadow flicker varies with the angle of sun, i.e., the time of year and the time of day. No shadow flicker occurs during cloudy days or when turbines are not rotating. Shadow flicker is reduced or eliminated when light-blocking materials, e.g., hills, buildings, trees are located between turbines and a receptor. Because of the number of variables involved, an estimate of the potential impact of shadow flicker for a specific residence (receptor) requires modeling (Figure 6).[84]

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[82] Adapted from Minnesota Biomass EAW, http://energyfacilities.puc.state.mn.us/Docket.html?Id=4452.

[83] Public Health Impacts of Wind Turbines, Minnesota Department of Health, May 22, 2009, p. 14, [hereafter Minnesota Dept. of Health Report] http://www.health.state.mn.us/divs/eh/hazardous/topics/windturbines.pdf. Shadow flicker in the frequency range of 5-30 cycles per second (Hz) can cause seizures in sensitive individuals. See, Photosensitivity and Epilepsy, http://www.epilepsyfoundation.org/about/photosensitivity/gerba.cfm. Flicker rates for wind turbines are less than 5 Hz – e.g., for the General Electric 1.5 MW wind turbine, the maximum flicker rate is 1.1 Hz (22 revolutions/minute x 3 flickers/revolution x 1 minute/60 seconds).

[84] See, e.g., Glacier Hills Wind Park Project, Volume 1, Final Environmental Impact Statement [hereafter Glacier Hills FEIS], Section 5.7.1, http://www.we-energies.com/environmental/gh_final_eis.pdf; Bornish Wind Power Project Shadow Flicker Assessment, http://www.canadianwindproposals.com/pdf/bornish/G-Shadow%20Flicker/Bornish_Wind_Farm_Shadow_Flicker_Assessment.pdf.

Mitigation

Mitigation of shadow flicker is best accomplished by proper siting of the project and individual wind turbines. In general, siting wind projects in less populated areas minimizes human impacts. The further a residence (receptor) is from a wind turbine, the less the impact from shadow flicker. Distance minimizes the number of hours that flicker occurs at a particular residence and the shadow intensity. Setbacks from individual turbines, as embodied by Minnesota's general permit standards, can mitigate shadow flicker.[85] These standards include setbacks to protect wind rights and mitigate noise impacts.[86] For the Goodhue Wind Project, the applicant is providing a setback of 1,500 ft. from all non-participating residences.[87]

There is not a Minnesota "light standard" that addresses potential impacts of shadow flicker, i.e. there is not a descriptive or numeric standard that would categorize a certain amount of flicker as acceptable or unacceptable. No other states have adopted such a standard. However, other countries have examined the issue and have adopted standards. Standards depend on assumptions about how flicker impacts are to be calculated:

- Germany has proposed a standard such that shadow flicker does not exceed 30 hours/yr. or 30 minutes/day at a receptor.[88] It is unclear whether this is a worst-case scenario (e.g., clear skies every day) or an actual-case scenario (e.g., weather representative of the project area).[89]
- Belgium has adopted the German standard.[90]
- Denmark recommends a maximum of 10 hours/yr. assuming actual weather conditions in the project area.[91]
- France has adopted no standard but requires shadow flicker modeling.[92]
- The Netherlands have adopted a yearly maximum of 5 hours and 40 minutes assuming clear skies.[93]
- The State of Victoria, Australia, has adopted a shadow flicker standard of 30 hours/yr.[94]

If siting and distance do not mitigate shadow flicker impacts, such impacts could be mitigated by other barriers, e.g., vegetative barriers could be planted, shades or curtains could be used on windows.

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[85] Commission Order Establishing General Permit Standards, http://energyfacilities.puc.state.mn.us/documents/19302/PUC%20Order%20Standards%20and%20Setbacks.pdf.
[86] Wind turbines must be set back from non-participating properties a distance of 5 rotor diameters (RD) on the prevailing wind direction and 3 RD on the non-prevailing wind direction. Potential setback distances for the Goodhue Wind Project are shown in Table 1. See Section 6.10 for a discussion of noise setbacks.
[87] Site Permit Application, Section 3.2.2. The applicant may provide a shorter setback of 1000 ft. from residences on participating lands, if the residents so agree.
[88] Spatial Planning of Wind Turbines, European Actions for Renewable Energy (PREDAC) [hereafter Spatial Planning Report], http://www.cler.org/info/IMG/pdf/WP8_ANG_guide.pdf.
[89] Shadow Flicker Assessment – Honeywood, Final Report, p. 5, http://www.eolectric.com/assets/honeywood/pdf/en/appendix%20k.pdf.
[90] Spatial Planning Report, p. 21.
[91] Id.
[92] Id.
[93] Id.
[94] Policy and planning guidelines for development of wind energy facilities in Victoria, p. 26, http://www.sustainability.vic.gov.au/resources/documents/WindEnergyGuidelines.pdf.

Generic 78 MW LWECS

A generic 78 MW LWECS located elsewhere in Minnesota would have shadow flicker impacts and mitigation strategies similar to those of the Goodhue Wind Project. Impacts could be mitigated by locating in a more rural area of Minnesota; however, such a location would need to have wind resources similar to those in Goodhue County (see Figures 5 and 7).[95] The project area has a population density of approximately 17 persons per square mile.[96]

30 MW Biomass Plant

A 30 MW biomass plant would not cause shadow flicker due to a lack of exterior moving parts that could cast alternating shadows.

6.3.2 Viewshed

Goodhue Wind Project

The Goodhue Wind Project would introduce large wind turbines to an otherwise rural countryside. The potential impact of such an introduction depends somewhat on the aesthetic values of the observer. For some, wind turbines are an intrusion on a rural landscape. For others, wind turbines have a grace that is harmonious with a rural landscape. Goodhue County is predominantly rural with an agricultural base. Wind turbines, as gatherers of a renewable wind harvest, are in some sense compatible with a rural, agricultural heritage.

Development of an objective measure of viewshed or aesthetic impairment is a difficult task. Current methods used to assess visual impacts include viewshed mapping, photographic simulations, and video animation.[97] All of these methods depend, to some extent, on assessing the current aesthetic resources of the project area, i.e., the aesthetics of the area before construction of a wind farm. Such an assessment can be subjective; however, state and federal agencies perform assessments regularly in the development of parks that have valuable aesthetic resources. The project area for the Goodhue Wind Project does not contain state or federal parks or other aesthetic resources designated as visually valuable. This does not mean the area is not aesthetically valuable on a local level. The patchwork of fields and farmsteads in the project area is likely considered by some residents and visitors to be pastoral.

Mitigation

As with potential shadow flicker impacts, mitigation of viewshed impairment is best accomplished by proper siting of the project and individual wind turbines. Viewshed impacts can be mitigated by siting wind projects outside of areas deemed visually valuable by the state, e.g., state parks. Distance minimizes viewshed impairment, i.e., the further away from a wind turbine, the less the visual impact. Accordingly, setbacks provided by Minnesota's general permit standards serve to mitigate viewshed impacts. Additionally, wind turbines are designed to be a uniform off-white color to blend in with the horizon and reduce visual impacts.

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[95] Goodhue County includes rural and urban areas. The average population density for Goodhue County is 58.2 persons per square mile; the population density for the State of Minnesota is 61.8 persons per square mile. See Population Density, http://www.demography.state.mn.us/resource.html?Id=5238.
[96] Site Permit Application, Section 4.2.
[97] Visual Considerations: Public Perceptions, Regulatory Environment and Assessment Methods in the Eastern U.S., http://www.nationalwind.org/assets/blog/Allen-NWCC_2009.pdf.

Impacts might also be mitigated by utilizing wind turbines capable of generating more power. For example, a 78 MW project consisting of 1.5 MW turbines requires 52 turbines; a similar project consisting of 1.6 MW turbines requires 49 turbines. The smaller number of turbines would likely create a relatively smaller visual impact for the project as a whole.

Generic 78 MW LWECS

A generic 78 MW LWECS located elsewhere in Minnesota would have viewshed impacts and mitigation strategies similar to those of the Goodhue Wind Project. Impacts could be mitigated by locating in a less populated area of Minnesota (see Figure 7).

30 MW Biomass Plant

A 30 MW biomass plant would impair the viewshed in the immediate area of plant, and to the extent a stack plume is visible, in the greater area. A biomass plant would be industrial in nature with many buildings, conveyors, biomass piles, and a boiler stack. The building that houses the boiler is likely to be at least 100 feet tall. The conveyors and biomass piles could range from 30 to 50 feet in height. The plant buildings, conveyors, and piles would likely be lighted to allow for nighttime operation. Lighting would also be necessary for wood fuel loading/unloading points, truck scales, and vehicle parking areas.

The estimated height for the boiler stack is approximately 150 feet. Particulate matter control devices would capture most of the particulates from the boiler exhaust gas stream. Thus, the majority of the plume from the boiler stack would be water vapor. This transparent plume may be seen during cold weather conditions, but would likely be virtually clear during warm weather.

Mitigation

Mitigation of viewshed impairment is best accomplished through selective location of the biomass plant. The site for the biomass plant does not need to be a rural, agricultural setting. The plant could be located in an industrial location allowing it to blend in with other industry. Thus, the plant could be located away from aesthetically valuable resources. However, the biomass plant would need to be located in an area where biomass is readily available in large quantities. Vegetative screening (trees, shrubs) could be used to partially block views of the industrial buildings, silos, conveyors, and boiler stack.

6.3.3 Lighting

Goodhue Wind Project

Wind turbines, per Federal Aviation Administration (FAA) requirements and because of their height, would be lighted.[98] In general, turbines have flashing white lights during the day and red lights during the evening. This lighting scheme is found on other FAA-permitted towers in and near the project area. Visual impacts due to this lighting are anticipated to be minimal. Synchronization of turbine lighting may improve aviation safety, but it is unclear if this practice

[98] FAA Advisory Circular AC 70/7460-2K, HTTP://RGL.FAA.GOV/REGULATORY_AND_GUIDANCE_LIBRARY/RGADVISORYCIRCULAR.NSF/0/22990146DB0931F186256C2A00721867/$FILE/AC70-7460-2K.PDF.

would mitigate lighting impacts.[99] Strategies to mitigate lighting impacts, e.g., synchronization, lighting turbine towers solely around the perimeter of the project, would require FAA approval.

Generic 78 MW LWECS

A generic 78 MW LWECS located elsewhere in Minnesota would have lighting impacts similar to those of the Goodhue Wind Project.

30 MW Biomass Plant

If taller than 200 feet, the boiler stack for a 30 MW biomass plant would require FAA lighting, similar to wind turbines.

6.4 Ozone Formation

Large electric power generating facilities have the potential to produce reactive organic gases, which can lead to ground-level ozone formation. Wind turbines do not produce ozone or ozone precursors. Minnesota Rules 7849.1500, subpart 2 requires that this ER address anticipated ozone formation.

Ozone can cause human health risks, and can also damage crops, trees, and other vegetation.[100]

Goodhue Wind Project

The Goodhue Wind Project would not produce ozone or ozone precursors. Thus, there would no human or environmental impacts due to ozone formation.

Generic 78 MW LWECS

A generic 78 MW LWECS would have ozone formation similar to the Goodhue Wind Project.

30 MW Biomass Plant

A 30 MW biomass plant would produce ozone precursors (e.g., NO_x, VOC) that would lead to ozone formation. Impacts from ozone can be localized. However, the state of Minnesota is currently designated as in attainment for ozone by the Environmental Protection Agency (EPA). Given this status, ground level ozone formation and associated impacts are anticipated to be minimal.

Mitigation

Ozone formation could be mitigated by mitigating ozone precursors. See discussion in Sections 6.1 and 6.2 regarding nitrous oxides (NO_X) and volatile organic compounds (VOC) respectively.

6.5 Fuel Availability

Large electric power generating facilities require some type of fuel. This section discusses the availability of fuel for the proposed project and alternatives.

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[99] See Development of Obstruction Lighting Standards for Wind Turbine Farms, http://www.airporttech.tc.faa.gov/safety/downloads/TN05-50.pdf.
[100] Ozone, http://www.epa.gov/Ozone/; Air Quality – Ozone, http://www.health.state.mn.us/divs/eh/air/ozone.htm.

Goodhue Wind Project

The Goodhue Wine Project relies on wind to generate electricity. Winds are generated by earth and solar processes; accordingly, the fuel for the project is a very long-term renewable resource. Wind is not consumed by wind turbines. However, wind turbine blades do extract kinetic energy and create turbulence downstream of the turbine blades. Thus, to operate effectively, turbines must be set back a distance from other turbines.[101]

The actual availability of wind varies considerably across Minnesota, and has been analyzed by the Minnesota Department of Commerce.[102] The wind resources in Goodhue County are relatively good (Figure 7). Estimated average wind speeds for the Goodhue Wind Project are 13.3 to 17.7 miles per hour (6.1 to 7.9 meters per second).[103] Power generation by the project depends not only on how quickly the wind blows (how much energy it contains), but also how frequently it blows. Wind turbines generate power only when the wind is blowing.[104] This frequency is expressed as capacity factor, i.e., how much power the turbine is generating compared to how much it could generate if it was operating all the time. Capacity factors of 35 to 43 percent are typically achievable in Minnesota for large wind farms. The Goodhue Wind Project is estimated to have a capacity factor in the range of 35 to 39 percent.[105]

Generic 78 MW LWECS

A generic 78 MW LWECS would utilize the same fuel as the Goodhue Wind Project – wind. To be economically feasible, a 78 MW LWECS sited elsewhere in Minnesota would need to be placed in a good wind resource. The availability of good, undeveloped wind resources in Minnesota remains high. Impacts on the fuel (wind) resources would be similar to those for the Goodhue Wind Project

30 MW Biomass Plant

A combination of wood chips and agricultural biomass would be the main fuel source for a 30 MW biomass plant. Natural gas would be used as a fuel backup. Such a plant would consume approximately 31,100 tons of biomass per month.

It is possible that rail could be used for delivery of fuel to the plant, depending on its location. However, the most likely method of delivery for wood and agricultural biomass fuel would be by semi-trailer trucks. Trucks would likely deliver wood and agricultural biomass by loads of 20 tons or greater. The biomass facility would operate 24 hours a day, but fuel delivery times would likely be limited. The total number of daily truck trips is estimated to be approximately 50. The origin of the biomass trucks and the total trip length required for delivery would depend on the location of the biomass source relative to the biomass plant.

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[101] The distance between turbines necessary for effective operation is approximately 6 rotor diameters (RD) on the non-prevailing wind axis and 10 RD on the prevailing wind axis. Accordingly, Minnesota requires setbacks of 3 x 5 RD for each turbine. See, PUC Order Establishing General Permit Standards, http://energyfacilities.puc.state.mn.us/documents/19302/PUC%20Order%20Standards%20and%20Setbacks.pdf.
[102] Wind Resource Analysis Program 2002, http://www.state.mn.us/mn/externalDocs/Commerce/WRAP_Report_110702040352_WRAP2002.pdf.
[103] Site Permit Application, Section 2.1.
[104] See Table 1 which list includes "Cut-in Wind Speeds", i.e., the minimum wind speed necessary for the turbine to operate.
[105] Site Permit Application, Section 3.8.

A back-up fuel source would be required for the biomass plant, to assist with plant start-up and to sustain the plant temporarily when the biomass fuel supplies are low. Natural gas would be used as a backup fuel. The construction of a natural gas pipeline would be required to deliver the natural gas to the biomass plant.

Potential impacts to the environment related to fuel for a biomass plant include possible degradation of the environment due to biomass removal (e.g., increased soil erosion due to removal of agricultural biomass; loss of wildlife habitat), air pollution due to biomass transport, and the impacts associated with building a natural gas pipeline.

Mitigation

Impacts related to fuel for a biomass plant could be mitigated by using guidelines for biomass harvest that minimize impacts and by siting the plant to minimize impacts related to biomass transportation. As an example, the Minnesota Forest Resource Council (MFRC) has developed woody biomass harvest guidelines to lessen impacts to wildlife habitat.[106] In order for mitigation to work, the biomass plant would need to require that its biomass suppliers follow biomass harvest guidelines.

6.6 Associated Transmission Facilities

Electrical generation facilities typically require construction of transmission facilities such as transmission lines and substations to connect to the transmission grid. This section discusses these associated transmission facilities and their potential impacts.

Transmission lines over 100 kilovolts and longer than 1,500 feet are defined as "high voltage transmission lines" and are subject to regulation by the Commission[107]. Wind generation facilities require construction of lower voltage electric facilities, e.g., collector lines and substations, to collect the power generated by the wind turbines and connect it to the electrical transmission grid. These "associated facilities" are typically permitted by the Commission through the site permitting process for the wind project.[108]

Goodhue Wind Project

The Goodhue Wind Project will require two new substations in the project area and a new 69 kV transmission line. The two project substations – "Goodhue North" substation and "Goodhue South" substation – would collect the electrical power generated by the project's wind turbines and transform the voltage from 34.5 kV to 69 kV. Power from the project substations will be transmitted to the electrical transmission grid. The Goodhue South substation will be located near an existing 69 kV transmission line and will interconnect with this line. The Goodhue North substation will transmit power via a new 69 kV transmission line, approximately four miles in length, to the existing Vasa substation north of the project area.

[106] Forest Biomass and Biofuels Harvest, http://www.frc.state.mn.us/initiatives_policy_biofuels.html.
[107] Minnesota Statute § 216E.01, Subd. 4.
[108] Minnesota Rules 7854.0100. Subp. 2.

Impacts from the project's associated transmission facilities would include impacts due to construction and impacts due to operation. Construction impacts would include impacts related to land clearing and materials transport. Operation impacts would include potential impacts related to electromagnetic fields (EMF), stray voltage, noise, and visibility. Power moving through a transmission line creates EMF. These fields decrease with distance from a transmission line. Stray voltage can occur with electrical distribution lines to residences and high voltage transmission lines that parallel them. Stray voltage flows through the ground between electrical systems that, by code, must be grounded (i.e., connected to the earth) to ensure safety.[109] This voltage may be commuted and felt by animals standing on the ground.

Stray voltage has been raised as a concern on dairy farms because of its potential to impact dairy cattle and milk production. Impacts, if they occur, are typically related to the grounding of electrical service to the farm (distribution lines) or on-farm electrical wiring.

During wet weather, water can be ionized adjacent to transmission lines creating a crackling noise. Visual impacts of a transmission line depend on context. High visual impacts occur when a line is located near areas with relatively higher population densities, e.g., residential areas.

Potential impacts from the project's associated transmission facilities are anticipated to be minimal. Collection lines will create temporary construction impacts; however, once underground, they will not create visual impacts. The project includes no distribution lines to residences and relatively lower voltage transmission; thus, impacts from stray voltage will be minimal. Additionally, impacts due to stray voltage can be mitigated by grounding of electrical service on farms. The new 69 kV transmission line to the Vasa substation will utilize existing road right-of-way and an existing 34.5 kV distribution line.[110] This use will minimize EMF, noise, and construction impacts.

Mitigation

Construction impacts can be mitigated by minimizing the amount of land clearing required. Use of existing features, e.g., roads, existing rights-of-way, can minimize impacts. Operation impacts can be mitigated by placing transmission lines away from population densities. Visual impacts can be mitigated by placing collector lines underground, while aesthetic impacts from overhead transmission lines can be mitigated through design and pole placement.

Siting collection lines to avoid erodible soils and steep topography can minimize soil and agricultural impacts.[111] Use of the existing 34.5 kV distribution line right-of-way for the 69 kV transmission line from the Goodhue North substation would mitigate construction and operation impacts.

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[109] For a discussion of EMF and stray voltage see Brookings County – Hampton 345 kV Transmission Line Project, Draft Environmental Impact Statement [hereafter Brookings DEIS], Section 6.2, http://energyfacilities.puc.state.mn.us/resource.html?Id=25589.

[110] CON Permit Application, Section 2.1. The existing 34.5 kV line would be rebuilt to accommodate the 34.5 kV and 69 kV transmission lines.

[111] Site Permit Application, Section 4.13.

Generic 78 MW LWECS

A generic 78 MW LWECS would have transmission facilities similar to the Goodhue Wind Project. Accordingly, potential impacts and mitigation strategies are also similar. The primary driver of potential impacts is the length and voltage of the transmission line(s) required to interconnect the wind project with the transmission grid. A relatively longer line(s) or higher voltage would create greater construction and operation impacts.

30 MW Biomass Plant

A 30 MW biomass plant would have transmission facilities similar to the Goodhue Wind Project; however an electrical collection system and collection substations would not be required. The plant would include a transformer to transform the voltage to transmission levels and a transmission line between the plant and a substation where the power would enter the grid.

Potential impacts and mitigation strategies would be similar to those for the Goodhue Wind Project. Again, the primary driver of potential impacts is the length and voltage of the transmission line(s) required to connect the biomass plant to the transmission grid. A relatively longer line(s) or higher voltage would create greater construction and operation impacts.

6.7 Water Appropriations

Large electric power generating facilities may require water for operations. This section discusses potential water appropriation impacts from such facilities.

Goodhue Wind Project

The Goodhue Wind Project would require water appropriations for potable and sanitary water for the operations and maintenance facility. Water would be supplied through either rural water or a single domestic-sized well. This amount of water used would be roughly equivalent to the amount consumed by a residence or farmstead in the area and would likely not require mitigation.

Generic 78 MW LWECS

A generic 78 MW LWECS would have water appropriations similar to the Goodhue Wind Project.

30 MW Biomass Plant

A 30 MW biomass plant would require water appropriations for energy production (process water) and sanitation. Process water could come from a well; however, a municipal water source may also be required. For some aspects of the process, such as in the cooling tower, effluent water from a wastewater treatment facility could be used. Thus, the sources of water would depend on the type and availability of water sources near the facility location.

The required quantity of water would depend on plant design and water quality. Functions within the plant that require water include cooling, sanitation, washing, and separations. The average anticipated water use would be approximately 482 gallons per minute. If a source of effluent wastewater were available, the appropriation of well or municipal water would be

relatively lower. If the plant used only well or municipal water, the water appropriation would be relatively higher. Based on anticipated water use, the plant would require a water appropriations permit from the Minnesota Department of Natural Resources (DNR).[112]

Mitigation

Mitigation of well water and municipal water use by the plant could be achieved through plant equipment choices and through the use of effluent water (water that has already been appropriated). If municipal water were used for the plant, modifications or an expansion of the municipal water treatment plant would be required to accommodate the increase in demand.

6.8 Wastewater

Large electric generation facilities have the potential to generate significant amounts of wastewater. This section discusses potential impacts from wastewater generation.

Goodhue Wind Project

The Goodhue Wind Project does not create wastewater during the generation of electricity. However, wastewater would be created by the operations and maintenance (O&M) building. This wastewater would likely be discharged into a septic system associated with the building. The potential impacts of this wastewater and septic system are anticipated to be minimal. Thus, mitigation of the impacts, beyond a properly functioning septic system, is not required.

Generic 78 MW LWECS

A generic 78 MW LWECS would have wastewater impacts similar to the Goodhue Wind Project.

30 MW Biomass Plant

A 30 MW biomass plant would have process and sanitary wastewater discharges. The amount of wastewater discharge would depend on the water sources used for the plant (see Section 6.7). If well and municipal water are used, anticipated average wastewater discharge would be approximately 63 million gallons per year. If effluent water is also utilized, wastewater discharge would increase to approximately 188 million gallons per year.

Mitigation

Wastewater impacts could be mitigated by proper processing. The most likely scenario is transference of the wastewater to a municipal sewage system for treatment and release. Wastewater could be held or pre-treated at the biomass plant. Holding could reduce discharges through evaporation. However, holding introduces risks related to storing wastewater away from surface and ground waters.

[112] Water Use Permits, http://www.dnr.state.mn.us/waters/watermgmt_section/appropriations/permits.html.

6.9 Solid and Hazardous Wastes

Large electric generation facilities have the potential to generate solid and hazardous wastes. This section discusses potential impacts from such wastes.

Goodhue Wind Project

The Goodhue Wind Project would create solid and hazardous wastes. Solid wastes would be generated during construction, e.g., scrap wood, plastics, cardboard, wire. Small amounts of solid and hazardous wastes would be generated during operation, e.g., oils, grease, hydraulic fluids, solvents. Lubricants and fluids would be stored at the operations and maintenance building.

Solid and hazardous wastes, if not properly handled, can contaminate surface and ground waters. This contamination can cause human health impacts, e.g., cancer.[113]

Mitigation

Potential impacts from solid and hazardous wastes can be mitigated by proper disposal, e.g., disposing of solid wastes according to Goodhue County's solid waste plan. Impacts from hazardous wastes can be mitigated by best management practices, e.g., maintaining a list of hazardous materials that may be used for the project and development of a spill response plan. The project may require a hazardous waste license. Hazardous waste generation could be near or above the quantity required for a very small quantity generator license (220 pounds per month).[114]

Generic 78 MW LWECS

A generic 78 MW LWECS would have solid and hazardous waste impacts similar to the Goodhue Wind Project.

30 MW Biomass Plant

A 30 MW biomass plant would create solid and hazardous wastes. Solid wastes would be generated during construction, e.g., scrap wood, plastics, cardboard, wire. Solid waste generated from operations would consist primarily of ash from the biomass boiler. Small amounts of hazardous wastes would be generated during operation, e.g., oils, grease, hydraulic fluids, solvents. Hazardous materials would likely be stored on site, e.g., diesel fuel.

Mitigation

Mitigation of wastes would be similar to the Goodhue Wind Project. Ash generated by the plant would be held on-site in an ash holding facility or removed to an off-site disposal facility. Storage tanks would be registered and maintained in accordance with Minnesota Pollution Control Agency (MPCA) guidelines.

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[113] Volatile Organic Compounds (VOCs) in Minnesota's Ground Water, http://www.pca.state.mn.us/water/groundwater/gwmap/voc-fs.pdf.
[114] Very Small Quantity Generator Hazardous Waste Collection Program, http://www.pca.state.mn.us/publications/w-hw2-50.pdf.

6.10 Noise

Large electric generation facilities have the potential to generate noise. This section discusses potential impacts from such noise.

Noise can be defined as unwanted or inappropriate sound. Sound has multiple characteristics which determine whether a sound is too loud or otherwise inappropriate. Sound travels in a wave motion and produces a sound pressure level. This sound pressure level is commonly measured in decibels (dB). Sounds also consists of frequencies, e.g., the high frequency (or pitch) of a whistle. Most sounds are not a single frequency but a mixture of frequencies. Finally, sounds can be constant or intermittent. The perceived loudness of a sound depends on all of these characteristics.

Typically a sound meter is used to measure loudness. The meter sums up the sound pressure levels for all frequencies of a sound and calculates a single loudness reading. This loudness reading is reported in decibels, with a suffix indicating the type of calculation used. For example, "dB(A)" indicates a loudness reading using an A-weighted calculation (or "scale").

The State of Minnesota has promulgated noise standards designed to ensure public health and minimize citizen exposure to inappropriate sounds (Table 4). The rules for permissible noise vary according to land use, i.e., according to their noise area classification (NAC). In a residential setting, for example, noise restrictions are more stringent than in an industrial setting. Rural residential homes are considered NAC 1 (residential), while agricultural land and agricultural activities are classified as NAC 3 (industrial). The rules also distinguish between nighttime and daytime noise; less noise is permitted at night. The rules list the sound levels not to be exceeded for 10 percent and 50 percent of the time in a one-hour survey (L_{10} and L_{50}) for each noise area classification.

Potential human impacts due to noise include hearing loss, stress, annoyance, and sleep disturbance.[115]

Goodhue Wind Project

The operation of wind turbines in the Goodhue Wind Project would produce noise. Turbines produce mechanical noise (noise due to the gearbox and generator in the nacelle) and aerodynamic noise (noise due to wind passing over the turbine blades).[116] Perceived sound characteristics would depend on the type/size of turbine, the speed of the turbine (if turning), and the distance of the listener (receptor) from the turbine.

Wind turbines produce audible, low frequency sound and sub-audible sound (infrasound). These sounds can have a rhythmic modulation due to the spinning of the turbine blades.[117] Impacts due to these sound characteristics are subjective, i.e., human sensitivity, especially to low frequency

[115] Occupational and Community Noise, World Health Organization, http://www.who.int/mediacentre/factsheets/fs258/en/.
[116] Minnesota Dept. of Health Report, p. 11-14.
[117] Id.

sound, is variable. However, in general, low frequency sounds may cause annoyance and sleep disturbance.[118]

Table 4. Minnesota Noise Standards[119]

Noise Area Classification[120]	Daytime		Nighttime	
	L_{50}[121]	L_{10}	L_{50}	L_{10}
1	60	65	50	55
2	65	70	65	70
3	75	80	75	80

Mitigation

The primary means of mitigating sound (noise) produced by wind turbines is proper siting. Turbines must be sited to comply with noise standards in Minnesota Rules 7030.[122] For rural residential areas in Goodhue County, this means that sound levels must meet an L_{50} standard of 50 dB(A) (Table 4). The distance that turbines are setback from residences would depend on the type and size of turbine. Setback distances to the 50 dB(A) level for turbines under consideration for this project are shown in Table 1 – the setback distance for both turbines is 725 feet. The applicant has stated that no turbines will be placed within 1,500 feet of any non-participating residence.[123] This setback is reflected in the preliminary turbine layout shown in Figure 4.

Cumulative noise impacts must also be considered. That is, if there are multiple turbines in the vicinity of a residence, the standards set by Minnesota Rules 7030 must still be met. This may require additional setbacks. Cumulative noise impacts for the project have been modeled and mapped (Figure 8). Based on this modeling, no residence within the project area is anticipated to experience noise levels greater than 50 dB(A). There are approximately two residences in the project area that will experience noise levels in the range of 45 – 50 dB(A) and 55 residences that

[118] Id., Section IV.
[119] Minnesota Rules 7030.0040, Noise Standards, https://www.revisor.leg.state.mn.us/rules/?id=7030.0040. Standards expressed in dB (A).
[120] Minnesota Rules 7030.0050, https://www.revisor.leg.state.mn.us/rules/?id=7030.0050. The noise area classification is based on the land use activity at the location of the receiver (listener).
[121] Minnesota Rules 7030.0020, https://www.revisor.leg.state.mn.us/rules/?id=7030.0020. "L_{50}" means the sound level, expressed in dB(A), which is exceeded 50 percent of the time for a one hour survey. "L_{10}" means the sound level, expressed in dB(A), which is exceeded ten percent of the time for a one hour survey.
[122] Minnesota Rules 7030.0040, Noise Standards, https://www.revisor.leg.state.mn.us/rules/?id=7030.0040.
[123] Site Permit Application, Section 3.2.2. The applicant may provide a shorter setback of 1000 ft. from residences on participating lands, if the residents so agree.

will experience noise levels in the range or 40 – 45 dB(A).[124] All other residences in the project area will experience noise levels of less than 40 dB(A).

Setback requirements related to noise are enforced by site permits issued by the Commission for wind farms. The Commission has reviewed LWECS setbacks and potential public health impacts, and evaluates each project on a case-by-case basis to determine if the setbacks remain appropriate and reasonable.[125]

Generic 78 MW LWECS

A generic 78 MW LWECS would have noise impacts and mitigation strategies similar to the Goodhue Wind Project.

30 MW Biomass Plant

A 30 MW biomass plant would create noise during operation from a variety of sources including the turbine/boiler building, conveyor system, hammer mill and bale choppers, front end loaders, and idling trucks. Based on noise studies, the plant would need to be located approximately 2,100 feet from a residence to the meet the daytime L_{50} standard of 60 dB(A), and approximately 6,200 feet from a residence to meet the nighttime L_{50} standard of 50 dB(A). These are conservative estimates – they are based on maximum equipment operation and have not been adjusted for possible noise shielding.

Mitigation

Sound (noise) from the biomass plant could be mitigated by proper siting. A study would likely be required to ensure that noise standards are met for all local residents. Enclosure of heavy equipment would reduce noise impacts. Vegetative screening, planted to lessen visual impacts, would provide noise mitigation. Fuel windrows could provide noise attenuation. Hours of operation, e.g., for fuel delivery or heavy equipment operation, could be managed to reduce noise impacts and meet daytime and nighttime standards.

6.11 Property Values

Large electric generation facilities have the potential to impact property values. This section discusses potential property value impacts from the operation of a generation facility in the project area.

Goodhue Wind Project

The Goodhue Wind Project would be located in Goodhue County in southeastern Minnesota. Goodhue County has a population of 45,836 persons.[126] The home ownership rate is approximately 79.0 percent.[127]

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[124] Estimates based on interpretation of Figure 8.
[125] Commission Investigation into Large Wind Energy Conversion Systems Permit Conditions on Setbacks and the Minnesota Department of Health Environmental Health Division's White Paper on Public Health Impacts of Wind Turbines, CI-09-845, http://www.puc.state.mn.us/puc/energyfacilities/012254#windhealth.
[126] U.S. Census Bureau, Goodhue County, Minnesota, http://quickfacts.census.gov/qfd/states/27/27049.html.
[127] Id.

The impact on property values due to the project are difficult to quantify because of the multitude of factors that influence a property's market value, including acreage, schools, parks, neighborhood characteristics, and improvements. A direct influence on property value is often the status of the housing/land market at the time of sale, i.e., a buyer's market or a seller's market.

The Renewable Energy Policy Project (REPP) conducted a statistical analysis to determine the extent to which property values are influenced in the vicinity of wind projects.[128] Ten communities in the United States were studied within a five mile radius of a wind project. The study indicated that property values were not negatively impacted within the viewshed of a wind project. Lawrence Berkeley National Laboratory recently completed a nationwide study on the potential impacts of wind projects on property values.[129] Results indicate that property values near wind projects are not negatively impacted. The study indicates that home buyers and sellers consider a property's scenic vista when determining an appropriate sales price; however, sales prices are not significantly affected by views of wind turbines.

This said, neither study (REPP or Lawrence Berkeley National Laboratory) precludes the possibility of negative impacts to property values in specific situations.

Mitigation

Potential negative impacts to property values can be mitigated by siting turbines away from residences and viewsheds. Property value impacts related to annoyance (e.g. noise, shadow flicker) can be mitigated by setbacks and proper siting (see Sections 6.3 and 6.10). Property value impacts related to aesthetics and viewsheds can be mitigated by proper siting, but are relatively more difficult to mitigate due to the height of wind turbines.

Generic 78 MW LWECS

A generic 78 MW LWECS would have property value impacts similar to the Goodhue Wind Project. Impacts could be mitigated by locating in a less populated area of Minnesota.

30 MW Biomass Plant

A 30 MW biomass plant would have the potential to negatively impact property values near the plant site and possibly along roads used to transport biomass. However, as with the Goodhue Wind Project, impacts on property values due to a plant are difficult to quantify because of the multitude of factors that influence a property's market value. For example, if biomass for the plant were supplied by neighboring land parcels, these parcels might experience an increase in property value.

[128] The Effect of Wind Development on Local Property Values, May 2003, http://www.repp.org/articles/static/1/binaries/wind_online_final.pdf.

[129] The Impact of Wind Power Projects on Residential Property Values in the United States: A Multi-Site Hedonic Analysis, December 2009, http://www1.eere.energy.gov/windandhydro/pdfs/wind_power_projects_residential_property_values.pdf.

Mitigation

Because the plant is sited in one location (as compared to multiple turbine locations), property value impacts could be mitigated by proper siting.

6.12 Communications

Large electric generation facilities have the potential to impact electronic communications (e.g., radio, television, internet, cell phone, microwave). This section discusses potential impacts to communications from the operation of a generation facility in the project area.

Goodhue Wind Project

Wind turbines can cause interference with electronic communications by obstructing the reception of communication signals. Digital signals (e.g., digital television, internet, cell phones) are not impacted by wind turbines unless the turbines directly obstruct the signal, i.e., are in the line of sight.[130] Analog signals (e.g. AM and FM radio, microwaves) can be interfered with by direct obstruction and by indirect signal interference, e.g., ghosting of television pictures, signal fading.

Potential communications impacts due to the Goodhue Wind Project are anticipated to be minimal. Digital television facilities provide signals from north of the project area (e.g., Minneapolis) and south of the project area (e.g. Rochester).[131] Multiple signals reduce the potential for television impacts. Internet and cell phone communications are conducted by multiple reception towers and/or satellites. The multiplicity of receptors reduces the potential for impacts to these services. FM radio is not impacted by wind turbines or transmission facilities; AM radio can be impacted near transmission facilities, e.g., signal fading underneath a transmission line.

Global positioning systems (GPS) use satellite signals to determine locations on the earth's surface and are commonly used to guide agricultural operations.[132] Because GPS uses multiple digital satellite signals, interference with the signals or subsequent uses is not anticipated. Obstruction of any one satellite signal would require direct line-of-sight obstruction due to a wind turbine. Such an obstruction would be temporary (i.e., there is concurrent GPS receiver movement, satellite movement, and wind turbine blade movement such that the obstruction would be resolved).

There are microwave beam paths in and near the project area (Figure 9).[133] Wind turbines can impact microwave communications by interfering with these beam paths (e.g., wind turbine blade slicing through a beam path). Thus, turbines need to be located within the project area such that they do not obstruct microwave beam paths.

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[130] Post Digital Television Transition - The Evaluation and Mitigation Methods for Off-Air Digital Television Reception in-and-around Wind Energy Facilities; http://www.comsearch.com/files/Wind_Energy_White_Paper.pdf.
[131] Minnesota – Full Powered Digital TV Channel Assignments, http://www.global-cm.net/FULL%20POWER%20DIG%20TV%20BY%20CH%20-%20MN.pdf.
[132] Precision Farming Tools: Global Positioning Systems (GPS), Virginia Cooperative Extension; http://www.pubs.ext.vt.edu/442/442-503/442-503.html.
[133] Site Permit Application, Section 6.5.2.

Wind turbines may impact radar systems, e.g., radar used for aviation, if they are in the radar line of sight.[134] Impacts may include an impairment of the ability to detect and track aircraft. Impacts can be mitigated by avoiding the placement of wind farms in radar lines of sight.[135] The U.S. Department of Defense is responsible for compatibility of wind farms with military radar installations; the Federal Aviation Administration is responsible for compatibility with commercial aviation radar.[136]

Mitigation

Impacts to electronic communications due to the Goodhue Wind Project are not anticipated. Potential impacts to microwave beam paths can be mitigated by proper wind turbine siting.

Generic 78 MW LWECS

A generic 78 MW LWECS would have communications impacts similar to the Goodhue Wind Project.

30 MW Biomass Plant

A 30 MW biomass plant would have communications impacts less than the Goodhue Wind Project. A biomass plant would be shorter than the project's wind turbines and sited in one location (as opposed to multiple turbine locations). If the biomass plant location is well chosen, the plant would not impact electronic communications.

6.13 Wildlife and Domesticated Animals

Large electric generation facilities have the potential to impact the health of animals, directly and through impacts to the ecosystem. This section discusses potential impacts to wildlife and domesticated animals due to the operation of a generation facility in the project area.

6.13.1 Wildlife

The Goodhue Wind project area is predominantly rural and agricultural (Figure 2). Crops include corn, soybeans, small grains, and forages; they account for approximately 72 percent of land cover in the project area.[137] Windbreaks are common around farmsteads; willows, grasses, and sedges are found near streams and ditches.[138] Wetlands within the project area are limited (Figure 10).

The project area is located in the Paleozoic plateau of Minnesota, an ecological section dissected by tributaries of the Mississippi River, e.g., Cannon River, Zumbro River.[139] Prior to development, prairies occupied the relatively flat, fire-prone areas in the western part of the section. Woodlands were common on the dissected hillsides leading to the Mississippi. The

[134] The Effect of Windmill Farms on Military Readiness, 2006, http://www.defense.gov/pubs/pdfs/WindFarmReport.pdf.
[135] Id.
[136] Id.
[137] Interpreted from Figure 2.
[138] Site Permit Application, Section 4.4.1.
[139] Paleozoic Plateau Section, http://www.dnr.state.mn.us/ecs/222L/index.html.

relative richness of habitat in the plateau varies with agricultural development, i.e., agricultural development has removed habitat for many animal species.[140]

Despite agricultural development, a number of animal species are adapted to the habitat of the project area. In agricultural landscapes, crops provide seasonal cover and food, while uncultivated areas provide long-term cover, food, and water. A variety of mammals are typical in this landscape, including deer, fox, gophers, squirrels, and mice.[141] Birds are common in this landscape.[142] The loggerhead shrike, listed as a threatened bird species by the State of Minnesota, has been observed on the eastern edge of the project area (Figure 11).[143] A bald eagle nest has been documented one mile west of the project area.[144] Waterfowl are not common due to lack of habitat. Similarly, amphibians and reptiles are relatively rare in the project area due to a lack of wetland habitat.[145]

Goodhue Wind Project

The Goodhue Wind Project would negatively impact select wildlife in the project area. Impacts related to construction are likely minimal. The physical footprint of a wind turbine is relatively small. Direct land use for the project is anticipated to be approximately 38 to 47 acres (turbines, access roads, operation and maintenance building).[146] The land used for project construction will be primarily agricultural land, which is relatively poorer habitat for wildlife.

Impacts on ground species due to operation of the project would be minimal. However there would be negative impacts to avian species, i.e., birds and bats. Birds can collide with spinning turbine blades, and may also suffer habitat loss. Bats can collide with turbines blades, but also appear to suffer injury to their respiratory systems (barotrauma) when they fly through low pressure wakes near turbine blades.[147]

Birds

Studies have been conducted throughout the Midwest in an attempt to quantify bird and bat mortality due to wind turbines. A study of bird mortality rates at a wind farm in Iowa resulted in estimated mortality rates between 0.3 and 0.8 birds per turbine per year.[148] This estimate is similar to results from studies in other states where mortality rates ranged between < 1 to 2.83 birds per turbine per year.[149] Studies conducted in the Buffalo Ridge region of southwestern Minnesota resulted in estimated bird mortality rates between 1.0 and 4.5 birds per turbine per

[140] See, e.g., Rochester Plateau, Subsection Profile, http://files.dnr.state.mn.us/assistance/nrplanning/bigpicture/cwcs/profiles/rochester_plateau.pdf.
[141] Site Permit Application, Section 4.18.
[142] Id.
[143] Site Permit Application, Section 4.19.
[144] Id.
[145] Site Permit Application, Section 4.18.
[146] Site Permit Application, Section 2.4.
[147] Extreme Pressure Changes near Blades Injures Bat Lungs, http://www.ucalgary.ca/news/aug2008/batdeaths.
[148] Bird and Bat Behavior and Mortality at a Northern Iowa Windfarm, Jain, 2005 http://www.batsandwind.org/pdf/Jain_2005.pdf.
[149] Id.

year.[150] Nocturnal migrants suffered relatively more mortalities; local grassland species suffered relatively less. The studies noted that birds tend to avoid turbine towers, but utilized the surrounding habitat. A study conducted for the Bitter Root Wind Project (proposed to be located in Yellow Medicine and Lincoln County, Minn.) found that passerines (perching songbirds) are relatively more likely to suffer mortalities due to wind turbines while waterfowl are less vulnerable to turbine collisions.[151]

Nationwide, bird mortality rates vary, but are generally in the range of 1 to 4 bird fatalities per MW per year (Appendix B).[152] Migratory songbirds comprise approximately 75 percent of these fatalities.[153]

Overall, studies of bird mortalities near wind farms indicate that mortalities will occur and that they will vary with bird type (e.g., songbirds) and bird use (habitat). These mortalities are not anticipated to be significant from a population standpoint.[154] Because of the relatively poor bird habitat in the project area, impacts to bird populations from operation of the Goodhue Wind Project are anticipated to be insignificant from a population standpoint.

Bats

Bats typically utilize forests, riparian corridors, and wetlands as feeding habitat due to higher nocturnal insect densities in these areas. The Iowa wind farm study estimated bat mortality rates between 6 and 9 bats per turbine per year.[155] A Buffalo Ridge study estimated bat mortality rates at 2.2 bats per turbine per year.[156] Nationwide, bat mortality rates range generally from 1 to 20 bat fatalities per MW per year (Appendix B).[157]

Two state-listed bat species of special concern are found in Goodhue County – the northern myotis and the eastern pipistrelle.[158] It is uncertain whether there are hibernation sites (hibernacula) in the project area to support these species.[159]

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[150] Avian Monitoring Studies at the Buffalo Ridge, Minnesota Wind Resource Area: Results of a 4-Year Study, http://energyfacilities.puc.state.mn.us/documents/AvianMonitoringBuffaloRidge.pdf [hereafter Buffalo Ridge Studies].
[151] Wildlife Studies for the Bitter Root Wind Resource Area, Yellow Medicine and Lincoln Counties, Minnesota, April 2009; Site Permit Application, Appendix F, http://energyfacilities.puc.state.mn.us/documents/25538/Appendix_%20F_Wildlife_Studies.pdf.
[152] Wind Turbine Interactions with Birds, Bats, and their Habitats: A Summary of Research Results and Priority Questions, Spring 2010 [hereafter Birds, Bats, and their Habitats], http://www.nationalwind.org/assets/publications/Birds_and_Bats_Fact_Sheet.pdf.
[153] Id.
[154] Id.
[155] Bird and Bat Behavior and Mortality at a Northern Iowa Windfarm, Jain, 2005 http://www.batsandwind.org/pdf/Jain_2005.pdf.
[156] Bat Interactions with Wind Turbines at the Buffalo Ridge, Minnesota Wind Resource Area, November 2003, http://my.epri.com/portal/server.pt?space=CommunityPage&cached=true&parentname=ObjMgr&parentid=2&control=SetCommunity&CommunityID=404&RaiseDocID=000000000001009178&RaiseDocType=Abstract_id.
[157] Birds, Bats, and their Habitats, Figure 3.
[158] Site Permit Application, Section 4.19.
[159] Id. These species typically hibernate in caves or old mines, but can use old barns, buildings, and rock crevices.

Generally, there is limited bat roosting habitat in the project area and a lack of feeding habitat (wetlands, forests). Thus, bat activity is anticipated to be relatively low. Accordingly, bat mortalities from project operation are not anticipated to be significant. This said, bat populations and movements within Minnesota are not well understood. Thus, population impacts of bat mortalities are uncertain.

Mitigation

Impacts to ground animals are expected to be minimal and mitigation is not required. Impacts to birds and bats are expected to be minimal but can be mitigated by siting. Siting away from bird habitat (grasslands, riparian areas) and bat feeding areas (forest, riparian areas) would reduce bird and bat mortalities. Birds and bats fly relatively less in windy conditions. Wind turbines operate in windy conditions and require a minimum wind speed (see Table 1). Thus, impacts to birds and bats could be mitigated by employing turbines with a relatively higher cut-in speed or by using SCADA system controls to implement a higher cut-in speed.[160]

Generic 78 MW LWECS

A generic 78 MW LWECS located elsewhere in Minnesota would have wildlife impacts similar to the Goodhue Wind Project. Information about local bird and bat populations within Minnesota is incomplete. These populations vary with habitat. Populations are relatively greater in areas where human development has spared supporting habitat, e.g. prairie grasslands, forests. Populations are greater in areas with water resources, e.g., waterfowl are more prevalent in the prairie pothole region of Minnesota.[161]

The Goodhue Wind project area has relatively poor habitat for birds and bats. If a generic wind project were sited in similar habitat, impacts would be similar. If a generic wind project were located in an area with relatively better habitat, impacts would likely be greater than that for the Goodhue Wind Project.

30 MW Biomass Plant

A 30 MW biomass plant would have wildlife impacts similar to the Goodhue Wind Project, excepting impacts to birds and bats. The plant would be constructed on an approximately 60 acre site. This acreage would be removed from use as wildlife habitat. However, the land used for the project would be agricultural land; such land is relatively poorer habitat for wildlife. Impacts from operation of the plant are anticipated to be minimal. Emissions from the plant (e.g., hazardous air pollutants) could, through impacts to the environment, impact wildlife. The extent of this impact is uncertain.

6.13.2 Domesticated Animals

For purposes of evaluation with respect to a wind farm, domesticated animals (livestock, pets) differ from wildlife in that (1) they have limited opportunity to move away wind turbines and (2)

[160] Effectiveness of Changing Wind Turbine Cut-In Speeds to Reduce Bat Fatalities at Wind Facilities, April 2009, http://www.batsandwind.org/pdf/curtailment_2008_final_report.pdf.
[161] Waterfowl Breeding Pair Distribution in the Prairie Pothole Region of Minnesota and Iowa, http://www.fws.gov/midwest/HAPET/DuckDensityMaps.htm.

they are more typically non-avian species. There are few aspects of animal health that can be considered outside of ecosystem health. That is, animal health depends on ecosystem health (clean water, fresh air, healthy soils and crops). Generation facilities that impair ecosystem functioning can negatively impact animal health, e.g., emissions of hazardous air pollutants. Potential ecosystem impacts due to generation facilities are discussed elsewhere in this report (e.g., Sections 6.1 and 6.2 discussing air pollutants).

There are potential impacts to animal health that are independent of ecosystem health, i.e., impacts to health due to annoyance or stress. This stress could result from a variety of impacts related to generation facility operations, e.g., lights, noises, electrical shock. Shadow flicker is discussed in Section 6.3; noise is discussed in section 6.10.

Electrical shock could be caused by stray voltage or induced voltage.[162] Stray voltage occurs with electrical distribution lines to residences and transmission lines that parallel them. Stray voltage flows through the ground. Induced voltage occurs with ungrounded metal objects (e.g., fences) that parallel transmission lines. Induced voltage flows through the metal objects. In general, transmission lines are electrical lines with voltages of 100 kV or greater; distribution lines are electrical lines with voltages less than 100 kV.[163]

Goodhue Wind Project

Domesticated animals in the area of the Goodhue Wind Project would be exposed to noise and shadow flicker created by wind turbines. Exposure would depend on the type of animal, animal husbandry practices, and the distance between animals and the turbines. Health impacts from turbine noise and shadow flicker are uncertain. Information about impacts to domesticated animals is anecdotal and indicates that animals are not impacted by turbine operations. Grazing animals appear to graze near, under, and up to turbine towers (Figure 12).

Studies designed to assess turbine impacts on avian wildlife have found that wildlife use areas near wind turbines (e.g., nesting, feeding), but avoid the areas directly under turbine towers.[164] It's unclear whether these species are avoiding stress due to noise or flicker, or if they are avoiding potential impact with turbine blades. Studies designed to assess direct turbine impacts to non-avian wildlife (e.g., mice, squirrels, deer) and domesticated animals (e.g., cattle, horses) are scarce, presumably because impacts to these species are anticipated to be minimal.

The Goodhue Wind Project does not include distribution lines to residences or transmission lines over 100 kV. Thus, impacts due to stray voltage are anticipated to be minimal. The 69 kV transmission line to the Vasa substation would parallel an existing distribution line and may parallel ungrounded metal objects such that it would produce an induced voltage. Thus, this area has a relatively higher risk of stray voltage. Due to the relatively low density of built

[162] See, e.g., Brookings DEIS, Section 6.2.
[163] Intermediate voltages, e.g., 69 kV, can, in some instances, serve as transmission lines.
[164] See discussion in Application for a Site Permit, 138 MW Buffalo Ridge Wind Farm Project, Section 8.17.2, http://energyfacilities.puc.state.mn.us/documents/25538/Bitter_Root_Applictext_10-13-09.pdf. For example, studies of grassland nesting songbirds show that use of grasslands areas was reduced within 50 meters (164 ft.) of turbines, but that areas further away did not have reduced use.

infrastructure in the area and the use of the existing 34.5 kV distribution line right-of-way, impacts from induced voltage are not anticipated.

Mitigation

Stray and induced voltage can be mitigated by proper grounding of facilities (e.g., buildings, fences, distribution line structures).

Generic 78 MW LWECS

A generic 78 MW LWECS located elsewhere in Minnesota would have impacts to domesticated animals similar to the Goodhue Wind Project.

30 MW Biomass Plant

A 30 MW biomass plant would likely have impacts to domesticated animals less than those of the Goodhue Wind Project. Biomass plant operations would create noise and lighting that could impact animal health. Additionally, the plant could have an associated transmission line that produced stray or induced voltage. However, the plant could be sited away from animals (e.g. livestock operations) to minimize health impacts. In this sense, the biomass plant represents a concentrated impact that can be moved away from animals. Wind turbines represent a diffuse impact that exists within landscapes utilized by animals.

6.14 Natural Resources

Large electric generation facilities have the potential to impact natural resources, including flora, fauna, soils, and waters. This section discusses potential natural resource impacts from the operation of a generation facility in the project area.

Goodhue Wind Project

The Goodhue Wind project area is located on the Paleozoic plateau of Minnesota – an area that, pre-settlement, consisted of woodlands and prairies. Post-settlement, almost all of the native vegetation in the area has been converted to agriculture (Figure 2). The project area does include small patches of forest and wetlands. These patches support unique plant communities, e.g., dry oak savanna, and unique plant species, e.g., snow trillium (Figure 11).[165]

Because the project area is primarily agricultural land, and because the project is proposed to be sited on agricultural land, impacts to native vegetation are anticipated to be minimal. Potential impacts to fauna (wildlife and domesticated animals) are discussed in Section 6.13. Such impacts are anticipated to be minimal, though impacts to birds and bats will occur.

Soils in the project area consistent of silt and sandy loams which are agriculturally productive (Figure 13).[166] Construction of the Goodhue Wind Project will impact these soils by (1) taking some portion of the soils out of agricultural production and (2) eroding soils during construction operations. The construction of turbines and access roads will use 38 to 47 acres of land.[167]

[165] Site Permit Application, Section 4.19.
[166] Site Permit Application, Section 4.13
[167] Site Permit Application, Section 2.4.

Waters in the project area include groundwater and surface waters. Bedrock in the project area consists of sandstone, limestone, and shale, and is overlaid by glacial drift.[168] Groundwater recharge occurs through infiltration and percolation. There is karst topography in Goodhue County; however it is not prevalent in the project area.[169] Based on mapping by the Minnesota Department of Natural Resources, the project is classified as having a low probability of sinkhole development.[170] However groundwater in the project area is noted as having a high sensitivity to pollution, i.e., surface waters commingle with bedrock aquifers relatively easily.[171]

Surface waters in the project area consist of streams, creeks, ditches, and small holding areas (ponds, quarries, reservoirs).[172] Drainage in the western half of the project area is to Belle Creek; drainage in the northeastern part of the project is to Hay Creek.[173]

Potential impacts to surface and ground waters are most likely during project construction. Construction will disturb soils, e.g., heavy machinery use, digging, trenching. This disturbance could create soil erosion, with soils entering surface and ground water. Additionally, construction will create impermeable surfaces that may increase the energy of flowing waters, leading to soil erosion.

Mitigation

Potential impacts to native vegetation can be mitigated by siting wind turbines to avoid such vegetation. Proposed turbine locations are primarily on agricultural land, away from native plant communities and unique plant species (see Figure 4). Final siting ("micro-siting"), especially for northern edge of the project which is near native plant communities, will be done in consultation with the Minnesota Department of Natural Resources and the U.S. Fish and Wildlife Service.[174]

Potential impacts to surface and ground waters can be mitigated by several strategies. The project will be required to obtain a National Pollution Discharge Elimination System / State Disposal System (NPDES/SDS) stormwater permit from the Minnesota Pollution Control Agency.[175] This permit is designed to minimize contamination of surface waters during construction. Proper siting of the turbines and associated facilities can reduce the potential for water contamination. Turbines sited on high ground, away from surface waters, have less potential for impacting surface waters. The project will create new impermeable surfaces in the project area. However, the 38 to 47 acres represents less than a 0.2 percent increase in

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[168] Site Permit Application, Section 4.14.
[169] Id. Karst landforms develop where mildly acidic groundwater contacts soluble limestone bedrock. Over time, this contact can dissolve portions of the bedrock, creating cracks and voids which serve as conduits for surface water to enter underlying aquifers. Thus soil and other materials which enter surface waters can be commuted relatively easily to ground waters.
[170] Id. See also, Sinkholes, Sinkhole Probability, and Springs and Seeps, http://files.dnr.state.mn.us/waters/groundwater_section/mapping/cga/c12_goodhue/pdf_files/plate10.pdf.
[171] Sensitivity to Pollution of the Uppermost Bedrock Aquifers, http://files.dnr.state.mn.us/waters/groundwater_section/mapping/cga/c12_goodhue/pdf_files/plate09.pdf.
[172] Site Permit Application, Section 4.15.
[173] Id.
[174] Site Permit Application, Section 4.19.3.
[175] Stormwater Program for Construction Activity, http://www.pca.state.mn.us/water/stormwater/stormwater-c.html.

impermeable surface in the 32,700 acre project area. This increase is expected to have a minimal impact on surface and ground waters.

Generic 78 MW LWECS

A generic 78 MW LWECS located elsewhere in Minnesota would have impacts to natural resources similar to the Goodhue Wind Project. If the generic site has relatively more native vegetation, impacts to native vegetation would likely be greater. Impacts to soils and waters are primarily through soil erosion during construction. Measures to combat soil erosion are adoptable statewide; thus, impacts due to soil erosion will likely not change with project location. This said, locating a generic project on steep slopes, e.g., bluff lands near the Mississippi River, would increase impacts to soils and waters.

30 MW Biomass Plant

A 30 MW biomass plant would have impacts to natural resources similar to the Goodhue Wind Project. Because a biomass plant would occupy a single site, proper siting of such a plant would likely mitigate impacts to native vegetation, soils, and waters.

6.15 Aviation

Large electric generation facilities have the potential to impact aviation. This section discusses potential impacts to aviation from the operation of a generation facility in the project area.

Goodhue Wind Project

Because of their height, wind turbines have the potential to impact aviation in and near a wind project. Wind turbines in the Goodhue Wind Project will require notice to and evaluation by the Federal Aviation Administration (FAA)[176] and the Minnesota Department of Transportation (MN DOT).[177] There are no airports in the project area – the nearest airports are the Fairview Red Wing Medical Center and Hospital heliports, located approximately 11.3 and 11.6 miles northeast of the project area.[178] The Stewart Farms Airport is approximately 12.7 miles northwest of the project area; the Red Wing Falls Regional Airport is approximately 14.7 miles northeast of the project area.[179] The Goodhue Wind Project does not impact the safety zones of any of these airports.[180]

Wind turbines could impact local aviation, i.e., aerial crop spraying. Wind turbines would make it relatively more difficult to apply chemicals from the air. Pilots making such applications would have their attention divided between aircraft systems, spraying requirements, weather, and obstructions.[181] Additionally, operating wind turbines create turbulence wakes which would

[176] FAA Advisory Circular AC 70/7460-2K, HTTP://RGL.FAA.GOV/REGULATORY_AND_GUIDANCE_LIBRARY/RGADVISORYCIRCULAR.NSF/0/22990146DB0931F186256C2A00721867/$FILE/AC70-7460-2K.PDF
[177] Tall Towers, Minnesota Structure Height Regulations, http://www.dot.state.mn.us/aero/avoffice/talltowers.html.
[178] Site Permit Application, Section 4.8.
[179] Id.
[180] For Minnesota safety zones, see Minnesota Rules, 8800.2400, https://www.revisor.mn.gov/rules/?id=8800.2400.
[181] Aerial crop sprayers in Wisconsin adopted a resolution in 2009 refusing to provide services within wind farm projects; Glacial Hill FEIS, Section 5.4.2.2.

make aircraft operation difficult. However, applications by air are typically made during low wind conditions. In these conditions, wind turbines would not be turning or creating turbulence wakes.

Wind turbines could impact local helicopter navigation, e.g., emergency medical helicopters needing to land in or near the project area. It's unclear whether the project would significantly increase the risks of helicopter navigation. Officials at the Mayo Clinic in Rochester, Minn., have noted that impacts on helicopter operations due to wind projects in the area have been insignificant.[182]

Mitigation

Potential impacts to aviation can be mitigated by proper siting of the project and adherence to FAA and MN DOT regulations.[183] Impacts to aerial crop spraying would be difficult to mitigate.

Generic 78 MW LWECS

A generic 78 MW LWECS located elsewhere in Minnesota would have aviation impacts similar to the Goodhue Wind Project.

30 MW Biomass Plant

A 30 MW biomass plant would have aviation impacts less than the Goodhue Wind Project. A biomass plant would be relatively shorter and located on one site. Thus, it's potential to disrupt aviation would be minimal.

[182] Mayo: Turbines do not hamper medical helicopters, Rochester Post-Bulletin, May 18, 2010, http://www.postbulletin.com/newsmanager/templates/localnews_story.asp?z=2&a=452955.
[183] Site Permit Application, Section 4.8.2.

7.0 Required Permits

The Goodhue Wind Project will require permits and approvals from entities other than the Minnesota Public Utilities Commission. Federal, state, and local permits or approvals that have been identified for construction and operation of the project are listed in Table 5.

Table 5. Permits and Approvals[184]

Agency	Type of Approval
Federal	
Federal Aviation Administration	Notice of Proposed Construction or Alteration; Determination of No Hazard
Natural Resources Conservation Service	Prime Farmland Filing
U.S. Army Corps of Engineers	Wetland (Section 404) Permit
State of Minnesota	
Minnesota Public Utilities Commission	Certificate of Need; LWECS Site Permit
Minnesota State Historical Preservation Office	Cultural and Historic Resources Review
Minnesota Board of Water and Soil Resources	Wetland Conservation Act Approval
Minnesota Department of Natural Resources	Pubic Water Works Permit
	License to Cross Public Lands and Waters
Minnesota Pollution Control Agency	NDPES/SDS Permit for Construction and Stormwater Pollution Prevention Plan (SWPPP)
	License for Small Quantity Generator of Hazardous Waste
	Aboveground Storage Tank (AST) Notification Form
	Spill Prevention, Control, and Countermeasure (SPCC) Plan
	State Water Quality (Section 401) Certification

[184] Potential permits and approvals required for the Goodhue Wind Project. Adapted from Site Permit Application, Section 5.0.

Agency	Type of Approval
Minnesota Department of Health	Water Well Permit; Plumbing Plan Review
Minnesota Department of Transportation	Utility Access Permit, Highway Access Permit
	Oversize and Overweight Vehicle Permit
	Aeronautics Airspace Obstruction Permit
Local Permits	
Goodhue County	Building Permit (O&M building), Conditional Use Permit (O&M building)
	Zoning Compliance Certificate (O&M building)
	Individual Septic Tank Systems Permit (O&M building)
	Driveway Permit, Utility Permit, Moving Permit
	Overwidth/Overweight Permits
Goodhue Soil and Water Conservation District	Wetland Conservation Act Approval
Townships	Road Access Permits