EXISTING ENERGY CONDITIONS

CITY OF BEMIDJI

AUGUST 2018

EXAMPLE REPORT

MINNESOTA LoGo PEP

Prepared by:

Great Plains Institute

The development of this guide is supported by the McKnight Foundation and the Department of Energy, Office of Energy Efficiency and Renewable Energy (EERE), under Award Number DE- DE-EE0007229. This project was made possible by a grant from the U.S. Department of Energy and the Minnesota Department of Commerce. The team includes LHB, Great Plains Institute, and the University of Minnesota's Energy Transition Lab and Center for Science, Technology, and Environmental Policy.

EXISTING ENERGY CONDITIONS: BEMIDJI

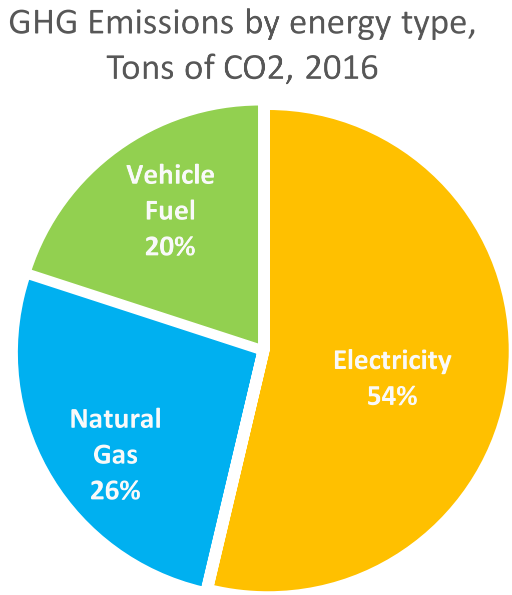
Understanding how energy is used within a community and the resources that are available is important when determining energy priorities and setting goals. The following report summarizes energy consumption and available clean energy resources for the City of Bemidji. The purpose of this report is to inform decision-makers about the city's existing energy conditions to assist in development of sound goals around future energy use in the City of Bemidji. The information for this report includes data from Ottertail Power, Minnesota Energy Resources Corporation (MERC), Minnesota Department of Transportation (MNDOT), Regional Indicators Imitative, and the U.S. Department of Energy.

Energy Use Profile

Ottertail Power provides almost all electricity in Bemidji, as only a very small area of Bemidji is served by the Beltrami Electric Cooperative, Inc. Minnesota Energy Resources (MERC) delivers natural gas services to businesses and residents in Bemidji. Within Beltrami County, the MERC service area is almost exclusively the Bemidji municipal boundary. Due to the nature of MERC reporting – which aggregates all natural gas consumption in Beltrami County – the natural gas estimates for Bemidji may be slightly higher than the actual usage. Few residents may use heating fuel, biomass, or propane as their primary heating source, but that is not captured in this report. Electricity is used for appliances, water and space heating, space cooling, lighting, commercial and industrial processes, as well as other electronic devices. Natural gas is primarily used for space and water heating, cooking, and various industrial processes.

The table and graphs below provide a summary snapshot of the total energy used in Bemidji.

SECTOR	ENERGY (MMBTU)	EMISSIONS (TONNES CO2)	% OF TOTAL EMISSIONS
COMMERCIAL/INDUSTRIAL	943,270	117,155.7	51%
RESIDENTIAL	759,598	66,896.0	29%
TRANSPORTATION	538,212	44,924.0	20%



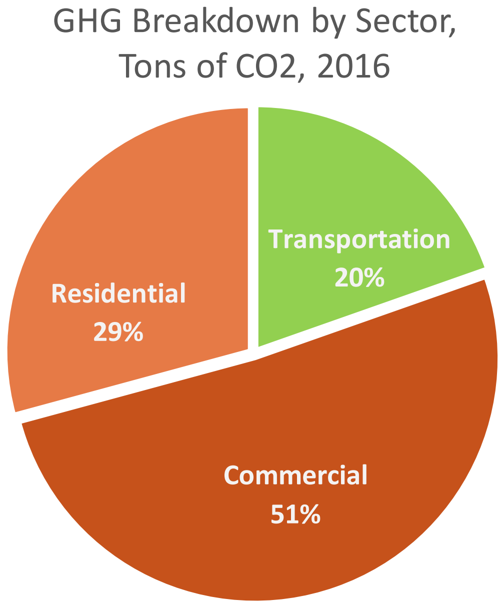


Figure 1 Data Source: Ottertail Electric (2017), Minnesota Energy Resources Corporation (MERC) (2016), Regional Indicators Initiative (2016), MNDOT (2017)

Energy and GHG Data Sources

The primary source for the community's energy and GHG data is the Regional Indicators Initiative (RII) program. RII utility energy and travel energy data is currently available for 20 metro-area communities. By Spring of 2018, the RII site will provide this data for all GreenStep Cities at Step 2 or higher, plus some additional metro area cities.

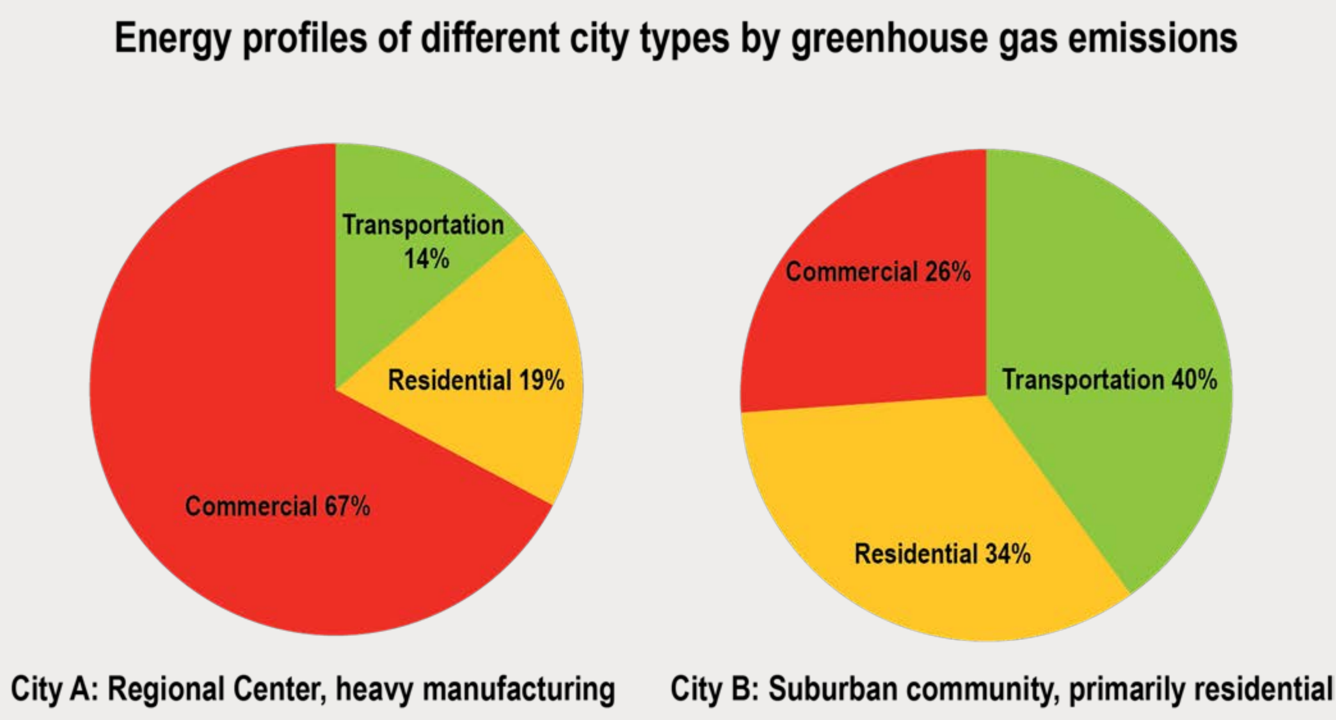
Another source of energy data, for those communities served by Xcel Energy, is the Xcel Energy Community Energy Reports. Xcel Energy currently provides data for 70 cities and counties. Electricity data is available in all reports, while natural gas information is only available to those communities served by Xcel Energy.

For communities that do not receive RII data and/or are outside of Xcel Energy territory may use another source of information from the U.S. Department of Energy (USDOE) State and Local Energy Data website, which provides estimates of community energy use for 23,000 cities across the U.S., based on a statistical model based on common community characteristics (See Cities LEAP, City Energy Profile).

All three of these data sources identify the greenhouse gas (GHG) amounts associated with the energy use included in the data set.

Different City Types, Different Energy Profiles

Different city types will have different looking energy profiles. More dense, urban communities will tend to have higher emissions from buildings as compared to transportation, where bedroom communities may have higher relative transportation emissions. Some communities may appear to have higher emissions due to a high concentration of industrial or large commercial uses. Understanding your community's energy profile is important to set appropriate goals.



From these graphs we see that energy use and greenhouse gas emissions are not evenly spread across sectors, with electricity responsible for a significantly larger proportion of emissions (54%) than natural gas and vehicle fuel. Further breakdown of this information demonstrates that the community consumes a greater share of natural gas (65%) as compared to electricity (35%) when looking at MMBtu for building energy use. However, from a GHG standpoint, electricity makes up a greater share (67%) than natural gas (33%) due to a higher carbon intensity of electricity generation as compared to the combustion of natural gas.

The city's efficiency resource is measured by looking at current energy use; the greater the energy consumption, the greater resource available for Bemidji to achieve greater efficiency. The largest energy consumption occurs in the commercial and residential sectors, suggesting greater opportunity for efficiency.

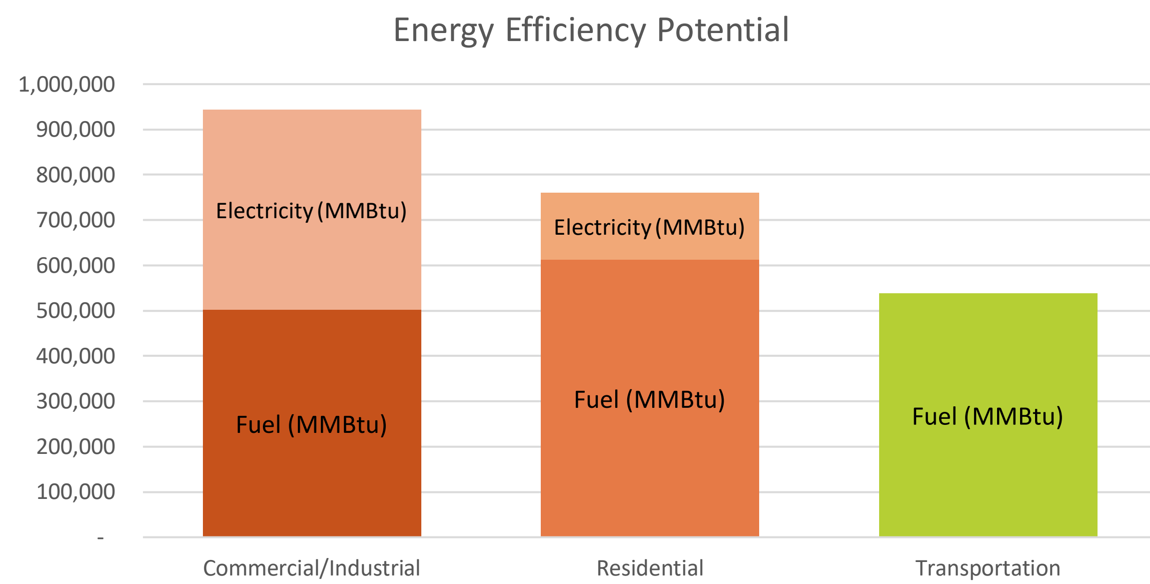


Figure 4 Data Source: Ottertail Electric (2017), Minnesota Energy Resources Corporation (MERC) (2016), Regional Indicators Initiative (2016), MNDOT (2017)

As the city looks to expand its efficiency outreach efforts, it should consider the areas that can have the biggest impact. As mentioned, the commercial sector uses a greater share of energy and associated emissions as compared to the residential sector. However, there are significantly fewer commercial buildings than residential (Figure 5). Because there is greater energy intensity (MMBtu/square foot) among commercial energy use, a single successful efficiency improvement may reap the efficiency benefits of dozens of residential successes.

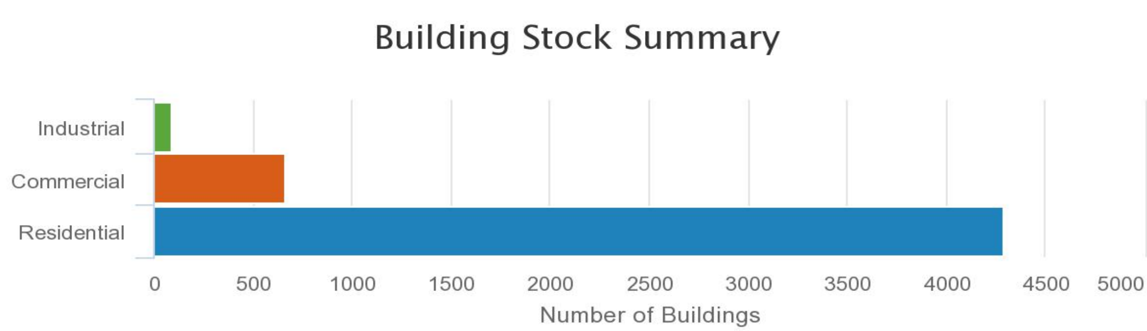


Figure 5 Data Source: U.S. Department of Energy State and Local Energy Data (2016)

Transportation Energy Use Profile

Transportation energy is almost exclusively attributable to car and truck travel, and is estimated by the vehicle miles traveled (VMT) within the city boundaries (regardless of through traffic or with an origin or destination in the city). VMT does not capture energy attributable to rail and airplanes, but those are generally a very small portion of transportation energy. MNDOT data shows that 104,885,511 vehicle miles were traveled within Bemidji in 2017, up approximately 400,000 from the prior year 2016. The greenhouse gas emissions associated with this travel is approximately 44,924 tonnes of CO2e, or about 20% the city's total GHG emissions.

The U.S. Department of Energy State and Local Energy Data reports that there are 29,000 light duty vehicles in the Bemidji market with an average fuel economy 21.5 miles per gallon, on par with the national average of 21.64 (Alternative Fuels Data Center). For primary fuel source, 84% of these vehicles use gasoline; flex fuel (e85) makes up the next highest fuel source.

MNDOT data includes VMT for communities dating back to 2001. The annual VMT in Bemidji has been increasing steadily since, with minor dips in 2006, and 2012. Figure 7 illustrates the trend over the 16-year period from 2001 to 2017.

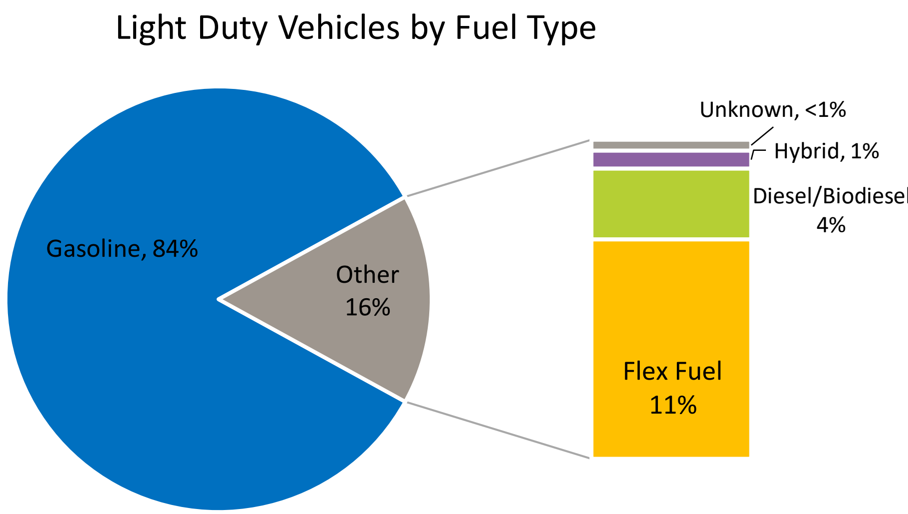


Figure 6 Data Source: U.S. Department of Energy State and Local Energy Data

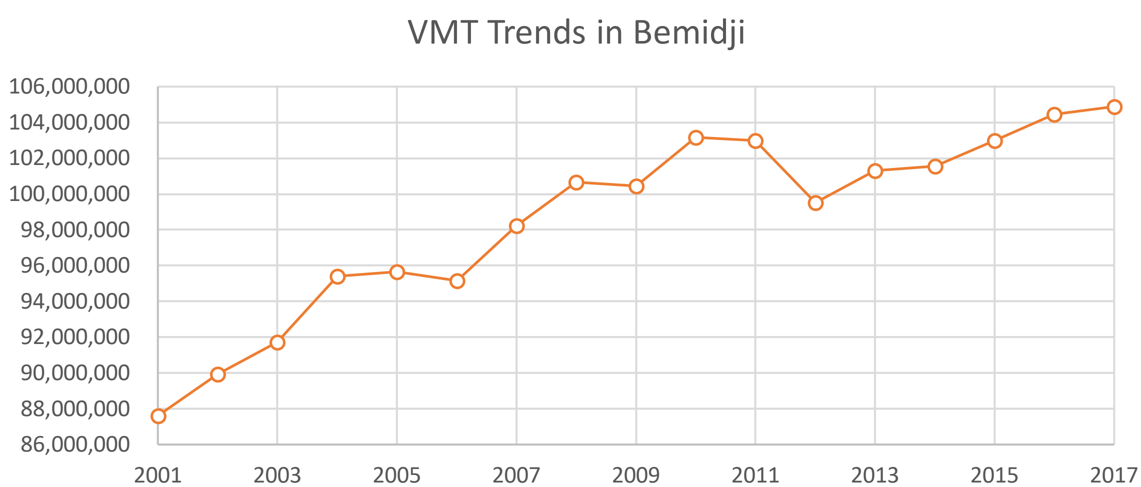


Figure 7 MNDOT Annual Reports (2001 to 2017)

Solar Resource

The University of Minnesota developed a high-resolution statewide solar resource map that allows cities to calculate how much electricity they could potentially receive from locally installed solar energy systems. These data (see map, next page) were used to calculate the solar resource, or the city's "solar reserves," in Bemidji. The solar reserves are how much solar energy is reasonably economically available for development, similar to the way in which oil or gas reserves are measured. The solar map shows the good sites for solar installations and helps identify where there may be land use conflicts with solar development. Table 2 shows the amount of solar energy reasonably available for development in Bemidji. The gross potential includes the total available resource, regardless of location; rooftop capacity and generation include only the resource available on the rooftops of commercial buildings located in the city.

Community	Total Generation Potential	Rooftop Generation Potential	Rooftop Capacity	Top 10 Rooftop Potential
Bemidji	2,170,603 MWh/year	76,695 MWh/year	59 MW	16,743 MWh/year

Table 2: Bemidji Solar Resource

The total capacity of the economic rooftop solar resource in Bemidji is 59 MW, equal to approximately 44.5% of all the electricity consumed in the city. This means that if the city wanted to maximize its entire commercial rooftop solar resource, it could set a solar generation goal of up to 44.5% on-site solar generation (note: this is an upper limit and does not consider individual site limitations due to roof structure, ownership, or local regulations that might limit solar installations). If buildings undergo high levels of energy efficiency investment, the solar resource could meet a higher percentage of electric needs. The efficiency and solar resources are, in this analysis, calculated independently of each other.

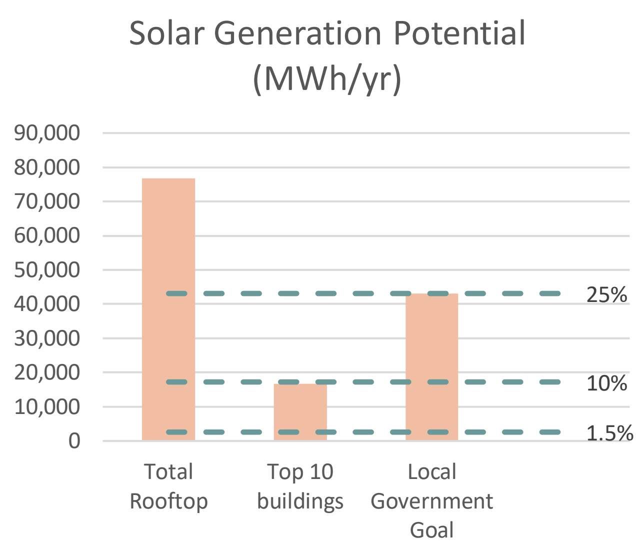


Figure 8 Example of Solar Potential and Community Goal

Solar installations are not limited to rooftop applications. This analysis does not include ground-mount systems, but the city will want to develop criteria for where they would and would not allow solar installations. For instance, commercial parking lots may make good solar resources or public right of ways; while areas planned for future development or park space may not.

Solar Data Resources

Metropolitan Council: The Metropolitan Council requires cities to include: 1. A calculation of your community's solar resource along with solar suitability map, 2. Policies relating to the development of access to direct sunlight for solar energy, per the Metropolitan Land Planning Act, and 3. Strategies to implement those policies. The Council has developed maps for every community within its jurisdiction.

Minnesota Solar Suitability App: For communities outside the Metropolitan Council's jurisdiction, solar data can be accessed through the state of Minnesota's Solar Suitability App, which provides a 1-meter resolution of a community's solar resource for nearly every section of the state (www.mn.gov/solarapp).

Google Project Sunroof: This resource can help communities or individuals estimate their solar resource and potential economic benefits from solar installations (www.google.com/get/sunroof).

Figure 9 Overview of building rooftop solar potential in Bemidji, MN. Top, lakeshore area of Bemidji State University. Bottom, commercial buildings along US-2 Old in downtown Bemidji.

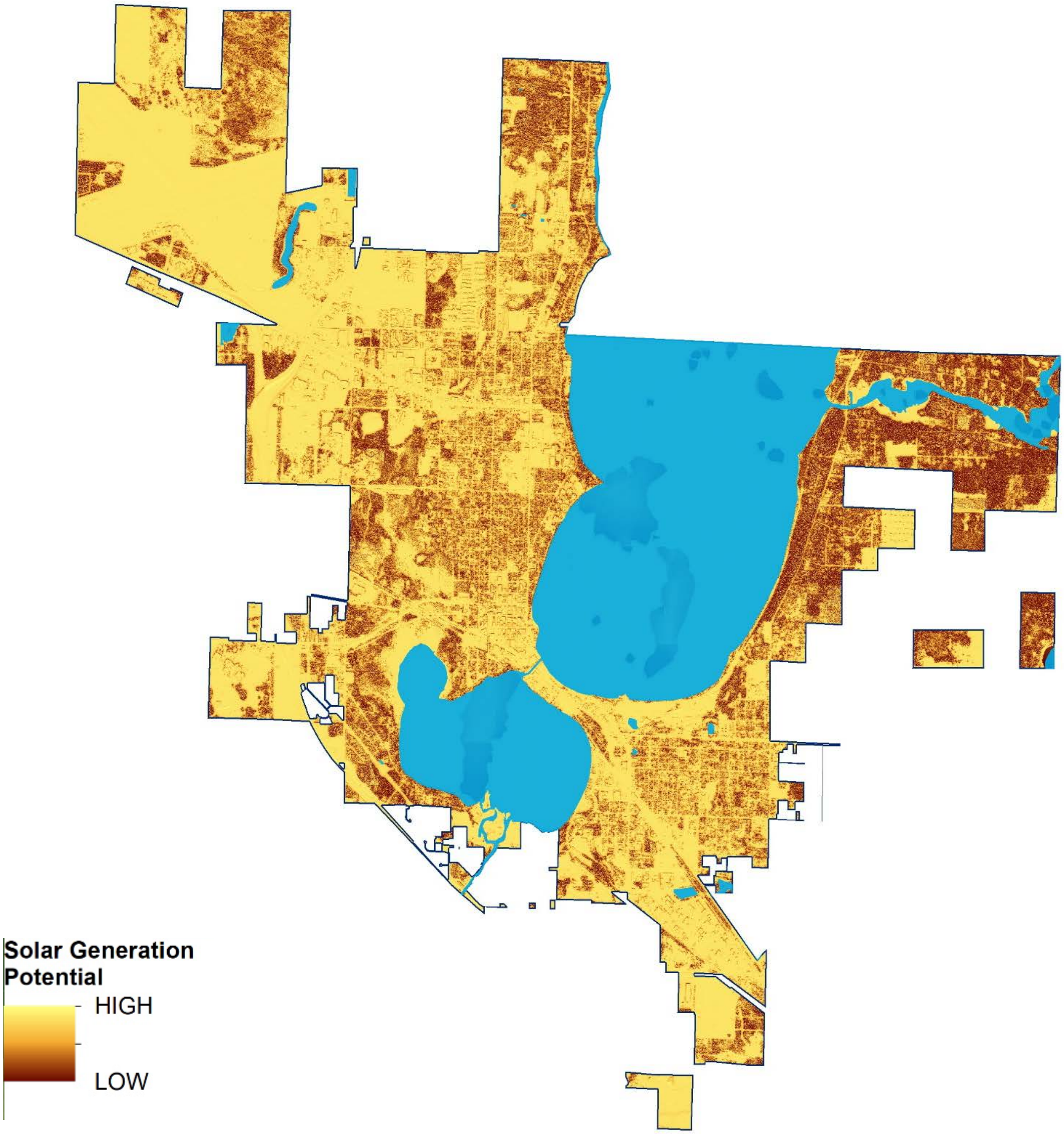


Figure 9 Overview of general solar potential in Bemidji, MN

Wind Resource

Wind Resource

A good wind energy site needs to meet a number of characteristics, the most important of which is a good wind resource. Other characteristics include soils that can support the weight of the turbine; a site large enough to accommodate safety setbacks from neighboring properties, structures, or other uses; and surrounding land uses for which the visual impact and potential nuisances will not create a conflict. Regarding the wind resource, the height the rotor needs to be above any disturbance within an ideal radius of 500 feet. The Distributed Wind Energy Association offers this guidance:

> The industry guidance on minimum wind turbine height states that the lowest extension of a wind turbine rotor must be 60 feet above the ground, assuming no surrounding obstacles. Where obstacles are present, the wind turbine rotor should be at least 30 feet above the tallest obstacle within a 500-foot radius. If trees are not fully grown, then the tower height must be adjusted for the growth over the next two or so decades, the life of the wind turbine.

Bemidji is a rural community with both urban and rural characteristics and is suitable for wind development. The Minnesota Department of Commerce developed wind speed maps at a 500-meter resolution to give a general sense of the wind resource at various tower heights, these are not adequate for a specific site assessment (Figure 10).

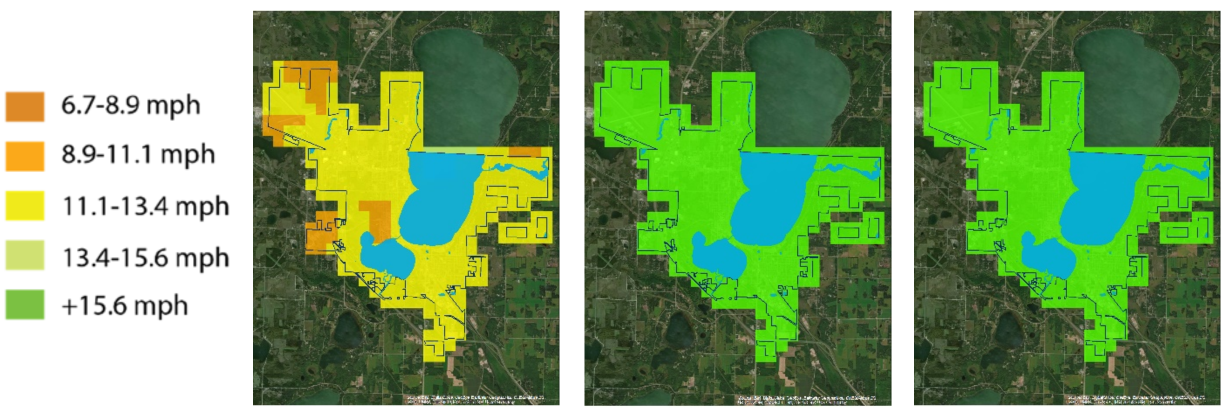


Figure 10 Wind speeds at different tower heights, 30 meters, 80 meters, and 100 meters from left to right. Source: MN Department of Commerce, maps made by Great Plains Institute

A good rule of thumb is that 12 mph is typically the minimum average annual wind speed for a good wind resource. At 30 meters, much of Bemidji has an average wind speed of approximately 11-13 miles per hour, right around the optimal speed needed for a productive wind energy system. At 80 and 100 meters respectively, there are significantly higher wind speeds, and ample resource for wind turbines to capture energy. Community characteristics and desires, along with land use should be taken into consideration for wind energy systems.

There may be some applications where smaller wind turbines can be appropriate for the community, but a more detailed, on-site assessment would need to be completed. However, the utility does offer green purchasing options through their TailWinds program, which allows customers to opt into wind-generated energy in 100-kWh blocks and may provide another viable option for Bemidji to utilize wind source.

Biomass Resource

Fuel derived from biomass can be used in several processes as a source of renewable energy, including electricity, waste heat, and renewable gas. Minnesota has several facilities that use biomass to generate electricity and/or heat. Biomass resources include municipal solid waste, landfill gas, wood waste, and agricultural byproducts, food processing residue and other organic waste.

Information about the type of biomass resources at the community level is difficult to acquire; there is little standardized assessment of potential biomass resources, and the type of resource varies widely across communities. Many communities have different types and volumes of biomass resources. Much of the biomass resource can come from the metropolitan area, particularly for solid waste and landfill gas, as well as yard waste. Communities in wooded areas may have excess wood waste from forest management, while agricultural communities may be able resources like corn stover or manure. All communities will have organic waste, like food and soiled paper products that could be recovered for better use.

In Minnesota, counties are ultimately responsible for coordinating the management of municipal solid waste. The county-level is also likely where the volume of waste would be at a scale where it could be repurposed for commercial uses like anaerobic digesters and similar technologies. Cities interested in pursuing such technology should coordinate with their counties.

Biomass as Renewable Energy

Anaerobic digestion is a process that uses captured biogas (methane and carbon dioxide) from the decomposition of organic material to generate heat and/or electricity. Biogas generated from this process can also be cleaned to remove carbon dioxide and other impurities to produce a renewable product equivalent to conventional natural gas, referred to as renewable natural gas. Renewable natural gas (or biogas) can serve as a replacement for any natural gas application and can also be compressed to provide a source of transportation fuel in place of conventional natural gas.

Biogas can be used to generate electricity in a process called combined heat and power. Combined heat and power (CHP) systems simultaneously generate electricity and thermal energy within a single system. By using the thermal energy, CHP systems efficiency is much greater than conventional power generating systems. While this system is well established in Minnesota, there is still great potential to harness this resource. Benefits CHP application include:

- Power is produced at a cost below retail electricity
- Enhance local power reliability
- Produces more useful energy than biogas that is used solely for thermal loads
- Reduces greenhouse gas emissions and other air pollutants