

TECHNICAL APPENDIX

This Technical Appendix explains the methodology and assumptions used for developing the estimated greenhouse gas (GHG) emissions reduced for each measure included in the proposal. The “GHG Emission Reduction Calculation Spreadsheet” included with this application provides the specific GHG emission reduction calculations for each measure.

1. Measure 1: Recycling, Composting, & Neighborhood Waste Disposal

a. GHG Reduction Estimate Method

- Diversion rate based on modeling provided by equipment/technology provider, incorporating MSW tonnage provided by Tribal Director of Solid Waste
- Transportation-related reductions based on current transportation patterns versus reduced need to transport to landfill following equipment installation at transfer station, and minimal transport for organic materials following creation of on-reservation organics composting site.
- Reductions based on electric refuse trucks and roll-offs estimated using current mpg and truck usage data from Tribal Director of Solid Waste and publicly available calculator for gallons of diesel consumed

b. Models/Tools Used

- EPA Greenhouse Gases Equivalencies Calculator: Gallons of diesel consumed (<https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references>)
- EPA Greenhouse Gases Equivalencies Calculator: Tons of waste recycled instead of landfilled (<https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references>)

c. Measure Implementation Assumptions

The following key assumptions about measure implementation were used to quantify emissions reductions for this measure:

- Implementation Measure Uptake:
- Implementation Milestones: assume partial year for 2025; full for future years
- Measure Lifetime: 20 years
- Capital Cost Assumptions:
- Operation and Maintenance Cost Assumptions: included personnel costs for first 5 years only; no additional O&M costs included

d. Emission Reduction Estimate Assumptions

The following key assumptions about emission reductions were used to quantify emission reductions for this measure:

- Emissions rates: see above tools utilized

- Emission factors: see above tools utilized
- Model/Tool Input Assumptions: assumes the mid point of the actual range of weekly MSW tonnage, assumes midpoint of diversion rate range provide by equipment/technology provider

e. Reference Case Scenario

- Reference case for MSW diversion rate is based on current MSW tonnage reported by Tribal Solid Waste Director.
- Reference case for electric garbage trucks and electric roll-off trucks assumes purchase of traditional diesel versions of trucks that provide same function, and electricity for charging trucks provided from 100% non-emitting sources (PV modules); thereby resulting in 100% “avoided emissions” by purchasing electric-powered vehicles
- Reference scenario for transportation-related emission is based on actual current activities, which includes diesel roll off carrier driving 256 miles round-trip 3 times weekly to landfill; and quarterly transport of baled cardboard 892 miles round-trip; and 15,000 miles driven annually by current diesel garbage trucks; and 100 additional miscellaneous miles driven weekly by diesel roll off carrier, as reported by Tribal Director of Solid Waste
- Reference scenario for building options is “traditional, BAU” construction methods and utility-provided electricity.

f. Measure-Specific Activity Data and Implementation Tracking Metrics

- Vehicle miles traveled
- MSW tonnage (current volume)
- MSW diversion rate (90-100%), based on currently available technology & equipment
- Vehicle miles avoided (due to on-reservation composting site)
- Vehicle miles avoided (due to reduced/eliminated transport to landfill)
- Vehicle miles avoided (due to identification of closer offtake partners, ability to store materials while maintaining value)

g. GHG Emissions Reduced

Implementation of this measure is anticipated to reduce **9,383** metric tons of carbon dioxide emissions per year with **51,610** cumulative metric tons of carbon dioxide emissions for the period between 2025 and 2030, and **234,593** cumulative metric tons of carbon dioxide emissions for the period between 2025 and 2050.

2. Measure 2: Residential Solar & Energy Efficiency

a. GHG Reduction Estimate Method

GHG Reduction Impact and GHG Emission Reduction Cost based on models provided by technical assistance provider

- Percent energy savings as a result of weatherization (compared to BAU) was calculated using estimated savings per household and estimated electricity and natural gas bills
- Estimated electricity usage was calculated from the electricity bill and Otter Tail Power's fixed and energy charges, and multiplied with the percent energy savings through weatherization to obtain an estimate of electricity savings
- From there, GHG impact from electricity savings was estimated using the number of households to be weatherized, factoring in the percentage of those households that fall into different utility service territories, as well as the power supply of those utilities
- GHG impact from natural gas savings were also calculated, using estimate natural gas savings and the GHG intensity of natural gas
- GHG impact from electricity and natural gas were combined to calculate total GHG impact from energy efficiency measures
- Estimated electricity savings were subtracted from estimated electricity usage to get an estimate of electricity usage for a single-family home after efficiency measures
- Solar installation size for each household was then calculated based on the electricity usage estimate, projected rooftop solar production in Belcourt ND, and an assumption of 30% energy load covered by solar
- Total solar production in MWh/yr was then calculated from by multiplying the solar size and solar production estimates
- The GHG impact of residential solar was then calculated from this production estimate, the number and distribution of households with solar, and power supply data from both utilities
- Finally, total GHG impact for energy efficiency and solar was calculated, factoring in that we will utilize a phased approach over the 5-year project period

b. Models/Tools Used

- Homeowner electricity and natural gas bills were estimated for the Turtle Mountain reservation using the Department of Energy Low-Income Energy Affordability Data (LEAD) Tool (<https://www.energy.gov/scep/slsc/lead-tool>)
- Estimated energy savings compared to BAU were based on DOE estimated savings per household from the Community Action Partnership of North Dakota: Weatherization Assistance Program Report (https://www.capnd.org/file_download/inline/9023c1cf-60ec-4e6b-ab16-fa015baea079)

- Estimated cost of weatherization per household was also from the Community Action Partnership of North Dakota: Weatherization Assistance Program Report
- Residential fixed and energy charges were obtained from Otter Tail Power Company (https://www.otpc.com/media/xigneadf/mn_0901.pdf)
- Average ND price of residential natural gas was from US Energy Information Administration (EIA) (<https://www.eia.gov/dnav/ng/hist/n3010nd3m.htm>)
- GHG intensity of natural gas was also from US EIA (<https://www.eia.gov/dnav/ng/hist/n3010nd3m.htm>)
- Projected rooftop solar production for Belcourt, ND was from National Renewable Energy Laboratory PVWatts tool (<https://pvwatts.nrel.gov/pvwatts.php>)
- Residential PV+Storage installed cost was estimated from Lawrence Berkeley National Laboratory's Tracking the Sun: Pricing and Design Trends for Distributed Photovoltaic Systems in the United States, 2023 Edition (https://emp.lbl.gov/sites/default/files/5_tracking_the_sun_2023_report.pdf)

c. Measure Implementation Assumptions

The following key assumptions about measure implementation were used to quantify emissions reductions for this measure:

- 400 households will be weatherized and receive residential rooftop solar installations
- 50% of households fall within Otter Tail Power Company service territory, with the remaining 50% falling within North Central Electric Cooperative territory
- 60% energy consumption in the summer
- The residential rooftop solar installations will cover 30% of household load
- A phased approach will be used to deploy the solar and energy efficiency measures, with 25% deployed by the end of 2026, 50% of the total deployed by the end of 2027, 75% deployed by the end of 2028, and 100% deployed by the end of 2029

d. Emission Reduction Estimate Assumptions

The following key assumptions about emission reductions were used to quantify emission reductions for this measure:

- Homeowners electricity bill for Turtle Mountain Reservation: \$2,194/yr
- Homeowners natural gas bill for Turtle Mountain Reservation: \$825/year
- Energy savings from energy efficiency (compared to BAU): 12%
- Estimated electricity usage: 28.05 MWh/yr
- Estimated natural gas consumption: 49.01 TCF
- Estimated natural gas savings: 6.04 TCF
- Single family home electricity usage after efficiency: 24.60 MWh/yr
- Rooftop solar production in Belcourt, ND: 1,328 kWh/kW*yr
- Estimate solar installation size per household: 5.56kW
- Estimated production: 7.38 MWh/yr

e. Reference Case Scenario

- Energy savings as a result of weatherization and GHG impact of residential solar installations were in comparison to business as usual (BAU)

f. Measure-Specific Activity Data and Implementation Tracking Metrics

- Percent of household energy load covered by solar
- Number of households receiving solar and energy efficiency improvements
- Distribution of households between utility territories

g. GHG Emissions Reduced

Implementation of this measure is anticipated to reduce **2,632.37** metric tons of carbon dioxide emissions per year with **6,580.93** cumulative metric tons of carbon dioxide emissions for the period between 2025 and 2030, and **59,228.41** cumulative metric tons of carbon dioxide emissions for the period between 2025 and 2050.

3. Measure 3: Solar Lighting in Priority Community Locations

a. GHG Reduction Estimate Method

GHG Reduction Impact and GHG Emission Reduction Cost based on models provided by technical assistance provider:

- Energy usage (MWh/yr) was estimated using the current energy charge for street lighting and Otter Tail Power Company's outdoor lighting charges
- The GHG impact of the solar lights was then calculated using the estimated energy usage, the number and distribution of the lights throughout the two utility service areas, and power supply data from the two utilities

b. Models/Tools Used

- Otter Tail Power Outdoor Lighting fixed and energy charges from (https://www.otpc.com/media/0lah5wch/mn_1103.pdf (pg.2))

c. Measure Implementation Assumptions

The following key assumptions about measure implementation were used to quantify emissions reductions for this measure:

- 300 lights will be installed
- 70% of proposed street lights fall within Otter Tail Power service territory, with 30% in North Central Electric Cooperative service territory
- Light post cost per unit: \$5,000
- System life: 20 years
- A phased approach will be used, with 30 lights installed by the end of Year 1, an additional 130 lights installed by the end of Year 2, and the remaining 140 lights installed by the end of Year 3

d. Emission Reduction Estimate Assumptions

The following key assumptions about emission reductions were used to quantify emission reductions for this measure:

- Estimated energy usage: 8.94 MWh/yr
- Otter Tail Power outdoor lighting fixed charge: \$3.20/month
- Otter Trail Power outdoor lighting energy charge: \$0.0544/kWh
- Current energy charge of street lighting: \$525/yr per light

e. Reference Case Scenario

- Calculations assume that each solar light will replace an existing grid-tied light

f. Measure-Specific Activity Data and Implementation Tracking Metrics

- Number and distribution of street lights across utility service territories

g. GHG Emissions Reduced

Implementation of this measure is anticipated to reduce **1,505.04** metric tons of carbon dioxide emissions per year with **5,468.32** cumulative metric tons of carbon dioxide emissions for the period between 2025 and 2030, and **35,569.17** cumulative metric tons of carbon dioxide emissions for the period between 2025 and 2050.

4. Measure 4: Green Head Start Building

a. GHG Reduction Estimate Method

GHG Reduction Impact and GHG Emission Reduction Cost based on models provided by technical assistance provider:

- Energy consumption both with and without energy efficiency measures was estimated using the square footage of the building multiplied by estimated energy consumption per area. These were then used to calculate energy savings through efficiency measures.
- GHG Impact of energy efficiency measures was calculated using the estimated energy savings and the utility's power supply data
- Estimated solar production and solar size was calculated using an assumption about the percent of energy load that will be covered by solar and an estimate on rooftop solar production for Belcourt, ND
- The GHG impact of solar was then calculate using the solar production estimate and power supply data from the utility provider
- Using estimates and assumptions on geothermal heat pump capacity, electricity consumption, propane costs, and changes in propane and electricity use, the reduction in emissions from reduced propane and electricity was calculated
- The GHG impact of geothermal was then calculated through the sum of reduced emissions from propane and electricity
- Finally, the total GHG impact for entire measure was calculated by adding the impacts from solar, geothermal, and energy efficiency measures, assuming completion of construction and interconnection at the end of Year 2.

b. Models/Tools Used

- Energy consumption per area estimate from Commercial Building Energy Consumption
(<https://blog.butterfly.com/building-energy-consumption#:~:text=The%20Department%20of%20Energy%20pegs,KWh%2Fsq%20ft%20for%20lighting>)
- Energy efficiency improvement estimate from EPA State and Local Climate and Energy Program Rules of Thumb
(https://www.epa.gov/sites/default/files/2016-03/documents/table_rules_of_thumb.pdf)
- Rooftop solar production for Belcourt, ND based on National Renewable Energy Laboratory PVWatts tool (<https://pvwatts.nrel.gov/pvwatts.php>)
- Estimates on installed cost of PV+storage from Lawrence Berkeley National Laboratory's Tracking the Sun: Pricing and Design Trends for Distributed Photovoltaic Systems in the United States, 2023 Edition
(https://emp.lbl.gov/sites/default/files/5_tracking_the_sun_2023_report.pdf)

c. Measure Implementation Assumptions

The following key assumptions about measure implementation were used to quantify emissions reductions for this measure:

- Assuming construction completion/interconnection near the end of year 2, GHG emission reductions beginning in Year 3 and onward
- Building size: 31,640 square feet
- Percent of load covered by solar: 20%
- Small non-residential PV + storage installed cost: \$5.2/W

d. Emission Reduction Estimate Assumptions

The following key assumptions about emission reductions were used to quantify emission reductions for this measure:

- Energy consumption per area: 22.5 kWh/square ft.
- Energy efficiency improvement: 27%
- Green Building Cost Premium (cost of efficiency upgrade): \$4/square ft.
- Energy consumption without efficiency measures: 711,900 kWh/yr
- Energy consumption with efficiency: 519,687 kWh/yr
- Rooftop solar production for Belcourt, ND: 1,329 kWh/kW*yr
- Estimated production: 104 MWh/yr
- Estimated solar size: 78.27 kW
- Geothermal heat pump capacity: 64 tons (REopt, based on 31,640 sq ft. Medium Office building)
- Geothermal electricity consumption: 37,748 kWh
- Estimated propane cost: \$18.58 \$/MMBTU (REopt, factoring in ground source heat pump and change in A/C)
- Emissions from propane: 0.05769 tonnes CO₂/MMBTU

e. Reference Case Scenario

- Reference scenario for energy consumption is based on projected “business as usual” (BAU) consumption (if the building was to be built with traditional construction methods without energy efficiency measures)
- Geothermal emissions reduction compared to BAU propane heating

f. Measure-Specific Activity Data and Implementation Tracking Metrics

- Energy savings through energy efficiency measures
- Solar production
- Reduction in emissions from reduced propane

g. GHG Emissions Reduced

Implementation of this measure is anticipated to reduce **209.1** metric tons of carbon dioxide emissions per year with **627.31** cumulative metric tons of carbon dioxide emissions for the period between 2025 and 2030, and **4809.35** cumulative metric tons of carbon dioxide emissions for the period between 2025 and 2050.