MTERA

Midwest Tribal Energy Resources Association, Inc.

EPA Climate Pollution Reduction Grant

Priority Climate Action Plan

Midwest Tribal Energy Resources Association

NAH-GAH-CHI-WA-NONG FOND DU LAC RESERVATION

GICHI ONIGAMING Grand Portage Chippewa

ONEIDA

LAC COURTE OREILLES Pride of the Ojibwe

THE GREAT SEAL OF THE HO-CHUNK NATION

LEECH LAKE BAND OF OJIBWE

MINNESOTA CHIPPEWA TRIBE

Contents

Tables

Figures

Midwest Tribal Energy Resources Association, Inc.

February 27, 2024

Acronyms

AC	Alternating Current
ASHP	Air Source Heat Pump
BESS	Battery Energy Storage System
BTU	British Thermal Unit
CAP	Criteria Air Pollutant
CCAP	Comprehensive Climate Action Plan
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
COP	Coefficient of Performance
CPRG	Climate Pollution Reduction Grant
DC	Direct Current
DMV	Department of Motor Vehicles
DOE	Department of Energy
DOT	Department of Transportation
EIA	Energy Information Administration
EPA	Environmental Protection Agency
EV	Electric Vehicle
GHG	Greenhouse Gas
GPM	Gallons per Minute
GWH	Gigawatt-hours
HAP	Hazardous Air Pollutant
HUD	Housing and Urban Development
HVAC	Heating, Ventilation, and Air Conditioning
IOU	Investor-Owned Utility
IPCC	International Panel on Climate Change
IRA	Inflation Reduction Act
ITC	Investment Tax Credit

kW, kWh	Kilowatt, Kilowatt-hours
LED	Light-emitting Diode
LIDAC	Low Income and Disadvantaged Communities
LNG	Liquified Natural Gas
MBH	Mega British Thermal Units per Hour
MEP	Mechanical, Electrical, Plumbing
MPG	Miles per Gallon
MROE	Midwest Reliability Organization East (EPA eGRID region)
MROW	Midwest Reliability Organization West (EPA eGRID region)
MT	Metric tons
MTERA	Midwest Tribal Energy Resources Association
MW, MWh	Megawatt, Megawatt-hours
N_2O	Nitrous Oxide
NEI	National Emissions Inventory
PCAP	Priority Climate Action Plan
PUC	Public Utilities Commission
PV	Photovoltaic (solar panels)
RFCW	Reliability First Corporation West (eGRID region)
SF	Square Feet
SLOPE	State and Local Planning for Energy (from National Renewable Energy Lab)
SOV	Single-occupancy Vehicle
TUA	Tribal Utility Authority
VMT	Vehicle Miles Traveled
WHO	World Health Organization

Definitions

Carbon Dioxide Equivalent (CO_2e): A unit of measure for the amount of global warming potential (GWP) that a greenhouse gas (GHG) has compared to carbon dioxide. For example, 1 kg of methane (CH_4) = 29.8 kg of CO_2e, which is the amount of CO_2 that would be emitted to cause the same amount of global warming. This allows for more accurate comparison of GWP between different GHG from various sources of emissions.

Clean / Renewable Energy: The production of energy to be used for electricity or heat through renewable energy sources that do not emit carbon into the air. These sources include solar, wind, water, and geothermal to name a few.

Decarbonization: The effort of eliminating carbon dioxide emissions from a process, project, or group.

EPA eGRID Region: U.S. Environmental Protection Agency (EPA) designated regions differentiated by specific electricity grid provider operation.

Fossil Fuels: A type of fuel made from decomposing plants and animals deep in the earth's crust that can be burned for energy. Natural gas, oil, and coal are all fossil fuels.

Greenhouse Gases (GHG): Gases that trap heat in the atmosphere. These gases include carbon dioxide, nitrous oxides, methane, and fluorinated gases. The Earth needs these gases in the atmosphere to trap heat and make the planet habitable, but the excess of GHG emissions leads to increased levels of heating resulting in a changing climate.

Mitigation: Prevention or intervention of climate harming activities. This includes reducing emissions and stabilizing levels of greenhouse gases in the atmosphere.

Natural Gas: Fuel source categorized as a fossil fuel. Natural gas can create harmful environmental impacts, such as pollution.

Particulate Matter (PM): Also called particle pollution, the term for a mixture of solid particles and liquid droplets found in the air. Some particles, such as dust, dirt, soot, or smoke, are large or dark enough to be seen with the naked eye. Others are so small they can only be detected using an electron microscope. PM causes severe health issues as well as contributing to environmental degradation.

Priority Climate Action Plan (PCAP): A document that is developed as part of a U.S. EPA Climate Pollution Reduction Grant (CPRG) Phase I Planning Grant, identifying priority measures for reducing GHG emissions and achieving other goals of the CPRG program, as well as a Low Income and Disadvantaged Community (LIDAC) benefits analysis.

Resilience: Ability to adapt to changing conditions and withstand and rapidly recover from disruption due to emergencies.

Scope 1 Emissions: Direct GHG emissions that occur from fossil fuel combustion. Common fuel sources are natural gas, propane, fuel oil, and coal, and these sources are most often used for heating systems and vehicles.

Scope 2 Emissions: Indirect GHG emissions that occur when fuel combustion occurs offsite and generates electricity to power a building or vehicle.

Sequestration or Carbon Sequestration: Reducing the amount of carbon in the atmosphere through capturing carbon dioxide. This is done naturally through either geological or biological measures. For example, forests are a large source of carbon sequestration.

Introduction

The Midwest Tribal Energy Resources Association (MTERA) has developed this Priority Climate Action Plan (PCAP) to support investment in policies, practices, and technologies that reduce pollutant emissions, create high-quality jobs, spur economic growth, and enhance the quality of life for all 35 Midwest Tribes. Developed through the Climate Pollution Reduction Grant (CPRG) Planning Grant, this Priority Climate Action Plan intends to tackle damaging climate pollution, accelerate work to address environmental injustice, and empower community-driven solutions in Midwest Tribal communities.

The development of this Priority Climate Action Plan was developed in partnership with the eight participating Tribes listed below, guided by the Board Members representing the 23 Member Tribes and provides findings that are indicative of all 35 Tribes in the MTERA ecosystem.

- The Bad River Band of Lake Superior Chippewa
- The Fond du Lac Band of Lake Superior Chippewa
- The Grand Portage Band of Lake Superior Chippewa
- The Ho-Chunk Nation
- The Lac Courte Oreilles Band of Lake Superior Chippewa Indians
- The Leech Lake Band of Ojibwe
- The Minnesota Chippewa Tribe
- The Oneida Nation of Wisconsin

The decision to develop this PCAP in partnership with an eight-Tribe subset was guided by MTERA’s goal to maximize the impact of CPRG Planning Grant funding by developing an in-depth Priority Climate Action Plan representative of all Tribes in the MTERA ecosystem, while ensuring that the benefits of such effort are available to all Midwest Tribes. These eight Tribes, comprising nearly a quarter of all Midwest Tribes, exhibit a mix of characteristics including size, location, economic resources, energy resources, and population density, and are intended to be an indicative sample of all Midwest Tribes that permits the findings in this priority climate action plan to be extrapolated to all 35 Tribes in the MTERA ecosystem. While the quantitative findings from the in-depth analysis of the eight Tribes data cannot be considered directly representative of all Midwest Tribes due to Tribal-specific limitations (including varying building stock and unique eGRID emissions factors that vary throughout EPA Region 5), the qualitative analysis provided in this PCAP paired with an understanding of each Midwest Tribe's individual circumstances can provide a meaningful synopsis of Midwest Tribal communities with regard to climate pollution reduction. The Priority Climate Action Plan and its components have been made available to all 35 Tribes in EPA Region 5 through a repository of CPRG Implementation Grant application resources.

The measures contained herein are intended to be broadly available to all federally-recognized Tribes in Environmental Protection Agency (EPA) Region 5 pursuing funding under the EPA’s Climate Pollution Reduction Implementation Grants (CPRG) through both the General competition and Tribes & Territories competition as well as other funding streams, as applicable.

Following this PCAP, further detail and refinement of the inputs will be included in the Comprehensive Climate Action Plan (CCAP) scheduled to be completed no later than July 2025.

1. GHG Inventory

This greenhouse gas (GHG) inventory is a record of quantified emissions by source measured in carbon dioxide equivalent (CO_2e) for the CPRG PCAP. GHGs quantified account for the following three gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O). Emissions of hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) were not estimated to be emitted in traceable amounts. In cases where data inputs were not available to collect, proxy data was calculated from a representative boundary. This inventory is used to understand the current sources of GHG emissions for Tribes and understand sectors to prioritize for priority emission reduction measures. The data provided in this section is based on GHG inventories provided by the eight participating Tribes and has been extrapolated by population data provided by MTERA to demonstrate the emissions of all 35 MTERA Tribes. The scaling factor was determined by taking the sum total of population on Tribal Lands for all 35 MTERA Tribes and dividing by the eight-Tribe subset. Due to differences in available data for each Tribe, Appendix B provides individual Tribe GHG inventories and calculation methodologies.

Table 1: Tribal GHG Emissions Inventory

Sector	**Emissions – Eight-Tribe Subset (Metric Tons of CO_2e)**	**Emissions – MTERA 35 Tribes (Metric Tons of CO_2e)**
Stationary Energy (Buildings)	179,543	433,159
Transportation	217,605	524,985
Waste	4,874	11,759
Agriculture, Other Land Use	1,107	2,671
Total	**403,129**	**972,573**

Total GHG emissions from the eight-Tribe subset are 403,000 $MTCO_2e$ (metric tons of carbon dioxide equivalent) and extrapolated total emissions for all 35 MTERA Tribes are 972,000 $MTCO_2e$. As shown in Figure 1, most of the greenhouse gas emissions produced come from the Transportation and Buildings sectors, while less than 1% of emissions are from Waste. Table 2 shows differences in the inventory parameters from the eight-Tribe subset specific to the boundary of inclusion, sectors included, and ownership information.

Table 2: Tribal-Specific Inventory Information

	Area	Population	State	Counties	Sectors Included	Building Ownership
Bad River	193 mi^2	1,423	Wisconsin	Ashland	Transportation, Buildings, Waste	Tribal-owned & Tribal-member
Fond du Lac	155 mi^2	4,168	Minnesota	Carlton, St. Louis	Transportation, Buildings, Waste	Tribal-owned commercial & all residences
Grand Portage	75 mi^2	630	Minnesota	Cook	Transportation, Buildings, Waste	Tribal-owned buildings and Tribal-member residential buildings
Ho-Chunk	N/A	5,505	Wisconsin	Dane, Jackson, Juneau, La Crosse, Monroe, Sauk, Shawano, Wood	Transportation, Buildings, Waste	Tribal-owned and Tribal-member buildings
Lac Courte Oreilles	120 mi^2	8,200	Wisconsin	Sawyer	Transportation, Buildings, Waste	Tribal-owned buildings
Leech Lake	1,350 mi^2	11,456	Minnesota	Beltrami, Cass, Hubbard, Itasca	Transportation, Buildings, Waste	Tribal-owned commercial & all residences
Minnesota Chippewa	N/A	N/A	Minnesota	Cass	Buildings	Tribal headquarters buildings
Oneida	102 mi^2	4,648	Wisconsin	Brown, Outagamie	Transportation, Buildings, Waste	Tribal-owned buildings

1.1 Summary Across Sectors

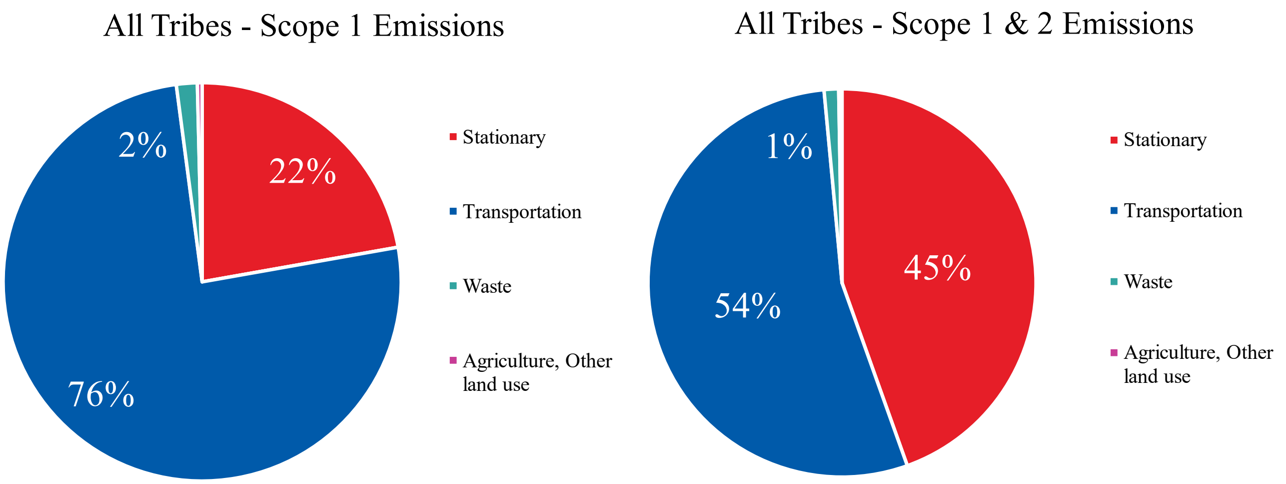


Figure 1: Summary of Emissions

GHG emissions are classified as direct (Scope 1) and indirect (Scope 2) based on the level of control a reporting entity has of the emitting source. Figure 1 shows the summary of all Tribal emissions; the first plot shows the Scope 1 emissions split across sectors, and the second plot shows the Scope 1 and 2 emissions split across sectors. In total, Transportation is the largest proportion of GHG emissions at 54%, followed closely by Stationary (from Buildings) with 45% of total emissions. Waste makes up 1% of total emissions, while Agriculture and Other Land Use makes up less than 1%. The majority of emissions for Stationary and

Transportation emissions occurs from carbon dioxide (CO2), whereas for Waste and Agriculture, methane (CH4) is often the most significant source of GHG emissions.

1.2 Buildings

1.2.1 Summary of Major Emissions

Based on PCAP estimates, commercial buildings emit the same amount of CO_2e as residential buildings (single-family and multifamily emissions combined). Within residential buildings, single-family buildings have 32% more emissions in aggregate than multifamily buildings. Some common commercial building types within the eight-Tribe subset are: gaming/entertainment, lodging, retail, healthcare, office, police/fire station, courthouse, recreation/community center, schools/colleges, museums, and storage/warehouse. For this PCAP analysis, a similar building type mix is assumed to exist on the Reservations of all 35 Tribes in the region with a similar expected emissions profile.

Industrial sector emissions were not found to be a significant source across the Tribes based on available data. Figure 2 shows the split of Scope 1 and 2 emissions across the eight-Tribe subset within the buildings sector. Scope 1 emissions (depicted in purple) are primarily resulting from the combustion of fuels, such as natural gas; while Scope 2 emissions (depicted in red) are from electricity. Figure 2 breaks down building emissions by both emission source and property type, showing that single-family buildings are most prevalent.

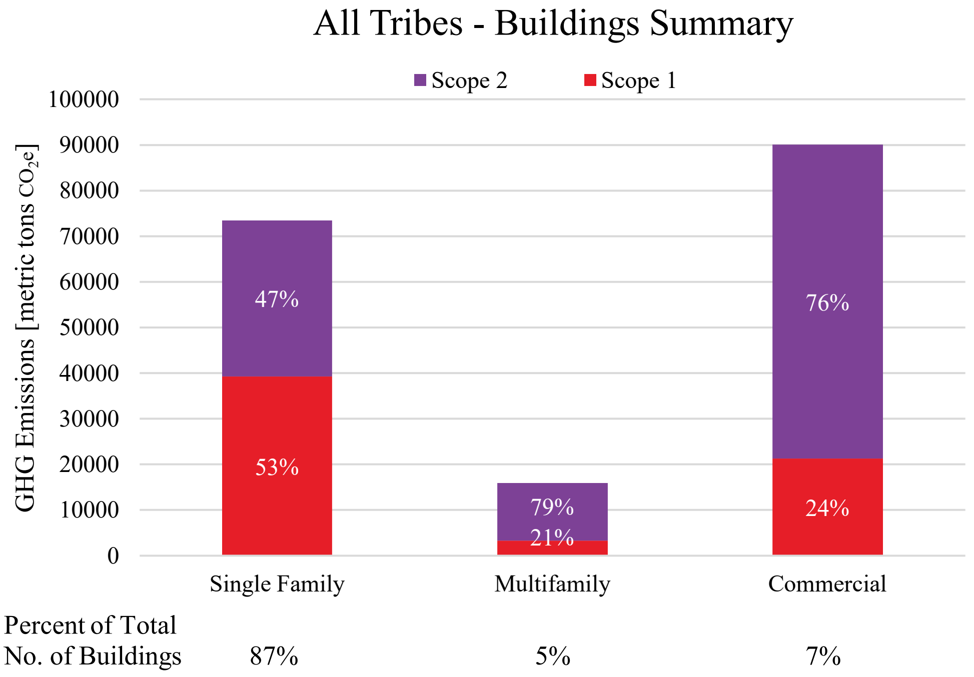


Figure 2: Building Emissions Summary

1.3 Transportation

1.3.1 Summary of Major Emissions

All reported Transportation emissions are Scope 1 from combustion vehicles. The majority of transportation emissions occur from on-road passenger cars and vehicles, which is calculated using proxy data when actual gasoline and diesel data was unavailable. Figure 3 shows the split between on-road gasoline vehicle emissions, on-road diesel emissions, and waterborne transportation emissions.

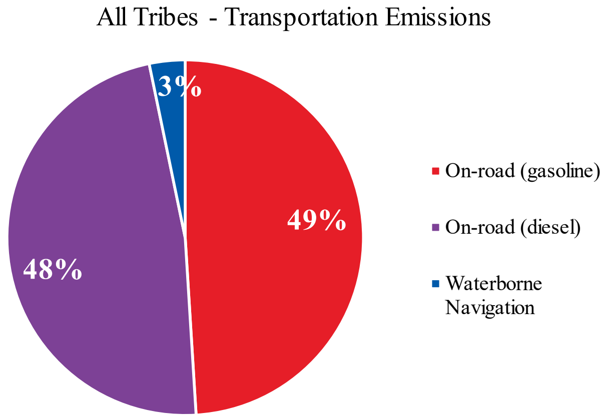


Figure 3: Transportation Emissions

1.4 Waste

1.4.1 Summary of Major Emissions

Waste information provided includes number of burn barrels, landfills, people served by anaerobic wastewater, aerobic wastewater, and septic systems. For the eight-Tribe subset there were no landfills onsite, and none of the Tribes were served by anaerobic wastewater treatment.

1.5 Processes for Improved Data Collection for Future Reporting

Future reporting will be improved as the data collection process continues. Several Tribes have requested data directly from third parties that that was unavailable for the PCAP but will be updated in the CCAP. This includes electric, gas, and propane utility data from utility companies, vehicle registration data from departments of motor vehicles, ridership numbers for public transportation, wastewater treatment plant data, gas station data on amount of sold fuel, and data on livestock and emissions associated with agriculture.

2. Priority GHG Reduction Measures

Reduction measures in this section are not exhaustive to reach all climate goals and GHG reduction targets of MTERA Tribes. The priority measures have been outlined in line with the EPA PCAP requirements of being near-term, high priority and implementation ready programs, policies, or projects.

The following section outlines GHG reduction measures across four categories: Energy Generation, Building Energy Consumption, Vehicle Emissions, and Environmental Management & Planning Techniques. At the beginning of each category, a summary table of estimated measure costs and annual GHG reduction is provided, both for the eight-Tribe Subset and extrapolated to the 35 MTERA Tribes based on population. The scaling factor was determined by taking the sum total of population on Tribal Lands for all 35 MTERA Tribes and dividing by the eight-Tribe subset. Appendix C: Reduction Measure Methodology includes further details for each measure, including baseline emissions, key assumptions, emissions methodology, emissions calculation, cost calculation, and cost methodology (as applicable).

2.1. Reduce Energy Generation Emissions

The following measures develop clean energy sources for electricity generation (including solar photovoltaics (PV), wind, and hydropower), heating and cooling energy through geothermal, and energy storage through battery systems integrated within microgrids. For each measure, the reduction in GHG comes from avoiding the generation of an equivalent amount of energy from the predominantly fossil-fuel powered electricity grid specific to each Tribal region.

2.1.1 Renewable Energy Development

Table 3: Renewable Energy Measures

		Eight-Tribe Subset		35 MTERA Tribes	
Reduction Measure	**Measure Description**	**Cost per Measure**	**$MTCO_2e$ Reduced**	**Cost per Measure**	**$MTCO_2e$ Reduced**
Install single-family renewables (PV, geothermal, wind)	29 MW of solar PV installed	$78,310,000	20,700	$188,920,000	49,900
	11 MW of wind installed	$92,240,000	21,100	$222,540,000	50,900
	30% of single-family homes install geothermal heat pumps	$67,500,000	9,400	$162,850,000	22,700
Install multifamily facility-scale renewables (PV, geothermal, wind)	15 MW of solar PV installed	$36,030,000	9,500	$86,930,000	23,000
	6 MW of wind installed	$45,270,000	10,400	$109,230,000	25,000
	30% of multifamily buildings install geothermal heat pumps	$10,750,000	800	$25,930,000	1,900
Install commercial facility-scale renewables (PV, geothermal, wind)	23 MW of solar PV installed	$61,550,000	16,300	$148,500,000	39,200
	11.5 MW of wind installed	$96,680,000	22,100	$233,240,000	53,400
	30% of commercial buildings install geothermal heat pumps	$26,350,000	4,700	$63,580,000	11,300
Implement community-scale renewables.	20 MW of solar PV installed	$35,220,000	14,200	$84,970,000	34,200
	20 MW of wind installed	$65,400,000	38,600	$157,780,000	93,000
	5 MW of hydropower installed	$12,870,000	8,700	$31,050,000	21,100
Implement utility-scale renewables	90 MW solar PV installed	$104,490,000	63,800	$252,090,000	153,800
	75 MW of wind installed	$131,250,000	144,600	$316,650,000	348,800

2.1.1.1. Solar Photovoltaics

Solar energy is a form of renewable energy that uses photovoltaics to generate power by absorbing energy from sunlight and converting it to electrical energy through semiconductor materials. The generation potential of solar photovoltaic systems on single-family homes and multifamily buildings was calculated using the PVWatts Calculator.[1] An average solar irradiance, representing the amount of sunlight reaching a solar panel, is based on data from Duluth, MN and Wausau, WI in the PVWatts software.

2.1.1.2. Wind Energy

Wind Energy is a renewable energy source created by using wind to make electricity through wind turbines. The wind spins the wind turbine's rotors, which in turn spin a generator to generate electricity. This reduction measure considers different scales of wind turbines; distributed wind turbines at the home or buildings scale, community scale wind turbines, and utility scale wind turbines. This measure assumes a capacity factor of 40%, in accordance with the Department of Energy's Land-Based Wind Market Report: 2023 Edition.[2]

2.1.1.3. Geothermal Heating and Cooling

Geothermal heat pump systems use the earth's natural heat to provide heating and cooling to a building. They are more energy efficient than the typical air-source heat pump (ASHP) due to the consistent temperature of the ground, unlike air temperature which is constantly changing. The coefficient of performance (COP) of geothermal heat pumps can range from 3.0 – 6.0, which is also much larger than typical ASHPs. There are three types of geothermal heat pump systems: vertical, horizontal, and pond/lake, all of which are space intensive; the system is chosen according to site constraints and feasibility, as it requires extensive site work to install geothermal heat pumps under an existing building.

2.1.1.4. Hydropower

Hydropower is a renewable source of energy that generates power from the use of a dam or other diversion that alters the natural low of a river. Hydropower uses turbines and generators to convert kinetic energy of water flowing across the diversion or dam into electricity. This measure focuses on what the DOE considers "small hydropower" sized between 100 kW and 30 MW.[3]

2.1.2. Energy Resilience

---

[1] *NREL PVWatts Calculator*. (1999). NREL PVWatts. Retrieved January 5, 2024, from https://pvwatts.nrel.gov/

[2] Department of Energy Office of Energy Efficiency and Renewable Energy. (2023). *Land-Based Wind Market Report: 2023 Edition* (R. Wiser & M. Bolinger, Authors).

[3] Water Powers Technologies Office. (n.d.). *Types of Hydropower Plants*. Office of Energy Efficiency and Renewable Energy. Retrieved January 5, 2024, from https://www.energy.gov/eere/water/types-hydropower-plants

Table 4: Energy Resilience Measures

		Eight-Tribe Subset		35 MTERA Tribes	
Reduction Measure	**Measure Description**	**Cost per Measure**	**MTCO$_2$e Reduced**	**Cost per Measure**	**MTCO$_2$e Reduced**
Install building-level solar & storage	40 MW of solar PV paired with 4-hour storage	$117,760,000	30,700	$284,100,000	74,100
Develop clean energy microgrids	200 MW of solar PV paired with 4-hour storage	$588,800,000	153,900	$1,420,520,000	371,300

2.1.2.1. Building Level Solar PV + BESS

Building level solar, paired with Battery Energy Storage Systems (BESS), are designed for smaller-scale installations. This measure is meant for smaller solar and storage systems integrated at the building scale. Its emissions methodology is identical to that of the preceding Solar Microgrids measure.

2.1.2.2. Solar Microgrids

Microgrids collect, store, and distribute energy. Solar microgrids are microgrids that are supplied by solar PV energy. The solar panels connected to a microgrid provide energy for either direct use by buildings that are connected to the microgrid or to batteries for storage and later use. Microgrids reduce emissions to a greater degree than solar PV systems alone by providing renewable energy that can be used during times when the electric grid has a high emission factor from generating electricity using fossil fuels.

2.2. Reduce Building Energy Emissions

Table 5: Building Energy Measures

		Eight-Tribe Subset		35 MTERA Tribes	
Reduction Measure	**Measure Description**	**Cost per Measure**	**MTCO$_2$e Reduced**	**Cost per Measure**	**MTCO$_2$e Reduced**
Electrify heating equipment	60% of all buildings retrofit to heat pumps	$148,980,000	33,300	$359,420,000	80,400
Install high-efficiency appliances, low flow fixtures for residences	60% of single-family & multifamily buildings install low-flow fixtures	$190,000	1,700	$460,000	4,200
	60% of residential buildings upgrade appliances	$72,340,000	1,600	$174,540,000	3,800
Install weatherization – insulation and weatherstripping	60% of single-family homes & multifamily buildings implement air sealing & insulation	$28,920,000	21,800	$69,770,000	52,500
	60% of commercial buildings install roof & wall insulation, window films	$6,560,000	3,200	$15,840,000	7,700

Retrofit interior lighting to LEDs	100% of interior & exterior lighting of all buildings to LEDs	$5,530,000	8,300	$13,340,000	20,100
Install smart thermostats	60% of buildings install smart thermostats	$3,210,000	8,600	$7,750,000	20,800
Adopt green building standards for major renovations	15% of buildings undergo major renovation projects	*	4,000	*	9,700

*No hard costs were calculated for the green building standards due to variability of existing building stock, regulations, and policy strategy. See Appendix C for more details.

2.2.1. Building Retrofits & Energy Conservation Measures

2.2.1.1. *Electrification of Heating Equipment*

Residential and commercial heating can be a large source of emissions. Many buildings are heated using combustion-based equipment and if the system is older, it can often be inefficient, leading to further energy consumption. Transitioning from combustible fuels for heating involves replacing existing equipment with all-electric systems, such as heat pumps. Heat pumps are significantly more efficient than other heating systems due to their ability to utilize existing heat, making them a valuable heating choice for higher efficiency and emissions reductions.

2.2.1.2. *Installation of High-efficiency Appliances*

Residential electricity use is made up of many components, including appliances used daily for cooking, cleaning, and cooling. These appliances include refrigerators, dishwashers, washing machines, clothes dryers, and air conditioning, among others. Installing newer appliances that are more energy- and water-efficient or abide by higher efficiency standards and certifications, such as EnergyStar rating, can help conserve energy and reduce emissions.

2.2.1.3. *Installation of Low-flow Fixtures*

Low-flow fixtures are specifically designed plumbing components that help reduce the flow rate of water to reduce water waste in relevant applications, such as sink or kitchen faucets, and showerheads. Reducing water waste helps conserve water, which also reduces the amount of energy needed to heat water, providing energy and cost savings.

2.2.1.4. *Building Weatherization Retrofits*

Weatherization is a series of energy efficiency retrofits that apply to a building envelope to reduce air infiltration and increase thermal resistance, to protect the interior of the building from exterior weather and temperature. Reducing air infiltration and adding insulation allows for a more stable indoor temperature, and therefore reduces the heating and cooling loads for buildings. This leads to a significant amount of energy savings and emissions reduction.

2.2.1.5. Interior & Exterior Lighting Upgrade to LEDs

Lighting emitting diode (LED) light bulbs are currently the most energy efficient products on the market. Switching to LED light bulbs is a low effort energy efficiency measure that has a significant impact on a building's energy use, particularly for commercial buildings.

2.2.1.6. Smart Thermostat Installation

Smart programmable thermostats have the potential to significantly reduce energy use from heating and cooling by adjusting setpoints based on occupancy patterns. For example, office buildings can be set higher temperatures during the summer and lower temperature during the winter to avoid cooling or heating the space more than necessary – and can be programmed to reduce space conditioning after 6pm, when the building is likely to be empty. This reduction measure quantifies the reduction in emissions due to energy savings from installing smart programmable thermostats in buildings.

2.2.2. Introduce New Building Standards

2.2.2.1. Adopt Green Building Standards for Major Renovations

Green building standards are a comprehensive way to upgrade building systems for greater energy efficiency. Implementing energy codes and minimum efficiency standards facilitates emissions reduction for existing buildings and new construction. Green buildings tend to have heating, ventilation, and air conditioning (HVAC) and mechanical, electrical, and plumbing (MEP) systems that are more efficient, more insulation, better window constructions, and can be all-electric.

2.3. Reduce Vehicle Emissions

2.3.1 Mode Shift

Table 6: Vehicle Measures

		Eight-Tribe Subset		**35 MTERA Tribes**	
Reduction Measure	**Measure Description**	**Cost per Measure**	**$MTCO_2e$ Reduced**	**Cost per Measure**	**$MTCO_2e$ Reduced**
Increase transit service	10% mode shift to bus	*	5,700	*	13,900
Influence ridesharing	50% mode shift to rideshare	*	4,400	*	10,500
Develop active transport network	30% mode shift from SOVs to biking/walking	*	5,200	*	12,600

* No hard costs were calculated for mode-shift measures due to the variability of implementation strategy and existing transit infrastructure, see Appendix C for more details.

2.3.1.1 Increase Transit Service

This reduction measure calculates emissions associated with mode shift from single-passenger vehicles to transit buses. According to the U.S. Department of Transportation (DOT), bus transit produces 33% less greenhouse gas emissions per passenger mile than an average single-occupancy vehicle[4] (SOV). This statistic was used to calculate emissions associated with a 10% mode shift to buses from single-occupancy vehicles. 10% of the baseline emissions from gasoline-powered SOVs was reduced by 33% to calculate the ultimate emissions reduction.

2.3.1.2 *Increase Ridesharing*

Ridesharing or carpooling can significantly reduce emissions associated with SOVs. This reduction measure calculates emissions associated with mode shift from SOVs to rideshare vehicles. A 2018 research study demonstrates a 5% VMT reduction by carpooling rather than driving SOVs for trips.[5] This calculation uses the baseline emissions associated with gasoline-powered SOVs and assumes 50% of the Tribal population shifts to rideshare vehicles.

2.3.1.3 *Develop Active Transport Network*

This reduction measure calculates emissions associated with a mode shift from SOVs to an active transport mode such as walking, running, or biking. Research demonstrates that walking or cycling can save nearly 10% of CO_2e emissions from car travel (assuming 41% of short car trips less than 3 miles are avoided).[6] In order to quantify this measure across all Tribes, a 30% mode shift to active transport was assumed.

2.3.2 Introduce Vehicle Electrification & Alternative Fuel Vehicles

Table 7: Vehicle Electrification & Alternative Fuel Measures

		Eight-Tribe Subset		**35 MTERA Tribes**	
Reduction Measure	**Measure Description**	**Cost per Measure**	**$MTCO_2e$ Reduced**	**Cost per Measure**	**$MTCO_2e$ Reduced**
Electrify SOV vehicles & provide charging infrastructure / hydrogen fuel cells	Assumes 80% of single-occupancy vehicles are converted to electric vehicles (EVs)	$6,920,000	65,600	$16,690,000	158,300
Convert bus fleet to electricity, hydrogen, or lower-emission fuels	Assumes half of buses converted to lower-emission fuels and half converted to electricity or hydrogen	$13,130,000	2,000	$31,690,000	4,900

---

[4] *Public transportation's role in responding to climate change.* (2010, January). U.S. Department of Transportation Federal Transit Administration. Retrieved January 5, 2024, from https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/PublicTransportationsRoleInRespondingToClimateChange2010.pdf

[5] Shaheen, S., Cohen, A., & Bayen, A. (2018). *The benefits of carpooling.* UC Berkeley Transportation Sustainability Research Center. Retrieved January 5, 2024, from https://escholarship.org/uc/ item/7jx6z631

[6] *Assessing the potential for carbon emissions savings from replacing short car trips with walking and cycling using a mixed GPS-travel diary approach.* (2019, May). Transportation Research Part A: Policy and Practice. Retrieved January 5, 2024, from https://www.sciencedirect.com/science/article/pii/S0965856417316117#:~:text=Taking%20into%20account%20individual%20travel,to%20existing%20walking%20and%20cycling.

2.3.2.1 Electrify Bus Fleet & Provide Charging Infrastructure

Electric buses result in much lower GHG emissions than diesel-burning buses; not only do they have zero tailpipe emissions, but as the electric grid continues to decarbonize, the emissions associated with powering electric buses will continue to decrease. If electric buses are powered 100% by on-site renewables, this would result in a full offset of baseline diesel emissions.

This reduction measure assumed an average grid emissions factor to calculate associated emissions. The baseline case for all buses within Tribes were assumed to run on diesel. To calculate the emissions associated with electrifying bus fleets, the miles per gallon (mpg) of the vehicles was conservatively assumed to be 6.2, based on data released by the U.S. Department of Energy (DOE) on average fuel economy for school buses,[7] last updated in February 2020. The annual miles traveled based on this mpg and gallons of diesel from the gallons of diesel from the GHG inventory were used to calculate kWh by assuming electric buses would have an efficiency of 1.5 kWh/mile, based on data from the DOE's alternative fuels data center[8]. An average of the EPA eGRID emissions factors from both MROW and MROE were used to calculate emissions associated with the annual electricity used to power the converted electric vehicles.

2.3.2.2 Provide Alternative Fuel Buses (Biodiesel, CNG, LNG, Propane)

"Alternative fuel buses" refers to buses that run on fuels other than diesel. In this reduction measure, biodiesel, compressed natural gas (CNG), liquified natural gas (LNG), and propane were used. These fuels all run cleaner than diesel, releasing fewer lbs CO_2e into the atmosphere than a diesel engine.

2.3.2.3 Electrify SOV & Provide Charging Infrastructure

The second reduction measure related to vehicle electrification is providing EV infrastructure to influence adoption among passenger vehicles. For the PCAP, 80% of SOVs were assumed to adopt EVs. In order to calculate emissions associated with this reduction, the emissions from gasoline-powered cars were compared to the emissions associated with electric vehicles for the equivalent number of miles traveled.

2.4 Implement Environmental Management & Planning Techniques

Table 8: Environmental Management & Planning Measures

		Eight-Tribe Subset		35 MTERA Tribes	
Reduction Measure	**Measure Description**	**Cost per Measure**	**$MTCO_2e$ Reduced**	**Cost per Measure**	**$MTCO_2e$ Reduced**
Sequester carbon through plants	100,000 trees planted	$30,000,000	1,200	$72,380,000	2,900
	100,000 shrubs planted	$2,500,000	20	$6,030,000	50

---

[7] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

[8] *Flipping the Switch on electric school buses: charging infrastructure: module 1.* (n.d.). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/vehicles/electric_school_buses_p4_m1.html#:~:text=A%20typical%20bus%20can%20travel,energy%20for%20every%20mile%20traveled

	1 million sf of grassland restored	$500,000	70	$1,210,000	180
Develop green infrastructure	800,000 sf of bioswales developed	$400,000	60	$970,000	140
Implement responsible development & zoning policies	20% of population affected by responsible development	*	4,000	*	9,700

* No hard costs were calculated for responsible development measure due to the variability of implementation strategy and existing zoning and policy; see Appendix C for more details.

2.4.1 Sequester Carbon Through Plants

The carbon sequestration potential of planting trees, grasses, and shrubs was calculated using the Climate Positive Design's Pathfinder tool[9] which provided carbon sequestration rates, which were used to assume appropriate values for the generalized plants.

2.4.2 Develop Green Infrastructure

Green infrastructure is a method of low-impact development that protects, restores, or mimics the natural water cycle. It reduces emissions by treating water naturally via rain gardens, bioswales, permeable pavements, and green streets. Stormwater can be treated through these methods rather than by a central wastewater treatment plant that collects runoff from hardscapes. Ultimately, this results in a reduction of energy used for water pumping and treatment. Additionally, bioswales provide carbon sequestration.

To quantify this reduction measure, bioswales were assumed to replace parking spots. While there are many diverse types of vegetation that can be used to develop a bioswale, the most common one used to calculate carbon sequestration is perennial grasses.

2.4.3 Implement Responsible Development & Zoning Policies

Changing zoning to support more transportation-efficient land use patterns ultimately reduces vehicle miles traveled (VMT). Transportation emissions are reduced due to minimized driving distances from denser housing & increased proximity to commercial spaces. The resulting emissions associated with gasoline from that reduction in VMT was calculated as the emissions reduction for this measure.

---

[9] *Get started using the Pathfinder*. (n.d.). Climate Positive Design. Retrieved December 19, 2023, from https://climatepositivedesign.com/pathfinder/; this online tool and application requires a sign-in to access the tool and underlying values for this measure.

3. Benefits Analysis

In addition to reducing greenhouse gas emissions, the priority measures included in this PCAP reduce co-pollutants including Hazardous Air Pollutants (HAP) and Criteria Air Pollutants (CAP) within Tribal communities. This analysis includes a baseline air pollution emissions inventory of co-pollutants for the counties associated with each of the eight-Tribe subset. The qualitative components of the benefits analysis described in this section can be broadly applied to all 35 Midwest Tribes.

3.1. Co-Pollutant Emissions Inventory

To develop the co-pollutant baseline emissions inventory, data was pulled from the EPA National Emissions Inventory (NEI) at the facility and county level. For the eight MTERA Tribes included within this PCAP, Fond du Lac is the only Tribe with facility-level data from the NEI pertaining to the Cloquet Carlton County Airport, which PCAP measures are not likely to influence. This analysis uses county-level data for the counties which best represent the Tribal jurisdictions for the eight-Tribes as shown in Table 20.

Table 9: Counties used for NEI data by Tribe

Tribe	State	Counties
Bad River	Wisconsin	Ashland
Fond du Lac*	Minnesota	Carlton, St. Louis
Grand Portage*	Minnesota	Cook
Ho-Chunk[10]	Wisconsin	Dane, Jackson, Juneau, La Crosse, Monroe, Sauk, Shawano, Wood
Lac Courte Oreilles	Wisconsin	Sawyer
Leech Lake*	Minnesota	Beltrami, Cass, Hubbard, Itasca
Oneida	Wisconsin	Brown, Outagamie

* Denotes Bands that are members of the Minnesota Chippewa Tribe. To avoid double-counting, Minnesota Chippewa is not listed as a unique row. See Appendix for co-pollutant inventory table specific to Minnesota Chippewa Tribe, consistent with GHG Inventory approach.

Though the 2020 NEI dataset includes emissions from many different sectors, this emissions inventory includes “Fuel Combustion” from building types “Commercial/Institutional” and “Residential” to account for PCAP building retrofit measures, as well as “Miscellaneous Non-Industrial Not Elsewhere Classified” – pertaining to “Fluorescent Lamp Breakage” due to PCAP lighting retrofit measures. Consistent with EPA guidance, base year inventories for the transportation sector were not provided. For a detailed description of how the data from Table 19 was determined for the Co-Pollutant Emissions Inventory, as well as a table presenting this info by Tribe, please see Appendix D: Co-Pollutant Emissions Inventory Analysis.

Note that due to the lack of PCAP GHG reduction measures associated with industrial categories, co-pollutant emissions changes were not reported.

---

[10] For the Ho-Chunk Nation, which encompasses several counties in Wisconsin, the counties with the highest concentration of Tribal membership and Tribal-owned facilities were used for the co-pollutant emissions inventory. This was done in order to stay consistent with the approach used in the GHG Inventory, which was based on conversations with representatives of the Ho-Chunk Nation.

Table 10: NEI Base Year Co-Pollutant Emissions Inventory (Total Across Eight-Tribe Subset)

CAP + HAP Total		**65,419**
CAP	**Total CAP**	**63,560**
	Ammonia	670
	Carbon Monoxide	40,814
	Nitrogen Oxides	4,552
	Volatile Organic Compounds	5,561
	Sulfur Dioxide	221
	PM10 Primary	5,927
	PM2.5 Primary	5,815
HAP	**Total HAP (see Appendix D for full list)**	**1,859**

3.2. LIDAC Benefits Analysis

Tribes are not required to complete Low-Income and Disadvantaged Communities (LIDAC) Analysis in the initial PCAP since Tribal Nations and the land within the Reservation boundaries of federally-recognized Tribes are designated as disadvantaged on resources such as the Climate and Economic Justice Screening Tool (CEJST) and the Environmental Justice Screening and Mapping Tool (EJScreen). The census tract information for all 35 Midwest Tribes in the MTERA ecosystem is included in Appendix E.

Aside from GHG and co-pollutant reductions, the priority measures within this PCAP provide additional community benefits to Tribal communities and surrounding areas. This analysis includes a qualitative outline of expected environmental, economic, social, and health benefits expected through the implementation of GHG reduction measures.

3.3. Qualitative Community Benefits

Community benefits represent the broad range of additional benefits from greenhouse gas reduction measures that influence a community's public health, economy, natural environment, and quality of life. Table 20 summarizes the community benefits anticipated through the implementation of PCAP GHG reduction measures. In the sections that follow, further details regarding these community benefits are provided, broken out by PCAP measure strategy area: renewables, building retrofits, transportation, and land use.

A core element to the majority of PCAP measures is the reduction of overall air pollution through avoided combustion of fossil fuels. Air pollution's downstream health impacts are incredibly detrimental to human health; including asthma exacerbation, cardiovascular illness, adverse birth outcomes such as low birthweight and preterm delivery, and increased emergency room visits, hospitalizations, and fatalities.[11] Any reduction in fossil fuel extraction that cause or reduction in energy use translates to improved air quality and public health.

---

[11] US EPA,ORD. (2017, November 2). *Disease and Conditions* | US EPA. US EPA. https://www.epa.gov/report-environment/disease-and-conditions

Table 11: Community Benefits Summary Tab

PCAP Measures	Environmental	Public Health	Economic	Other
Renewable Energy • Solar PV + Storage • Wind • Geothermal • Clean energy microgrids	• Reduction in air pollution	• Reduction in hospitalization & respiratory issues	• Job creation • Potential to sell excess energy	• Energy independence • Climate resilience to grid outages through storage
Building Energy Efficiency • Electrify heating equipment • High efficiency appliances • Low-flow fixtures • Weatherization • LED lighting • Smart thermostats • Green building standards	• Reduction in air pollution	• Improved respiratory health • Improved indoor thermal comfort	• Lower energy bills • Job creation	• Greater passive survivability and resilience (in the event of a power outage) • Reduced risk of power outage from decreased loads on utility grid
Transportation • Increase transit service • Influence ridesharing • Active transport network • Electrify SOVs and provide charging infrastructure • Low-to-Zero emissions bus fleet	• Reduction in air pollution • Reduction in noise pollution	• Improved health from physical activity (walking, biking) • Reduced risk of risk of chronic diseases	• Job creation • Transit accessibility to jobs and economic opportunities	• Increased connectivity of communities • Energy independence • Improved community relationships with increased opportunity for social interactions on public transit • Decreased traffic congestion
Land Use • Plant trees, shrubs, and grass • Green infrastructure • Zoning policies	• Improved air quality • Stormwater mitigation • Reduction in soil erosion • Increased ecosystem support and biodiversity	• Improved respiratory health and faster patient recovery • Improved well-being • Improved indoor and outdoor thermal comfort	• Lower energy bills	• Addresses socio-spatial inequity by promoting better land-use and zoning • Improves resilience by reducing heat island effect

3.3.1.Renewable Energy Development

Renewable energy projects can strengthen Tribal sovereignty by providing benefits across economic, social, environmental, and cultural focus areas [12].

---

[12] Tsinnajinnie, L., & Begay-Campbell, S. (2006, August 25). *Benefits of Renewable Energy for Native Nations from the Environmental and Native Perspectives*. Retrieved February 8, 2024, from https://www.energy.gov/sites/prod/files/2016/01/f28/interns2006tsinnajinnie.pdf

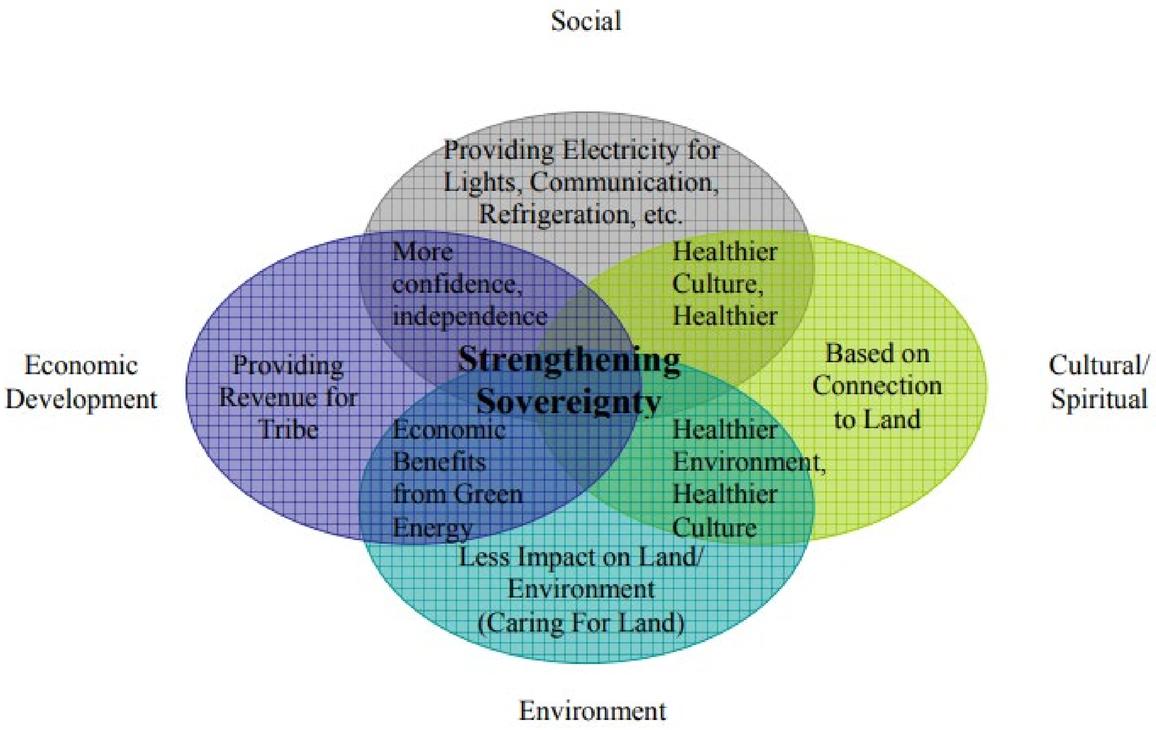


Figure 4: Categories of Renewable Energy Benefits for Tribal Nations

In addition to many human health benefits from the reduction of fossil fuel combustion, renewable energy development on Tribal land can help promote climate resilience through reduced reliance on the electric grid and the furthering of energy independence. Tribally-managed renewable energy generation and energy storage allows Tribes to maintain power during grid outages due to disruptions, such as those from extreme weather events. Further development in grid-interactive technologies can allow microgrids to also discharge to the grid during times of high stress and enable a stronger, more resilient grid infrastructure. These new projects also provide a long-term pipeline to many different careers in the clean energy industry for Tribal members.

3.3.2. Building Energy Efficiency

Energy cost savings from building efficiency projects can provide direct economic savings to building owners and renters. While some projects are easily managed by a homeowner or renter, others will spur career development and skilled labor expansion in the workforce. In addition to these key economic benefits, energy efficiency measures also can provide human health benefits in greater thermal comfort and overall wellbeing.

3.3.3. Transportation

Reduced emissions from transportation measures can support healthier communities through enhanced air quality and increased human activity.

The benefits from zero tailpipe emission vehicles, like EVs, result in improved air quality for the vehicle driver and passengers as well as the surrounding community.

Vehicle electrification also presents an opportunity for economic vitality - new jobs are emerging in vehicle maintenance, charger installation, and charger equipment maintenance.

3.3.4. Environmental Management and Planning Techniques

Planting trees, shrubs, and grasses in communities contribute many benefits towards health, air quality, stormwater mitigation, habitat preservation and mitigating urban heat islands.

Intentionally designed landscapes can help to provide wind breaks in winter months and shade in summer months. Adjacent to transportation corridors, planting can sequester CO_2 emissions and provide an acoustic barrier to surrounding areas.

In addition to planting efforts, zoning policies and land use planning can influence mental wellbeing and human health, while also driving strong economic outcomes.

4. Authority to Implement

The Midwest Tribal Energy Resources Association has reviewed existing statutory and regulatory authority to implement each priority measure continued in this PCAP. For any priority measure where authority must still be obtained, this section contains a schedule of milestones for actions needed by key entities for obtaining any authority needed to implement such measure(s).

The path to ensuring Tribes' authority to implement GHG reduction measures varies greatly throughout EPA Region 5. Driven by a range of stakeholders including federally-recognized Tribes, state governments, local governments, utilities, and individual residents, each Tribe is characterized by a unique regulatory landscape that will define their path forward to achieving ambitious climate pollution reduction goals. **While state, local, and utility regulations are important considerations, it is crucial to note that all Tribes may choose to exercise Tribal sovereignty should state and state-regulated utility policy prevent the implementation of priority measures.** Because this situation is unique to Tribes, an overview of Tribal sovereignty and how it applies to energy-related activities on Tribal land is provided below.

4.1. Overview of Tribal Sovereignty

Sovereignty refers to the independence and autonomy of a Tribe, state, government, or political entity to govern without external interference. It enables a government to establish and enforce its own laws. Within the United States, there are specific criteria and hierarchies that define the relationships between sovereigns. The concept of supremacy, where one sovereign has authority over others for the common good of a nation, grants the federal government the power to supersede state and Tribal authority in certain instances. The United States derives its authority from its citizens, as outlined in founding documents such as the United States Constitution. The federal government, as the supreme authority, determines the areas in which states can govern themselves, effectively granting state sovereignty.

In contrast, Tribes were recognized as preexisting sovereigns with inherent authority when the United States was formed. They had established relationships, signed treaties, and interacted with the federal government as independent nations. The creation of numerous treaties led to the development of government-to-government relationships between individual Tribes and the federal government, resulting in the concept of Tribes as "domestic dependent nations." These entities possess distinct independent authority but remain subject to certain powers of the United States, including the application of certain federal laws.

Tribal sovereignty, therefore, refers to the inherent right of Tribes to govern themselves, their borders, lands, and people. It is unique in that it is directly tied to cultural beliefs, lands, and historical traditions. While sovereignty grants Tribes the right to establish their own government, determine membership requirements, enact legislation, and establish law enforcement and court systems, these rights are based on a distinct culture and history that protects an important way of life for each of the 574 federally-recognized Tribes in the United States. Sovereignty is not just a political concept that provides Tribes with power, but also a mechanism to protect important cultural and historical aspects of a Tribe, which can have a significant impact on government-to-government interactions. **Tribes are not subject to individual states' laws and are entitled to regulate and operate independently of states.** This provides a pathway to leverage sovereignty to overcome regulatory or policy barriers defined at the state-level that may hinder Tribal implementation of priority measures, as described below.

4.2. Tribal Authority to Implement Priority Measures: Reduce Emissions from Energy Generation

There is a variety of federal, state, and utility policies that impact Tribal authority to implement reduction measures associated with reducing emissions from energy generation. This section first provides an overview of the federal policies that impact Tribes' authority to implement utility-scale generation and clean energy microgrids regardless of state affiliation. This section then provides a state-by-state overview of the relevant state and federal policies that impact all 35 Midwest Tribes' authority to implement renewable energy development and energy resilience measures. For all reduction measures covered under the goal of reducing emissions from energy generation, progress will be tracked by quantifying increases in clean energy generation and metrics associated with energy resilience including outage frequency and duration. Implementation schedule of such measures will be identified and directed by individual Tribal CPRG Implementation Grant applicants.

Table 12: Goals, Strategies, and Priority Reduction Measures

GOAL	STRATEGY	REDUCTION MEASURE
REDUCE EMISSIONS FROM ENERGY GENERATION	Renewable Energy Development	Install residential single-family renewables (PV, geothermal, wind)
		Install multifamily facility-scale renewables (PV, geothermal, wind)
		Install commercial facility-scale renewables (PV, geothermal, wind)
		Implement community-scale renewables.
		Implement utility-scale renewables
	Energy Resilience	Install building-level solar & storage
		Develop clean energy microgrids
REDUCE ENERGY CONSUMPTION FROM BUILDINGS (COMMERCIAL & RESIDENTIAL).	Building Retrofits & Energy Conservation Measures	Electrify heating equipment.
		Install high-efficiency appliances, low-flow fixtures for homes & residences
		Install weatherization - insulation & weatherstripping
		Retrofit interior lighting to LEDs
		Install smart thermostats
	New Building Standards	Adopt green building standards for major renovations
REDUCE EMISSIONS FROM VEHICLES	Mode-shift	Increase transit service
		Influence ride sharing
		Develop active transport network
	Zero Emissions Single-occupancy vehicles	Electrify SOV vehicles & provide charging infrastructure / hydrogen fuel cells
	Low or Zero Emissions Bus Fleet	Convert bus fleet to electricity, hydrogen, or lower-emission fuels
ENVIRONMENTAL MANAGEMENT & PLANNING TECHNIQUES	Land Use	Sequester carbon through plants
		Develop green infrastructure
		Implement responsible development & zoning policies

4.2.1. Authority to Implement Utility-Scale Generation and Clean Energy Microgrids

All energy enterprises in the United States, including Tribal utilities, Tribal energy businesses, and Tribal renewable or traditional energy generators, must comply with applicable federal laws. Under the Commerce Clause of the U.S. Constitution, Congress has the power to regulate commerce among the states and with Indian Tribes. Generally, Congress can regulate any commodity sold across state lines, known as interstate commerce. Any commerce not governed by federal law can be locally regulated.

The federal laws that define the split between federal, state, or local jurisdiction include the Federal Power Act (FPA), the Department of Energy Organization Act of 1977, the Energy Policy Act, and the Public Utility

Regulatory Policies Act of 1978. Tribal utilities doing business in a federally regulated manner or Tribes wishing to build or own facilities connected to the grid must comply with federal law and regulations.

Because utility-scale projects are interconnected to the federally regulated transmission system, federal policy will generally apply to priority measures related to utility-scale energy development.

The question of jurisdictional authority over projects that are not interconnected to the transmission system becomes more complex. In general, the following key facts apply to the options MTERA Tribes have to implement priority measures:

- **Implement priority projects based on the de facto regulations and policies set by state regulators and local utilities.** In some cases, Tribes will choose to accept the current policy defined by non-Tribal entities because the policy does not prevent the Tribe from implementing its priority measures. The existing set of policies for each state are summarized in the following sections. Pursuing this option would be the quickest and lowest risk path for implementing priority measures; however, it may not be available to all Tribes if existing policy is not aligned with the Tribe's priority measures.
- **Leverage Tribal sovereignty to enable the implementation of priority measures that are restricted based on the current de facto regulations and policies set by non-Tribal entities**. In some cases, existing policy will constrain a Tribe's ability to implement priority measures in a way that aligns with the Tribe's energy vision and goals. Under such a scenario, the Tribe could leverage its inherent sovereignty to redefine the policies to better align with the Tribe's priority measures. The specifics of how a Tribe would pursue this route depend on *where* the activity takes place (land ownership and designation), *who* is involved, and the type of interests at stake.

In terms of where the activity takes place, there are four common Tribal land holdings:

Allotted lands: Land owned by the United States in trust for one or more individual Tribal members. Allotments may not be within a Reservation's boundaries and may not be affiliated with a Tribe.

Restricted fee lands: Land to which a Tribe or individual Tribal member holds legal title, but the title is subject to restrictions by the United States against alienation or encumbrance.

Fee or fee simple lands: Lands previously conveyed out of Tribal ownership that are freely alienable or can be encumbered without federal approval. Fee lands may be owned by non-Indians or may be repurchased and owned by a Tribe or individual Tribal members. Tribally owned fee lands do not have the same restrictions that trust lands have. Fee lands may be within or outside of the Reservation. Fee lands within the Reservation may be owned by non-Indians. State and local laws typically apply on fee land outside of Reservations and may apply on fee land within Reservations.

Trust land: The federal government holds title to the land. The use of trust land is governed by Tribes. The land is not subject to state laws but is subject to certain federal laws.

In terms of who is involved, almost all Reservations have third party utility companies providing services to the Tribe and to Tribal members, with the exception of a small number of Tribes in the Midwest with Tribally-owned utilities. Most of the utility companies operating on Reservations are under some type of state sanction and in many cases the utility's activities, rates, and service standards are governed or regulated by state public utility commissions. Because of this, there is a de facto application of state rules by the utilities to their Tribal customers on Indian lands. In most cases, the Tribal members and Tribes have not questioned utility policies and rate tariffs established under state rules and regulations and have paid the charges as an assumed condition of service. Utility policies generally apply to the whole utility service territory, and not just to the part outside of Indian Country. Generally, Indian Tribes and their members pay the utility rates published by the utility. However, Tribal sovereignty affords the Tribe the ability to push back on the situation where a state-regulated utility requires the Tribe to participate in state mandated programs, contribute to state energy policy goals, or pay the state approved rates. As Tribes aim to implement priority measures, they do not want to be limited by their utility's state-approved policies, or by a utility's full-requirements contracts (which were not approved by the Tribe) which limit customer generation options.

The following section provides a state-by-state overview of the relevant state and federal policies that impact Tribes' authority to implement renewable energy development and energy resilience measures. The Michigan, Minnesota, and Wisconsin state restrictions detailed in this section apply only to Tribes who have not exerted Tribal sovereignty through the formation of a Public Utilities Commission (PUC), a Tribal Utility Authority (TUA), and/or the development of Tribal energy codes. Several EPA Region 5 Tribes have already formed PUC or TUAs. A path to establishing full authority to implement through the formation of a PUC or a TUA is described at the end of this section, including a schedule of milestones for actions needed by key entities needed to obtain authority to implement such measures.

Table 13: Tribal Authority Renewables Measure Implementation

GOAL	STRATEGY	REDUCTION MEASURE	TRIBAL AUTHORITY TO IMPLEMENT *IF NOT EXERCISING SOVEREIGNTY THROUGH PUC OR TUA FORMATION		
			Michigan	Minnesota	Wisconsin
REDUCE EMISSIONS FROM ENERGY GENERATION	Renewable Energy Development	Install residential single-family renewables (PV, geothermal, wind)	Systems must be sized at 100% of average annual usage or 20 kW, whichever is smaller	Systems must be sized under 40 kW	System must be sized under 20 kW and serviced by an IOU or Municipal utility
		Install multifamily facility-scale renewables (PV, geothermal, wind)	Systems must be sized at 100% of average annual usage or 20 kW, whichever is smaller	Systems must be sized under 40 kW	System must be sized under 20 kW and serviced by an IOU or Municipal utility
		Install commercial facility-scale renewables (PV, geothermal, wind)	Systems must be sized at 100% of average annual usage or 150 kW, whichever is smaller	Systems must be sized under 40 kW	System must be sized under 20 kW and serviced by an IOU or Municipal utility
		Implement community-scale renewables.	Dependent on sponsorship by a utility with no Tribal ownership	Dependent on sponsorship by a utility with no Tribal ownership	Dependent on sponsorship by a utility with no Tribal ownership
		Implement utility-scale renewables	See Section 4.2.1	See Section 4.2.1	See Section 4.2.1
	Energy Resilience	Install building-level solar & storage	Systems must be sized at 100% of average annual usage or 20 kW, whichever is smaller	Systems must be sized under 40 kW	System must be sized under 20 kW and serviced by an IOU or Municipal utility
		Develop clean energy microgrids	See Section 4.2.1	See Section 4.2.1	See Section 4.2.1

4.2.1.1. Michigan

Michigan has replaced its net metering policies with a Distributed Generation Program in which residential distributed generation systems cannot be larger than what is needed to produce 100% of a facility's annual electricity usage, *or* 20 kW – whichever is smaller. A second category, typically for commercial or institutional customers, is available for systems between 20 kW and 150 kW with a similar system limitation of 100% of a facility's annual electricity usage or 150 kW, whichever is smaller. Tribes have full authority to implement battery storage with these distributed generation systems. Michigan state law allows utilities to cap participation in the Distributed Generation Program at 1% of their peak load, with suballocations of 0.5% for systems smaller than 20 kW, 0.25% for systems between 20 and 150 kW, and 0.25% exclusively for smaller anaerobic digestion systems. Several Investor-Owned Utility (IOUs) have already reached their program limits and are denying new Distributed Generation applicants. Municipal utilities and electric cooperatives are not required to participate in the Distributed Generation Program and may develop own programs and caps.

Tribes are not able to own community solar projects since only regulated utilities can sponsor community solar projects. Senate Bills 152 and 153 were introduced in early 2023 and would enable community solar to be owned by third-party developers such as Tribes, but these bills have not yet passed.

Michigan summary: Within the constraints set by Michigan's Distributed generation program, Tribes have limited authority to implement facility-scale distributed generation under existing policy. More complex community-scale and microgrid projects that serve multiple facilities are likely to be restricted by the existing policy. If these restrictions are prohibitive to each Tribe's goals, **Tribes can ensure full authority to implement all measures** associated with renewable energy development and energy resilience by exercising their sovereignty and creating a Tribal PUC, TUA, or by enacting Tribal energy codes to reshape the regulatory and policy landscape on their respective Tribal lands. Utility-scale projects in all states will largely be driven by federal law and policy and the Midcontinent Independent System Operator (MISO) generator interconnection policies.

4.2.1.2. Minnesota

All utilities in Minnesota, including energy cooperatives, are required to offer a net metering tariff to residential customers with distributed generation systems up to 40 kW, and Tribes are ensured full authority to implement systems under 40 kW on single family, multifamily and commercial buildings. Tribes have full authority to implement battery storage with these distributed generation systems. Only regulated utilities can sponsor community solar projects and thus Tribes do not have full authority to implement community solar projects. Tribes have full authority to implement utility-scale renewable development including ownership and receiving Investment Tax Credit (ITC) benefits if the Tribe is granted the siting permits from either the State or Local Government.

Minnesota summary: Tribes have full authority to implement distributed generation with battery storage projects under 40 kW. More complex community-scale and microgrid projects that serve multiple facilities are likely to be restricted by the existing policy. If these restrictions are prohibitive to each Tribe's goals, **Tribes can ensure full authority to implement all measures** associated with renewable energy development and energy resilience by exercising their sovereignty and creating a Tribal PUC, TUA, or by enacting Tribal energy codes to reshape the regulatory and policy landscape on their respective Tribal lands. Utility-scale projects in all states will largely be driven by federal law and policy and the Midcontinent Independent System Operator (MISO) generator interconnection policies.

4.2.1.3. Wisconsin

All investor-owned and municipal utilities in Wisconsin, not including energy cooperatives, are required to offer a net metering tariff to residential customers with distributed generation systems up to 20 kW, and Tribes serviced by investor-owned and municipal utilities are ensured full authority to implement systems under 20 kW on single family, multifamily and commercial buildings. Tribes have full authority to implement battery storage with these distributed generation systems. Only regulated utilities can sponsor community solar projects and thus Tribes do not have full authority to implement community solar projects.

Wisconsin summary: Tribes have full authority to implement distributed generation with battery storage projects under 20 kW if serviced by investor-owned or municipal utilities. More complex community-scale and microgrid projects that serve multiple facilities are likely to be restricted by the existing policy. If these restrictions are prohibitive to each Tribe's goals, **Tribes can ensure full authority to implement all measures** associated with renewable energy development and energy resilience by exercising their sovereignty and creating a Tribal PUC, TUA, or by enacting Tribal energy codes to reshape the regulatory and policy landscape on their respective Tribal lands. Utility-scale projects in all states will largely be driven by federal law and policy and the Midcontinent Independent System Operator (MISO) generator interconnection policies.

4.2.2. Authority to Implement: Reduce Energy Consumption from Buildings

Table 14: Building Energy Consumption Reduction Measures

REDUCE ENERGY CONSUMPTION FROM BUILDINGS (COMMERCIAL & RESIDENTIAL).	Building Retrofits & Energy Conservation Measures	Electrify heating equipment.
		Install high-efficiency appliances, low-flow fixtures for homes & residences
		Install weatherization - insulation & weatherstripping
		Retrofit interior lighting to LEDs
		Install smart thermostats
	New Building Standards	Adopt green building standards for major renovations

Tribal governments have full authority to implement measures to reduce building energy consumption for Tribally-owned buildings and housing and have full authority to adopt new building standards for on-Reservation residential buildings. However, unless the Tribe chooses to enact changes to Reservation-wide housing policies, the Tribe must work with on-Reservation homeowners to encourage participation with implementing building retrofits and energy conservation measures, likely involving incentives to encourage participation in implementation. For all reduction measures covered under the goal of reducing energy consumption from buildings, progress will be tracked by quantifying emissions savings from the implementation of building efficiency measures. Implementation schedule of such measures will be identified and directed by individual Tribal CPRG Implementation Grant applicants.

4.2.3. Authority to Implement: Reduce Energy Emissions from Vehicles

Table 15: Vehicle Emission Reduction Measures

REDUCE EMISSIONS FROM VEHICLES	Mode-shift	Increase transit service
		Influence ride sharing
		Develop active transport network
	Zero Emissions Single-occupancy vehicles	Electrify SOV vehicles & provide charging infrastructure / hydrogen fuel cells
	Low or Zero Emissions Bus Fleet	Convert bus fleet to electricity, hydrogen, or lower-emission fuels

Tribal governments have full authority to implement measures to reduce emissions from Tribally-owned vehicles, although Tribes must ensure they have adequate power supply to support substantial EV fleet additions the Tribe may want to implement. The Tribe may have to develop new infrastructure to support larger electric loads associated with zero-emission vehicle uptake either through the installation of Tribally-owned infrastructure such as solar and storage, or they may have to work with their utility to ensure that increased load demand can be met.

Tribes do not have direct authority to reduce emissions from vehicles owned by Tribal members but can encourage measure uptake by providing incentives to increase participation. If member uptake of zero emission vehicles is significant, Tribes may be required to take similar action as described above to support increased electric load, including developing Tribally-owned infrastructure or working with their utility to ensure load demand can be met. Tribes have full authority to expand Tribally-run transportation services to encourage mode shift but must rely on incentives and member buy-in to achieve increased public mode shift participation goals.

For all reduction measures covered under the goal of reducing emissions from vehicles, progress will be tracked by quantifying emissions savings from the implementation of mode-shifting and vehicle electrification. Implementation schedule of such measures will be identified and directed by individual Tribal CPRG Implementation Grant applicants.

4.2.4. Authority to Implement: Implement Low-Emissions Land-Use Planning Techniques

Table 16: Low-Emission Land-Use Planning Techniques

ENVIRONMENTAL MANAGEMENT & PLANNING TECHNIQUES	Land Use	Sequester carbon through plants
		Develop green infrastructure
		Implement responsible development & zoning policies

Tribes have full authority to implement environmental management and planning techniques on Tribally-owned land. To implement these measures on on-Reservation land owned by members or other non-Tribal entities, Tribes will have to work with landowners to incentivize participation. For all reduction measures covered under the goal of reducing emissions through environmental management and planning techniques, progress will be tracked by quantifying emissions savings from the implementation of such activities. Implementation schedule of such measures will be identified and directed by individual Tribal CPRG Implementation Grant applicants.

5. Intersection with Other Funding Availability

Many of the priority measures included in this PCAP expand upon or complement existing programs. The Midwest Tribal Energy Resources Association has explored federal and non-federal funding sources to determine whether these sources could fund each priority measure and whether such funding is sufficient to fully implement the measure. This section describes the results of this analysis for each priority measure.

Table 17: Additional Funding Opportunities

Funding Opportunity	**Description**	**Timeline**	**Applicable Measure Goal**
DOE Tribal Energy Efficiency Block Grant (EECBG)	Provides formula awards to Tribes for projects that reduce fossil fuel emissions or improve energy efficiency. Voucher award for Tribes is approximately 10-15k.	Full application due April 30, 2024	Reduce energy consumption from buildings (residential and commercial)
DOE Tribal Home Electrification and Appliance Rebates Program	Rebate program to support Tribal households to reduce energy bills, increase home comfort, improve indoor air quality, and reduce emissions by providing direct funding for energy efficiency and electrification home upgrades. $225 million available. Electrification and Appliance Rebates Program	Letter of Intent to apply by May 15, 2024. Applications accepted on a rolling basis until May 31, 2025	Reduce energy consumption from buildings (residential and commercial)
Environmental and Climate Justice Block Grants	$3B in Inflation Reduction Act (IRA) funding for financial and technical assistance to carry out environmental and climate justice activities to benefit underserved and overburdened communities.	Awards must be made by EPA by September 30, 2026.	Variable
Philanthropy funding	Various sources	Depends on foundation and specific opportunity	Variable
DOE SCEP - **Assistance for the Adoption of the Latest and Zero Building Energy Codes**	This opportunity assists eligible entities in further decarbonizing their buildings through the adoption of the latest national model building energy codes, zero energy codes, other codes that deliver equivalent or greater energy savings, including innovative approaches to decarbonize existing buildings through certain measurable and enforceable requirements.	Concept paper due February 9, 2024. Full application due April 30, 2024.	Reduce energy consumption from buildings (residential and commercial)

Funding Opportunity	**Description**	**Timeline**	**Applicable Measure Goal**
FEMA BRIC	$50M Tribal set aside for projects that respond to FEMA Hazard Mitigation Plan and reduce risks they face from disasters and natural hazards.	February 29, 2024	Variable
Community Change Grants	Partnership grant. $2B in IRA funding to benefit disadvantaged communities through projects that reduce pollution, increase climate resilience, and build community capacity to respond to environmental and climate justice challenges. $300 million reserved for Tribes.	Rolling with a deadline of November 21, 2024.	Variable
Energy and Mineral Development (EMDP) Program Grant	Offers Tribes financial support to assess the energy mineral resource potential of their lands.	Likely opens Q1 2024 and is an annual program	None
Tribal Energy Development Capacity (TEDC) Grant	Offers Tribes financial support to enhance a Tribe's internal capacity to manage energy resources through things like Tribal utility feasibility and formation	FY2024 due in January 2024 and is an annual program	Reduce emissions from energy generation
Production Tax Credit/Investment Tax Credit/Other Tax Credits	"Direct Pay" Tax Credits for non-profits, Tribes, consumers for clean energy, energy efficiency, EV and charging stations. 30-50% of project costs. Stackable with USDA/other funds.	Comment period has closed. Final rule to be issued soon.	Reduce emissions from energy generation

MTERA
Midwest Tribal Energy Resources Association, Inc.

EPA Climate Pollution Reduction Grant

Priority Climate Action Plan

Combined Appendices: A-F

Contents

Tables

Figures

Appendix A: GHG Inventory Methodology

1.1 Summary Across Sectors

Table 2 provides a summary of all Scope 1 and 2 Tribal emissions for the eight-Tribe subset, split between sectors. While the specific inventory data referenced within this GHG Inventory Methodology reference the eight-Tribe subset, the methodology is applicable to the full 35 MTERA Tribes.

Table 1: Total Tribal GHG Emissions Inventory

metric tons			All Tribes	Grand Portage	Oneida Nation	Fond du Lac	Leech Lake	Ho-Chunk	Bad River	Lac Courte Oreilles	MCT
Scope 1	Stationary	**CO2e**	**63858**	**3792**	**12014**	**9641**	**18152**	**10249**	**4479**	**5508**	**24**
		CO2	62903	2970	11999	9617	18095	10236	4471	5491	24
		CH4	1.97	0.14	0.25	0.33	0.71	0.21	0.12	0.21	0.00
		N2O	0.34	0.03	0.03	0.06	0.14	0.03	0.02	0.04	0.00
	Transportation	**CO2e**	**217605**	**10054**	**21425**	**19201**	**61472**	**40146**	**8814**	**56492**	**0**
		CO2	215266	10006	21315	19017	60991	39056	8771	56110	0
		CH4	54.72	0.51	1.33	4.27	10.00	31.34	0.40	6.87	0.00
		N2O	3.04	0.13	0.28	0.24	0.76	0.80	0.12	0.72	0.00
	Waste	**CO2e**	**4874**	**139**	**127**	**351**	**0**	**2371**	**80**	**1807**	**0**
		CO2	379	0	0	344	0	30	4	2	0
		CH4	113.88	3.52	3.21	0.12	0.00	59.34	1.93	45.76	0.00
		N2O	4.93	0.15	0.14	0.02	0.00	2.56	0.08	1.98	0.00
	Agriculture	**CO2e**	**1107**	**11**	**1078**	**18**	**0**	**0**	**0**	**0**	**0**
		CO2	0	0	0	0	0	0	0	0	0
		CH4	39.55	0.39	38.50	0.66	0.00	0.00	0.00	0.00	0.00
		N2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Scope 2	Stationary	**CO2e**	**115685**	**6017**	**23215**	**6600**	**26197**	**35913**	**5778**	**11912**	**51**
		CO2	114828	5972	23069	6589	26089	35499	5734	11825	51
		CH4	12.86	0.70	2.16	0.16	1.66	6.14	0.69	1.34	0.01
		N2O	1.87	0.10	0.32	0.02	0.23	0.91	0.10	0.19	0.00
Scope 1+2	Stationary	**CO2e**	**179543**	**9809**	**35229**	**16241**	**44349**	**46162**	**10257**	**17420**	**75**
		CO2	177731	8942	35068	16206	44184	45736	10204	17316	75
		CH4	14.82	0.84	2.41	0.49	2.38	6.35	0.80	1.55	0.01
		N2O	2.21	0.13	0.35	0.08	0.37	0.94	0.12	0.23	0.00
	Transportation	**CO2e**	**217605**	**10054**	**21425**	**19201**	**61472**	**40146**	**8814**	**56492**	**0**
		CO2	215266	10006	21315	19017	60991	39056	8771	56110	0
		CH4	54.72	0.51	1.33	4.27	10.00	31.34	0.40	6.87	0.00
		N2O	3.04	0.13	0.28	0.24	0.76	0.80	0.12	0.72	0.00
	Waste	**CO2e**	**4874**	**139**	**127**	**351**	**0**	**2371**	**80**	**1807**	**0**
		CO2	379	0	0	344	0	30	4	2	0
		CH4	113.88	3.52	3.21	0.12	0.00	59.34	1.93	45.76	0.00
		N2O	4.93	0.15	0.14	0.02	0.00	2.56	0.08	1.98	0.00
	Agriculture	**CO2e**	**1107**	**11**	**1078**	**18**	**0**	**0**	**0**	**0**	**0**
		CO2	0	0	0	0	0	0	0	0	0
		CH4	39.55	0.39	38.50	0.66	0.00	0.00	0.00	0.00	0.00
		N2O	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

1.2 Data Table (All Sectors)

Key data used for the development of the GHG Inventory is summarized in Table 2 below. For each data input, a mix of Tribal-provided information and proxy calculations were used, depending on the Tribe. For a detailed accounting of data sources by Tribe, see Appendix B for a list of GHG Inventories specific to each Tribe.

Table 2: Summary of GHG Emissions Sources Across Tribes

Sector	Sub-sector	GHG Emissions source	Input Value	Unit
Stationary Energy	Residential Single-family	Building Nat Gas	1695770	Annual therms of NG
		Building LP	3883278	Annual gallons of LP
		Building Fuel Oil (Res No. 5)	269714	Annual gallons of Fuel Oil
		Building Wood	2216	Annual cords of wood
	Multifamily Residential	Building Nat Gas	539545	Annual therms of NG
		Building LP	80697	Annual gallons of LP
		Building Fuel Oil (Res No. 5)	N/A	Annual gallons of Fuel Oil
	Commercial Buildings	Building Nat Gas	3451246	Annual therms of NG
		Building LP	406,653	Annual gallons of LP
		Building Fuel Oil (No. 2)	N/A	Annual gallons of Fuel Oil
		Building Wood	N/A	Annual cords of wood
Transportation	On-road	On-road (gasoline)	19750141	Annual gallons of gasoline
		On-road (diesel)	458226	Annual gallons of diesel
	Waterborne Navigation	Waterborne Navigation	1325210	Annual gallons of gasoline
	Aviation	Aviation	N/A	Annual gallons of jet fuel
	Off-road (tractors, ATVs, etc)	Off-road (gasoline)	2543316	Annual gallons of gasoline
		Off-road (diesel)	314958	Annual gallons of diesel
Waste		Disposal of solid-waste via Tribal-managed landfill	N/A	Metric tons of solid waste sent to Tribal-managed landfill annually
		Waste open-burning	11213	# burn barrels
Agriculture, Other land use		Livestock	19773	# of cattle (Bison)
Electricity	Residential Buildings		54568	Annual MWh
	Multifamily Buildings		29177	Annual MWh
	Commercial Buildings		35116	Annual MWh
	Industrial Buildings		88007	Annual MWh
	On-road	Electric Vehicles	N/A	Annual MWh

1.3 Buildings

1.3.1 Summary of Major Emissions

All Tribes use natural gas for heating, but some Tribes use propane more than natural gas for single-family residences, and natural gas primarily for commercial buildings. Tribes that use natural gas primarily across all buildings often also use propane as a secondary source. All Tribes reported using some wood stoves for heating in single-family residences as a tertiary source estimated to apply to up to 10% of single-family houses.

In order to calculate emissions related to electricity use in the Tribes, Arup used the Environmental Protection Agency's (EPA) eGRID regions' emissions factors[1]. Table 3 shows which eGRID region was used for each Tribe's electric utilities; Arup used these associated emissions factors from 2021.

Table 3: eGRID Regions Across Tribes

eGRID Region	Tribes within eGRID Region
MROW	Minnesota Chippewa, Leech Lake, Grand Portage, Fond du Lac, Bad River, Lac Courte Oreilles
MROE	Ho-Chunk, Oneida (Wisconsin Public Service Corp, 75%)
RFCW	Oneida (WE Energies, 25%)

1.3.2 Methodology for Proxy

The buildings included in this GHG accounting were limited to Tribal-owned commercial buildings and residential buildings (single-family and multifamily) that Tribal members reside in. Buildings were separated by building-types: residential single-family, residential multifamily, commercial, and industrial. All commercial buildings included are Tribal owned. While some Tribes only included residential buildings with Tribal members, other Tribes included all residential buildings within the Reservation regardless of occupant.

For all buildings, the first priority was to use utility data provided by the Tribal members. When this was not available, proxy data was used to estimate building energy use based on building typology, size, and location.

Residential Single-Family Methodology

When a Tribe was able to provide utility data for electricity and fuel use, or a representative sample size, this data was scaled up to total number of single-family buildings in that Tribe. Refer to Appendix B for tribal specific methodology.

---

[1] *EPA eGrid Emission Factors*. (2022, January). Retrieved January 5, 2024, from https://www.epa.gov/egrid

For single-family homes, if utility data was not provided, the U.S. Energy Information Administration (EIA) 2020 Residential Energy Consumption Survey (RECS)[2] was used for proxy. This data surveys a nationally representative sample of housing units. The 15th RECS data survey collected from nearly 18,500 households.

Data from the single-family homes in Minnesota and Wisconsin were used as proxy for single-family homes within those states. Consumption data was used by fuel type: propane (gallons), natural gas (ccf), fuel oil (gallons) and electricity (kWh) per household. This data was scaled up by number of single-family homes within each Tribe in the consortia.

Understanding that some households within Tribes of the CPRG rely on wood-burning stoves for heating, the EIA survey: "Increase in wood as main source of household heating most notable in the Northeast" provides an estimate of MMBtu/year of wood burned per household. This was used to calculate cords/wood burned annually in households that relied on wood stoves for heating.

Finally, best approximation from the Band on percentage of single-family homes that use natural gas, propane, wood stoves, and fuel oil for heating is multiplied by proxy calculations for each fuel type, to account for the different fuel types used.

Residential Multifamily Methodology

When a Tribe was able to provide utility data for electricity and fuel use, or a representative sample size, this data was scaled up to total number of multifamily buildings in that Tribe. Refer to Appendix B for tribal specific methodology.

For multifamily homes, if utility data was not provided, the Building Performance Database (BPD)[3] was used as proxy data for multifamily buildings. This database is sponsored by the U.S. Department of Energy (DOE) Building Technologies Office and was developed by the Lawrence Berkely National Laboratory. This database contains information for over one million commercial and residential buildings. Data was used for all multifamily buildings in Minnesota and Wisconsin. Due to the limited sample size for only Minnesota and Wisconsin, data was also used from Michigan, Iowa, and Illinois to get an upper-Midwest regional average. This database was referenced for EUI values for electricity consumption and natural gas consumption. These values were scaled up based on the assumed square footages of each multifamily building per Tribe.

Commercial Building Methodology

When a Tribe was able to provide utility data for electricity and fuel use, or a representative sample size, this data was scaled up to total commercial building area (square footage) in that Tribe. Refer to Appendix B for tribal specific methodology.

If utility data was not provided, the U.S. EIA 2018 Commercial Buildings Energy Consumption Survey (CBECS)[4] results and data was used for proxy data. For electricity use in commercial buildings, electricity consumption and conditional energy intensity by census division was used. Census divisions referenced were East North Central (for Tribes located in Wisconsin) and West North Central (for Tribes located in Minnesota). Similarly, natural gas consumption and conditional energy intensity by census division was available for these two regions. This data was released on December 21st, 2022. The natural gas data is available on a per square

---

[2] *2020 Residential Energy Consumption Survey.* (2020). U.S. Energy Information Administration. Retrieved February 24, 2024, from https://www.eia.gov/consumption/residential/data/2020/

[3] *Building Performance Database (BPD).* (n.d.). US DOE. Retrieved February 24, 2024, from https://bpd.lbl.gov/

[4] *2018 Commercial Buildings Energy Consumption Survey*. (2018). U.S. EIA. Retrieved February 24, 2024, from https://www.eia.gov/consumption/commercial/data/2018/

footage basis, so an estimate for average square footage per commercial basis was made to scale this data. This assumption is unique for each Tribe and requires Tribal input.

1.4 Transportation

1.4.1 Methodology for Proxy

The predominant source of GHG emissions related to transportation within the tribes are from single-occupancy vehicles. The sources included in PCAP GHG inventory included transportation emissions from on-road vehicles, as well as waterborne navigation, and off-road vehicles as applicable by Tribe. On-road vehicles included both on-road gasoline vehicles and on-road diesel vehicles. Off-road vehicles includes both off-road gasoline vehicles such as all-terrain vehicles (ATV's), and off-road diesel vehicles such as tractors.

In the initial request for information (RFI), Arup requested the number of gas, diesel, and EVs by passenger cars, light trucks, or heavy-duty vehicles. When Tribes were able to provide number of vehicles, Arup used these vehicles as well as proxy data on annual traveled VMT per driver based on the annual average traveled VMT per driver data published at the state level from the Federal Highway Administration[5] data last published in 2019. Without actual gasoline and diesel data from a Tribe, proxy data was calculated for on-road gasoline emissions using regional VMT data and scaling it down using the Band's population data.

Arup used DOE Average Fuel Economy[6] to calculate the gallons of fuel used to travel the annual average miles traveled per vehicle as shown in Figure 1.

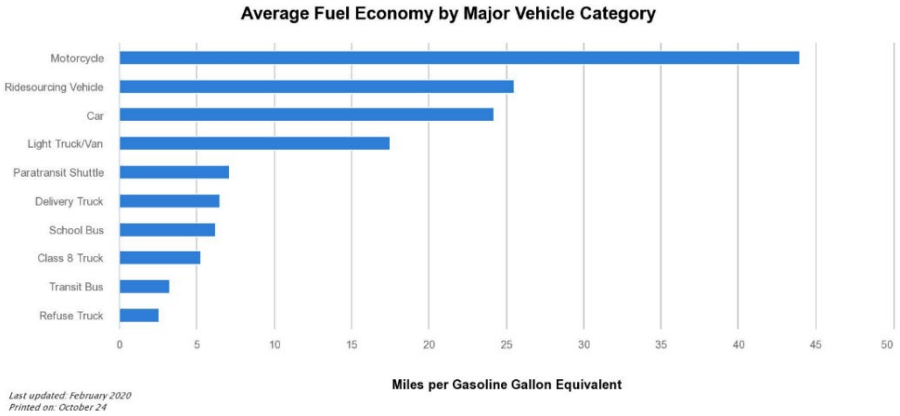


Figure 1: Average Fuel Economy by Vehicle

In addition to the number of vehicles listed in the original RFI, Arup requested data on number of school buses, transit buses, tractors, and average daily distance traveled. When this data was available, the associated emissions were also calculated. School buses, transit buses, and tractors were all assumed to use diesel fuel.

$$Annual\ Gallons\ of\ Diesel = \frac{(\#\ of\ Vehicle)(Annual\ VMT)}{Vehicle\ MPG^{7}}$$

---

[5] *Highway Statistics 2019.* (2019). US DOT Federal Highway Administration. Retrieved February 24, 2024, from https://www.fhwa.dot.gov/policyinformation/statistics/2019/

[6] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

[7] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

Because many Tribal members use all-terrain vehicles (ATV's), Arup asked Tribes to estimate percentage of population that owned an ATV and assumed 1,500 miles/year for those that ride ATV's.

$$\begin{aligned}&\mathit{Annual\ Gallons\ of\ Gasoline}\\&=\frac{\left[\mathit{Tribal\ population} * (\mathit{percent\ of\ population\ with\ an\ ATV}) * \left(1{,}500\,\frac{\mathit{miles}}{\mathit{year}}\right)\right]}{20\ \mathit{MPG}}\end{aligned}$$

If a Tribe did not initially provide the number and types of vehicles to be included in the inventory, Arup requested that the Tribes ascertain data from the local Tribal DMV (Department of Motor Vehicles), police or sheriff office, or office of the registrar on vehicles registered within each Tribe. This provides granular data on number of vehicles, average age of vehicle, and vehicle type (light truck, single passenger, EV, etc.).

If this data was not attainable, the next methodology used to calculate transportation emissions included taking data from Tribal-owned gas stations on annual gallons of gasoline and diesel fuel sold. When this was available, the inventory includes these annual gallons of gasoline sold to calculate GHG emissions.

Without either the gallons of gasoline sold or vehicle registration data, Arup relied on VMT data published from Minnesota[8] and Wisconsin[9] Department of Transportation (DOT) at the county level. County population and VMT data was taken from the counties that encompass the Tribes. The annual VMT per county population was scaled down to the population of each Tribe.

Additionally, many Tribes have significant use of motorized boats. If available, data for gasoline sold at marinas was used to calculate emissions associated with boat travel. If monthly gasoline sold was available, this data was scaled to represent the boating season, typically early April through early November. If gasoline sold was not available, Arup asked the Tribes to estimate the percentage of their population with motorized boats, average boat trip distance, and number of boat trips per year.

$$\mathit{Annual\ gallons\ of\ gasoline} = \frac{[(\mathit{Tribal\ Population}) * (\mathit{Percentage\ of\ Tribal\ members\ with\ motorized\ boats}) * (\mathit{Average\ boat\ trip\ distance}) * (\mathit{Number\ of\ annual\ boat\ trips})]}{4\ \mathit{MPG}}$$

1.5 Waste

1.5.1 Summary of Major Emissions

The amounts of sources of GHG emissions within the waste sector across all Tribes is summarized in Table 4:

Table 4: Summary of GHG Emissions Sources in Waste Sector

	Number of Burn Barrels	Number of Landfills	People Served by Anaerobic Wastewater Treatment	People Served by Aerobic Wastewater Treatment	People Served by Septic Systems
Bad River	108	0	0	346	203

---

[8] *Roadway Data*. (2022). Minnesota Department of Transportation. Retrieved February 24, 2024, from https://www.dot.state.mn.us/roadway/data/data-products.html#VMT

[9] *2021 Vehicle Miles of Travel (VMT) by County*. (2021). Wisconsin Department of Transportation. Retrieved February 24, 2024, from https://wisconsindot.gov/Documents/projects/data-plan/veh-miles/vmt2021-c.pdf

Fond du Lac	10,170	0	0	0	0
Grand Portage	1	0	0	0	0
Ho-Chunk	17	0	0	10,632	1,348
Lac Courte Oreilles	50	0	0	0	528
Leech Lake	0	0	0	0	0
Minnesota Chippewa	0	0	0	0	0
Oneida	0	0	0	576	500

1.5.2 Methodology for Proxy

In this GHG inventory for the PCAP, only Scope 1 emissions associated with waste were included in the inventory. This includes emissions associated with solid waste disposed in landfills *if the landfills are located within the Tribal boundary.* This also includes solid waste generated by the Tribe that is incinerated or burned in the open. This also includes Scope 1 emissions associated with wastewater treatment so long as that treatment is located within the Tribal boundary.

With limited data on the actual make-up of tribal municipal solid waste (MSW), Arup assumed the U.S. EPA MSW Generation Make-up[10]. This gave assumptions for the fraction of solid waste that was food, garden waste, paper, wood, textiles, and metals.

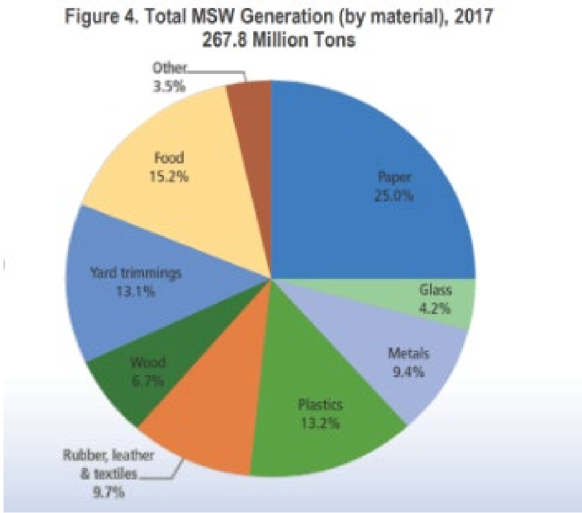


Figure 2: EPA MSW Make-Up

Waste Open Burning

Waste open burning is another method of municipal waste disposal that is still practiced within some of the Tribes. The same assumptions were made on the make-up of the MSW to calculate the emissions associated with open waste burning. The Tribes provided the number of burn barrels used annually. These burn barrels were assumed to be 55-gallon drums. The waste was assumed to be mixed waste – from either residential or

---

[10] *National Overview: Facts and Figures on Materials, Wastes and Recycling*. (2023, November 22). US EPA. Retrieved February 24, 2024, from https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

commercial sources – and uncompacted, giving an approximate density of 275 lbs/cubic yard [11]. Using the EPA's default heat content ratio of 9.953 MMBtu/short ton of waste [12], Arup calculated associated emissions. The EPA's emissions factors for GHG Inventories includes emissions factors associated with MSW burning on a kg CO_2, g CH_4, and g N_2O on a MMBtu basis, which was converted to metric tons of CO_2e.

Wastewater

There are both CH_4 and N_2O emissions associated with wastewater treatment. To calculate the CH_4 emissions associated with wastewater treatment, Arup assumed 85 g/person/day [13] for Biochemical Oxygen Demand (BOD), in line with the United States default values per IPCC (International Panel on Climate Change) guidance on wastewater treatment and discharge. Arup assumed no additional industrial wastewater flowing to the Tribal sewers. Methane correction factors vary depending on whether the wastewater treatment system is an untreated system, centralized aerobic, anaerobic, or other septic system. For this initial inventory, the Methane Correction Factor, 0.3 [14], corresponds with a centralized aerobic wastewater treatment system. Using these factors, Arup calculated the CH_4 emissions associated with the Tribal population.

To calculate N_2O emissions associated with wastewater treatment, Arup used default values for protein consumed as a fraction of protein supply, 0.80, and assumed the same centralized, aerobic treatment plant [15]. Using these values, as well as the U.S. annual protein supply per capita, 117 grams of protein/day [16], the N_2O emissions were calculated on a per person basis. These values were multiplied by the Tribal population that were being served by the wastewater treatment plant.

---

[11] *Volume-to-Weight Conversion Factors*. (2016, April). U.S. Environmental Protection Agency. https://www.epa.gov/sites/default/files/2016-04/documents/volume_to_weight_conversion_factors_memorandum_04192016_508fnl.pdf

[12] *Default Heat Content for Energy Conversions*. (n.d.). US EPA. https://www.epa.gov/system/files/ documents/2022-10/Default%20Heat%20Content%20Ratios%20for%20Help%20and%20User%20Guide%20%281%29.pdf

[13] Doorn, M., Towprayoon, S., Maria Manso Vieira, S., Irving, W., Palmer, C., Pipatti, R., and Wang, C. (2006). WASTEWATER TREATMENT AND DISCHARGE (Table 6.3). 2006 IPCC Guidelines for National Greenhouse Gas Inventories. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/ V5_6_Ch6_Wastewater.pdf

[14] Doorn, M., Towprayoon, S., Maria Manso Vieira, S., Irving, W., Palmer, C., Pipatti, R., and Wang, C. (2006). WASTEWATER TREATMENT AND DISCHARGE (Table 6.4). 2006 IPCC Guidelines for National Greenhouse Gas Inventories. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/ V5_6_Ch6_Wastewater.pdf

[15] Doorn, M., Towprayoon, S., Maria Manso Vieira, S., Irving, W., Palmer, C., Pipatti, R., and Wang, C. (2006). WASTEWATER TREATMENT AND DISCHARGE (Table 6.8, 6.10). 2006 IPCC Guidelines for National Greenhouse Gas Inventories. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/ V5_6_Ch6_Wastewater.pdf

[16] *Daily per capita protein supply*. (n.d.). Our World in Data. Retrieved February 15, 2024, from https://ourworldindata.org/grapher/daily-per-capita-protein-supply?tab=chartandcountry=~USA

Appendix B: Tribal GHG Inventories

Individual GHG Inventories are provided below for each of the 8 Tribe subset.

B.1 Bad River Band of the Lake Superior Tribe of the Chippewa Indians GHG Inventory

A GHG inventory is a record of GHG emissions sources and quantified emissions, typically measured in CO2e. This CO2e measure accounts for the following six gases in one unit of measure: CO2, CH4 (methane), N2O (nitrous oxide), HFC (hydrofluorocarbons), PFC (perfluorocarbons), and SF6 (sulfur hexafluoride). In many cases, it is not possible to collect total and exact GHG emissions data; therefore, sample size data is collected and proxy data from an available boundary is scaled to fill in the gaps. This inventory is used to understand the largest sources of GHG emissions within a system boundary and understand sectors to prioritize for emissions reduction measures. The goal is to develop measures that can be implemented to significantly reduce GHG emissions within a system boundary.

Stakeholder Engagement

To accurately document the GHG emissions associated with Bad River Band of the Lake Superior Tribe of the Chippewa Indians (Band River Tribe), Arup initially sent a request for information (RFI) to the Tribe to better understand the sectors that make up Scope 1 and 2 emissions for the Tribe. After reviewing this initial information, Arup had a 1:1 meeting with members of Bad River Tribe to ask further questions and ensure the extent of emissions for the initial PCAP inventory was captured correctly.

Boundary of Inclusion

The Reservation of the Bad River Tribe is approximately 193 square miles in area and lies on the south shore of Lake Superior, straddling Ashland and Iron counties in Wisconsin. For the purposes of this study the boundary of inclusion was identical to boundaries of the Reservation. Only Tribal-owned and Tribe-member buildings, transportation, and waste are included in this analysis.

Methodology for Proxy

The buildings included in this GHG accounting were limited to Tribal-owned buildings and residential homes that Tribal members reside in. Buildings were separated by building-types: residential single-family, residential multifamily, and commercial. For all buildings, the first priority was to use utility data provided by the Tribal members. When this was not available, proxy data was used to estimate building energy use based on building typology, size, and location.

Residential Single-Family Methodology

For single-family homes, building area (sf) and electricity usage (kWh) was provided for a sample of 34 houses. This was used to calculate electricity usage per building area (kWh/sf). The average building area was applied to total of 465 houses to get total building area, and the electricity usage per building area was used to calculate total electricity usage in kWh. This was then converted to megawatt hours (MWh) to then calculate metric tons of CO_2e.

For wood stove usage in single-family homes, an estimation of 2.5 cords / 1000sf was used. Using the sample of 34 houses, the average building area is 1,070sf. The total of 135 single-family homes that use wood stoves was used to calculate cords of wood.

For natural gas, propane, and fuel oil, since data was not provided, the U.S. EIA database for Residential Energy Consumption Survey (RECS) was used for proxy. This data, administered by EIA, surveys a nationally representative sample of housing units. The data used for proxy was from 2020, which was the 15th RECS data survey collected from nearly 18,500 households.

Data from the single-family homes in Minnesota and Wisconsin were used as proxy for Tribal single-family homes within those states. Consumption data was used by fuel type: propane (gallons) and natural gas (ccf) per household. This data was scaled up by number of single-family homes within each Tribe.

While this data provided at the state level did not include fuel oil data for single-family homes, the EIA survey did have averages for single-family homes in the Midwest. This was used for estimated annual household fuel oil use for single-family homes that relied on fuel oil for heating.

Residential Multifamily Methodology

For multifamily homes, building area (sf) and electricity usage (kWh) was provided for a sample of one house. This was used to calculate electricity usage per building area (kWh/sf). The average building area was applied to total of 58 houses to get total building area, and the electricity usage per building area was used to calculate total electricity usage in kWh. This was then converted to MWh to then calculate metric tons of CO_2e.

The Building Performance Database (BPD) was used as proxy data for multifamily buildings. This database is sponsored by the U.S. DOE Building Technologies Office and was developed by the Lawrence Berkely National Laboratory. This database contains information for over 1 million commercial and residential buildings. Data was used for all multifamily buildings in Minnesota and Wisconsin. This databased was referenced for EUI values for natural gas consumption. These values were scaled up based on the assumed square footages of each multifamily building per Tribe.

Commercial Building Methodology

For commercial buildings, building area (sf) and electricity usage (kWh) was provided for a sample of 13 buildings. This was used to calculate electricity usage per building area (kWh/sf). The average building area was applied to total of 25 commercial buildings to get total building area, and the electricity usage per building area was used to calculate total electricity usage in kWh. This was then converted to MWh to then calculate metric tons of CO_2e.

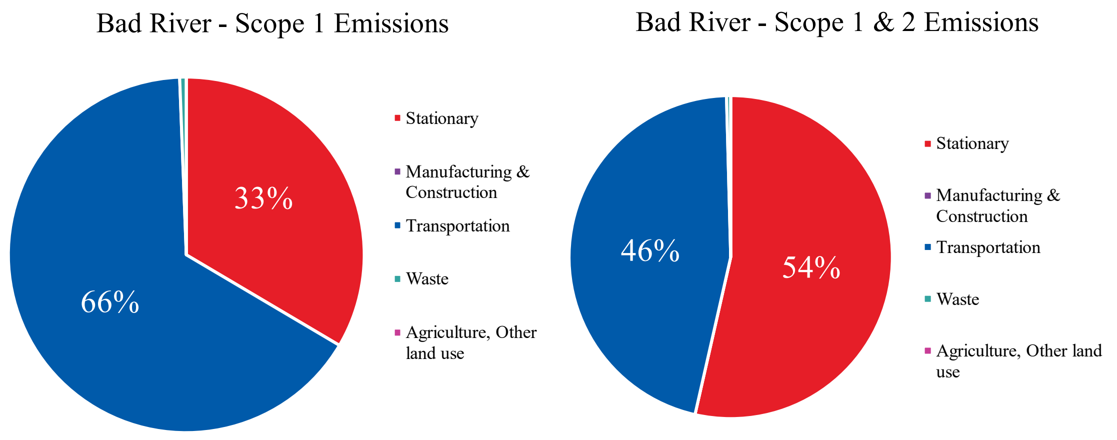
EIA publishes Commercial Buildings Energy Consumption Survey (CBECS) results. The latest data available from this survey is from 2018, which was referenced for proxy data for commercial buildings. For electricity use in commercial buildings, electricity consumption and conditional energy intensity by census division was used. Census divisions referenced were East North Central (for Tribes located in Wisconsin) and West North Central (for Tribes located in Minnesota). Similarly, natural gas consumption and conditional energy intensity by census division was available for these two regions. This data was released on December 21st, 2022. The natural gas data is available on a per square footage basis, so an estimate for average square footage per commercial basis was made to scale this data. This assumption is unique for each Tribe and requires Tribal input.

EIA CBECS data has refined energy use intensity data available per building type (i.e., education, food service, healthcare, lodging, mercantile, worship) that may be used once actual building types included in GHG inventory are refined.

Applicable Sectors

Most of the GHG emissions produced by Bad River Tribe comes from the Buildings and Transportation sectors. Less than 1% of emissions are from Waste.

Summary Across Sector


Bad River - Scope 1 Emissions

Bad River - Scope 1 & 2 Emissions

Figure 3: Bad River Band Summary of Emissions

The majority of Scope 1 emissions come from transportation, but when considering Scope 1 and 2 emissions, Stationary Energy Use (particularly electricity from commercial buildings), becomes the most significant source of emissions.

Data Table (All Sectors)

Table 5: Bad River Band Summary Across All Sectors

Sector	Sub-sector	GHG Emissions source	Input Value	Unit	Source
Stationary Energy	Residential Single-family	Building Nat Gas	*209,510*	Annual therms of NG	Proxy data, refer to methodology
		Building LP	*199,727*	Annual gallons of LP	Proxy data, refer to methodology
		Building Fuel Oil (Res No. 5)	*2,674*	Annual gallons of Fuel Oil	Proxy data, refer to methodology
		Building Wood	*361*	Annual cords of wood	Estimated based on usage by building area
	Multifamily Residential	Building Nat Gas	*186,702*	Annual therms of NG	Proxy data, refer to methodology
		Building LP	-	Annual gallons of LP	This fuel understood to not be used
		Building Fuel Oil (Res No. 5)	-	Annual gallons of Fuel Oil	This fuel understood to not be used
	Commercial Buildings	Building Nat Gas	96,502	Annual therms of NG	Proxy data, refer to methodology
		Building LP	517	Annual gallons of LP	Proxy data, refer to methodology
		Building Fuel Oil (No. 2)	-	Annual gallons of Fuel Oil	Proxy data, refer to methodology
		Building Wood	-	Annual cords of wood	Proxy data, refer to methodology
	Industrial Buildings	Building Nat Gas	-	Annual therms of NG	Not applicable
		Building LP	-	Annual gallons of LP	Not applicable
		Building Fuel Oil (No. 2)	-	Annual gallons of Fuel Oil	Not applicable
		Building Wood	-	Annual cords of wood	Not applicable
Transportation	On-road	On-road (gasoline)	*905,456*	Annual gallons of gasoline	Proxy data, refer to methodology
		On-road (diesel)	*62,274*	Annual gallons of diesel	Proxy data, refer to methodology
	Waterborne Navigation	Waterborne Navigation	*10,459*	Annual gallons of gasoline	Proxy data, refer to methodology
	Aviation	Aviation	-	Annual gallons of jet fuel	This fuel understood to not be used
	Off-road (tractors, ATVs, etc)	Off-road (gasoline)	*10,673*	Annual gallons of gasoline	Proxy data, refer to methodology
		Off-road (diesel)	-	Annual gallons of diesel	Proxy data, refer to methodology
Waste		Disposal of solid-waste	-	tonnes of MSW sent to landfill annually	Understood to be zero due to no landfill without boundary
		Waste open-burning	108	Annual # burn barrels	Estimated based on reported number of burn barrels
	Aerobic Digestion	Wastewater generated	346	Population served	Estimated based on RFI response
Agriculture, Other land use	Livestock	Livestock	-	Number of cattle (Bison)	Not applicable
Electricity	Residential Buildings		4,549	Annual MWh	Electricity data from a sample scaled up
	Multifamily Buildings		2,167	Annual MWh	Electricity data from a sample scaled up
	Commercial Buildings		5,979	Annual MWh	Electricity data from a sample scaled up
	Industrial Buildings		-	Annual MWh	Not applicable
	On-road	Electric Vehicles	-	Annual MWh	Not applicable

Buildings

Summary of Major Emissions

Based on initial findings, the majority of emissions in the building sector come from residential buildings, particularly single-family houses. Commercial building types within Bad River Tribe Reservation include gaming/entertainment, lodging, retail, healthcare, office, police/fire station, recreation/community center, and storage/warehouse. Arup understands Bad River Tribe does not have industrial buildings within its Reservation, though the pump house, lift station, and water tower may potentially be classified as industrial buildings.

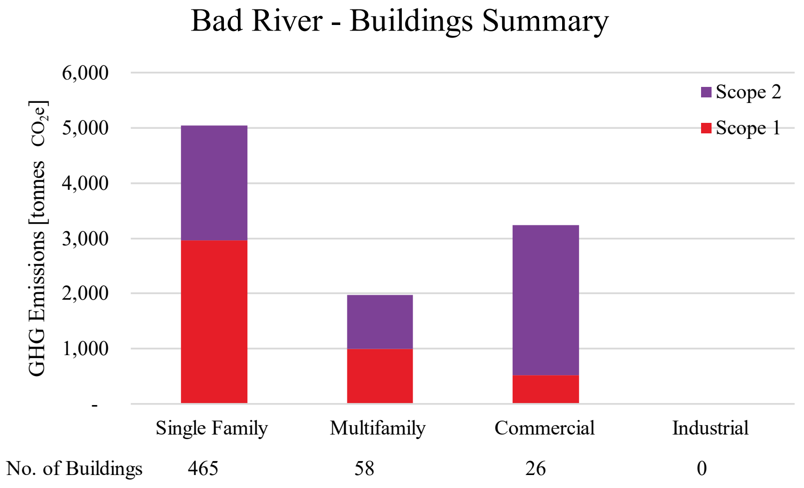


Figure 4: Bad River Building Emissions Summary

Single-family homes are heated primarily with natural gas and liquid propane, and some single-family homes have additional heating source from wood stoves. Very few on the entire Reservation use fuel oil. Multifamily and commercial buildings rely primarily on natural gas for space heating, though some commercial buildings use propane.

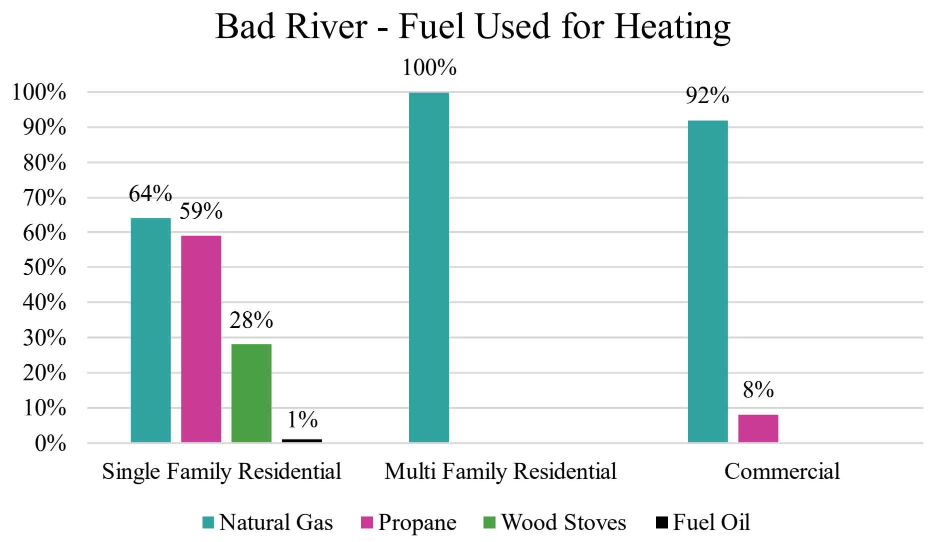


Figure 5: Bad River Fuel Use by Building Type

In order to calculate emissions related to electricity use in the Tribes, Arup used EPA's eGRID regions' emissions factors[17]. The MROE (Midwest Reliability Organization East) eGRID region encompasses Bad River's electric utilities; Arup used these associated emissions factors from 2021.

Transportation

Summary of Major Emissions

Majority of transportation emissions occurs from on-road passenger cars and vehicles, which is calculated using proxy data.

---

[17] *EPA eGrid Emission Factors*. (2022, January). Retrieved January 5, 2024, from https://www.epa.gov/egrid

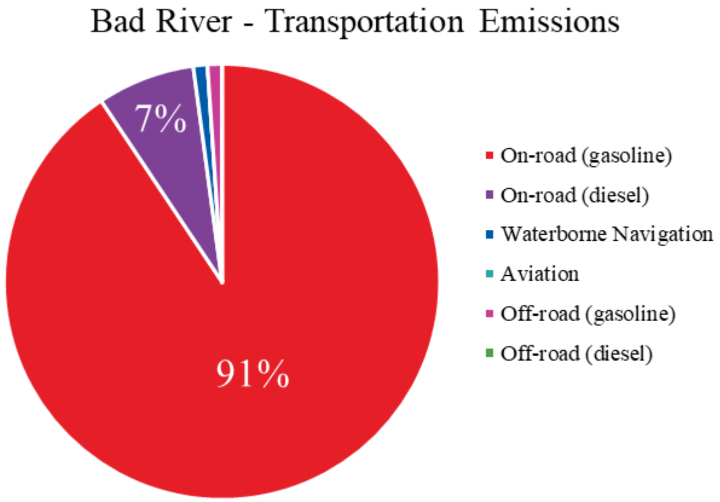


Figure 6: Bad River Transportation Emissions

Estimates were provided for vehicle data such as 4 school buses with 80 vehicle miles traveled per day, 6 public transit buses with 150 vehicle miles traveled per day, 5% of the population owns a boat, and 10% of the population owns an ATV. Proxy data was used to calculate GHG emissions.

Methodology for Proxy

There are a few methodologies for calculating GHG emissions associated with transportation for the Tribes. The predominant source of GHG emissions related to transportation within the tribes is from single-occupancy vehicles. The sources included in the PCAP GHG inventory included transportation emissions from: on-road vehicles, waterborne navigation, and off-road vehicles. On-road vehicles included both on-road gasoline vehicles and on-road diesel vehicles. Off-road vehicles includes both off-road gasoline vehicles such as all-terrain vehicles (ATV's), and off-road diesel vehicles such as tractors.

In the initial request for information (RFI), Arup requested the number of gas, diesel, and EVs that were either passenger cars, light trucks, or heavy-duty vehicles. When Tribes were able to provide number of vehicles, Arup used these vehicles as well as proxy data traveled annual average VMT per driver data published at the state level from the Federal Highway Administration[18] data last published in 2019.

Arup used DOE Average Fuel Economy[19] to calculate the gallons of fuel used to travel the annual average miles traveled per vehicle.

---

[18] *Highway Statistics 2019.* (2019). US DOT Federal Highway Administration. Retrieved February 24, 2024, from https://www.fhwa.dot.gov/policyinformation/statistics/2019/

[19] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

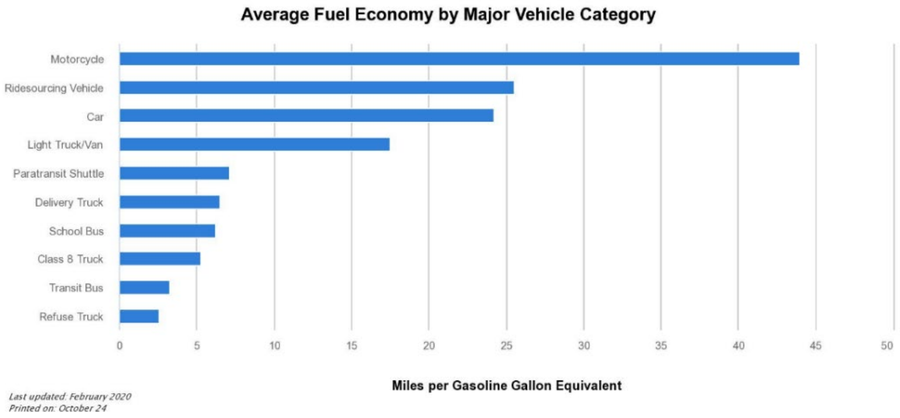


Figure 7: Average Fuel Economy by Vehicle

$$Annual\ Gallons\ of\ Diesel = \frac{[(\#\ heavy\ duty\ trucks) * (Annual\ VMT\ per\ driver)]}{6.5\ MPG}$$

In addition to the number of vehicles listed in the original RFI, Arup requested data on number of school buses, transit buses, tractors, and average daily distance traveled. When this data was available, the associated emissions were also calculated. School buses, transit buses, and tractors were all assumed to use diesel fuel.

$$Annual\ Gallons\ of\ Diesel = \frac{(\#\ of\ Vehicle)(Annual\ VMT)}{Vehicle\ MPG^{20}}$$

Because many Tribal members use all-terrain vehicles (ATV's), Arup asked Tribes to estimate percentage of population that owned an ATV and assumed 1,500 miles/year for those that ride ATV's.

$$Annual\ Gallons\ of\ Gasoline = \frac{\left[Tribal\ population * (percent\ of\ population\ with\ an\ ATV) * \left(1{,}500\frac{miles}{year}\right)\right]}{20\ MPG}$$

If a Tribe did not initially provide the number and types of vehicles to be included in the inventory, Arup requested that the Tribes ascertain data from the local Tribal DMV, police or sheriff office, or office of the registrar on vehicles registered within each Tribe. This provides granular data on number of vehicles, average age of vehicle, and vehicle type (light truck, single passenger, EV, etc).

If this data was not attainable, the next methodology used to calculate transportation emissions included taking data from Tribal-owned gas stations on annual gallons of gasoline and diesel fuel sold. When this was available, the inventory includes these annual gallons of gasoline sold to calculate GHG emissions.

---

[20] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

Without either the gallons of gasoline sold or vehicle registration data, Arup relied on VMT data from the annual VMT data published from Minnesota[21] and Wisconsin[22] Department of Transportation (DOT) at the county level. County population and VMT data was taken from the counties that encompass the Tribes. The annual VMT per county population was scaled down to the population of each Tribe.

Additionally, many Tribes have significant use of motorized boats. If available, data for gasoline sold at marinas was used to calculate emissions associated with boat travel. If monthly gasoline sold was available, this data was scaled to represent the boating season, typically early April through early November. If gasoline sold was not available, Arup asked the Tribes to estimate the percentage of their population with motorized boats, average boat trip distance, and number of boat trips per year.

$$Annual\ gallons\ of\ gasoline = \frac{[(Tribal\ Population)*(Percentage\ of\ Tribal\ members\ with\ motorized\ boats)*(Average\ boat\ trip\ distance)*(Number\ of\ annual\ boat\ trips)]}{4\ MPG}$$

For marine emissions, given the amount of wetlands on the Reservation as well as its adjacency to Lake Superior, Arup assumed that 75 percent of Bad River Tribe residents make boat trips. Arup further assumed that the average distance of each boat trip is 7 miles and residents make 3 trips per week for seven months of the year, or 84 yearly trips per boat user. Based on these assumptions, annual marine fuel consumption is estimated to be 156,886 gallons of gasoline and annual site emission from marine fuel consumption is estimated to be 1,377 metric tons of CO_2.

Waste

Summary of Major Emissions

Waste information provided includes 108 burn barrels used per year, 203 people served by septic systems for wastewater, and 346 people served by aerobic wastewater treatment.

Methodology for Proxy

In this GHG inventory for the PCAP, only Scope 1 emissions associated with waste were included in the inventory. This includes emissions associated with solid waste disposed in landfills *if the landfills are located within the Tribal boundary.* This also includes solid waste generated by the Tribe that is incinerated or burned in the open. This also includes Scope 1 emissions associated with wastewater treatment so long as that treatment is located within the Tribal boundary. There are no landfills on Bad River Reservation, so no emissions were assumed to be associated with landfill emissions.

With limited data on the actual make-up of tribal MSW, Arup assumed the U.S. EPA MSW Generation Make-up[23]. This gave assumptions for the fraction of solid waste that was food, garden waste, paper, wood, textiles, and metals.

---

[21] *Roadway Data*. (2022). Minnesota Department of Transportation. Retrieved February 24, 2024, from https://www.dot.state.mn.us/roadway/data/data-products.html#VMT

[22] *2021 Vehicle Miles of Travel (VMT) by County*. (2021). Wisconsin Department of Transportation. Retrieved February 24, 2024, from https://wisconsindot.gov/Documents/projects/data-plan/veh-miles/vmt2021-c.pdf

[23] *National Overview: Facts and Figures on Materials, Wastes and Recycling*. (2023, November 22). US EPA. Retrieved February 24, 2024, from https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

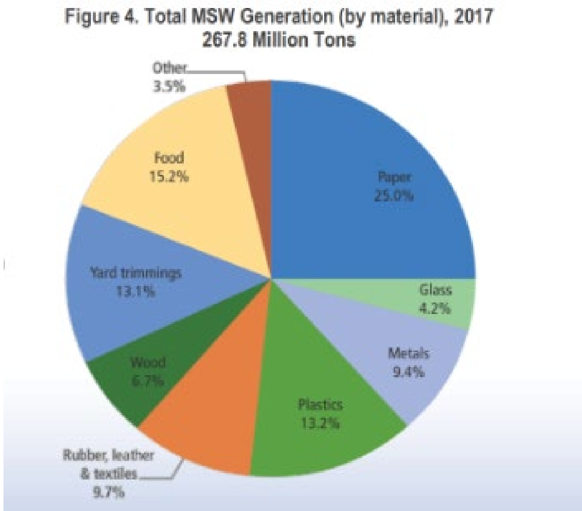


Figure 8: EPA MSW Make-Up

Waste Open Burning

Waste open burning is another method of municipal waste disposal that is still practiced within some of the Tribes. The same assumptions were made on the make-up of the MSW in order to calculate the emissions associated with open waste burning. The Tribes provided the number of burn barrels used annually. These burn barrels were assumed to be 55-gallon drums. The waste was assumed to be mixed waste – from either residential or commercial sources – and uncompacted, giving an approximate density of 275 lbs/cubic yard[24]. Using the EPA's default heat content ratio of 9.953 MMBtu/short ton of waste[25], Arup calculated associated emissions. The EPA's emissions factors for GHG Inventories includes emissions factors associated with MSW burning on a kg CO_2, g CH_4, and g N_2O on a MMBtu basis, which was converted to metric tons of CO_2e.

Bad River Tribe is understood to use 108 barrel burns throughout the course of the year. Based on these assumptions, it is estimated that the total annual site emissions resulting from barrel burns is approximately 3.65 metric tons of CO_2, and a negligible amount of CH_4 and N_2O.

Wastewater

There are both CH_4 and N_2O emissions associated with wastewater treatment. In order to calculate the CH_4 emissions associated with wastewater treatment, Arup assumed 85 g/person/day[26] for Biochemical Oxygen Demand (BOD), in line with the United States default values per IPCC guidance on wastewater treatment and discharge. Arup assumed no additional industrial wastewater flowing to the Tribal sewers. Methane correction factors vary depending on whether the wastewater treatment system is an untreated system, centralized aerobic, anaerobic, or other septic system. For this initial inventory, the Methane Correction Factor, 0.3[27], corresponds with a centralized aerobic wastewater treatment system. Using these factors, Arup calculated the CH_4 emissions associated with the Tribal population.

To calculate N_2O emissions associated with wastewater treatment, Arup used default values for protein consumed as a fraction of protein supply, 0.80, and assumed the same centralized, aerobic treatment plant[28].

---

[24] EPA Volume-to-Weight Conversion Factors

[25] Default Heat Content for Energy Conversions. (n.d.). US EPA. https://www.epa.gov/system/files/ documents/2022-10/Default%20Heat%20Content%20Ratios%20for%20Help%20and%20User%20Guide%20%281%29.pdf

[26] IPCC - Table 6.4

[27] IPCC - Table 6.3

[28] IPCC - Table 6.8A, 6.10A

Using these values, as well as the U.S. annual protein supply per capita, 117 grams of protein/day[29], the N_2O emissions were calculated on a per person basis. These values were multiplied by the Tribal population that were being served by the wastewater treatment plant.

It is understood that Bad River Tribe's wastewater treatment facilities serve 549 persons per year (including visitors to casinos and other commercial buildings). Based on this understanding, Arup estimates the annual site emissions from this wastewater treatment to be 3.1 metric tons of CH_4 and 0.1 metric tons of N_2O.

Processes for Improved Data Collection for Future Reporting

Future reporting will be improved as the data collection process continues. Many of the Tribes have requested data directly from third parties that have not yet provided data but are likely to be able to provide with more time ahead of the next inventory. This includes electric, gas, and propane utility data from utility companies, vehicle registration data from departments of motor vehicles, ridership numbers for public transportation, wastewater treatment plant data, gas station data on amounts of sold fuel, and data on livestock and emissions associated with agriculture

---

[29] U.S. Protein Supply

B.2 Fond du Lac Band of Lake Superior Chippewa GHG Inventory

A GHG inventory is a record of GHG emissions sources and quantified emissions, typically measured in CO_2e. This CO_2e measure accounts for the following six gases in one unit of measure: CO_2, CH_4 (methane), N_2O (nitrous oxide), HFC (hydrofluorocarbons), PFC (perfluorocarbons), and SF_6 (sulfur hexafluoride). In many cases, it is not possible to collect total and exact GHG emissions data; therefore, sample size data is collected and proxy data from an available boundary is scaled to fill in the gaps. This inventory is used to understand the largest sources of GHG emissions within a system boundary and understand sectors to prioritize for emissions reduction measures. The goal is to develop measures that can be implemented to significantly reduce GHG emissions within a system boundary.

Stakeholder Engagement

In order to accurately document the GHG emissions associated with Fond du Lac, Arup initially sent a request for information (RFI) to the Band to better understand the sectors that make up Scope 1 and 2 emissions for the Band. After reviewing this initial information, Arup had a 1:1 meeting with members of the Fond du Lac Band to ask further questions and ensure the extent of emissions for the initial PCAP inventory was captured correctly.

Boundary of Inclusion

The Fond du Lac Band of Lake Superior Chippewa Reservation is located along the St. Louis River. The homeland, named Nagaajiwanaang, is made up of three districts: Bapashkominitigong (Cloquet), Gwaaba’iganing (Sawyer), and Ashkibwaakaaning (Brookston). The entire Fond du Lac Reservation is about 154.5 square miles.

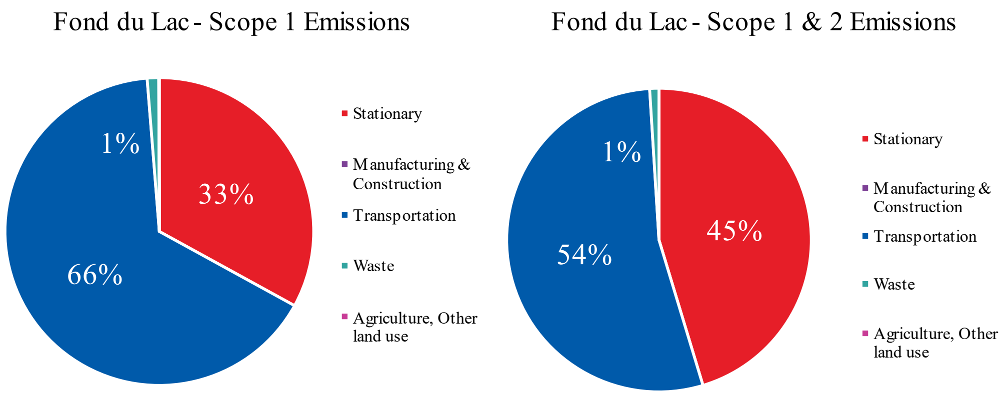
This inventory includes Band-owned commercial and industrial buildings and all occupied housing units on the Reservation, including non-Tribal residences according to the 2019 Emissions Inventory, which references Census Data for housing units. Propane emissions from buildings account for all the buildings that purchased propane from the Fond du Lac Propane Company. Though Cloquet Carlton County Airport is located within reservation boundaries, it was not included in this inventory since it is not Band-owned.

The proxy data and calculations for transportation emissions uses the given population, 4,168 people, which is the total population of the Reservation, including non-Tribal members, according to the ACS 2021 Census Data.

Applicable Sectors

The sectors that make up the majority of GHG emissions for the Fond du Lac Band are buildings and transportation.

Summary Across Sector


Fond du Lac - Scope 1 Emissions

Fond du Lac - Scope 1 & 2 Emissions

Figure 9: Fond du Lac Summary of Emissions

	Scope 1 Emissions	Scope 1 and 2 Emissions
Stationary	31.7%	43.9%
Manufacturing & Construction	0.0%	0.0%
Transportation	67.1%	55.1%
Waste	1.2%	0.9%
Agriculture, Other land use	0.1%	0.0%

Even after accounting for Scope 2 building electricity use, transportation in the Fond du Lac Band has greater GHG emissions than buildings or stationary sources. Waste also contributes to 1% of the Band’s emissions.

Data Table (All Sectors)

Table 6: Fond du Lac Summary Across All Sectors

Sector	Sub-sector	GHG Emissions source	Input Value	Unit	Source
Stationary Energy	Residential Single-family	Building Nat Gas	*51,316*	Annual therms of NG	Proxy data, refer to methodology
		Building LP	868,861	Annual gallons of LP	FDL Propane Sales
		Building Fuel Oil (Res No.	-	Annual gallons of Fuel Oil	Not applicable
		Building Wood	*199*	Annual cords of wood	Proxy data, refer to methodology
	Multifamily Residential	Building Nat Gas	20,493	Annual therms of NG	Noresco IGA
		Building LP	-	Annual gallons of LP	Not applicable
		Building Fuel Oil (Res No.	-	Annual gallons of Fuel Oil	Not applicable
	Commercial Buildings	Building Nat Gas	704,346	Annual therms of NG	Noresco IGA
		Building LP	22,955	Annual gallons of LP	FDL Propane Sales
		Building Fuel Oil (No. 2)	-	Annual gallons of Fuel Oil	Not applicable
		Building Wood	-	Annual cords of wood	Not applicable
	Industrial Buildings	Building Nat Gas	-	Annual therms of NG	Not applicable
		Building LP	3,618	Annual gallons of LP	FDL Propane Sales
		Building Fuel Oil (No. 2)	-	Annual gallons of Fuel Oil	Not applicable
		Building Wood	-	Annual cords of wood	Not applicable
Transportation	On-road	On-road (gasoline)	*1,888,851*	Annual gallons of gasoline	Proxy data, refer to methodology
		On-road (diesel)	*32,516*	Annual gallons of diesel	Proxy data, refer to methodology
	Waterborne Navigation	Waterborne Navigation	*153,174*	Annual gallons of gasoline	Proxy data, refer to methodology
	Aviation	Aviation	-	Annual gallons of jet fuel	Not applicable
	Off-road (tractors, ATVs, etc)	Off-road (gasoline)	*218,820*	Annual gallons of gasoline	Proxy data, refer to methodology
		Off-road (diesel)	-	Annual gallons of diesel	
Waste		Disposal of solid-waste	-	tonnes of MSW sent to	Not applicable
		Waste open-burning	10,170	# burn barrels	2019 EL
	Livestock	Livestock	12	Number of cattle (Bison)	Not applicable
Electricity	Residential Buildings	0	*12,373*	Annual MWh	Proxy data, refer to methodology
	Multifamily Buildings		*1,055*	Annual MWh	Proxy data, refer to methodology
	Commercial Buildings		*1,160*	Annual MWh	Proxy data, refer to methodology
	Industrial Buildings		-	Annual MWh	Not applicable
	On-road	Electric Vehicles	-	Annual MWh	Not applicable

Buildings

Summary of Major Emissions

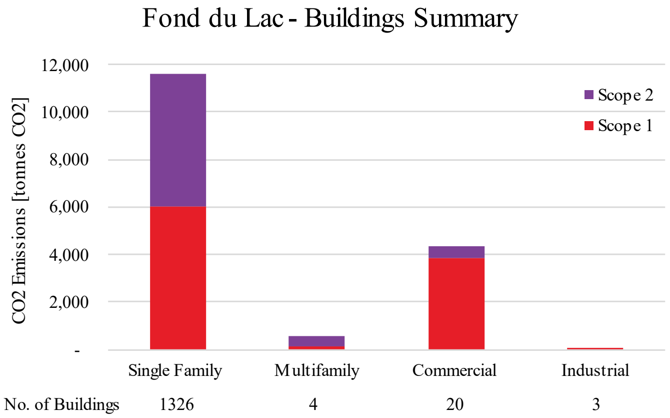


Figure 10: Fond du Lac Building Emissions Summary

When accounting for Scope 2 electricity emissions, single-family buildings have the largest GHG emissions. There is no fuel oil used for heating within Fond du Lac. Commercial buildings have lower-than-expected GHG emissions for 20 buildings, which is likely due to the solar panels that are used for some commercial buildings, particularly the Black Bear Casino. Some solar air systems and panel systems are also used for single-family buildings, though it is not enough to make a significant impact on GHG emissions.

Other commercial buildings include the Black Bear resort, the other casino (Fond du Luth casino), Fond du Lac Tribal center, human services, a health clinic, police station, Sawyer community center, Fond du Lac community college and dormitory, and a K-12 school.

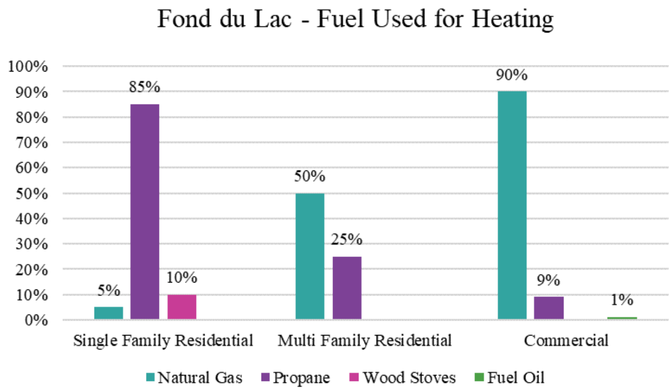


Figure 11: Fond du Lac Fuel Use By Building Type

Fond du Lac single-family buildings rely on propane for heating, whereas multifamily and commercial buildings primarily rely on natural gas. Additionally, multifamily buildings use propane and electricity for heating. There are also a small number of single-family homes that use wood stoves for heating, and even fewer use natural gas due to lack of access and service for most of the Reservation.

In order to calculate emissions related to electricity use, Arup used EPA's eGRID regions' emissions factors[30]. The MROW (Midwest Reliability Organization West (MROW) eGRID region encompasses Fond du Lac's electric utilities; Arup used these associated emissions factors from 2021.

Methodology for Proxy

The buildings included in this GHG accounting were limited to Band-owned buildings and residential homes that Band members reside in. Buildings were separated by building-types: residential single-family, residential multifamily, commercial, and industrial. For all buildings, the priority was to use utility data provided by the Band members. When this was not available, proxy data was used to estimate building energy use based on building typology, size, and location.

Residential Single-Family Methodology

Fond du Lac provided total gallons of propane sold in 2022 from the Fond Du Lac Propane Company, as well as how much propane was used by multifamily, commercial and industrial buildings. The difference between total gallons of propane sold and propane used for other building typologies was used to find total gallons of propane used for single-family houses. Propane usage was then converted to therms, and then into metric tons of CO_2 emissions.

For single-family homes, if utility data was not provided, the U.S. EIA database for Residential Energy Consumption Survey (RECS) was used for proxy. This data, administered by EIA, surveys a nationally representative sample of housing units. The data used for proxy was from 2020, which was the 15th RECS data survey collected from nearly 18,500 households.

Data from the single-family homes in Minnesota and Wisconsin were used as proxy for single-family homes within those states. Consumption data was used by fuel type: propane (gallons), natural gas (ccf) and electricity

---

[30] *EPA eGrid Emission Factors*. (2022, January). Retrieved January 5, 2024, from https://www.epa.gov/egrid

(kWh) per household. This data was scaled up by number of single-family homes within each Tribe in the consortia.

While this data provided at the state level did not include fuel oil data for single-family homes, the EIA survey did have averages for single-family homes in the Midwest. This was used for estimated annual household fuel oil use for single-family homes that relied on fuel oil for heating.

Understanding that some households within Tribes of the CPRG (Climate Pollution Reduction Grant) rely on wood-burning stoves for heating, the EIA survey from 2009 provides an estimate of MMBtu/year of wood burned per household. This was used to calculate cords/wood burned annually in households that relied on wood stoves for heating.

Finally, best approximation from the Band on percentage of single-family homes that use natural gas, propane, wood stoves, and fuel oil for heating is multiplied by proxy calculations for each fuel type, to account for the different fuel types used.

Residential Multifamily Methodology

Fond du Lac provided the total amount of natural gas used in therms from the 2015 NORESCO IGA document, which was then converted into metric tons of CO_2 emitted. Multifamily buildings only use natural gas for heating on this Reservation. Fond du Lac provided total gallons of propane sold in 2022 from the Fond Du Lac Propane Company, as well as how much propane was used by multifamily, commercial and industrial buildings.

Commercial Building Methodology

Fond du Lac provided the total amount of natural gas used in therms and propane use in gallons and therms from the 2015 NORESCO IGA document, which was then converted into metric tons of CO_2 emitted. Commercial buildings do not use fuel oil or wood for heating on this Reservation. Fond du Lac provided total gallons of propane sold in 2022 from the Fond Du Lac Propane Company, as well as how much propane was used by multifamily, commercial and industrial buildings.

Industrial Building Methodology

Fond du Lac provided the total amount of propane used in gallons and therms from the 2015 NORESCO IGA document, which was then converted into metric tons of CO_2 emitted. Industrial buildings do not use natural gas, fuel oil, or wood on this Reservation. Fond du Lac provided total gallons of propane sold in 2022 from the Fond Du Lac Propane Company, as well as how much propane was used by multifamily, commercial and industrial buildings.

Transportation

Summary of Major Emissions

The majority of transportation emissions occur from on-road passenger cars and vehicles. Without actual gasoline and diesel data from Fond du Lac, proxy data was calculated for on-road gasoline emissions using regional vehicle miles traveled (VMT) data and scaling it down using the Band's population data of 4,168 people.

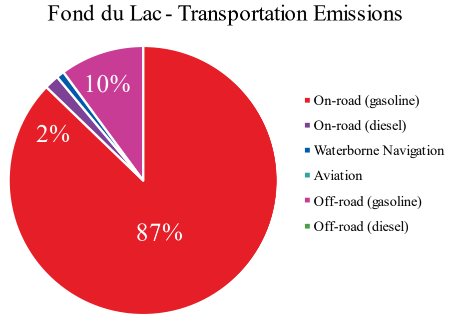


Figure 12: Fond du Lac Transportation Emissions

On-road (gasoline)	**86.7%**
On-road (diesel)	1.7%
Waterborne	0.9%
Aviation	0.0%
Off-road (gasoline)	10.6%
Off-road (diesel)	0.0%

For waterborne transportation, an estimate of 10% of population owns boats, and trips occur approximately once a week for 7-8 boatable months. Using Google maps, length of the St. Louis River along the reservation is approximately twenty-one miles; assuming it is typical for about a third of the river to be traveled for each trip, average boat trip distance is 7 miles. This information and estimates from the Band's leaders provides waterborne VMT and therefore informs proxy data calculations.

On-road diesel emissions occur from eight school buses used on the Reservation. These school buses have about 140 miles of daily trips, which is multiplied by 180 typical school days to get VMT for diesel, and therefore informs proxy data calculations.

Off-road gasoline proxy data uses the estimate that 70% of the Band's population owns an ATV.

Methodology for Proxy

There are a few methodologies for calculating GHG emissions associated with transportation for the Tribes in the CPRG. The predominant source of GHG emissions related to transportation within the Tribes is from single-occupancy vehicles. The sources included in the PCAP GHG inventory included transportation emissions from: on-road vehicles, waterborne navigation, and off-road vehicles. On-road vehicles included both on-road gasoline vehicles and on-road diesel vehicles. Off-road vehicles includes both off-road gasoline vehicles such as all-terrain vehicles (ATV's), and off-road diesel vehicles such as tractors.

In the initial request for information (RFI), Arup requested the number of gas, diesel, and EVs that were either passenger cars, light trucks, or heavy-duty vehicles. When Tribes were able to provide number of vehicles, Arup used these vehicles as well as proxy data based on the annual average VMT per driver data published at the state level from the Federal Highway Administration[31] data last published in 2019.

---

[31] *Highway Statistics 2019.* (2019). US DOT Federal Highway Administration. Retrieved February 24, 2024, from https://www.fhwa.dot.gov/policyinformation/statistics/2019/

Arup used DOE Average Fuel Economy[32] to calculate the gallons of fuel used to travel the annual average miles traveled per vehicle.

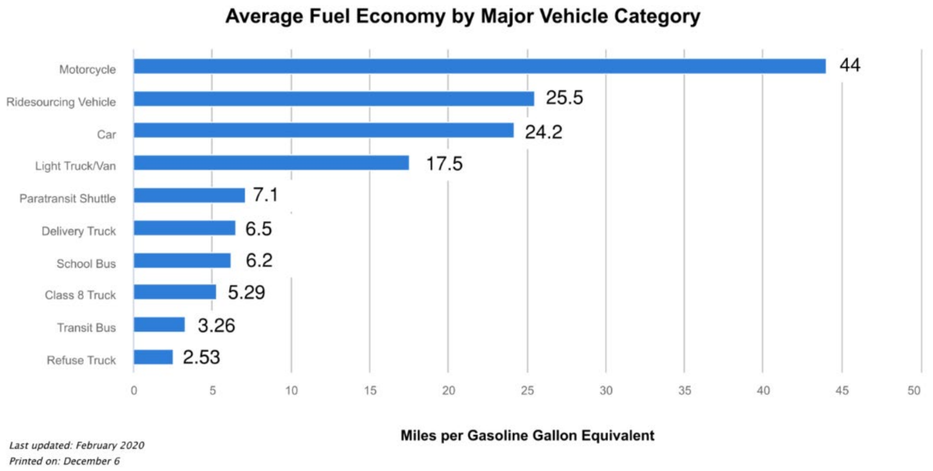


Figure 13: Average Fuel Economy by Vehicle

$$Annual\ Gallons\ of\ Diesel = \frac{[(\#\ heavy\ duty\ trucks) * (Annual\ VMT\ per\ driver)]}{6.5\ MPG}$$

In addition to the number of vehicles listed in the original RFI, Arup requested data on number of school buses, transit buses, tractors, and average daily distance traveled. When this data was available, the associated emissions were also calculated. School buses, transit buses, and tractors were all assumed to use diesel fuel.

$$Annual\ Gallons\ of\ Diesel = \frac{(\#\ of\ Vehicle)(Annual\ VMT)}{Vehicle\ MPG^{33}}$$

Because many Tribal members use all-terrain vehicles (ATV’s), Arup asked Tribes to estimate percentage of population that owned an ATV, and assumed 1,500 miles/year for those that ride ATV’s.

$$Annual\ Gallons\ of\ Gasoline = \frac{\left[Tribal\ population * (percent\ of\ population\ with\ an\ ATV) * \left(1{,}500\frac{miles}{year}\right)\right]}{20\ MPG}$$

If a Tribe did not initially provide the number and types of vehicles to be included in the inventory, Arup requested that the Tribes ascertain data from the local Tribal DMV, police or sheriff office, or office of the registrar on vehicles registered within each Tribe. This provides granular data on number of vehicles, average age of vehicle, and vehicle type (light truck, single passenger, EV, etc).

---

[32] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

[33] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

If this data was not attainable, the next methodology used to calculate transportation emissions included taking data from Tribal-owned gas stations on annual gallons of gasoline and diesel fuel sold. When this was available, the inventory includes these annual gallons of gasoline sold to calculate GHG emissions.

Without either the gallons of gasoline sold or vehicle registration data, Arup relied on vehicle-miles-traveled data from the annual VMT data published from Minnesota[34] and Wisconsin[35] Department of Transportation (DOT) at the county level. County population and VMT data was taken from the counties that encompass the Tribes. The annual VMT per county population was scaled down to the population of each Tribe.

Additionally, many Tribes have significant use of motorized boats. If available, data for gasoline sold at marinas was used to calculate emissions associated with boat travel. If monthly gasoline sold was available, this data was scaled to represent the boating season, typically early April through early November. If gasoline sold was not available, Arup asked the Tribes to estimate the percentage of their population with motorized boats, average boat trip distance, and number of boat trips per year.

$$\mathit{Annual\ gallons\ of\ gasoline} = \frac{[(\mathit{Tribal\ Population}) * (\mathit{Percentage\ of\ Tribal\ members\ with\ motorized\ boats}) * (\mathit{Average\ boat\ trip\ distance}) * (\mathit{Number\ of\ annual\ boat\ trips})]}{4\ \mathit{MPG}}$$

Waste

Summary of Major Emissions

While there are no landfills on the Reservation and wastewater is treated off Reservation by a third party, there is some open waste burning that contributes to Fond du Lac’s emissions.

Methodology for Proxy

In this GHG inventory for the PCAP, only Scope 1 emissions associated with waste were included in the inventory. This includes emissions associated with solid waste disposed in landfills *if the landfills are located within the Tribal boundary* for each Tribe in this CPRG. This also includes solid waste generated by the Tribe that is incinerated or burned in the open. This also includes Scope 1 emissions associated with wastewater treatment so long as that treatment is located within the Tribal boundary.

With limited data on the actual make-up of tribal MSW Arup assumed the U.S. EPA MSW Generation Make-up[36]. This gave assumptions for the fraction of solid waste that was food, garden waste, paper, wood, textiles, and metals.

---

[34] *Roadway Data*. (2022). Minnesota Department of Transportation. Retrieved February 24, 2024, from https://www.dot.state.mn.us/roadway/data/data-products.html#VMT

[35] *2021 Vehicle Miles of Travel (VMT) by County*. (2021). Wisconsin Department of Transportation. Retrieved February 24, 2024, from https://wisconsindot.gov/Documents/projects/data-plan/veh-miles/vmt2021-c.pdf

[36] *National Overview: Facts and Figures on Materials, Wastes and Recycling*. (2023, November 22). US EPA. Retrieved February 24, 2024, from https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

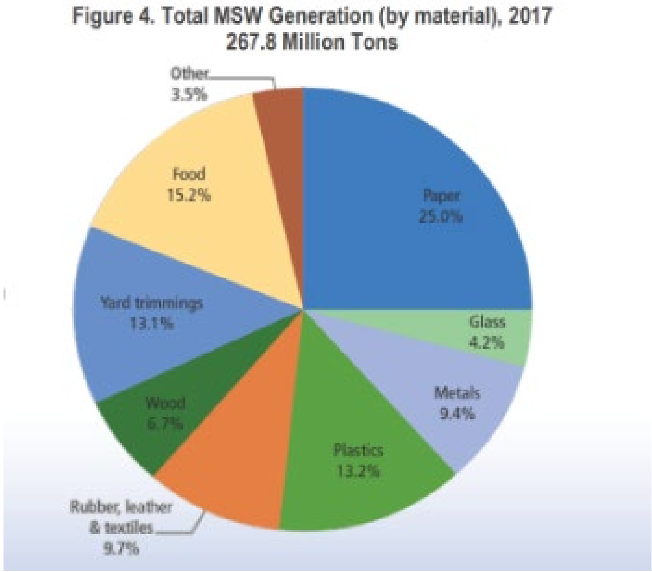


Figure 14: EPA MSW Make-Up

Waste Open Burning

Waste open burning is another method of municipal waste disposal that is still practiced within some of the Tribes in this CPRG. The same assumptions were made on the make-up of the MSW in order to calculate the emissions associated with open waste burning. The Tribes provided the number of burn barrels used annually. These burn barrels were assumed to be 55-gallon drums. The waste was assumed to be mixed waste – from either residential or commercial sources – and uncompacted, giving an approximate density of 275 lbs/cubic yard[37]. Using the EPA's default heat content ratio of 9.953 MMBtu/short ton of waste[38], Arup calculated associated emissions. The EPA's emissions factors for GHG Inventories includes emissions factors associated with MSW burning on a kg CO_2, g CH_4, and g N_2O on a MMBtu basis, which was converted to metric tons of CO_2e.

Fond du Lac is understood to use 10,170 barrel burns throughout the course of the year. Based on these assumptions, it is estimated that the total annual site emissions resulting from barrel burns is approximately 351 metric tons of CO_2, and a negligible amount of CH_4 and N_2O.

Processes for Improved Data Collection for Future Reporting

Future reporting will be improved as the data collection process continues. Many of the Tribes in the consortia of this CPRG application have requested data directly from third parties that have not yet provided data but are likely to be able to provide with more time ahead of the next inventory. This includes electric, gas, and propane utility data from utility companies, vehicle registration data from departments of motor vehicles, ridership numbers for public transportation, wastewater treatment plant data, gas station data on amounts of sold fuel, and data on livestock and emissions associated with agriculture.

---

[37] EPA Volume-to-Weight Conversion Factors

[38] Default Heat Content for Energy Conversions. (n.d.). US EPA. https://www.epa.gov/system/files/ documents/2022-10/Default%20Heat%20Content%20Ratios%20for%20Help%20and%20User%20Guide%20%281%29.pdf

B3. Grand Portage Band of Lake Superior Chippewa

Stakeholder Engagement

In order to accurately document the GHG emissions associated with Grand Portage, Arup initially sent a request for information (RFI) to the Tribe to better understand the sectors that make up Scope 1 and 2 emissions for the Tribe. After reviewing this initial information, Arup had a 1:1 meeting with members of the Grand Portage Tribe to ask further questions and ensure the extent of emissions for the initial PCAP inventory was captured correctly.

Boundary of Inclusion

The Grand Portage Band of Lake Superior Chippewa Reservation is located along the northern shore of Gichigami (Lake Superior) near the Canadian border. The homeland, named Gichi Onigaming, is in a rural area of Northern Minnesota, about thirty-five miles away from the closest U.S. town in Cook County, MN. The entire Grand Portage Reservation is about seventy-five square miles; most of the Reservation is land with about 1.23 square miles of water. This inventory includes all Scope 1 and 2 emissions.

The buildings included in this GHG accounting were limited to Tribal-owned buildings and residential homes that Tribal members reside in. The population used for this analysis include the 630 Tribal members. The primary emissions source for transportation is annual gallons sold from marinas and gas stations on the Reservation. This means that transportation emissions include not only Tribal-members, but any tourists or members of the larger community that purchase gasoline and diesel at the gas stations and marinas. Other transportation data including ATV use and school buses were calculated based on Tribal population use only.

Applicable Sectors

The sectors that make up the majority of GHG emissions for the Grand Portage Tribe are buildings and transportation.

Summary Across Sector

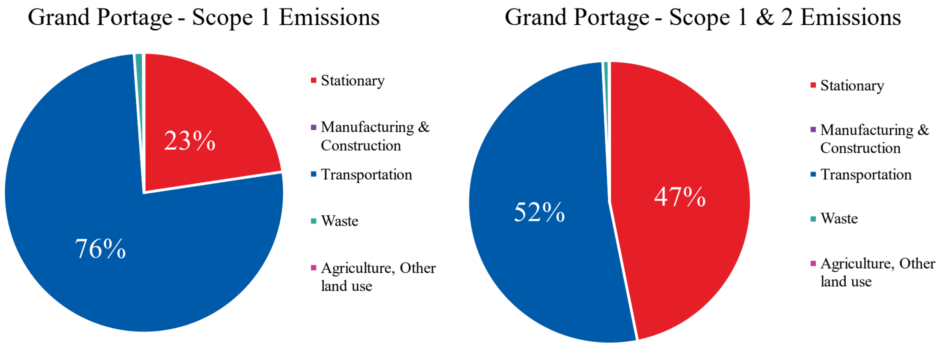


Figure 15: Grand Portage Summary of Emissions

Transportation has the largest GHG emissions even after accounting for Scope 2 stationary emissions.

Data Table (All Sectors)

Table 7: Grand Portage Summary Across All Sectors

Sector	Sub-sector	GHG Emissions source	Input Value	Unit	Source
Stationary Energy	Residential Single-family	Building Nat Gas	-	Annual therms of NG	Not applicable
		Building LP	*131,727*	Annual gallons of LP	Proxy data, refer to methodology
		5)	-	Annual gallons of Fuel Oil	Not applicable
		Building Wood	*30*	Annual cords of wood	Given number of homes, proxy
	Multifamily Residential	Building Nat Gas	-	Annual therms of NG	Not applicable
		Building LP	76,725	Annual gallons of LP	15% of overall propane usage
		Building Fuel Oil (Res No.	-	Annual gallons of Fuel Oil	Not applicable
	Commercial Buildings	Building Nat Gas	-	Annual therms of NG	Not applicable
		Building LP	300,875	Annual gallons of LP	Casino + comm. Center, +25% total
		Building Fuel Oil (No. 2)	-	Annual gallons of Fuel Oil	Not applicable
		Building Wood	-	Annual cords of wood	Not applicable
	Industrial Buildings	Building Nat Gas	-	Annual therms of NG	Not applicable
		Building LP	-	Annual gallons of LP	Not applicable
		Building Fuel Oil (No. 2)	-	Annual gallons of Fuel Oil	Not applicable
		Building Wood	-	Annual cords of wood	Not applicable
Transportation	On-road	On-road (gasoline)	1,075,670	Annual gallons of gasoline	Provided gasoline sold
		On-road (diesel)	12,194	Annual gallons of diesel	Provided school buses, route
	Waterborne Navigation	Waterborne Navigation	*42,667*	Annual gallons of gasoline	Provided gallons sold
	Aviation	Aviation	-	Annual gallons of jet fuel	Not applicable
	Off-road (tractors, ATVs, etc)	Off-road (gasoline)	*7,088*	Annual gallons of gasoline	Provided % of ATV owners, proxy
		Off-road (diesel)	-	Annual gallons of diesel	
Waste		Disposal of solid-waste	-	annually	
		Waste open-burning	1	Annual # burn barrels	Provided in RFI
	Livestock	Livestock	7	Number of cattle (Bison)	GP Bison herd
Electricity	Residential Buildings	0	*2,062*	Annual MWh	Proxy data, refer to methodology
	Multifamily Buildings		*7,911*	Annual MWh	Proxy data, refer to methodology
	Commercial Buildings		*3,248*	Annual MWh	Proxy data, refer to methodology
	Industrial Buildings		-	Annual MWh	Not applicable
	On-road	Electric Vehicles	-	Annual MWh	Not applicable

Buildings

Summary of Major Emissions

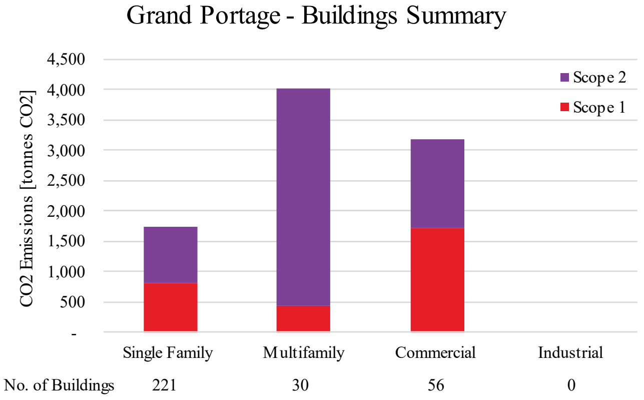


Figure 16: Grand Portage Buildings Emissions

Grand Portage does not have industrial buildings within its Reservation. Though single-family buildings have greater Scope 1 emissions, when accounting for Scope 2 electricity emissions, multifamily buildings have the largest GHG emissions. Commercial buildings also have considerable GHG emissions for both Scope 1 and Scope 2.

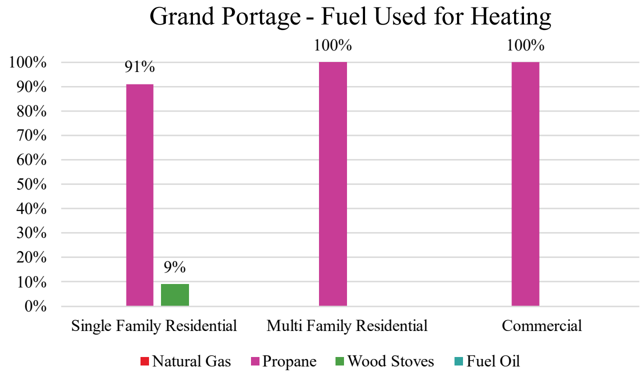


Figure 17: Grand Portage Fuel Use by Building Type

Buildings predominantly rely on liquid propane for heating in the winter. There are also a small number of single-family homes that use wood stoves for heating, and a small number that use electric baseboard heating.

The commercial buildings that emit the most emissions on the Reservation are the Casino and community center. Additional "commercial" building types within the Reservation include a clinic, school, museum, park service buildings, (3) business office buildings, (7) garages for commercial vehicles, Tribal government building, American Legion Building, and a non-operational sawmill.

In order to calculate emissions related to electricity use in the Tribes, Arup used EPA's eGRID regions' emissions factors[39]. The MROW eGRID region encompasses Grand Portage's electric utilities; Arup used these associated emissions factors from 2021.

Methodology for Proxy

Buildings were separated by building-types: residential single-family, residential multifamily, commercial, and industrial. For all buildings, first priority was to use utility data provided by the Tribal members. When this was not available, proxy data was used to estimate building energy use based on building typology, size, and location.

Residential Single-Family Methodology

For single-family homes, if utility data was not provided, the U.S. EIA database for Residential Energy Consumption Survey (RECS) was used for proxy. This data, administered by EIA, surveys a nationally representative sample of housing units. The data used for proxy was from 2020, which was the 15th RECS data survey collected from nearly 18,500 households.

Data from the single-family homes in Minnesota and Wisconsin were used as proxy for Tribal single-family homes within those states. Consumption data was used by fuel type: propane (gallons), natural gas (ccf) and electricity (kWh) per household. This data was scaled up by number of single-family homes within each Tribe.

Understanding that some households within Grand Portage rely on wood-burning stoves for heating, the EIA survey from 2009 provides an estimate of MMBtu/year of wood burned per household. This was used to calculate cords/wood burned annually in households that relied on wood stoves for heating.

Finally, best approximation from Tribes on percentage of single-family homes that use natural gas, propane, wood stoves, and fuel oil for heating is multiplied by proxy calculations for each fuel type, to account for the different fuel types used.

---

[39] *EPA eGrid Emission Factors*. (2022, January). Retrieved January 5, 2024, from https://www.epa.gov/egrid

Residential Multifamily Methodology

The Building Performance Database (BPD) was used as proxy data for multifamily buildings. This database is sponsored by the U.S. DOE Building Technologies Office, and was developed by the Lawrence Berkely National Laboratory. This database contains information for over one million commercial and residential buildings. Data was used for all multifamily buildings in Minnesota and Wisconsin. Due to the limited sample size for only Minnesota and Wisconsin, data was also used from Michigan, Iowa, and Illinois to get an upper-Midwest regional average. This database was referenced for EUI values for electricity consumption and natural gas consumption. These values were scaled up based on the assumed square footages of each multifamily building per Tribe.

For Grand Portage, this proxy data was used to calculate electricity use in multifamily buildings. However, Grand Portage was able to provide annual gallons of propane used in multifamily buildings on the Reservation. This data was used directly to calculate resulting emissions, rather than the proxy data for propane use.

The best approximation from Tribes on percentage of multifamily homes that use natural gas, propane, wood stoves, and fuel oil for heating is multiplied by proxy calculations for each fuel type, to account for the different fuel types used.

Commercial Building Methodology

EIA publishes Commercial Buildings Energy Consumption Survey (CBECS) results. The latest data available from this survey is from 2018, which was referenced for proxy data for commercial buildings. For electricity use in commercial buildings, electricity consumption and conditional energy intensity by census division was used. Census divisions referenced were East North Central (for Tribes located in Wisconsin) and West North Central (for Tribes located in Minnesota). Similarly, natural gas consumption and conditional energy intensity by census division was available for these two regions. This data was released on December 21st, 2022. Both the natural gas and electricity consumption data are available on a per square footage basis, so an estimate for average square footage per commercial basis was made to scale this data. This assumption is unique for each Tribe and requires Tribal input.

EIA CBECS data has refined energy use intensity data available per building type (i.e., education, food service, healthcare, lodging, mercantile, worship) that may be used once actual building types included in GHG inventory are refined.

This proxy data was used to calculate electricity use in commercial buildings; however, Grand Portage was able to provide annual gallons of propane used in commercial buildings. There was also a specific amount of propane used by the community center and casino – the highest users of propane on the Reservation.

The best approximation from Tribes on percentage of commercial buildings that use natural gas, propane, wood stoves, and fuel oil for heating is multiplied by proxy calculations for each fuel type, to account for the different fuel types used.

Transportation

Summary of Major Emissions

The vast majority of transportation emissions occur from on-road passenger cars and vehicles, which is calculated using gallons of gasoline sold at gas stations within Grand Portage.

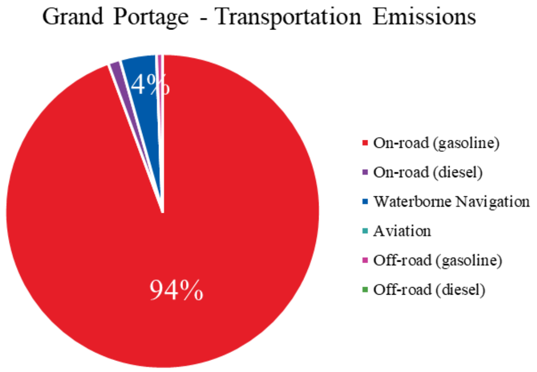


Figure 18: Grand Portage Transportation Emissions

Methodology for Proxy

There are a few methodologies for calculating GHG emissions associated with transportation for the Tribes. The predominant source of GHG emissions related to transportation within the tribes is from single-occupancy vehicles. The sources included in the PCAP GHG inventory included transportation emissions from: on-road vehicles, waterborne navigation, and off-road vehicles. On-road vehicles included both on-road gasoline vehicles and on-road diesel vehicles. Off-road vehicles includes both off-road gasoline vehicles such as all-terrain vehicles (ATV's), and off-road diesel vehicles such as tractors.

In the initial request for information (RFI), Arup requested the number of gas, diesel, and EVs that were either passenger cars, light trucks, or heavy-duty vehicles. When Tribes were able to provide number of vehicles, Arup used these vehicles as well as proxy data based on the annual average VMT per driver data published at the state level from the Federal Highway Administration[40] data last published in 2019.

Arup used DOE Average Fuel Economy[41] to calculate the gallons of fuel used to travel the annual average miles traveled per vehicle.

---

[40] *Highway Statistics 2019.* (2019). US DOT Federal Highway Administration. Retrieved February 24, 2024, from https://www.fhwa.dot.gov/policyinformation/statistics/2019/

[41] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

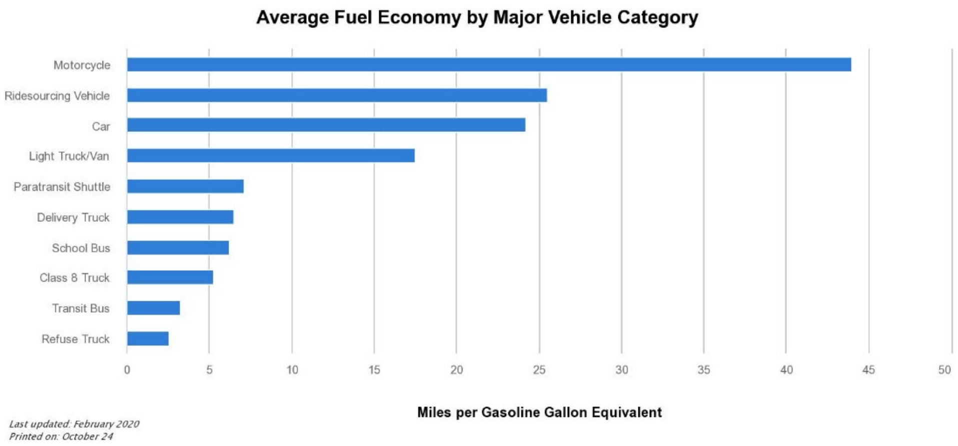


Figure 19: Average Fuel Economy by Vehicle

In addition to the number of vehicles listed in the original RFI, Arup requested data on number of school buses, transit buses, tractors, and average daily distance traveled. When this data was available, the associated emissions were also calculated. School buses, transit buses, and tractors were all assumed to use diesel fuel.

$$12{,}194\ \mathit{Annual\ Gallons\ of\ Diesel} = \frac{(3\ \mathit{school\ buses})(180\ \mathit{days} * 140\ \mathit{miles/day})}{6.2\ \mathit{MPG}^{42}}$$

Because many Tribal members use all-terrain vehicles (ATV's), Arup asked Grand Portage to estimate percentage of population that owned an ATV, and assumed 1,500 miles/year for those that ride ATV's.

$$7{,}088\ \mathit{Annual\ Gallons\ of\ Gasoline} = \frac{\left[630\ \mathit{people} * (15\%) * \left(1{,}500\frac{\mathit{miles}}{\mathit{year}}\right)\right]}{20\ \mathit{MPG}}$$

If a Tribe did not initially provide the number and types of vehicles to be included in the inventory, Arup requested that the Tribes ascertain data from the local Tribal DMV, police or sheriff office, or office of the registrar on vehicles registered within each Tribe. This provides granular data on number of vehicles, average age of vehicle, and vehicle type (light truck, single passenger, EV, etc).

If this data was not attainable, the next methodology used to calculate transportation emissions included taking data from Tribal-owned gas stations on annual gallons of gasoline and diesel fuel sold. When this was available, the inventory includes these annual gallons of gasoline sold to calculate GHG emissions. Grand Portage provided gallons of gasoline sold on the Reservation (1,075,670 gallons), which Arup used directly to calculate GHG emissions.

Additionally, many Tribes have significant use of motorized boats. If available, data for gasoline sold at marinas was used to calculate emissions associated with boat travel. If monthly gasoline sold was available, this data was scaled to represent the boating season, typically early April through early November. If gasoline sold was not available, Arup asked the Tribes to estimate the percentage of their population with motorized boats, average boat trip distance, and number of boat trips per year.

Grand Portage was able to provide the gasoline sold at their marina; given 32,000 gallons of gasoline sold at the marina in year-to-date numbers, Arup calculated an annual sale of 42,667 gallons of gasoline.

---

[42] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

Waste

Summary of Major Emissions

Waste generates a relatively minor amount of overall GHG emissions when compared to buildings or transportation. The primary source of GHG emissions in the waste sector for Grand Portage is due to wastewater treatment. Grand Portage treats their own wastewater, and many single-family homes have their own septic systems. Grand Portage does not have a landfill located on their Reservation, and they estimate only one burn barrel used annually.

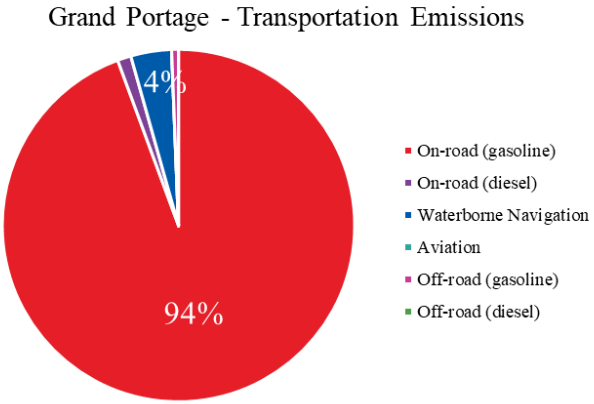


Figure 20: Grand Portage Waste GHG Emissions

Methodology for Proxy

In this GHG inventory for the PCAP, only Scope 1 emissions associated with waste were included in the inventory. This includes emissions associated with solid waste disposed in landfills *if the landfills are located within the Tribal boundary.* This also includes solid waste generated by the Tribe that is incinerated or burned in the open. This also includes Scope 1 emissions associated with wastewater treatment so long as that treatment is located within the Tribal boundary.

With limited data on the actual make-up of tribal MSW, Arup assumed the U.S. EPA MSW Generation Make-up[43]. This gave assumptions for the fraction of solid waste that was food, garden waste, paper, wood, textiles, and metals.

---

[43] *National Overview: Facts and Figures on Materials, Wastes and Recycling*. (2023, November 22). US EPA. Retrieved February 24, 2024, from https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

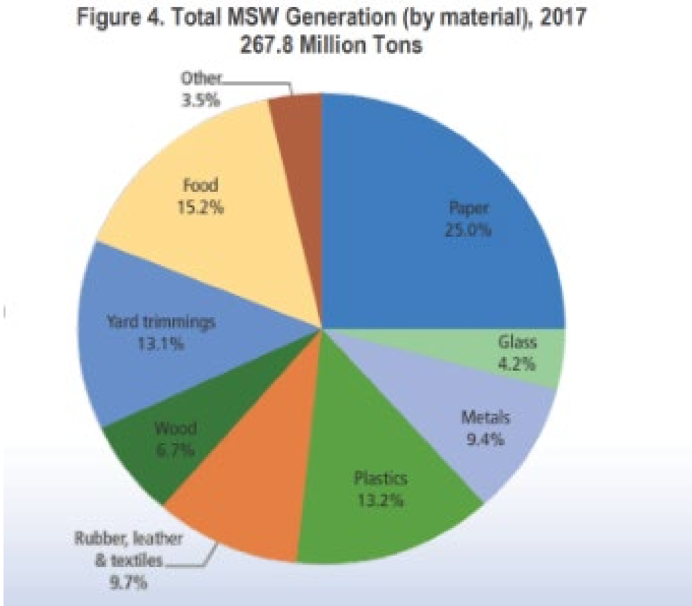


Figure 21: EPA MSW Make-Up

Waste Open Burning

Waste open burning is another method of municipal waste disposal that is still practiced within some of the Tribes. The same assumptions were made on the make-up of the MSW in order to calculate the emissions associated with open waste burning. The Tribes provided the number of burn barrels used annually. These burn barrels were assumed to be 55-gallon drums. The waste was assumed to be mixed waste – from either residential or commercial sources – and uncompacted, giving an approximate density of 275 lbs/cubic yard[44]. Using the EPA's default heat content ratio of 9.953 MMBtu/short ton of waste[45], Arup calculated associated emissions. The EPA's emissions factors for GHG Inventories includes emissions factors associated with MSW burning on a kg CO_2, g CH_4, and g N_2O on a MMBtu basis, which was converted to metric tons of CO_2e.

Wastewater

There are both CH_4 and N_2O emissions associated with wastewater treatment. In order to calculate the CH_4 emissions associated with wastewater treatment, Arup assumed 85 g/person/day[46] for Biochemical Oxygen Demand (BOD), in line with the United States default values per IPCC guidance on wastewater treatment and discharge. Arup assumed no additional industrial wastewater flowing to the Tribal sewers. Methane correction factors vary depending on whether the wastewater treatment system is an untreated system, centralized aerobic, anaerobic, or other septic system. For this initial inventory, the Methane Correction Factor, 0.3[47], corresponds with a centralized aerobic wastewater treatment system. Using these factors, Arup calculated the CH_4 emissions associated with the Tribal population.

To calculate N_2O emissions associated with wastewater treatment, Arup used default values for protein consumed as a fraction of protein supply, 0.80, and assumed the same centralized, aerobic treatment plant[48].

---

[44] EPA Volume-to-Weight Conversion Factors

[45] Default Heat Content for Energy Conversions. (n.d.). US EPA. https://www.epa.gov/system/files/ documents/2022-10/Default%20Heat%20Content%20Ratios%20for%20Help%20and%20User%20Guide%20%281%29.pdf

[46] IPCC - Table 6.4

[47] IPCC - Table 6.3

[48] IPCC - Table 6.8A, 6.10A

Using these values, as well as the U.S. annual protein supply per capita, 117 grams of protein/day[49], the N_2O emissions were calculated on a per person basis. These values were multiplied by the Tribal population that were being served by the wastewater treatment plant.

Livestock

Summary of Major Emissions

Grand Portage has seven bison on their Reservation; these bison contribute to relatively minor emissions.

Methodology for Proxy

Livestock production emits both CH_4 and N_2O emissions through manure management, and additional CH_4 emissions through enteric fermentation. The amount of CH_4 released via enteric fermentation is dependent on the number of animals, type of animals, and type and amount of feed consumed. Using default values for livestock from the IPCC Enteric Fermentation Emission Factors and IPCC manure management methane emissions factors for cattle, swine, and buffalo, Arup calculated associated emissions.

Processes for Improved Data Collection for Future Reporting

Future reporting will be improved as the data collection process continues. Many of the Tribes have requested data directly from third parties that have not yet provided data but are likely to be able to provide with more time ahead of the next inventory. This includes electric, gas, and propane utility data from utility companies, vehicle registration data from departments of motor vehicles, ridership numbers for public transportation, wastewater treatment plant data, gas station data on amounts of sold fuel, and data on livestock and emissions associated with agriculture.

B.4 Ho-Chunk Nation of Wisconsin GHG Inventory

Stakeholder Engagement

To accurately document the GHG emissions associated with Ho-Chunk Nation, Arup initially sent a request for information (RFI) to the Tribe to better understand the sectors that make up Scope 1 and 2 emissions for the Tribe. After reviewing this initial information, Arup had a 1:1 meeting with members of Ho-Chunk Nation to ask further questions and ensure the extent of emissions for the initial PCAP inventory was captured correctly.

Boundary of Inclusion

Ho-Chunk Nation does not have designated Reservation, but the Tribe owns land in Wisconsin and its membership is concentrated in Wisconsin. However, the Tribe has members living in neighboring Minnesota and indeed across the continental United States. Based on our conversations with representatives of the Ho-Chunk Nation, we collectively decided to concentrate our focus on the Wisconsin counties with the highest concentration of Tribal membership and Tribal-owned facilities: Jackson, Wood, La Crosse, Monroe, Juneau, Sauk, Shawano, and Dane. The characteristics of these Tribal membership from these communities would be assumed to be representative of the Nation as whole. Only Tribal-owned and Tribe-member buildings are included in this analysis. For transportation, all fuel sales at Tribal-owned fuel stations are included in the analysis. For wastewater, emissions from all Tribal-owned facilities are included in this analysis. These wastewater emissions include non-Tribal guests at Tribal-owned gaming and lodging facilities.

---

[49] U.S. Protein Supply

Applicable Sectors

Most of the GHG emissions produced by Ho-Chunk Nation comes from the Buildings and Transportation sectors.

1.5.3 Summary Across Sector

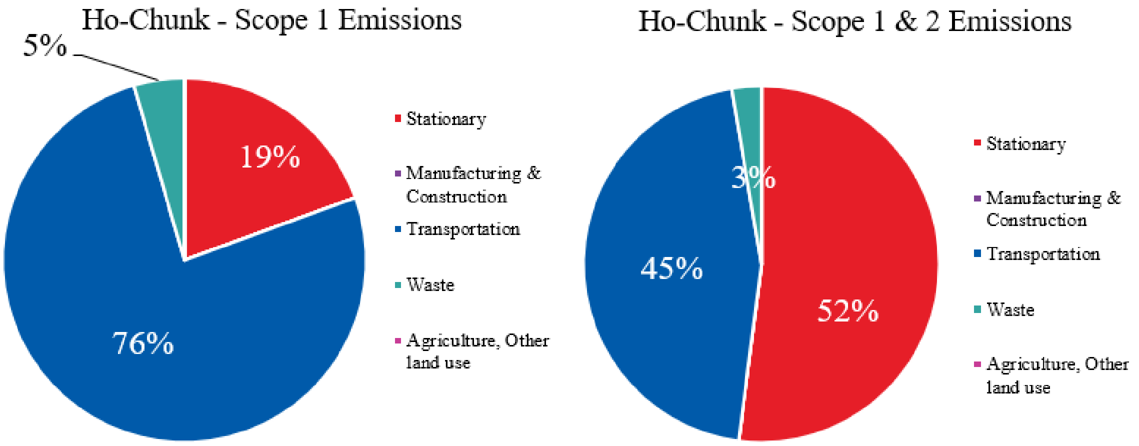


Figure 22: Ho-Chunk Summary of Emissions

The majority of Scope 1 emissions come from transportation, but when considering Scope 1 and 2 emissions, Stationary Energy Use (particularly electricity from commercial buildings), becomes the majority of emissions.

Data Table (All Sectors)

Table 8: Ho-Chunk Summary Across All Sectors

Sector	Sub-sector	GHG Emissions source	Input Value	Unit	Source
Stationary Energy	Residential Single-family	Building Nat Gas	*185,328*	Annual therms of NG	Proxy data, refer to methodology
		Building LP	*51,106*	Annual gallons of LP	Proxy data, refer to methodology
		Building Fuel Oil (Res No. 5)	*5,046*	Annual gallons of Fuel Oil	Proxy data, refer to methodology
		Building Wood	*527*	Annual cords of wood	Proxy data, refer to methodology
	Multifamily Residential	Building Nat Gas	*111,000*	Annual therms of NG	Proxy data, refer to methodology
		Building LP	-	Annual gallons of LP	This fuel understood to not be used
		Building Fuel Oil (Res No. 5)	-	Annual gallons of Fuel Oil	This fuel understood to not be used
	Commercial Buildings	Building Nat Gas	*1,344,365*	Annual therms of NG	Proxy data, refer to methodology
		Building LP	33,132	Annual gallons of LP	This fuel understood to not be used
		Building Fuel Oil (No. 2)	-	Annual gallons of Fuel Oil	This fuel understood to not be used
		Building Wood	-	Annual cords of wood	This fuel understood to not be used
	Industrial Buildings	Building Nat Gas	-	Annual therms of NG	Not applicable
		Building LP	-	Annual gallons of LP	Not applicable
		Building Fuel Oil (No. 2)	-	Annual gallons of Fuel Oil	Not applicable
		Building Wood	-	Annual cords of wood	Not applicable
Transportation	On-road	On-road (gasoline)	2,229,768	Annual gallons of gasoline	Total fuel sales data
		On-road (diesel)	95,402	Annual gallons of diesel	Total fuel sales data
	Waterborne Navigation	Waterborne Navigation	*11,561*	Annual gallons of gasoline	Proxy data, refer to methodology
	Aviation	Aviation	-	Annual gallons of jet fuel	This fuel understood to not be used
	Off-road (tractors, ATVs, etc)	Off-road (gasoline)	*1,732,146*	Annual gallons of gasoline	Estimated based on fuel sales data
		Off-road (diesel)	*312,958*	Annual gallons of diesel	Estimated based on fuel sales data
Waste		Disposal of solid-waste	-	tonnes of MSW sent to landfill	No landfill without boundary
		Waste open-burning	884	Annual # burn barrels	Estimated based on RFI response
	Aerobic	Wastewater generated	10,632	Population served	Estimated based on RFI response
Agriculture, Other land use	Livestock	Livestock	-	Number of cattle (Bison)	Not applicable
Electricity	Residential Buildings		*2,960*	Annual MWh	Proxy data, refer to methodology
	Multifamily Buildings		*1,582*	Annual MWh	Proxy data, refer to methodology
	Commercial Buildings		44,926	Annual MWh	Estimated based on aggregate data
	Industrial Buildings		-	Annual MWh	Not applicable
	On-road	Electric Vehicles	-	Annual MWh	Not applicable

Buildings

Summary of Major Emissions

Ho-Chunk Nation does not have industrial buildings within its membership. The majority of emissions in the building sector come from commercial buildings.

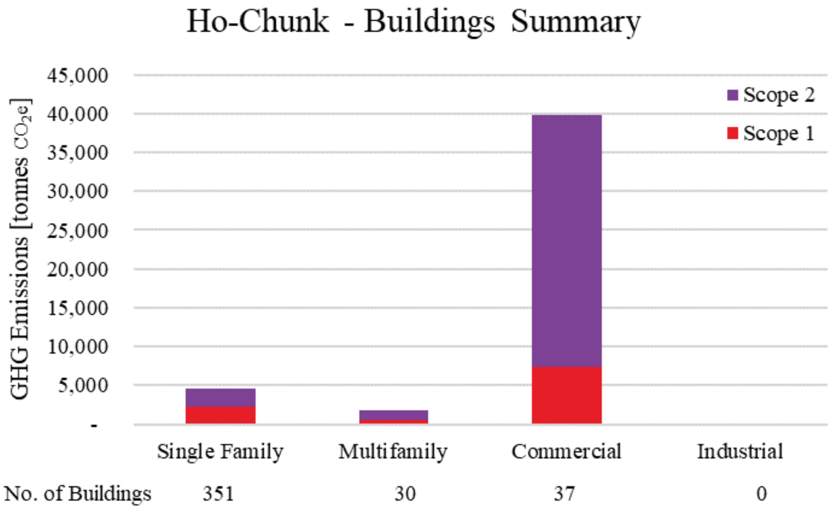


Figure 23: Ho-Chunk Buildings Summary

There are thirty-seven commercial buildings included in the inventory. Thirty-one buildings and their baseline electricity, natural gas, and propane use (if available) come from an Energy Efficiency and Conservation Block Grant report in January 2011 provided by Ho-Chunk Nation. Tribal Commercial building types include office, education, healthcare, warehouse/storage, courthouse, retail, and recreation/community center.

The other six buildings represent the casino facilities, which make up the large majority of commercial building energy use. Ho-Chunk Nation provided prorated electricity and natural gas use data for the Ho-Chunk Gaming location in Wisconsin Dells (the biggest gaming facility). Arup scaled up the data to be representative of one year of energy use and averaged the three years of data to estimate natural gas and electricity use for the Inventory. For the five casinos Arup did not have data for, each facility’s square footage was measured in Google maps, then used to scale the provided energy use data from Wisconsin Dells to the other Ho-Chunk Gaming locations.

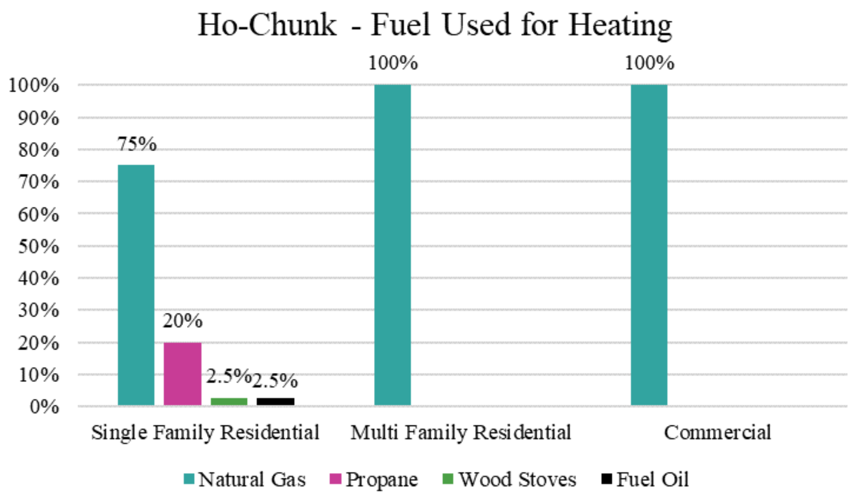


Figure 24: Ho-Chunk Fuel Use by Building Type

Buildings predominantly rely on natural gas for heating in the winter. There are also a small number of single-family homes that use wood stoves for heating, and a small number that use electric resistance heating.

In order to calculate emissions related to electricity use in the Tribes, Arup used EPA's eGRID regions' emissions factors [50]. The MROE eGRID region encompasses Ho-Chunk's electric utilities; Arup used these associated emissions factors from 2021.

Methodology for Proxy

The buildings included in this GHG accounting were limited to Tribal-owned buildings and residential homes that Tribal members reside in. Buildings were separated by building-types: residential single-family, residential multifamily, commercial, and industrial. For all buildings, the first priority was to use utility data provided by the Tribal members. When this was not available, proxy data was used to estimate building energy use based on building typology, size, and location.

Residential Single-Family Methodology

For single-family homes, if utility data was not provided, the U.S. EIA database for Residential Energy Consumption Survey (RECS) was used for proxy. This data, administered by EIA, surveys a nationally representative sample of housing units. The data used for proxy was from 2020, which was the 15th RECS data survey collected from nearly 18,500 households.

Data from the single-family homes in Minnesota and Wisconsin were used as proxy for Tribal single-family homes within those states. Consumption data was used by fuel type: propane (gallons), natural gas (ccf) and electricity (kWh) per household. This data was scaled up by number of single-family homes within each Tribe.

While this data provided at the state level did not include fuel oil data for single-family homes, the EIA survey did have averages for single-family homes in the Midwest. This was used for estimated annual household fuel oil use for single-family homes that relied on fuel oil for heating.

Understanding that some households within Tribes rely on wood-burning stoves for heating, the EIA survey from 2009 provides an estimate of MMBtu/year (millions of British thermal units) of wood burned per

---

[50] *EPA eGrid Emission Factors*. (2022, January). Retrieved January 5, 2024, from https://www.epa.gov/egrid

household. This was used to calculate cords/wood burned annually in households that relied on wood stoves for heating.

Residential Multifamily Methodology

The Building Performance Database (BPD) was used as proxy data for multifamily buildings. This database is sponsored by the U.S. DOE Technologies Office, and was developed by the Lawrence Berkely National Laboratory. This database contains information for over one million commercial and residential buildings. Data was used for all multifamily buildings in Minnesota and Wisconsin. This databased was referenced for EUI values for electricity consumption and natural gas consumption. These values were scaled up based on the assumed square footages of each multifamily building per Tribe.

Commercial Building Methodology

EIA publishes Commercial Buildings Energy Consumption Survey (CBECS) results. The latest data available from this survey is from 2018, which was referenced for proxy data for commercial buildings. For electricity use in commercial buildings, electricity consumption and conditional energy intensity by census division was used. Census divisions referenced were East North Central (for Tribes located in Wisconsin) and West North Central (for Tribes located in Minnesota). Similarly, natural gas consumption and conditional energy intensity by census division was available for these two regions. This data was released on December 21st, 2022. Both the natural gas and electricity consumption data are available on a per square footage basis, so an estimate for average square footage per commercial basis was made to scale this data. This assumption is unique for each Tribe and requires Tribal input.

EIA CBECS data has refined energy use intensity data available per building type (i.e., education, food service, healthcare, lodging, mercantile, worship) that may be used once actual building types included in GHG inventory are refined.

Transportation

Summary of Major Emissions

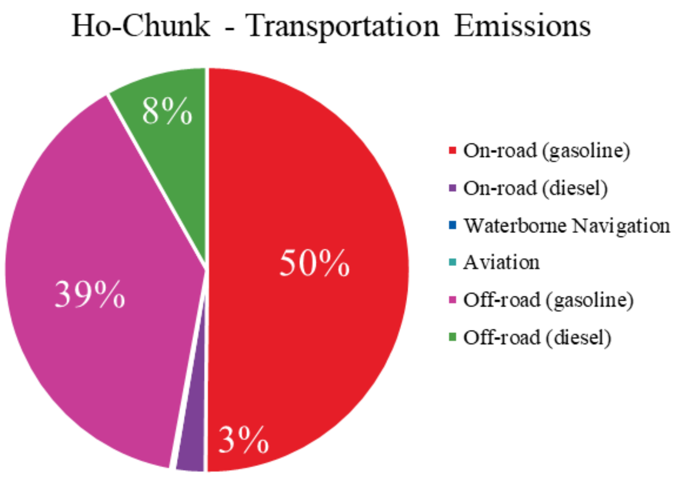


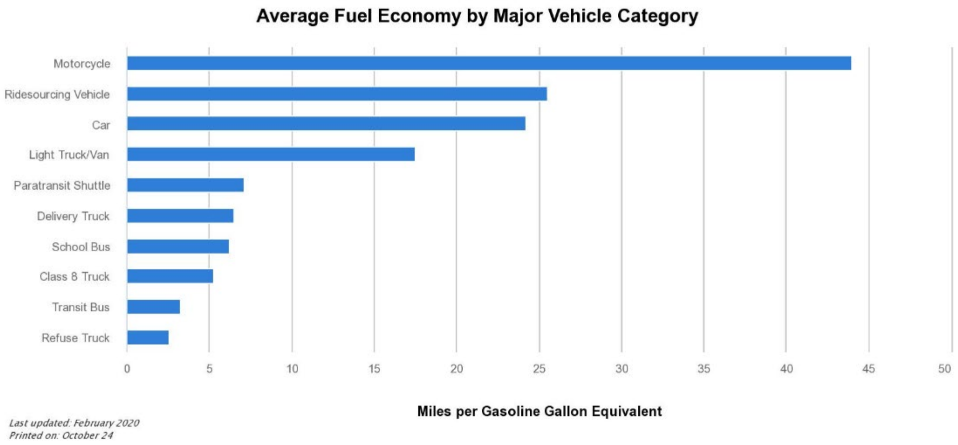
Figure 25: Ho-Chunk Transportation Emissions

Methodology for Proxy

There are a few methodologies for calculating GHG emissions associated with transportation for the Tribes. The predominant source of GHG emissions related to transportation within the tribes is from single-occupancy vehicles. The sources included in the PCAP GHG inventory included transportation emissions from: on-road vehicles, waterborne navigation, and off-road vehicles. On-road vehicles included both on-road gasoline vehicles and on-road diesel vehicles. Off-road vehicles includes both off-road gasoline vehicles such as all-terrain vehicles (ATV's), and off-road diesel vehicles such as tractors.

In the initial request for information (RFI), Arup requested the number of gas, diesel, and EVs that were either passenger cars, light trucks, or heavy-duty vehicles. When Tribes were able to provide number of vehicles, Arup used these vehicles as well as proxy data based on the annual average VMT per driver data published at the state level from the Federal Highway Administration[51] data last published in 2019.

Arup used DOE Average Fuel Economy[52] to calculate the gallons of fuel used to travel the annual average miles traveled per vehicle.



Last updated: February 2020
Printed on: October 24

Figure 26: Average Fuel Economy by Vehicle

$$\begin{aligned} \mathit{Annual\ Gallons\ of\ Gasoline} &= \frac{[(\#\ passenger\ cars) * (Annual\ VMT\ per\ driver)]}{24.2\ MPG} \\ &+ \frac{[[(\#\ light\ trucks) * (Annual\ VMT\ per\ driver)]]}{17.5\ MPG} \\ &+ \frac{[(\#\ heavy\ duty\ trucks) * (Annual\ VMT\ per\ driver)]}{6.5\ MPG} \end{aligned}$$

$$\mathit{Annual\ Gallons\ of\ Diesel} = \frac{[(\#\ heavy\ duty\ trucks) * (Annual\ VMT\ per\ driver)]}{6.5\ MPG}$$

In addition to the number of vehicles listed in the original RFI, Arup requested data on number of school buses, transit buses, tractors, and average daily distance traveled. When this data was available, the associated emissions were also calculated. School buses, transit buses, and tractors were all assumed to use diesel fuel.

---

[51] *Highway Statistics 2019.* (2019). US DOT Federal Highway Administration. Retrieved February 24, 2024, from https://www.fhwa.dot.gov/policyinformation/statistics/2019/

[52] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

$$Annual\ Gallons\ of\ Diesel = \frac{(\#\ of\ Vehicle)(Annual\ VMT)}{Vehicle\ MPG^{53}}$$

Because many Tribal members use all-terrain vehicles (ATV's), Arup asked Tribes to estimate percentage of population that owned an ATV, and assumed 1,500 miles/year for those that ride ATV's.

$$Annual\ Gallons\ of\ Gasoline = \frac{\left[Tribal\ population * (percent\ of\ population\ with\ an\ ATV) * \left(1{,}500\frac{miles}{year}\right)\right]}{20\ MPG}$$

If a Tribe did not initially provide the number and types of vehicles to be included in the inventory, Arup requested that the Tribes ascertain data from the local Tribal DMV, police or sheriff office, or office of the registrar on vehicles registered within each Tribe. This provides granular data on number of vehicles, average age of vehicle, and vehicle type (light truck, single passenger, EV, etc).

If this data was not attainable, the next methodology used to calculate transportation emissions included taking data from Tribal-owned gas stations on annual gallons of gasoline and diesel fuel sold. When this was available, the inventory includes these annual gallons of gasoline sold to calculate GHG emissions.

Without either the gallons of gasoline sold or vehicle registration data, Arup relied on data from the annual VMT data published from Minnesota[54] and Wisconsin[55] Department of Transportation (DOT) at the county level. County population and VMT data was taken from the counties that encompass the Tribes. The annual VMT per county population was scaled down to the population of each Tribe.

Additionally, many Tribes have significant use of motorized boats. If available, data for gasoline sold at marinas was used to calculate emissions associated with boat travel. If monthly gasoline sold was available, this data was scaled to represent the boating season, typically early April through early November. If gasoline sold was not available, Arup asked the Tribes to estimate the percentage of their population with motorized boats, average boat trip distance, and number of boat trips per year.

$$Annual\ gallons\ of\ gasoline = \frac{[(Tribal\ Population)*(Percentage\ of\ Tribal\ members\ with\ motorized\ boats)*(Average\ boat\ trip\ distance)*(Number\ of\ annual\ boat\ trips)]}{4\ MPG}$$

For marine emissions Arup assumed that 10 percent of Ho-Chunk residents make boat trips and that the average distance of each boat trip is seven miles and residents make one boat trip per month. Based on these assumptions, annual marine fuel consumption is estimated to be 11,560 gallons of gasoline and annual site emission from marine fuel consumption is estimated to be 102 metric tons of CO_2e.

---

[53] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

[54] *Roadway Data*. (2022). Minnesota Department of Transportation. Retrieved February 24, 2024, from https://www.dot.state.mn.us/roadway/data/data-products.html#VMT

[55] *2021 Vehicle Miles of Travel (VMT) by County*. (2021). Wisconsin Department of Transportation. Retrieved February 24, 2024, from https://wisconsindot.gov/Documents/projects/data-plan/veh-miles/vmt2021-c.pdf

Waste

Summary of Major Emissions

Ho-Chunk does not have landfill within the assumed boundary. There are single-family homes on septic systems, though the associated emissions are not calculated here.

There are reported 884 burn barrels used annually for Ho-Chunk, and those associated emissions are included in this inventory, and represent the largest portion of CO_2 emissions.

Wastewater is treated within the assumed boundary, and emissions associated with Aerobic treatment are included in this inventory. There are single-family homes on septic systems, though the associated emissions are not calculated here.

Methodology for Proxy

In this GHG inventory for the PCAP, only Scope 1 emissions associated with waste were included in the inventory. This includes emissions associated with solid waste disposed in landfills *if the landfills are located within the Tribal boundary.* This also includes solid waste generated by the Tribe that is incinerated or burned in the open. This also includes Scope 1 emissions associated with wastewater treatment so long as that treatment is located within the Tribal boundary.

With limited data on the actual make-up of tribal MSW, Arup assumed the U.S. EPA MSW Generation Make-up[56]. This gave assumptions for the fraction of solid waste that was food, garden waste, paper, wood, textiles, and metals.

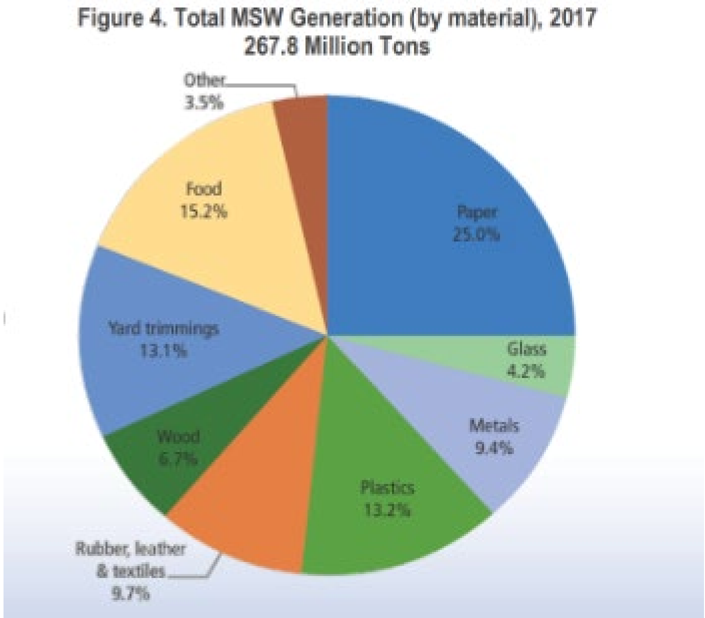


Figure 27: EPW MSW Make-Up

Waste Open Burning

Waste open burning is another method of municipal waste disposal that is still practiced within some of the Tribes. The same assumptions were made on the make-up of the MSW in order to calculate the emissions

---

[56] *National Overview: Facts and Figures on Materials, Wastes and Recycling*. (2023, November 22). US EPA. Retrieved February 24, 2024, from https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

associated with open waste burning. The Tribes provided the number of burn barrels used annually. These burn barrels were assumed to be 55-gallon drums. The waste was assumed to be mixed waste – from either residential or commercial sources – and uncompacted, giving an approximate density of 275 lbs/cubic yard[57]. Using the EPA's default heat content ratio of 9.953 MMBtu/short ton of waste[58], Arup calculated associated emissions. The EPA's emissions factors for GHG Inventories includes emissions factors associated with MSW burning on a kg CO_2, g CH_4, and g N_2O on a MMBtu basis, which was converted to metric tons of CO_2e.

Ho-Chunk Nation is understood to use seventeen burn barrels throughout the course of the year. It was assumed that the contents of these barrels are burned once per week, or 884 total barrel burns per year. Based on these assumptions, it is estimated that the total annual site emissions resulting from barrel burns is approximately thirty metric tons of CO_2e, and negligible amount of CH_4 and N_2O.

Wastewater

There are both CH_4 and N_2O emissions associated with wastewater treatment. To calculate the CH_4 emissions associated with wastewater treatment, Arup assumed 85 g/person/day[59] for Biochemical Oxygen Demand (BOD), in line with the United States default values per IPCC guidance on wastewater treatment and discharge. Arup assumed no additional industrial wastewater flowing to the Tribal sewers. Methane correction factors vary depending on whether the wastewater treatment system is an untreated system, centralized aerobic, anaerobic, or other septic system. For this initial inventory, the Methane Correction Factor, 0.3[60], corresponds with a centralized aerobic wastewater treatment system. Using these factors, Arup calculated the CH_4 emissions associated with the Tribal population.

To calculate N_2O emissions associated with wastewater treatment, Arup used default values for protein consumed as a fraction of protein supply, 0.80, and assumed the same centralized, aerobic treatment plant[61]. Using these values, as well as the U.S. annual protein supply per capita, 117 grams of protein/day[62], the N_2O emissions were calculated on a per person basis. These values were multiplied by the Tribal population that were being served by the wastewater treatment plant.

It is understood that Ho-Chunk Nation's wastewater treatment facilities serve 10,632 persons per year (including visitors to casinos and other commercial buildings). Based on this understanding, Arup estimates the annual site emissions from this wastewater treatment to be 59.3 metric tons of CH_4 and 2.6 metric tons of N_2O.

Processes for Improved Data Collection for Future Reporting

Future reporting will be improved as the data collection process continues. Many of the Tribes have requested data directly from third parties that have not yet provided data but are likely to be able to provide with more time ahead of the next inventory. This includes electric, gas, and propane utility data from utility companies, vehicle registration data from departments of motor vehicles, ridership numbers for public transportation, wastewater treatment plant data, gas station data on amounts of sold fuel, and data on livestock and emissions associated with agriculture.

---

[57] EPA Volume-to-Weight Conversion Factors

[58] Default Heat Content for Energy Conversions. (n.d.). US EPA. https://www.epa.gov/system/files/ documents/2022-10/Default%20Heat%20Content%20Ratios%20for%20Help%20and%20User%20Guide%20%281%29.pdf

[59] IPCC - Table 6.4

[60] IPCC - Table 6.3

[61] IPCC - Table 6.8A, 6.10A

[62] U.S. Protein Supply

B.5 Lac Courte Oreilles Band of Lake Superior Chippewa Indians of Wisconsin GHG Inventory

Stakeholder Engagement

In order to accurately document the GHG emissions associated with Lac Courte Oreilles, Arup initially sent a request for information (RFI) to the Tribe to better understand the sectors that make up Scope 1 and 2 emissions for the Tribe. After reviewing this initial information, Arup had a 1:1 meeting with a member of the Lac Courte Oreilles Tribe to ask further questions and ensure the extent of emissions for the initial PCAP inventory was captured correctly.

Boundary of Inclusion

The Lac Courte Oreilles Reservation is located in the northwest part of Wisconsin in Sawyer County. The overall population of the Tribe is ~8200 people, though not all live on the Reservation; this population is also representative of the number of non-Tribal and Tribal members living within the Tribal Reservation boundary and is used for estimating some categories of Transportation emissions. Nearly a third of the Reservation is water, which is included in the boundary. The Inventory only includes Tribal-owned single-family homes, multifamily building, and commercial buildings to calculate emissions from buildings. Transportation emissions encompasses reported Tribal-owned or Tribal-member owned vehicles for waterborne navigation, on-road diesel, and off-road vehicles (both gasoline and diesel), but the population data is used to scale County estimates for on-road gasoline vehicle miles traveled and ATV use. Burn barrels on Tribal land and Tribal population are used to estimate waste and wastewater emissions.

Applicable Sectors

The Lac Courte Oreilles Tribe mostly reflect Buildings and Transportation.

1.5.4 Summary Across Sector

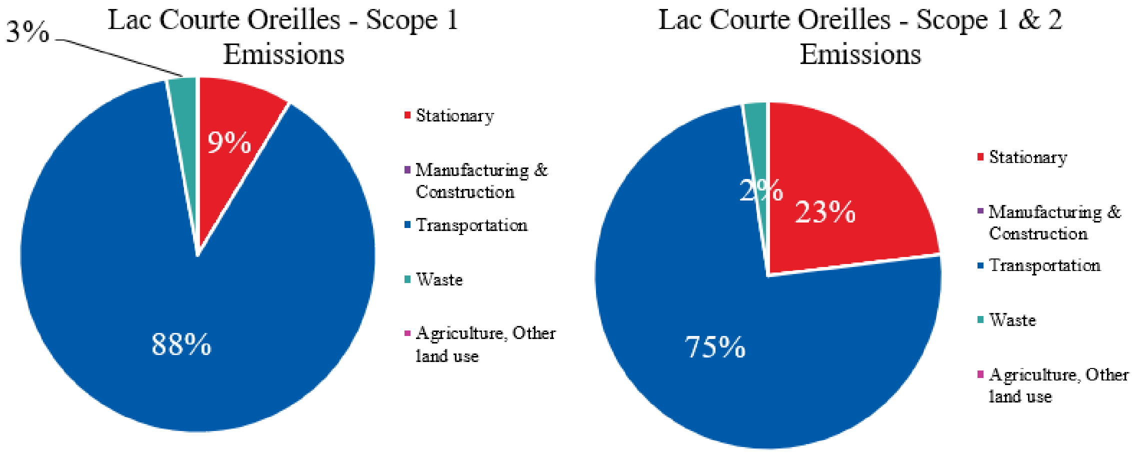


Figure 28: Lac Courte Oreilles Summary of Emissions

Transportation is by far the biggest contributor to LCO's emissions as far as Scope 1 (fuel use), but Buildings (Stationary emissions) starts to contribute a larger portion once Scope 2 emissions, i.e., electricity use of buildings is factored in. This could be due to higher vehicle miles traveled according to Arup's estimate, or a slightly lower number of Tribal-owned buildings reported compared to other Tribes.

Data Table (All Sectors)

Table 9: Lac Courte Oreilles Summary Across All Sectors

Sector	Sub-sector	GHG Emissions source	Input Value	Unit	Source
Stationary Energy	Residential Single-family	Building Nat Gas	42,537	Annual therms of NG	Proxy data, refer to methodology
		Building LP	580,636	Annual gallons of LP	Proxy data, refer to methodology
		Building Fuel Oil (Res No.	-	Annual gallons of Fuel Oil	This fuel understood to not be used
		Building Wood	63	Annual cords of wood	Proxy data, refer to methodology
	Multifamily Residential	Building Nat Gas	27,100	Annual therms of NG	Proxy data, refer to methodology
		Building LP	3,972	Annual gallons of LP	Proxy data, refer to methodology
		Building Fuel Oil (Res No.	-	Annual gallons of Fuel Oil	This fuel understood to not be used
	Commercial Buildings	Building Nat Gas	275,877	Annual therms of NG	Estimated based on data provided
		Building LP	34,013	Annual gallons of LP	Estimated based on data provided
		Building Fuel Oil (No. 2)	-	Annual gallons of Fuel Oil	This fuel understood to not be used
		Building Wood	-	Annual cords of wood	This fuel understood to not be used
	Industrial Buildings	Building Nat Gas	-	Annual therms of NG	Not applicable
		Building LP	-	Annual gallons of LP	Not applicable
		Building Fuel Oil (No. 2)	-	Annual gallons of Fuel Oil	Not applicable
		Building Wood	-	Annual cords of wood	Not applicable
Transportation	On-road	On-road (gasoline)	5,909,396	Annual gallons of gasoline	Proxy data, refer to methodology
		On-road (diesel)	68,129	Annual gallons of diesel	Proxy data, refer to methodology
	Waterborne Navigation	Waterborne Navigation	94,500	Annual gallons of gasoline	Proxy data, refer to methodology
	Aviation	Aviation	-	Annual gallons of jet fuel	This fuel understood to not be used
	Off-road (tractors, ATVs, etc)	Off-road (gasoline)	307,500	Annual gallons of gasoline	Proxy data, refer to methodology
		Off-road (diesel)	-	Annual gallons of diesel	This fuel understood to not be used
Waste		Disposal of solid-waste	-	tonnes of MSW sent to landfill	No landfill without boundary
		Waste open-burning	50	Annual # burn barrels	Estimated based on RFI response
	Aerobic	Wastewater generated	8,200	Population served	Proxy data, refer to methodology
Agriculture, Other land use	Livestock	Livestock	-	Number of cattle (Bison)	Not applicable
Electricity	Residential Buildings		7,589	Annual MWh	Proxy data, refer to methodology
	Multifamily Buildings		9,506	Annual MWh	Estimated based on data provided
	Commercial Buildings		9,084	Annual MWh	Estimated based on data provided
	Industrial Buildings		-	Annual MWh	Not applicable
	On-road	Electric Vehicles	-	Annual MWh	Not applicable

Buildings

Summary of Major Emissions

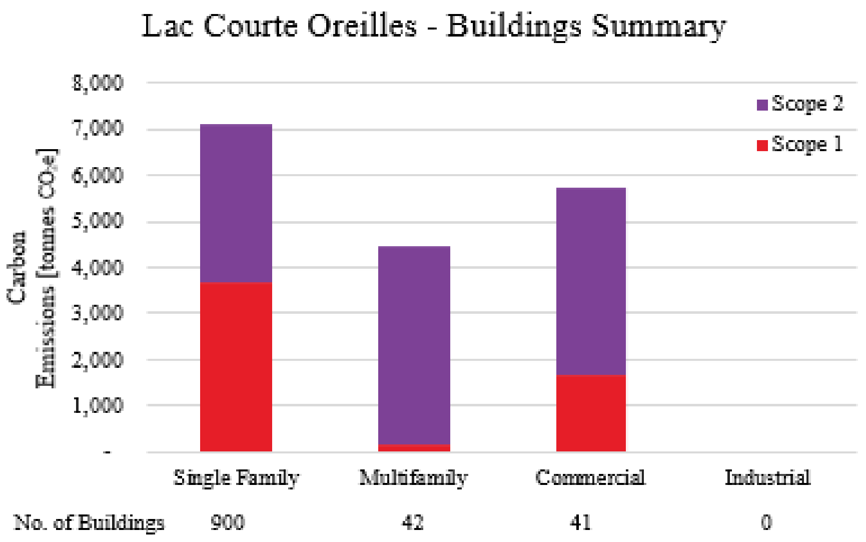


Figure 29: Lac Courte Oreilles Building Emissions

The majority of emissions from Buildings come from single-family homes (over 7000 metric tons CO_2 annually) on LCO's Reservation, followed by commercial buildings (just under 6000 metric tons annually). The Inventory includes about 900 single-family homes, the large majority of which are on propane. A small number of single-family homes are on natural gas and wood. Commercial buildings are the second largest category, which represents a 41-building sample of LCO Utility Data with average annual natural gas, propane, and electricity usage. There are 42 multifamily buildings with about 184 rental units - these buildings reflect a large amount of Scope 2 emissions (electricity) but minimal Scope 1 emissions (other fuel).

For commercial buildings, the buildings with the highest electricity use are the Sevenwinds Casino and Lodge, and the building with the highest natural gas use annually is the Ojibwe School. The building with the highest propane use annually is the LCO Country Store. While LCO does have a few industrial buildings, we assume some are captured in the LCO Utility data provided with commercial buildings. The CCAP may contain further information or breakdowns of industrial building data, depending on magnitude and further data acquired.

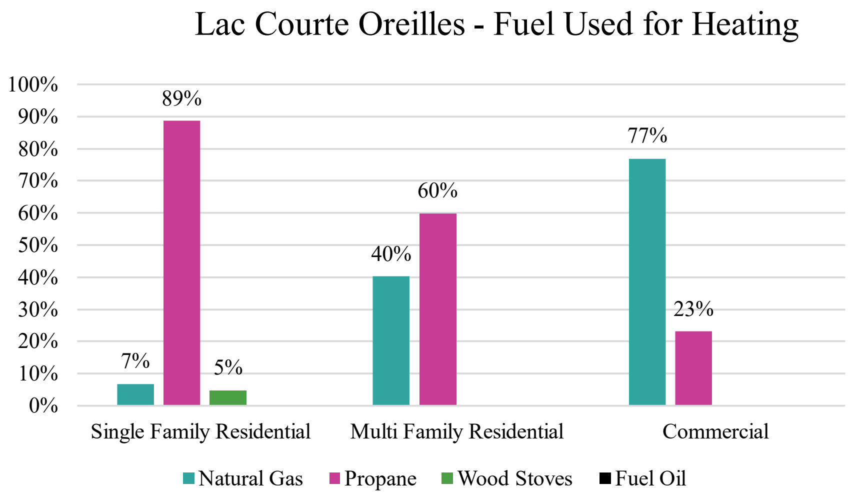


Figure 30: Lac Courte Oreilles Fuel Used by Building Type

In order to calculate emissions related to electricity use in the Tribes, Arup used EPA's eGRID regions' emissions factors[63]. The MROW eGRID region encompasses Lac Courte Oreilles's electric utilities; Arup used these associated emissions factors from 2021.

Methodology for Proxy

The buildings included in this GHG accounting were limited to Tribal-owned buildings and residential homes that Tribal members reside in. Buildings were separated by building-types: residential single-family, residential multifamily, commercial, and industrial. For all buildings, first priority was to use utility data provided by the Tribal members. When this was not available, proxy data was used to estimate building energy use based on building typology, size, and location.

Residential Single-Family Methodology

Lac Courte Oreilles provided number of single-family homes on each fuel type, but not total annual energy use. No buildings run on fuel oil. The proportion of buildings on each fuel use was determined using the breakdown of single-family homes by fuel type.

For single-family homes, the U.S. EIA database for Residential Energy Consumption Survey (RECS) was used for proxy. This data, administered by EIA, surveys a nationally representative sample of housing units. The data used for proxy was from 2020, which was the 15th RECS data survey collected from nearly 18,500 households.

---

[63] *EPA eGrid Emission Factors*. (2022, January). Retrieved January 5, 2024, from https://www.epa.gov/egrid

Data from the single-family homes in Wisconsin were used as proxy for Tribal single-family homes. Consumption data was used by fuel type: propane (gallons), natural gas (ccf) and electricity (kWh) per household. This data was scaled up by number of single-family homes within each Tribe.

Understanding that some households within Tribes rely on wood-burning stoves for heating, the EIA survey from 2009 provides an estimate of MMBtu/year of wood burned per household. This was used to calculate cords/wood burned annually in households that relied on wood stoves for heating. Las Courte Oreilles is awaiting more specific data on home wood delivery annually.

Residential Multifamily Methodology

The Building Performance Database (BPD) was used as proxy data for multifamily buildings. This database is sponsored by the U.S. DOE Building Technologies Office and was developed by the Lawrence Berkely National Laboratory. This database contains information for over one million commercial and residential buildings. Data was used for all multifamily buildings in Minnesota and Wisconsin. This database was referenced for EUI values for electricity consumption and natural gas consumption. These values were scaled up based on the assumed square footages of each multifamily building per Tribe.

Commercial Building Methodology

Lac Courte Oreilles provided average annual building energy consumption for natural gas, propane, and electricity from the LCO utility for forty-one commercial and industrial buildings. These values were used directly to convert to emissions. The CCAP may break out the 2-3 industrial buildings if more granular data is provided.

Transportation

Summary of Major Emissions

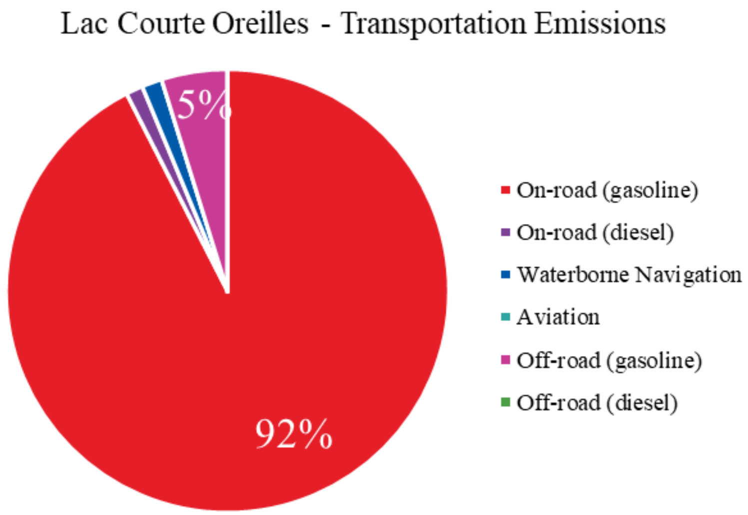


Figure 31: Lac Courte Oreilles Transportation Emissions

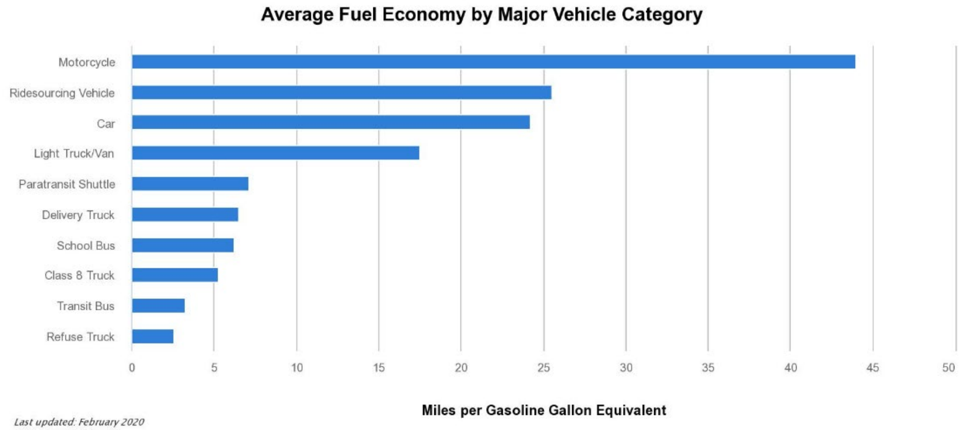
The majority of emissions comes from on-road gasoline, which has an outsized impact (see proxy explanation below). LCO reported 25 total school buses, shuttles, and minibuses as well as 3 transit buses, contributing to on-road diesel. LCO also reported high ATV use; Arup assumed 50% of the population owned an ATV, hence the presence of some off-road gasoline. LCO also indicated frequent use of motorboats, both for fishing and recreation, given the multiple lakes on or adjacent to the Reservation.

Methodology for Proxy

There are a few methodologies for calculating GHG emissions associated with transportation for the Tribes. The predominant source of GHG emissions related to transportation within the tribes is from single-occupancy vehicles. The sources included in the PCAP GHG inventory included transportation emissions from: on-road vehicles, waterborne navigation, and off-road vehicles. On-road vehicles included both on-road gasoline vehicles and on-road diesel vehicles. Off-road vehicles includes both off-road gasoline vehicles such as all-terrain vehicles (ATV's), and off-road diesel vehicles such as tractors.

In the initial request for information (RFI), Arup requested the number of gas, diesel, and EVs that were either passenger cars, light trucks, or heavy-duty vehicles. When Tribes were able to provide number of vehicles, Arup used these vehicles as well as proxy data based on the annual average VMT per driver data published at the state level from the Federal Highway Administration[64] data last published in 2019.

Arup used DOE Average Fuel Economy[65] to calculate the gallons of fuel used to travel the annual average miles traveled per vehicle.


Average Fuel Economy by Major Vehicle Category

Last updated: February 2020
Printed on: October 24

Figure 32: Average Fuel Economy by Vehicle

$$\begin{aligned} Annual\ Gallons\ of\ Gasoline \\ &= \frac{[(\#\ passenger\ cars) * (Annual\ VMT\ per\ driver)]}{24.2\ MPG} \\ &+ \frac{\big[[(\#\ light\ trucks) * (Annual\ VMT\ per\ driver)]\big]}{17.5\ MPG} \\ &+ \frac{[(\#\ heavy\ duty\ trucks) * (Annual\ VMT\ per\ driver)]}{6.5\ MPG} \end{aligned}$$

$$Annual\ Gallons\ of\ Diesel = \frac{[(\#\ heavy\ duty\ trucks) * (Annual\ VMT\ per\ driver)]}{6.5\ MPG}$$

---

[64] *Highway Statistics 2019.* (2019). US DOT Federal Highway Administration. Retrieved February 24, 2024, from https://www.fhwa.dot.gov/policyinformation/statistics/2019/

[65] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

In addition to the number of vehicles listed in the original RFI, Arup requested data on number of school buses, transit buses, tractors, and average daily distance traveled. When this data was available, the associated emissions were also calculated. School buses, transit buses, and tractors were all assumed to use diesel fuel.

$$Annual\ Gallons\ of\ Diesel = \frac{(\#\ of\ Vehicle)(Annual\ VMT)}{Vehicle\ MPG^{66}}$$

Because many Tribal members use all-terrain vehicles (ATV’s), Arup asked Tribes to estimate percentage of population that owned an ATV, and assumed 1,500 miles/year for those that ride ATV’s.

$$Annual\ Gallons\ of\ Gasoline = \frac{\left[Tribal\ population * (percent\ of\ population\ with\ an\ ATV) * \left(1{,}500\frac{miles}{year}\right)\right]}{20\ MPG}$$

If a Tribe did not initially provide the number and types of vehicles to be included in the inventory, Arup requested that the Tribes ascertain data from the local Tribal DMV, police or sheriff office, or office of the registrar on vehicles registered within each Tribe. This provides granular data on number of vehicles, average age of vehicle, and vehicle type (light truck, single passenger, EV, etc).

If this data was not attainable, the next methodology used to calculate transportation emissions included taking data from Tribal-owned gas stations on annual gallons of gasoline and diesel fuel sold. When this was available, the inventory includes these annual gallons of gasoline sold to calculate GHG emissions.

Without either the gallons of gasoline sold or vehicle registration data, Arup used data from the annual VMT data published from Minnesota[67] and Wisconsin[68] Department of Transportation (DOT) at the county level. County population and VMT data was taken from the counties that encompass the Tribes. The annual VMT per county population was scaled down to the population of each Tribe.

LCO provided data on motorboats and buses. To estimate on-road gasoline use from passenger vehicles, Arup scaled the county VMT from Sawyer County to the population of LCO, but Sawyer County had a high number of vehicle miles traveled per person, which likely scaled up the estimate of LCO’s vehicle miles traveled.

Additionally, many Tribes have significant use of motorized boats. If gasoline sold was not available, Arup asked LCO to estimate the percentage of their population with motorized boats, average boat trip distance, and number of boat trips per year.

$$Annual\ gallons\ of\ gasoline = \frac{[(Tribal\ Population)*(Percentage\ of\ Tribal\ members\ with\ motorized\ boats)*(Average\ boat\ trip\ distance)*(Number\ of\ annual\ boat\ trips)]}{4\ MPG}$$

LCO provided Arup with the estimate of ~60 trips/year (about 3 trips per month for 5 months of the year), and Arup assumed one boat per single-family home as well as an average distance of 7 miles per boat trip.

---

[66] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

[67] *Roadway Data*. (2022). Minnesota Department of Transportation. Retrieved February 24, 2024, from https://www.dot.state.mn.us/roadway/data/data-products.html#VMT

[68] *2021 Vehicle Miles of Travel (VMT) by County*. (2021). Wisconsin Department of Transportation. Retrieved February 24, 2024, from https://wisconsindot.gov/Documents/projects/data-plan/veh-miles/vmt2021-c.pdf

Waste

Summary of Major Emissions

Waste and wastewater emissions on the Reservation are minimal. There's wastewater assumed to be generated per person for the entire population, and about ~50 burn barrels of waste used annually reported by the Reservation. All single-family homes are assumed to be on septic systems, though the associated emissions are not calculated here.

Methodology for Proxy

In this GHG inventory for the PCAP, only Scope 1 emissions associated with waste were included in the inventory. This includes emissions associated with solid waste disposed in landfills *if the landfills are located within the Tribal boundary.* This also includes solid waste generated by the Tribe that is incinerated or burned in the open. This also includes Scope 1 emissions associated with wastewater treatment so long as that treatment is located within the Tribal boundary.

With limited data on the actual make-up of tribal MSW, Arup assumed the U.S. EPA MSW Generation Make-up[69]. This gave assumptions for the fraction of solid waste that was food, garden waste, paper, wood, textiles, and metals.

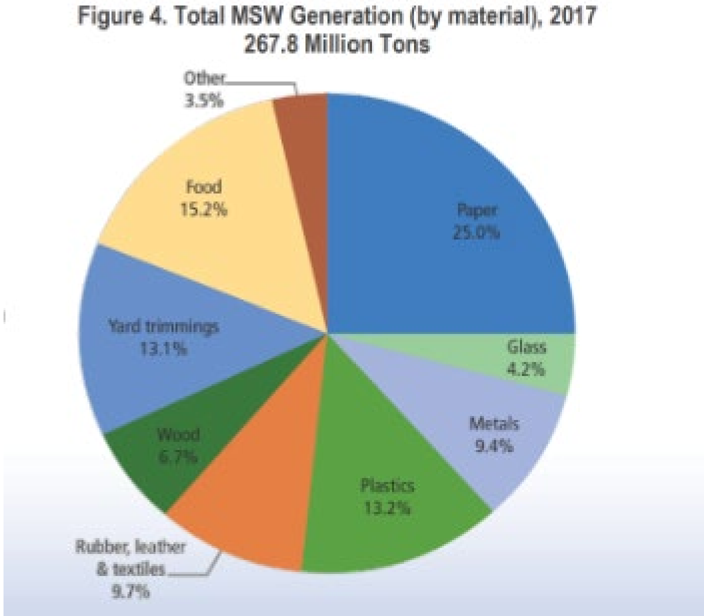


Figure 33: EPA MSW Make-Up

Waste Open Burning

Waste open burning is a method of municipal waste disposal that is still practiced within some of the Tribes. The same assumptions were made on the make-up of the MSW in order to calculate the emissions associated with open waste burning. The Tribes provided the number of burn barrels used annually. These burn barrels were assumed to be 55-gallon drums. The waste was assumed to be mixed waste – from either residential or commercial sources – and uncompacted, giving an approximate density of 275 lbs/cubic yard[70]. Using the

---

[69] *National Overview: Facts and Figures on Materials, Wastes and Recycling*. (2023, November 22). US EPA. Retrieved February 24, 2024, from https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

[70] EPA Volume-to-Weight Conversion Factors

EPA's default heat content ratio of 9.953 MMBtu/short ton of waste[71], Arup calculated associated emissions. The EPA's emissions factors for GHG Inventories includes emissions factors associated with MSW burning on a kg CO_2, g CH_4, and g N_2O on a MMBtu basis, which was converted to metric tons of CO_2e.

Wastewater

There are both CH_4 and N_2O emissions associated with wastewater treatment. In order to calculate the CH_4 emissions associated with wastewater treatment, Arup assumed 85 g/person/day[72] for Biochemical Oxygen Demand (BOD), in line with the United States default values per IPCC guidance on wastewater treatment and discharge. Arup assumed no additional industrial wastewater flowing to the Tribal sewers. Methane correction factors vary depending on whether the wastewater treatment system is an untreated system, centralized aerobic, anaerobic, or other septic system. For this initial inventory, the Methane Correction Factor, 0.3[73], corresponds with a centralized aerobic wastewater treatment system. Using these factors, Arup calculated the CH_4 emissions associated with the Tribal population.

To calculate N_2O emissions associated with wastewater treatment, Arup used default values for protein consumed as a fraction of protein supply, 0.80, and assumed the same centralized, aerobic treatment plant[74]. Using these values, as well as the U.S. annual protein supply per capita, 117 grams of protein/day[75], the N_2O emissions were calculated on a per person basis. These values were multiplied by the Tribal population that were being served by the wastewater treatment plant.

Processes for Improved Data Collection for Future Reporting

Future reporting will be improved as the data collection process continues. Many of the Tribes have requested data directly from third parties that have not yet provided data but are likely to be able to provide with more time ahead of the next inventory. This includes electric, gas, and propane utility data from utility companies, vehicle registration data from departments of motor vehicles, ridership numbers for public transportation, wastewater treatment plant data, gas station data on amounts of sold fuel, and data on livestock and emissions associated with agriculture.

B.6 Leech Lake Band of Lake Superior Chippewa GHG Inventory

Stakeholder Engagement

In order to accurately document the GHG emissions associated with Leech Lake, Arup initially sent a request for information (RFI) to the Tribe to better understand the sectors that make up Scope 1 and 2 emissions for the Tribe. After reviewing this initial information, Arup had a 1:1 meeting with members of the Leech Lake Tribe to ask further questions and ensure the extent of emissions for the initial PCAP inventory was captured correctly.

Boundary of Inclusion

The Leech Lake Band of Ojibwe Reservation is in north central Minnesota, around Leech Lake and Lake Winnibigoshish, and encompasses a total of 256 fishable lakes (including but not limited to: Cass Lake, Squaw Lake, Ball Club Lake, Boy Lake, Pike Bay, Portage Lake, Six mile Lake Bowstring Lake, Sand Lake, Round Lake, and Big Lake). It is located southeast of Bemidji and is made up of the following communities:

---

[71] Default Heat Content for Energy Conversions. (n.d.). US EPA. https://www.epa.gov/system/files/ documents/2022-10/Default%20Heat%20Content%20Ratios%20for%20Help%20and%20User%20Guide%20%281%29.pdf

[72] IPCC - Table 6.4

[73] IPCC - Table 6.3

[74] IPCC - Table 6.8A, 6.10A

[75] U.S. Protein Supply

District 1: Ball Club, Inger, Otenagen, S. Lake, and Winnie Dam.

District 2: Bena, Boy Lake, Brevick, Kego Lake, Nut Hill, Portage Lake, Ryan’s Village, Smokey Point, and Sugar Point.

District 3: Buck Lake, Cass Lake, Cass River, Mission, Oak Point, Onigum, Pennington, and Prescott.

The reservation is also in the middle of four counties: Cass, Itasca, Beltrami, and Hubbard. The entire Leech Lake Reservation is about 1,350 square miles.

This inventory includes Tribal-owned commercial buildings and all occupied housing units on the Reservation, including non-Tribal residences. The transportation emissions from passenger vehicles account for all the vehicles that purchased gas on the Leech Lake Reservation, particularly at the Che We and Leech Lake Market gas stations. The proxy data and calculations for transportation emissions uses the given population, 11,456 people, which is the total population of the Reservation, including non-Tribal members.

Applicable Sectors

The sectors that make up the majority of GHG emissions for the Leech Lake Tribe are buildings and transportation. Currently there is no data available on waste, manufacturing & construction, or agriculture and land use.

Summary Across Sectors

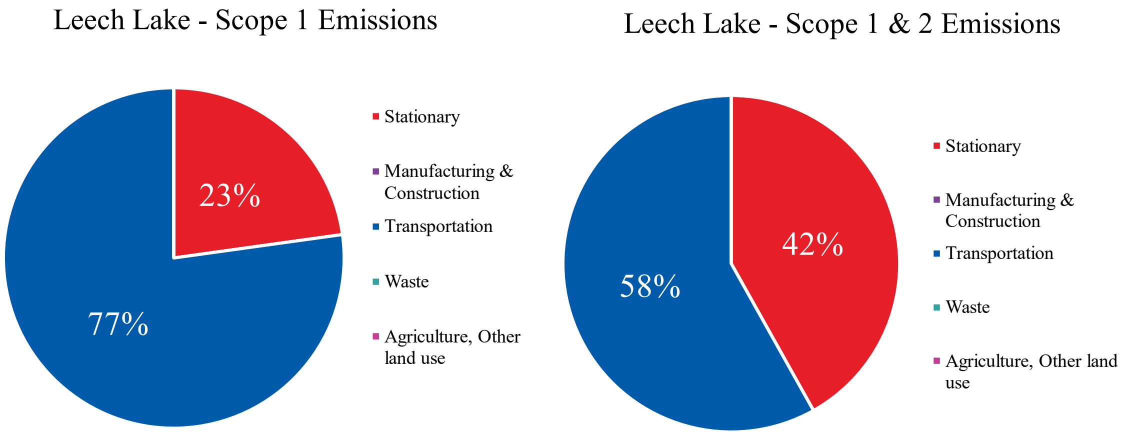


Figure 34: Leech Lake Summary of Emissions

After accounting for Scope 2 electricity use in buildings, transportation emissions is still greater than stationary emissions.

Data Table (All Sectors)

Table 10: Leech Lake Summary Across All Sectors

Sector	Sub-sector	GHG Emissions source	Input Value	Unit	Source
Stationary Energy	Residential Single-family	Building Nat Gas	*163,546*	Annual therms of NG	Proxy data, refer to methodology
		Building LP	*1,937,621*	Annual gallons of LP	Proxy data, refer to methodology
		5)	*242,995*	Annual gallons of Fuel Oil	Proxy data, refer to methodology
		Building Wood	*951*	Annual cords of wood	Proxy data, refer to methodology
	Multifamily Residential	Building Nat Gas	*98,790*	Annual therms of NG	Proxy data, refer to methodology
		Building LP	-	Annual gallons of LP	Not applicable
		5)	-	Annual gallons of Fuel Oil	Not applicable
	Commercial Buildings	Building Nat Gas	107,522	Annual therms of NG	Provided in RFI
		Building LP	-	Annual gallons of LP	Not applicable
		Building Fuel Oil (No. 2)	-	Annual gallons of Fuel Oil	Not applicable
		Building Wood	-	Annual cords of wood	Not applicable
	Industrial Buildings	Building Nat Gas	-	Annual therms of NG	Not applicable
		Building LP	-	Annual gallons of LP	Not applicable
		Building Fuel Oil (No. 2)	-	Annual gallons of Fuel Oil	Not applicable
		Building Wood	-	Annual cords of wood	Not applicable
Transportation	On-road	On-road (gasoline)	5,406,606	Annual gallons of gasoline	Proxy data, refer to methodology
		On-road (diesel)	*154,452*	Annual gallons of diesel	Proxy data, refer to methodology
	Waterborne Navigation	Waterborne Navigation	*1,145,600*	Annual gallons of gasoline	Proxy data, refer to methodology
	Aviation	Aviation	-	Annual gallons of jet fuel	
	Off-road (tractors, ATVs, etc)	Off-road (gasoline)	*214,800*	Annual gallons of gasoline	Proxy data, refer to methodology
		Off-road (diesel)	-	Annual gallons of diesel	
Waste		Disposal of solid-waste	-	annually	
		Waste open-burning	-	Annual # burn barrels	
	Livestock	Livestock	-	Number of cattle (Bison)	
Electricity	Residential Buildings		*39,433*	Annual MWh	Proxy data, refer to methodology
	Multifamily Buildings		*2,347*	Annual MWh	Proxy data, refer to methodology
	Commercial Buildings		15,979	Annual MWh	Provided in RFI
	Industrial Buildings		-	Annual MWh	Not applicable
	On-road	Electric Vehicles	-	Annual MWh	Not applicable

Buildings

Summary of Major Emissions

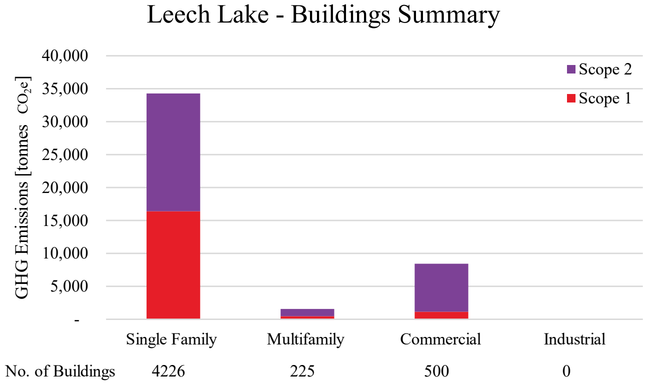


Figure 35: Leech Lake Buildings Emissions

Single-family buildings have greater Scope 1 and Scope 2 emissions than multifamily and commercial buildings combined.

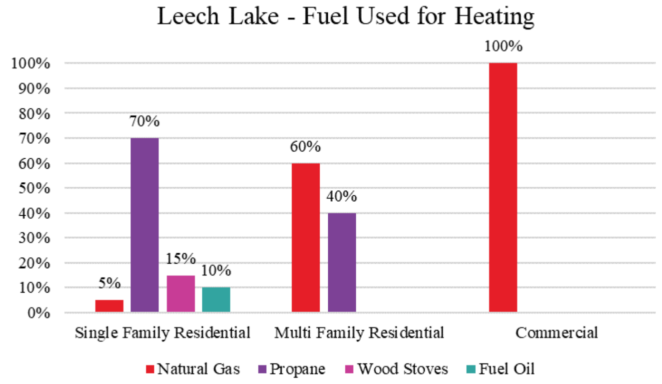


Figure 36: Leech Lake Fuel Used for Heating by Building Type

Leech Lake single-family buildings predominantly rely on propane for heating, whereas multifamily and commercial buildings primarily rely on natural gas. Additionally, multifamily buildings use propane for heating, whereas commercial buildings only use natural gas. There are also a small number of single-family homes that use wood stoves and fuel oil for heating, and even fewer use natural gas due to lack of natural gas infrastructure across the Reservation.

There are many commercial buildings on the Reservation, including over 100 resorts, three Tribal-owned casinos, and a marina with a sports bar, restaurant, convenience, and liquor store as destinations for tourists. There are many reservation-based and Native American-owned contractors for housing, commercial, and retail construction, and some manufacturing businesses as well as wood-processing plants. Public buildings include four municipal centers and 12 tribal community centers, some satellite health clinics, a K-12 public-school, day-care facilities, and the Leech Lake Tribal College facilities. The main industries in Leech Lake Reservation are arts and recreation, accommodation and food, retail, mining, and construction.

In order to calculate emissions related to electricity use in the Tribes, Arup used EPA’s eGRID regions’ emissions factors [76]. The MROW eGRID region encompasses Leech Lake’s electric utilities; Arup used these associated emissions factors from 2021.

Methodology for Proxy

The buildings included in this GHG accounting were limited to Tribal-owned commercial buildings and all occupied housing units in the Leech Lake Reservation. Buildings were separated by building-types: residential single-family, residential multifamily, commercial, and industrial. For all buildings, the first priority was to use utility data provided by the Tribal members, such as the provided commercial building natural gas and electricity usage. When this was not available, proxy data was used to estimate building energy use based on building typology, size, and location.

Residential Single-Family Methodology

For single-family homes, if utility data was not provided, the U.S. EIA database for Residential Energy Consumption Survey (RECS) was used for proxy. This data, administered by EIA, surveys a nationally representative sample of housing units. The data used for proxy was from 2020, which was the 15th RECS data survey collected from nearly 18,500 households.

---

[76] *EPA eGrid Emission Factors*. (2022, January). Retrieved January 5, 2024, from https://www.epa.gov/egrid

Data from the single-family homes in Minnesota and Wisconsin were used as proxy for Tribal single-family homes within those states. Consumption data was used by fuel type: propane (gallons), natural gas (ccf) and electricity (kWh) per household. This data was scaled up by number of single-family homes within each Tribe.

While this data provided at the state level did not include fuel oil data for single-family homes, the EIA survey did have averages for single-family homes in the Midwest. This was used for estimated annual household fuel oil use for single-family homes that relied on fuel oil for heating.

Understanding that some households within Tribes rely on wood-burning stoves for heating, the EIA survey from 2009 provides an estimate of MMBtu/year of wood burned per household. This was used to calculate cords/wood burned annually in households that relied on wood stoves for heating.

Finally, best approximation from Tribes on percentage of single-family homes that use natural gas, propane, wood stoves, and fuel oil for heating is multiplied by proxy calculations for each fuel type, to account for the different fuel types used.

Residential Multifamily Methodology

The Building Performance Database (BPD) was used as proxy data for multifamily buildings. This database is sponsored by the U.S. DOE Building Technologies Office, and was developed by the Lawrence Berkely National Laboratory. This database contains information for over 1 million commercial and residential buildings. Data was used for all multifamily buildings in Minnesota and Wisconsin. This databased was referenced for EUI values for electricity consumption and natural gas consumption. These values were scaled up based on the assumed square footages of each multifamily building per Tribe.

The best approximation from Tribes on percentage of multifamily homes that use natural gas, propane, wood stoves, and fuel oil for heating is multiplied by proxy calculations for each fuel type, to account for the different fuel types used.

Commercial Building Methodology

Leech Lake was able to provide actual natural gas and electricity consumption data for Tribally-owned commercial buildings. The natural gas data, in therms, and the electricity data, in kWh, was converted into metric tons of CO_2.

Transportation

Summary of Major Emissions

The majority of transportation emissions occur from on-road passenger cars and vehicles, which is calculated using proxy data.

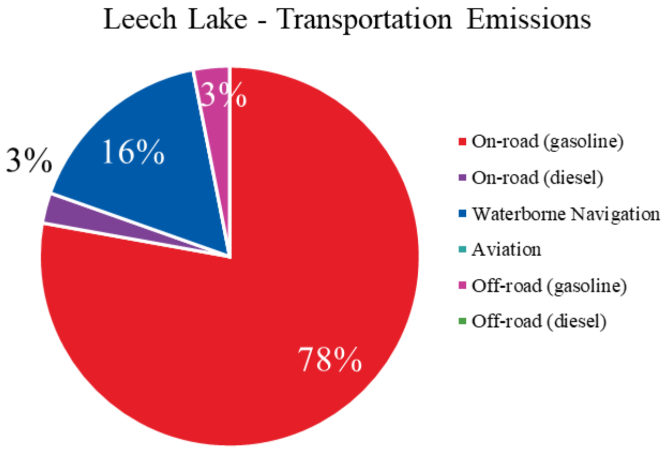


Figure 37: Leech Lake Transportation Emissions

For waterborne transportation, a proxy estimate of 25% of population was used for boat ownership, and trips are assumed to occur 40 times annually since it is primarily tourism on the weekends, and for an average of 40 miles of boat trips due to the size and quantity of lakes in the region using Google Maps. This information and estimates from Tribal leaders provides waterborne VMT and therefore informs proxy data calculations.

On-road diesel emissions occur from a proxy estimate based on the assumption that there is 1 school bus for every 300 people. Since the population is 11,456, this means there is an estimate of 38 school buses on the Reservation. These school buses have about 140 miles of daily trips, which is multiplied by 180 typical school days to get VMT for diesel, and therefore informs proxy data calculations.

Off-road gasoline proxy data uses the estimate that 25% of the Tribal population owns an ATV.

Methodology for Proxy

There are a few methodologies for calculating GHG emissions associated with transportation for the Tribes. The predominant source of GHG emissions related to transportation within the tribes is from single-occupancy vehicles. The sources included in the PCAP GHG inventory included transportation emissions from: on-road vehicles, waterborne navigation, and off-road vehicles. On-road vehicles included both on-road gasoline vehicles and on-road diesel vehicles. Off-road vehicles includes both off-road gasoline vehicles such as all-terrain vehicles (ATV's), and off-road diesel vehicles such as tractors.

In the initial request for information (RFI), Arup requested the number of gas, diesel, and EVs that were either passenger cars, light trucks, or heavy-duty vehicles. When Tribes were able to provide number of vehicles, Arup used these vehicles as well as proxy data based on the annual average VMT per driver data published at the state level from the Federal Highway Administration[77] data last published in 2019.

Arup used DOE Average Fuel Economy[78] to calculate the gallons of fuel used to travel the annual average miles traveled per vehicle.

---

[77] *Highway Statistics 2019.* (2019). US DOT Federal Highway Administration. Retrieved February 24, 2024, from https://www.fhwa.dot.gov/policyinformation/statistics/2019/

[78] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

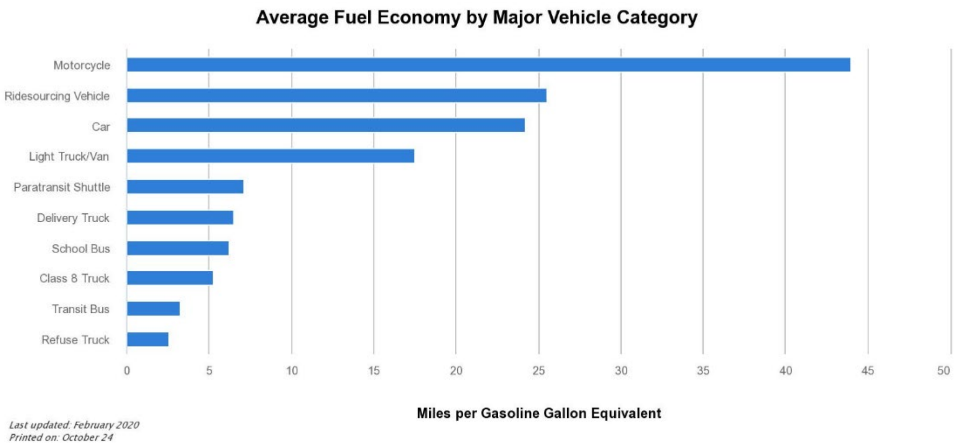


Figure 38: Average Fuel Economy by Vehicle

$$Annual\ Gallons\ of\ Diesel = \frac{[(\#\ heavy\ duty\ trucks) * (Annual\ VMT\ per\ driver)]}{6.5\ MPG}$$

In addition to the number of vehicles listed in the original RFI, Arup requested data on number of school buses, transit buses, tractors, and average daily distance traveled. When this data was available, the associated emissions were also calculated. School buses, transit buses, and tractors were all assumed to use diesel fuel.

$$Annual\ Gallons\ of\ Diesel = \frac{(\#\ of\ Vehicle)(Annual\ VMT)}{Vehicle\ MPG^{79}}$$

Because many Tribal members use all-terrain vehicles (ATV's), Arup asked Tribes to estimate percentage of population that owned an ATV, and assumed 1,500 miles/year for those that ride ATV's.

$$Annual\ Gallons\ of\ Gasoline = \frac{\left[Tribal\ population * (percent\ of\ population\ with\ an\ ATV) * \left(1{,}500\frac{miles}{year}\right)\right]}{20\ MPG}$$

If a Tribe did not initially provide the number and types of vehicles to be included in the inventory, Arup requested that the Tribes ascertain data from the local Tribal DMV, police or sheriff office, or office of the registrar on vehicles registered within each Tribe. This provides granular data on number of vehicles, average age of vehicle, and vehicle type (light truck, single passenger, EV, etc).

If this data was not attainable, the next methodology used to calculate transportation emissions included taking data from Tribal-owned gas stations on annual gallons of gasoline and diesel fuel sold. When this was available, the inventory includes these annual gallons of gasoline sold to calculate GHG emissions.

---

[79] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

Without either the gallons of gasoline sold or vehicle registration data, Arup relied on vehicle-miles-traveled data from the annual Vehicle Miles Traveled (VMT) data published from Minnesota[80] and Wisconsin[81] Department of Transportation (DOT) at the county level. County population and VMT data was taken from the counties that encompass the Tribes. The annual VMT per county population was scaled down to the population of each Tribe.

Additionally, many Tribes have significant use of motorized boats. If available, data for gasoline sold at marinas was used to calculate emissions associated with boat travel. If monthly gasoline sold was available, this data was scaled to represent the boating season, typically early April through early November. If gasoline sold was not available, Arup asked the Tribes to estimate the percentage of their population with motorized boats, average boat trip distance, and number of boat trips per year.

$$Annual\ gallons\ of\ gasoline = \frac{[(Tribal\ Population)*(Percentage\ of\ Tribal\ members\ with\ motorized\ boats)*(Average\ boat\ trip\ distance)*(Number\ of\ annual\ boat\ trips)]}{4\ MPG}$$

Waste

Summary of Major Emissions

Leech Lake's MSW is taken off Reservation by a 3rd party provider. There is no open burning of waste, and wastewater is treated off Reservation by a 3rd party. There were no emissions related to waste in this inventory for Leech Lake.

Livestock

Summary of Major Emissions

Leech Lake did not provide a number of livestock and therefore does not have emissions related to livestock within this inventory.

Processes for Improved Data Collection for Future Reporting

Future reporting will be improved as the data collection process continues. Many of the Tribes have requested data directly from third parties that have not yet provided data but are likely to be able to provide with more time ahead of the next inventory. This includes electric, gas, and propane utility data from utility companies, vehicle registration data from departments of motor vehicles, ridership numbers for public transportation, wastewater treatment plant data, gas station data on amounts of sold fuel, and data on livestock and emissions associated with agriculture.

B.7 Minnesota Chippewa Tribe GHG Inventory

Stakeholder Engagement

In order to accurately document the GHG emissions associated with Minnesota Chippewa Tribe (MCT), Arup initially sent a request for information (RFI) to the Tribe to better understand the sectors that make up Scope 1 and 2 emissions for the Tribe. MCT sent Arup utility data for the buildings included in their inventory. Arup also conducted follow-up e-mail correspondence to confirm the buildings that would be included in the inventory.

---

[80] *Roadway Data*. (2022). Minnesota Department of Transportation. Retrieved February 24, 2024, from https://www.dot.state.mn.us/roadway/data/data-products.html#VMT

[81] *2021 Vehicle Miles of Travel (VMT) by County*. (2021). Wisconsin Department of Transportation. Retrieved February 24, 2024, from https://wisconsindot.gov/Documents/projects/data-plan/veh-miles/vmt2021-c.pdf

Boundary of Inclusion

The Minnesota Chippewa Tribe is comprised of six Bands: Bois Forte, Fond du Lac, Grand Portage, Leech Lake, Mille Lacs, and White Earth. Fond du Lac, Grand Portage, Leech Lake, and Mille Lacs have separate individual GHG inventories. This GHG inventory is limited to the MCT Headquarters property: The main MCT Tribal Headquarters office building, the Adult Day Services Center, and (2) heated garages on the MCT property. The office building is 18,000 square feet, and includes conference rooms, maintenance rooms, office rooms, exercise room, break rooms, and storage areas. The Adult Day Services Center is a 2,400 square foot building that is currently being rented out to the Leech Lake Band of Ojibwe. The main heated garage is 2,400 square feet and includes storage, parking and a kitchen area. The additional garage is 1,500 square feet and includes a shop area, parking area, and property maintenance. Residential buildings, other commercial buildings, industrial buildings, transportation, waste, and agricultural emissions are not accounted for in this inventory.

Applicable Sectors

The sectors that contributes to GHG emissions for Minnesota Chippewa Tribe are buildings. This inventory is limited to the MCT Headquarters property.

Data Table (All Sectors)

Table 11: Minnesota Chippewa Scope 1 and 2 Emissions

Sector	Sub-sector	GHG Emissions source	Input Value	Unit	Source
Stationary Energy	Residential Single-family	Building Nat Gas	-	Annual therms of NG	Proxy data, refer to methodology
		Building LP	-	Annual gallons of LP	Proxy data, refer to methodology
		Building Fuel Oil (Res	-	Annual gallons of Fuel Oil	Proxy data, refer to methodology
		Building Wood	-	Annual cords of wood	Proxy data, refer to methodology
	Multifamily Residential	Building Nat Gas	-	Annual therms of NG	Proxy data, refer to methodology
		Building LP	-	Annual gallons of LP	Not applicable
		Building Fuel Oil (Res	-	Annual gallons of Fuel Oil	Not applicable
	Commercial Buildings	Building Nat Gas	3,627	Annual therms of NG	Provided in RFI
		Building LP	758	Annual gallons of LP	Not applicable
		Building Fuel Oil (No. 2)	-	Annual gallons of Fuel Oil	Not applicable
		Building Wood	-	Annual cords of wood	Not applicable
	Industrial Buildings	Building Nat Gas	-	Annual therms of NG	Not applicable
		Building LP	-	Annual gallons of LP	Not applicable
		Building Fuel Oil (No. 2)	-	Annual gallons of Fuel Oil	Not applicable
		Building Wood	-	Annual cords of wood	Not applicable
Electricity	Residential Buildings		-	Annual MWh	Proxy data, refer to methodology
	Multifamily Buildings		-	Annual MWh	Proxy data, refer to methodology
	Commercial Buildings		113	Annual MWh	Provided in RFI
	Industrial Buildings		-	Annual MWh	Not applicable
	On-road	Electric Vehicles	-	Annual MWh	Not applicable

Buildings

Summary of Major Emissions

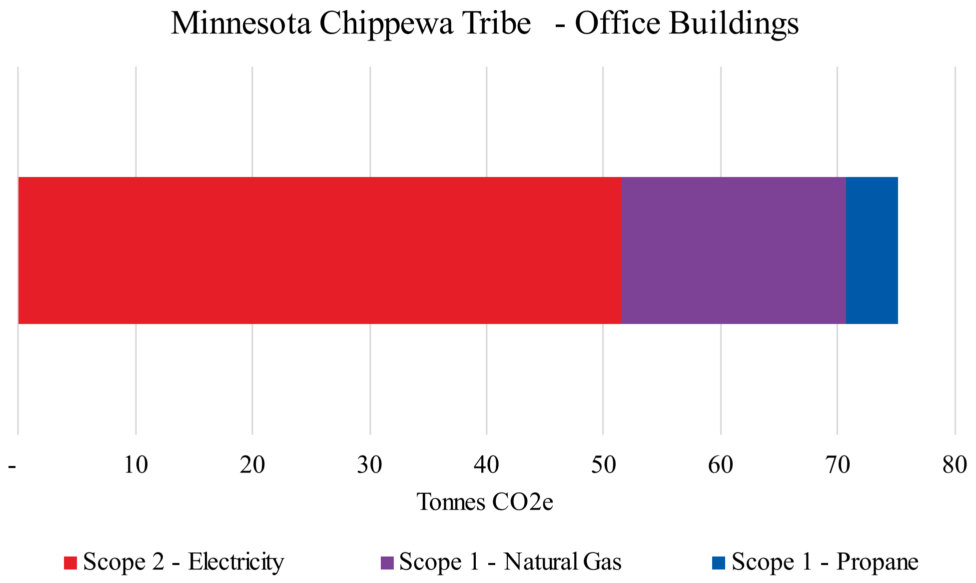


Figure 39: Minnesota Chippewa Building Emissions by Fuel Type

Minnesota Chippewa Tribe provided direct annual energy use data, specifically natural gas, propane, and electricity, for its headquarters office and adult day care buildings. Propane gallons were provided on an annual basis, and 2022 data was used for the inventory. Electricity and Natural Gas utility data was provided from November 2022 to October 2023.

The total metric tons of CO_2e related to Scope 1 emissions is 24 metric tons CO_2e; natural gas burning results in 19 metric tons CO_2e and propane burning results in 4 metric tons CO_2e. The total metric tons of CO_2e for Scope 2 emissions are 54.

This data does not include potential residential, commercial, or industrial emissions from other Tribal-owned buildings.

In order to calculate emissions related to electricity use in the Tribes, Arup used EPA's eGRID regions' emissions factors[82]. The MROW eGRID region encompasses Minnesota Chippewa electric utilities; Arup used these associated emissions factors from 2021. In order to calculate emissions related to propane and fuel use, Arup used EPA's eGRID Emissions factors for GHG inventories[83] for both propane and natural gas.

Methodology for Proxy

The buildings included in this GHG accounting were limited to Tribal-owned. For all buildings, first priority was to use utility data provided by the Tribal members.

Commercial Building Methodology

Minnesota Chippewa Tribe provided direct annual energy use data, specifically natural gas, propane, and electricity, for its headquarters office and adult day services buildings.

---

[82] *EPA eGrid Emission Factors*. (2022, January). Retrieved January 5, 2024, from https://www.epa.gov/egrid

[83] EPA Emissions Factors for GHG Inventories

B.8 Oneida Nation GHG Inventory

Stakeholder Engagement

In order to accurately document the GHG emissions associated with Oneida Nation, Arup initially sent a request for information (RFI) to the Tribe to better understand the sectors that make up Scope 1 and 2 emissions for the Tribe. After reviewing this initial information, Arup had a 1:1 meeting with members of the Oneida Nation to ask further questions and ensure the extent of emissions for the initial PCAP inventory was captured correctly. Arup also conducted a few follow-ups calls to confirm PCAP estimates.

Boundary of Inclusion

The Oneida Nation Reservation is 65,400 acres located across Outagamie County and Brown County in Wisconsin. The land includes agriculture, suburban development, urban development, and areas of restoration (such as forest land and wetlands). For this inventory, only the annual energy use of Tribal-owned single-family homes, Tribal-owned multifamily buildings, and Tribal-owned commercial buildings (including governmental and community buildings) were included. For transportation, both Tribal-owned vehicles and vehicles registered to Tribal-members were included. The Tribal population was used to estimate landfill waste, and only the livestock from the two Tribal-operated farms were included.

Applicable Sectors

The sectors that make up the majority of GHG emissions for Oneida Nation are buildings and transportation.

Summary Across Sectors

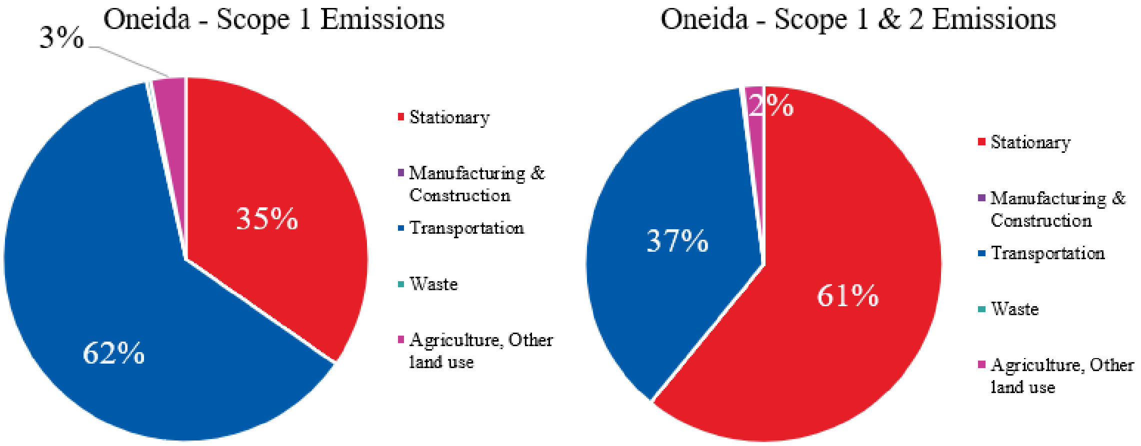


Figure 40: Oneida Summary of Emissions

The Scope 1 emissions are ~34,600 metric tons CO_2e, and the Scope 2 emissions are ~23,200 metric tons CO_2e. Transportation now makes up the largest sector of Scope 1 emissions, but buildings make up the largest sector of emissions when considering Scope 1 and 2 emissions.

Data Table (All Sectors)

Table 12: Oneida Summary Across All Sectors

Sector	Sub-sector	GHG Emissions source	Input Value	Unit	Source
Stationary Energy	Residential Single-family	Building Nat Gas	1,043,532	Annual therms of NG	Estimated based on data provided
		Building LP	113,600	Annual gallons of LP	Estimated based on data provided
		Building Fuel Oil (Res No. 5)	19,000	Annual gallons of Fuel Oil	Estimated based on data provided
		Building Wood	86	Annual cords of wood	Proxy data, refer to methodology
	Multifamily Residential	Building Nat Gas	95,460	Annual therms of NG	Proxy data, refer to methodology
		Building LP	-	Annual gallons of LP	This fuel understood
		Building Fuel Oil (Res No. 5)	-	Annual gallons of Fuel Oil	This fuel understood
	Commercial Buildings	Building Nat Gas	919,006	Annual therms of NG	Estimated based on data provided
		Building LP	10,785	Annual gallons of LP	Estimated based on data provided
		Building Fuel Oil (No. 2)	-	Annual gallons of Fuel Oil	This fuel understood
		Building Wood	-	Annual cords of wood	This fuel understood
	Industrial Buildings	Building Nat Gas	-	Annual therms of NG	Not applicable
		Building LP	-	Annual gallons of LP	Not applicable
		Building Fuel Oil (No. 2)	-	Annual gallons of Fuel Oil	Not applicable
		Building Wood	-	Annual cords of wood	Not applicable
Transportation	On-road	On-road (gasoline)	2,334,395	Annual gallons of gasoline	Estimated based on data provided
		On-road (diesel)	33,260	Annual gallons of diesel	Proxy data, refer to methodology
	Waterborne Navigation	Waterborne Navigation	-	Annual gallons of gasoline	This fuel understood
	Aviation	Aviation	-	Annual gallons of jet fuel	This fuel understood
	Off-road (tractors, ATVs, etc)	Off-road (gasoline)	52,290	Annual gallons of gasoline	Proxy data, refer to methodology
		Off-road (diesel)	2,000	Annual gallons of diesel	This fuel understood to not be used
Waste		Disposal of solid-waste	-	tonnes of MSW sent to	Estimated based on data provided
		Waste open-burning	-	Annual # burn barrels	Not applicable
	Aerobic System	Wastewater generated	576	Population served	Estimated based on data provided
Agriculture, Other land use	Livestock	Livestock	700	Number of livestock	Estimated based on data provided
Electricity	Residential Buildings		2,768	Annual MWh	Estimated based on data provided
	Multifamily Residential		1,361	Annual MWh	Proxy data, refer to methodology
	Commercial Buildings		28,018	Annual MWh	Estimated based on data provided
	Industrial Buildings		-	Annual MWh	Not applicable
	On-road	Electric Vehicles	-	Annual MWh	Not applicable

Buildings

Summary of Major Emissions

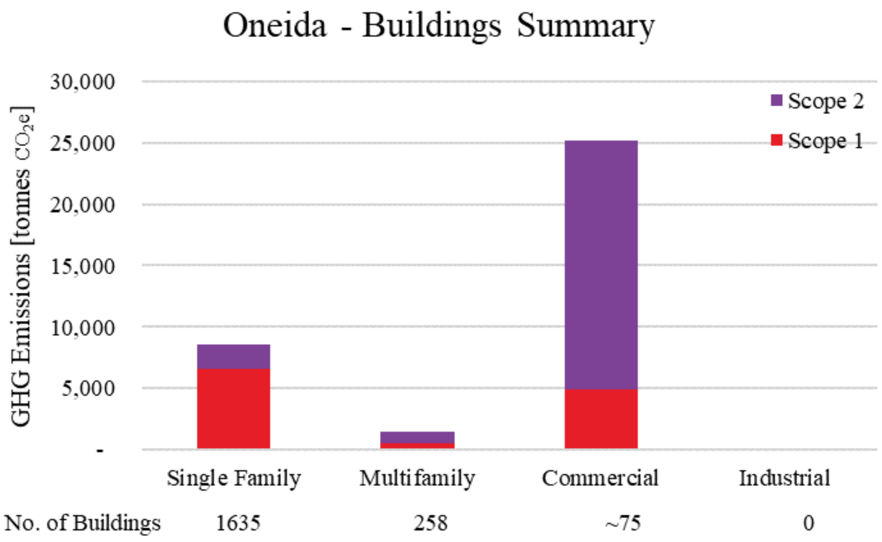


Figure 41: Oneida Building Emissions

Oneida Nation provided direct annual energy use data (natural gas and electricity) for single-family homes and commercial buildings. The majority of buildings on the Reservation are single-family homes (1635), followed by multifamily homes (258, as mentioned). The primary emissions from fuel use of buildings (over 70% of total Scope 1 and 2 building emissions) are generated by ~75 Commercial buildings, which include Tribal-owned commercial, community, and government facilities. Single-family homes are the second largest source of emissions, making up ~24% of building emissions. Multifamily buildings generate the least amount of emissions; the energy use was estimated from proxy data rather than direct consumption. A small amount of single-family homes use wood or fuel oil for heating (~5%), and a small number of commercial buildings rely on propane (~3%). This data does not include potential industrial emissions from warehouse data and other Tribal-owned Industrial buildings, which may be incorporated for the CCAP.

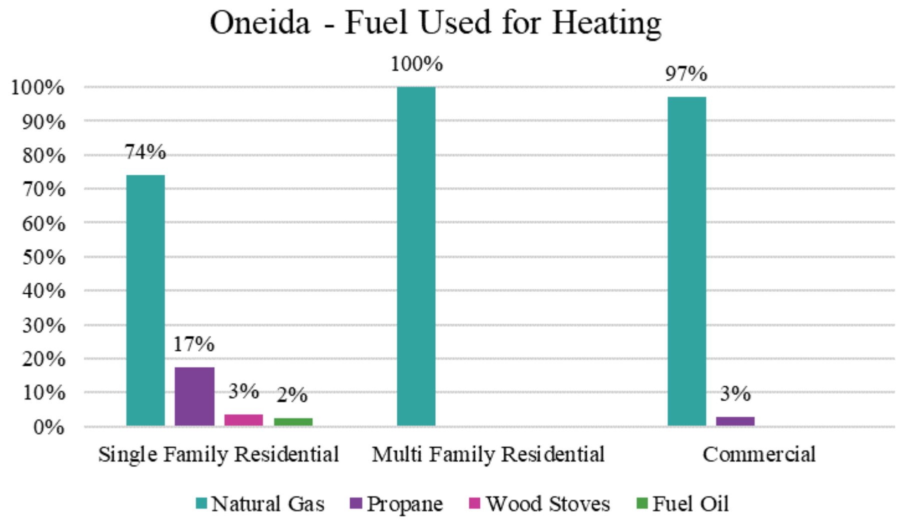


Figure 42: Oneida Fuel Use by Building Type

In order to calculate emissions related to electricity use in the Tribes, Arup used EPA's eGRID regions' emissions factors[84]. The MROW eGRID region encompasses Oneida's electric utilities; Arup used these associated emissions factors from 2021.

Methodology for Proxy

The buildings included in this GHG accounting were limited to Tribal-owned buildings and residential homes that Tribal members reside in. Buildings were separated by building-types: residential single-family, residential multifamily, commercial, and industrial. For all buildings, first priority was to use utility data provided by the Tribal members. When this was not available, proxy data was used to estimate building energy use based on building typology, size, and location.

Residential Single-Family Methodology

Oneida Nation provided a total annual energy use for natural gas, propane, and electricity based on a random sample of utility statements. Fuel oil use was estimated using an approximation based on personal use of Tribal contacts.

For single-family homes, the U.S. EIA database for Residential Energy Consumption Survey (RECS) was used to estimate wood use. This data, administered by EIA, surveys a nationally representative sample of housing units. The data used for proxy was from 2020, which was the 15th RECS data survey collected from nearly 18,500 households. Understanding that some households within Tribes rely on wood-burning stoves for heating, the EIA survey from 2009 provides an estimate of MMBtu/year of wood burned per household. This was used to calculate cords/wood burned annually in households that relied on wood stoves for heating.

---

[84] *EPA eGrid Emission Factors*. (2022, January). Retrieved January 5, 2024, from https://www.epa.gov/egrid

Residential Multifamily Methodology

Oneida Nation provided the number of multifamily buildings (which includes townhouses, condominiums, and apartment units) but not average fuel consumption. To estimate energy use, the Building Performance Database (BPD) was used as proxy data for multifamily buildings. This database is sponsored by the U.S. DOE Building Technologies Office, and was developed by the Lawrence Berkely National Laboratory. This database contains information for over 1 million commercial and residential buildings. Data was used for all multifamily buildings in Minnesota and Wisconsin. This databased was referenced for EUI values for electricity consumption and natural gas consumption. These values were scaled up based on the assumed square footages of each multifamily building per Tribe. For Oneida Nation, all multifamily buildings are assumed to rely on natural gas and electricity only.

Commercial Building Methodology

Oneida Nation provided total natural gas and electricity usage for Tribal commercial, governmental, and community buildings, as well as an approximate portfolio size of 175 buildings. They also provided the number of buildings on propane in follow-up conversations as well as approximate fuel use from energy audits. While included in commercial buildings for now, this fuel use could also be considered industrial building energy data.

Transportation

Summary of Major Emissions

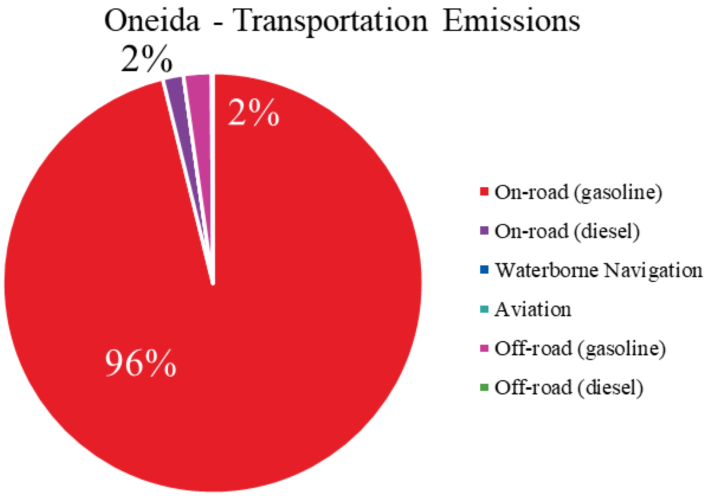


Figure 43: Oneida Transportation Emissions

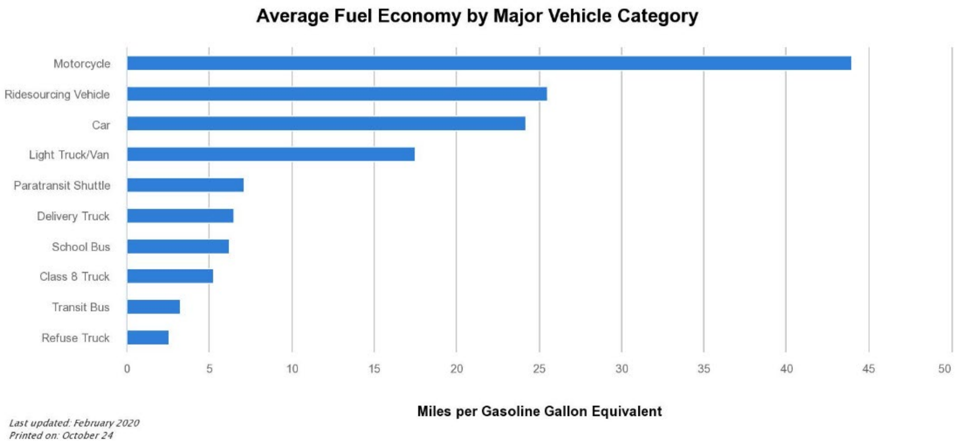
The vast majority of emissions came from Oneida's on-road gasoline, likely due to the large number of vehicles owned and registered by Tribal members (over 3000), all assumed to be on-road gasoline. Oneida Nation reported some ATV use (10-20% of the population) and some heavy-duty vehicles, such as tractors, owned by the Reservation. There are no school buses (only public transit) offered on the Reservation.

Methodology for Proxy

There are a few methodologies for calculating GHG emissions associated with transportation for the Tribes. The predominant source of GHG emissions related to transportation within the tribes is from single-occupancy vehicles. The sources included in the PCAP GHG inventory included transportation emissions from: on-road vehicles, waterborne navigation, and off-road vehicles. On-road vehicles included both on-road gasoline vehicles and on-road diesel vehicles. Off-road vehicles includes both off-road gasoline vehicles such as all-terrain vehicles (ATV's), and off-road diesel vehicles such as tractors.

In the initial request for information (RFI), Arup requested the number of gas, diesel, and EVs that were either passenger cars, light trucks, or heavy-duty vehicles. When Tribes were able to provide number of vehicles, Arup used these vehicles as well as proxy data based on the annual average VMT per driver data published at the state level from the Federal Highway Administration[85] data last published in 2019.

Arup used DOE Average Fuel Economy[86] to calculate the gallons of fuel used to travel the annual average miles traveled per vehicle.



Last updated: February 2020
Printed on: October 24

Figure 44: Average Fuel Economy by Vehicle Type

$$Annual\ Gallons\ of\ Gasoline = \frac{[(\#\ passenger\ cars) * (Annual\ VMT\ per\ driver)]}{24.2\ MPG} + \frac{[[(\#\ light\ trucks) * (Annual\ VMT\ per\ driver)]]}{17.5\ MPG} + \frac{[(\#\ heavy\ duty\ trucks) * (Annual\ VMT\ per\ driver)]}{6.5\ MPG}$$

$$Annual\ Gallons\ of\ Diesel = \frac{[(\#\ heavy\ duty\ trucks) * (Annual\ VMT\ per\ driver)]}{6.5\ MPG}$$

In addition to the number of vehicles listed in the original RFI, Arup requested data on number of school buses, transit buses, tractors, and average daily distance traveled. When this data was available, the associated emissions were also calculated. School buses, transit buses, and tractors were all assumed to use diesel fuel.

$$Annual\ Gallons\ of\ Diesel = \frac{(\#\ of\ Vehicle)(Annual\ VMT)}{Vehicle\ MPG^{87}}$$

---

[85] *Highway Statistics 2019.* (2019). US DOT Federal Highway Administration. Retrieved February 24, 2024, from https://www.fhwa.dot.gov/policyinformation/statistics/2019/

[86] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

[87] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

Because many Tribal members use all-terrain vehicles (ATV's), Arup asked Tribes to estimate percentage of population that owned an ATV, and assumed 1,500 miles/year for those that ride ATV's.

$$Annual\ Gallons\ of\ Gasoline = \frac{\left[Tribal\ population * (percent\ of\ population\ with\ an\ ATV) * \left(1{,}500\frac{miles}{year}\right)\right]}{20\ MPG}$$

If a Tribe did not initially provide the number and types of vehicles to be included in the inventory, Arup requested that the Tribes ascertain data from the local Tribal DMV, police or sheriff office, or office of the registrar on vehicles registered within each Tribe. This provides granular data on number of vehicles, average age of vehicle, and vehicle type (light truck, single passenger, EV, etc).

Using both data from the Fleet Manager for fleet-owned vehicles and Tribal DMV data (list of registered vehicles, largely on gasoline), Arup was able to estimate the number of vehicles of each type, particularly light-duty and heavy-duty vehicles, at a high-level for the PCAP.

Waste

Summary of Major Emissions

Oneida Nation no longer has landfill on the Reservation, so there are no emissions included for landfilled waste. Around ~500 people are estimated to be served through septic systems, though the associated emissions are not calculated here.

There were no reported burn barrels used for open burning of waste within the Reservation.

Methodology for Proxy

In this GHG inventory for the PCAP, only Scope 1 emissions associated with waste were included in the inventory. This includes emissions associated with solid waste disposed in landfills *if the landfills are located within the Tribal boundary.* This also includes solid waste generated by the Tribe that is incinerated or burned in the open. This also includes Scope 1 emissions associated with wastewater treatment so long as that treatment is located within the Tribal boundary.

With limited data on the actual make-up of tribal MSW, Arup assumed the U.S. EPA MSW Generation Make-up[88]. This gave assumptions for the fraction of solid waste that was food, garden waste, paper, wood, textiles, and metals.

---

[88] *National Overview: Facts and Figures on Materials, Wastes and Recycling*. (2023, November 22). US EPA. Retrieved February 24, 2024, from https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

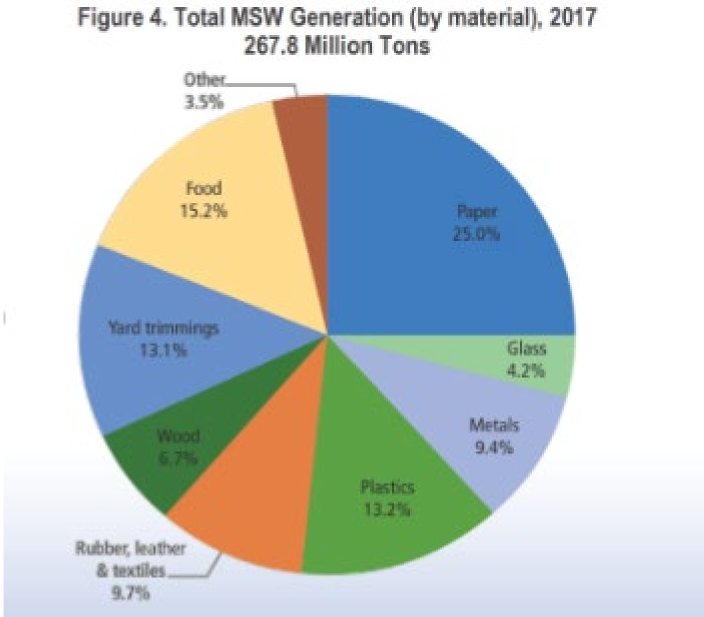


Figure 45: EPA MSW Make-Up

Waste in Landfills

For Tribes that have landfills within the Tribal boundary, there are methane emissions associated with the disposal of waste within the landfill. There are two primary methodologies for calculating methane emissions associated with waste disposal: Methane commitment (MC) and First Order of Decay (FOD). While the First Order Decay methodology is more accurate in calculating emissions associated with a single year, it requires detailed historical data. With only proxy assumptions on the amount of waste disposed of on an annual basis, Arup used the Methane Commitment methodology to calculate methane emissions. This rolls together current and future emissions and treats them as equal.

Using this assumption for typical MSW make-up, as well as the default carbon content values from the Intergovernmental Panel on Climate Change (IPCC), the degradable organic content (DOC) of the MSW was calculated. This allowed calculations of the Methane generation potential of the MSW, and ultimately the associated methane emissions per metric ton of MSW.

Waste Open Burning

Waste open burning is another method of municipal waste disposal that is still practiced within some of the Tribes. Oneida Nation did not have waste open burning to report, so it is excluded from the report.

Wastewater

Oneida Nation serves 576 people through Tribal Aerobic treatment. There are both CH_4 and N_2O emissions associated with wastewater treatment. In order to calculate the CH_4 emissions associated with wastewater treatment, Arup assumed 85 g/person/day[89] for Biochemical Oxygen Demand (BOD), in line with the United States default values per IPCC guidance on wastewater treatment and discharge. Arup assumed no additional industrial wastewater flowing to the Tribal sewers. Methane correction factors vary depending on whether the wastewater treatment system is an untreated system, centralized aerobic, anaerobic, or other septic system. For

---

[89] IPCC - Table 6.4

this initial inventory, the Methane Correction Factor, 0.3[90], corresponds with a centralized aerobic wastewater treatment system. Using these factors, Arup calculated the CH_4 emissions associated with the Tribal population.

To calculate N_2O emissions associated with wastewater treatment, Arup used default values for protein consumed as a fraction of protein supply, 0.80, and assumed the same centralized, aerobic treatment plant[91]. Using these values, as well as the U.S. annual protein supply per capita, 117 grams of protein/day[92], the N_2O emissions were calculated on a per person basis. These values were multiplied by the Tribal population that were being served by the wastewater treatment plant.

Livestock

Summary of Major Emissions

Oneida Nation reported about ~700 livestock across its 2 main farms. The emissions from livestock are larger than emissions from waste but does not compare to the scale of the Buildings and Transportation sectors.

Methodology for Proxy

Livestock production emits both CH_4 and N_2O emissions through manure management, and additional CH_4 emissions through enteric fermentation. The amount of CH_4 released via enteric fermentation is dependent on the number of animals, type of animals, and type and amount of feed consumed. Using default values for livestock from the IPCC Enteric Fermentation Emission Factors and IPCC manure management methane emissions factors for cattle, swine, and buffalo, Arup calculated associated emissions.

Processes for Improved Data Collection for Future Reporting

Future reporting will be improved as the data collection process continues. Many of the Tribes have requested data directly from third parties that have not yet provided data but are likely to be able to provide with more time ahead of the next inventory. This includes electric, gas, and propane utility data from utility companies, vehicle registration data from departments of motor vehicles, ridership numbers for public transportation, wastewater treatment plant data, gas station data on amounts of sold fuel, and data on livestock and emissions associated with agriculture.

Oneida Nation provided the following context regarding land and building leases from the Land Office to support future data collection.

- Oneida Land Office manages 122 commercial leases.
    - 80 leases are just for the land. Building and utilities are responsibility of the lessee.
    - 36 leases are for the land and the building. Utilities are the responsibility of the lessee.
- Oneida Land Office manages 78 agriculture leases, which consist of 255 parcels and 6,430 acres of agricultural leases. About15 businesses + non-profits lease about 100 parcels.

---

[90] IPCC - Table 6.3

[91] IPCC - Table 6.8A, 6.10A

[92] U.S. Protein Supply

Appendix C: Reduction Measure Methodology

Appendix C provides further details regarding measure methodology, including emissions and cost calculations and overall assumptions. Data pertaining to the 8 Tribe subset is included to further detail the methodology used to determine the values for estimates of GHG reductions and costs included within Section 2 of the PCAP report: Priority GHG Reduction Measures.

Renewable Energy Development

While the sector emissions baseline for renewables is 100% of Scope 2 emissions, solar, wind, and hydro measures were allowed to "overproduce" and generate more electricity than the baseline usage. This occasionally led to a higher emissions reduction than the baseline Scope 2 emissions for all Tribes. This approach is meant to encourage renewable energy deployment and realize the potential for Tribes to strive towards "net-zero" emissions with offsets from overproduction of renewables offsetting Scope 1 fuel emissions. For all renewable electricity generation measures, the GHG emissions reductions were determined by determining the avoided emissions of electricity that would have been purchased. An average value of 1,213 lbs CO_2e/ MWh was used, which was determined by taking a weighted average of emissions factors by eGRID region, weighted by the total electricity usage from each region. Table 6 shows the eGRID regions and emissions factors used for the Tribes' inventories and reduction measures.

Table 13: EPA eGRID Regions for Tribes

eGRID Region	**EPA eGRID Emission Factor 2020 (lbCO_2e/MWh)**	**Tribes**
MROW	1,003	Leech Lake, Grand Portage, Fond du Lac, Bad River, Lac Courte Oreilles
MORE	1,592	Ho-Chunk, Oneida (assumed 75% of electricity)
RFCW	1,052	Oneida (assumed 25% of electricity)
Weighted Average (all Tribes)	1,213	All

Solar Photovoltaic

Solar energy is a form of renewable energy that uses photovoltaics to generate power by absorbing energy from sunlight and converting it to electrical energy through semiconductor materials. The generation potential of solar photovoltaic systems on single-family homes and multifamily buildings was calculated using the PVWatts Calculator.[93] An average solar irradiance, representing the amount of sunlight reaching a solar panel, is based on data from Duluth, MN and Wausau, WI in the PVWatts software.

Baseline emissions: All Scope 2 emissions for the Tribes are the baseline for this reduction measure. However, due to the scale of ambition MTERA Tribes have to increase overall renewable generation and strive for "net-

---

[93] *NREL PVWatts Calculator*. (1999). NREL PVWatts. Retrieved January 5, 2024, from https://pvwatts.nrel.gov/

zero" emissions, this measure quantifies emissions reductions that exceed the current total Scope 2 emissions baseline.

Key assumptions:

- 80% of single-family homes install 4 kW solar array; 7,300 single-family homes
- 75% of multifamily buildings install a 50 kW solar array; 270 multifamily buildings
- 60% of commercial buildings install a 50 kW solar array; 459 commercial buildings
- Community-solar: 20 MW solar arrays are installed
- Utility-solar: 90 MW solar arrays are installed
- 16% efficient modules
- DC-to-AC size ratio of 1.1

Emissions Methodology: The National Renewable Energy Laboratory's PVWatts Calculator was used to estimate annual energy production with the 4 kW and 50 kW solar arrays for rooftop solar, 1 MW systems for community solar, and 30 MW systems for utility-scale solar. An average solar irradiance was used between data pertaining to Duluth, MN and Wausau, WI in the PVWatts software.

Emissions Calculation:

Assuming that a 50 kW array produces 64,404 kWh/year using the PVWatts model, and that there is one solar array per building:

$$\underline{Carbon\ Reduction\ from\ Solar\ PVs}$$

$$\left\{\left(energy\ generation\ for\ one\ solar\ array\,\frac{MWh}{array}\right) * \left(amount\ of\ solar\,\frac{arrays}{building}\right) * (amount\ of\ buildings) * \left(EPA\ Grid\ average\ conversion\ factor\,\frac{lbCO2e}{MWh}\right) * \left(conversion\ factor\,\frac{MT\ CO2e}{lb\ CO2e}\right)\right\}$$

$$\left\{\left(64.4\,\frac{MWh}{array}\right) * \left(1\,\frac{array}{building}\right) * (459\ buildings) * \left(1{,}213\,\frac{lbCO2e}{MWh}\right) * \left(\frac{1\ MTCO2e}{2{,}204.62\ lbCO2e}\right)\right\} = \mathbf{16,265\ MTCO2e}$$

The same methodology was done for 4 kW arrays on single-family homes, the 1 MW community-solar arrays, and the 30 MW utility-solar arrays.

Cost Estimate:

Cost assumptions are sourced from the National Renewable Energy Lab (NREL)'s Quarterly Cost Benchmark Report (2022)[94] , with $2,682/kW for residential-scale: below 500 kW, $1,761/kW for community-scale: 500 kW to 20 MW, and $1,161/kW for utility-scale: 20 MW and above. Costs consist of model market price

---

[94] Ramasamy, V., Zuboy, J., Woodhouse, M., O'Shaughnessy, E., Feldman,, D., Desai, J., Walker, A., Margolis, R., and Basore, P. (2023, September). *U. S. solar photovoltaic system and energy storage cost benchmarks, with minimum sustainable price analysis: Q1 2023*. National Renewable Energy Laboratory.

benchmarks including modules, inverters, Energy Balance of System, Structural Balance of System, and soft costs.

$$\left(\frac{\$2{,}682}{kw}\right) * (4\ kW) = \$\mathbf{10{,}728}$$

Wind Energy

Wind Energy is a renewable energy source created by using wind to make electricity through wind turbines. The wind spins the wind turbine's rotors, which in turn spin a generator to generate electricity. This reduction measure considers different scales of wind turbines; distributed wind turbines at the home or buildings scale, community scale wind turbines, and utility scale wind turbines. This measure assumes a capacity factor of 40%, in accordance with the DOE's Land-Based Wind Market Report: 2023 Edition[95].

Baseline emissions: All Scope 2 emissions for the Tribes were the baseline for this reduction measure. However, due to the scale of ambition MTERA Tribes have to increase overall renewable generation and strive for "net-zero" emissions, this measure quantifies emissions reductions that exceed the current total Scope 2 emissions baseline.

Key assumptions:

- Utility wind: 75 MW wind farms are installed
- Community-scale wind: 20 MW wind farms are installed
- Distributed wind:
  - 30% of single-family homes install a 4 kW wind turbine; 2,700 homes
  - 30% of multifamily buildings install a 50 kW wind turbine; 110 buildings
  - 30% of commercial buildings install a 50 kW wind turbine; 230 buildings
- Capacity factor: 40%

Emissions Methodology:

Translating the 40% capacity factor from DOE data[96] into 40% of 24/7 operation (8,760 hours a year), allows us to calculate the total amount of electricity produced – which is then multiplied by the average grid emission factor to determine the amount of emissions reduced.

Emissions Calculation:

$$\begin{aligned} &Reduction\ in\ emissions \\ &\quad = Size\ of\ wind\ turbine\ system * annual\ hours * Capacity\ factor \\ &\quad * number\ of\ installed\ systems * grid\ emissions\ factor \end{aligned}$$

$$25\ MW * 8760\ hours * (40\%) * 3\ wind\ farms * \left(1{,}213\frac{lbCO2e}{MWh}\right) * \left(\frac{1\ MTCO2e}{2{,}204.62\ lbCO2e}\right) = 144{,}594\ MTCO2e$$

---

[95] Department of Energy Office of Energy Efficiency and Renewable Energy. (2023). *Land-Based Wind Market Report: 2023 Edition* (R. Wiser and M. B olinger, Authors).

[96] Department of Energy Office of Energy Efficiency and Renewable Energy. (2023). *Land-Based Wind Market Report: 2023 Edition* (R. Wiser and M. B olinger, Authors).

This same calculation methodology was followed for wind turbines at community scale, and distributed wind at the building scale.

Cost Calculation:

Cost assumptions are sourced from the National Renewable Energy Lab (NREL)'s Cost of Wind Energy Review (2022)[97] Costs provided $8,425/kW for distributed wind below 500 kW, $1,761/kW for community-scale: 500 kW to 20 MW, and $1,161/kW for utility scale: 20 MW and above. These costs do not explicitly consider grid capacity and potential need for transmission infrastructure upgrades to support wind energy generation.

$$Cost\ of\ wind\ turbine\ reduction\ measure = Size\ of\ wind\ turbine * Cost\ per\ kW * number\ of\ systems$$

$$50kW * \frac{\$8{,}425}{kW} * 230\ turbines = \$96{,}887{,}500$$

This same cost methodology would be carried through for the smaller distributed wind, and the larger community and utility scale wind turbines.

Geothermal

Geothermal heat pump systems use the earth's natural heat to provide heating and cooling to a building. They are more energy efficient than the typical air-source heat pump (ASHP) due to the consistent temperature of the ground, unlike air temperature which is constantly changing. The coefficient of performance (COP) of geothermal heat pumps can range from 3.0 – 6.0, which is also much larger than typical ASHPs. There are three types of geothermal heat pump systems: vertical, horizontal, and pond/lake, all of which are space intensive; the system is chosen according to site constraints and feasibility, as it requires extensive site work to install geothermal heat pumps under an existing building.

Baseline emissions: Single-Family, Multifamily, and Commercial Scope 1 emissions for the Tribes were the baseline for this reduction measure.

Key assumptions: Geothermal measure assumptions are summarized in Table 14.

Table 14: Geothermal Reduction Measure Assumptions

	Percent of Application	Number of Buildings/ MF Units	Building Typology Emissions Factor	Geothermal System Size
Single-Family	30%	2,737	4.30 metric tons CO_2e/building	5 tons/building
Multifamily	30%	430	2.32 metric tons CO_2e/unit	5 tons/unit
Commercial	60%	230	25.6 metric tons CO_2e/building	23 tons/building

- Geothermal system size estimate is based on based on Minnesota Geothermal Heat Pump Association analysis, and average home heating load of 60MBH[98]. For multifamily buildings, it is assumed that one unit has the same heating load as a single-family home. For commercial buildings, a sizing estimate of

---

[97] Stehly, T., Duffy, P., and Hernando, D. M. (2023, December). *2022 Cost of Wind Energy Review.* NREL Transforming Energy. Retrieved January 5, 2024, from https://www.nrel.gov/docs/fy24osti/88335.pdf

[98] *Geo vs. Fossil Fuels: How does a Geothermal Heat Pump Stack up against fossil fuels?* (n.d.). Minnesota Geothermal Heat Pump Association. Retrieved February 5, 2024, from https://www.minnesotageothermalheatpumpassociation.com/geothermal/how-geo-compares/

55 Btuh/sf for heating was applied based on industry experience, with representative building square footages assumed to be 5,000 sf for commercial buildings.

- 80% energy savings from geothermal heat pumps translates to an equivalent 80% reduction of baseline Scope 1 emissions.

Emissions Methodology: According to a study by the non-profit RMI and 5 Lakes Energy, geothermal systems in the Midwest result in 80% energy savings[99]. The total Scope 1 emissions for each building typology across all tribes was divided by total number of buildings or units of that building type to develop a carbon emissions factor by building typology, which is used to scale the data accordingly. The total number of single-family, multifamily units, and commercial receiving geothermal retrofits across the Tribes is being used to calculate the total reduction in carbon emissions.

Emissions Calculation:

The equation below can be used for single-family, multifamily, and commercial buildings. The example calculation in blue is for single-family buildings.

$$\underline{Carbon\ Reduction\ from\ Geothermal\ Heatpumps}$$

$$\begin{aligned} &Carbon\ Reduction, Geothermal \\ &\quad = \left\{(amount\ of\ buildings) * \left(building\ typology\ emissions\ factor\,\frac{MT\ CO2e}{building}\right)\right. \\ &\quad \left. * (\%\ energy\ savings\ from\ geothermal\ heatpumps)\right\} \end{aligned}$$

$$Carbon\ Reduction, Geothermal =$$

$$\left\{(2{,}737\ single\ family\ buildings) * \left(4.30\ \frac{MT\ CO2e}{single\ family\ building}\right) * (80\%)\right\} = \mathbf{9{,}419\ MT\ CO_2e}$$

Cost Methodology: The Minnesota Geothermal Heat Pump Association, estimates geothermal heat pump systems cost approximately $5,000/ton, before incentives[100]. This rate is applied to single-family, multifamily, and commercial buildings.

Cost Calculation:

$$\left(\frac{\$5{,}000}{ton}\right) * (5\ ton) * (2{,}737\ single\ family\ buildings) = \$\mathbf{67,500,000}$$

Hydropower

Hydropower is a renewable source of energy that generates power from the use of a dam or other diversion that alters the natural low of a river. Hydropower uses turbines and generators to convert kinetic energy of water

---

[99] Reeg, L., Henchen, M., Potter, C., and Stone, C. (2023, March 29). *Clean Energy 101: Geothermal Heat Pumps*. RMI. Retrieved February 5, 2024, from https://rmi.org/clean-energy-101-geothermal-heat-pumps

[100] *Geo vs. Fossil Fuels: How does a Geothermal Heat Pump Stack up against fossil fuels? (*n.d.). Minnesota Geothermal Heat Pump Association. Retrieved February 5, 2024, from https://www.minnesotageothermalheatpumpassociation.com/geothermal/how-geo-compares/

flowing across the diversion or dam into electricity. This measure focuses on what the DOE considers "small hydropower" at scales between 100 kW and 30 MW[101].

Baseline emissions: All Scope 2 emissions for the Tribes are the baseline for this reduction measure. However, due to the scale of ambition MTERA Tribes have to increase overall renewable generation and strive for "net-zero" emissions, this measure quantifies emissions reductions that exceed the current total Scope 2 emissions baseline.

Emissions Methodology: In order to calculate annual potential electricity generation among Tribes, the U.S. annual average capacity factor from utility scale hydroelectric generators from 2022 was used: 36.3%[102]. Emissions reductions for (5) 1 MW hydroelectric systems was used for this measure. An average of the EPA eGRID emissions factors from both MROW and MORE were used to calculate emissions associated with the annual electricity used for baseline Scope 2 emissions.

Key Assumptions:

- 5 MW Hydroelectric systems are installed
- Hydroelectric capacity factor: 36.3%

Emissions Calculation:

$$\begin{aligned} &Reduction\ in\ emissions \\ &\qquad = Size\ of\ hydroelectric\ generation * Capacity\ factor * number\ of\ installed\ systems \\ &\qquad * grid\ emissions\ factor \end{aligned}$$

$$1\ MW * (36.3\%) * 5\ systems * \left(1{,}213 \frac{lbCO2e}{MWh}\right) * \left(\frac{1\ MTCO2e}{2{,}204.62\ lbCO2e}\right) = 8{,}746\ MTCO2e$$

Cost Methodology:

Cost assumptions are sourced from the National Renewable Energy Lab (NREL)'s Hydropower Cost Tool[103]. Costs assumed non-powered dams and low-cost lakes. These costs do not explicitly consider grid capacity and potential need for transmission infrastructure upgrades to support hydropower energy generation.

Cost Calculation:

$$Cost\ per\ kW * Size\ of\ system * Number\ of\ systems$$

$$\frac{\$2{,}574}{kw} * 1{,}000\ kW * 5 = 12{,}870{,}000$$

Energy Resilience

Solar Microgrids

Microgrids collect, store, and distribute energy. Solar microgrids are microgrids that are supplied by solar energy. The solar panels connected to a microgrid provide energy for either direct use by buildings that are

---

[101] Water Powers Technologies Office. (n.d.). *Types of Hydropower Plants*. Office of Energy Efficiency and Renewable Energy. Retrieved January 5, 2024, from https://www.energy.gov/eere/water/types-hydropower-plants

[102] *Table 6.07.B. Capacity Factors for Utility Scale Generators Primarily Using Non-Fossil Fuels.(n.d.).* EIA Electric Power Monthly. https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_b

[103] Annual Technology Baseline. (2022, July 21). NREL Hydropower. Retrieved January 5, 2024, from https://atb.nrel.gov/electricity/2022/hydropower

connected to the microgrid or to batteries for storage and use later on. Microgrids reduce emissions to a greater degree than solar photovoltaic (PV) systems alone by providing renewable energy that can be used during times when the electric grid has a high emission factor from generating electricity using fossil fuels.

Baseline emissions: All Scope 2 emissions for the Tribes are the baseline for this reduction measure. However, due to the scale of ambition MTERA Tribes have to increase overall renewable generation and strive for "net-zero" emissions, this measure quantifies emissions reductions that exceed the current total Scope 2 emissions baseline.

Emissions Methodology: GHG Emissions reductions are quantified in two ways: first from the solar energy generated and directly used to offset electricity use from the grid, and secondly from the solar energy stored in batteries and used later when the grid is at its dirtiest. It is assumed that half of the solar energy generated is used directly at the time of generation, while the other half is stored and used later in the day during which the grid has a higher emissions factor. For the first portion of GHG reductions from direct use of solar energy, the average grid emissions factor is used to calculate the avoided emissions of electricity that would have been used from the grid. For the second portion of battery-stored energy a higher grid emissions factor, 10% higher than the average, is used.

The 10% higher grid emissions factor was determined by analyzing a DOE dataset of hourly eGRID emissions factors [104]. By averaging monthly data by hour across the year and comparing the maximum and minimum hourly values, a % difference value is calculated for each eGRID region, ranging from 7-13% between the MROW, MROW, and RFCW regions. This % difference between the lowest and highest emissions factors is used as a proxy for determining the higher grid emissions factor to apply when the battery discharges when the grid is dirtiest. To account for grid differences across different eGRID regions, a weighted average of these % is taken weighted on total energy usage, leading to a 10% factor used for this analysis.

Key Assumption:

- Battery storage is paired with on-site solar
- 4 hours of storage per battery
- Microgrid controls are installed to devote 50% of solar generation to charge the battery and discharge during the hours when the grid has the highest emissions factor
- 200 MW microgrids are installed
- There is a 10% GHG savings relative to average grid emissions factor for battery energy discharge based on time-of-use (TOU) during periods of higher grid emissions.

Emissions Calculation:

$$\begin{aligned} &\mathit{Reduction\ in\ emissions} \\ &\quad = \mathit{grid\ emissions\ avoided\ from\ direct\ use\ of\ solar\ energy} \\ &\quad + \mathit{grid\ emissions\ avoided\ from\ use\ of\ stored\ solar\ energy} \end{aligned}$$

$$\begin{aligned} &\mathit{Grid\ emissions\ avoided\ from\ direct\ use\ of\ solar\ energy} \\ &\quad = (\mathit{annual\ solar\ generation}) * (\mathit{number\ of\ microgrids}) \\ &\quad * (\%\ \mathit{energy\ stored\ in\ battery}) * (\mathit{average\ grid\ emissions\ factor}) \end{aligned}$$

$$\begin{aligned} &\mathit{Grid\ emissions\ avoided\ from\ use\ of\ solar\ stored\ energy} \\ &\quad = \mathit{Energy\ sent\ to\ battery} * \mathit{average\ grid\ emissions\ factor} * 110\% \end{aligned}$$

---

[104] *EPA eGrid Emission Factors*. (2022, January). Retrieved January 5, 2024, from https://www.epa.gov/egrid

$$\left\{\left(13{,}307\frac{MWh}{year}\right)*20\ microgrids*50\%*\left(1{,}213\frac{lbCO2e}{MWh}\right)*\left(\frac{1\ MT}{2{,}204.63\ lb}\right)\right\}-\left\{\left(13{,}307\frac{MWh}{year}\right)*20\ microgrids*50\%*\left(1{,}213\frac{lbCO2e}{MWh}\right)*110\%\left(\frac{1\ MT}{2{,}204.63\ lb}\right)\right.=153{,}903\ \mathrm{MTCO_2e}$$

Cost Calculation:

Cost assumptions are sourced from the National Renewable Energy Lab (NREL)'s Quarterly Cost Benchmark Report (2022)[105] Costs provided $2,944/kW for community-scale: 500 kW to 20 MW, and $2,106/kw for utility-scale: 20 MW and above. Costs consist of model market price benchmarks including modules, inverters, Energy Storage System, Energy Balance of System, Structural Balance of System, and soft costs.

$$Cost\ per\ kW*Size\ of\ system*Number\ of\ systems$$

$$\frac{\$2{,}944}{kw}*10{,}000\ kW*20=\$588{,}800{,}000$$

Building Level Solar + BESS

Building level solar, paired with Battery Energy Storage Systems (BESS), are designed for smaller-scale installations. This measure is meant for smaller solar and storage systems integrated at the building scale. Its emissions methodology is identical to that of the preceding Solar Microgrids measure.

Cost Calculation:

Cost assumptions are sourced from the National Renewable Energy Lab (NREL)'s Quarterly Cost Benchmark Report (2022)[106], with $2,944/kW for community-scale solar microgrids between 500 kW and 20MW and $4,702/kW for residential-scale below 500 kW. Costs consist of model market price benchmarks including modules, inverters, Energy Storage System, Energy Balance of System, Structural Balance of System, and soft costs.

$$Cost\ per\ kW*Size\ of\ system*Number\ of\ systems$$

$$\frac{\$2{,}944}{kw}*1{,}000\ kW*40=\$117{,}760{,}000$$

Reducing Emissions from Building Energy Consumption

Building Retrofits & Energy Conservation Measures

Electrification of Heating Equipment

Residential and commercial heating can be a large source of emissions. Many buildings are heated using combustion-based equipment and if the system is older, it can often be inefficient, leading to further energy consumption. Transitioning from combustible fuels for heating involves replacing existing equipment with all-

---

[105] Ramasamy, V., Zuboy, J., Woodhouse, M., O'Shaughnessy, E., Feldman,, D., Desai, J., Walker, A., Margolis, R., and Basore, P. (2023, September). *U .S. solar photovoltaic system and energy storage cost benchmarks, with minimum sustainable price analysis: Q1 2023*. National Renewable Energy Labora tory.

[106] Ramasamy, V., Zuboy, J., Woodhouse, M., O'Shaughnessy, E., Feldman,, D., Desai, J., Walker, A., Margolis, R., and Basore, P. (2023, September). *U .S. solar photovoltaic system and energy storage cost benchmarks, with minimum sustainable price analysis: Q1 2023*. National Renewable Energy Labora tory.

electric systems, such as heat pumps. Heat pumps are significantly more efficient than other heating systems due to their ability to utilize existing heat, making them a valuable heating choice for higher efficiency and emissions reductions.

Baseline emissions: All Scope 1 Building Fuel emissions for the Tribes are the baseline for this reduction measure.

Key Assumptions: Heating equipment fuel efficiency was assumed per Table 15.

Table 15: Assumed Heating Equipment Efficiency

Fuel Use	**COP (Efficiency)**	**Conversion (kWh equivalent)**
Natural Gas (therms)	0.8	29.3
Fuel Oil (gallons)	0.6	40.6
Propane (gallons)	0.8	27
Wood (cords)	0.7	3690
Electric Heat Pump	**3.97**	

- 60% of buildings retrofit to heat pumps, which results in ~5500 single-family homes, ~860 multifamily units, and ~460 commercial buildings undergoing this measure
- 1 heat pump per residential unit
- 1 system per commercial building
- Default commercial building is 5,000 SF

Emissions Methodology: To quantify the reduction of Scope 1 emissions through electrification of heating equipment, a standard COP for typical heating systems was applied for each of the following fuel uses: natural gas (0.8), fuel oil (0.6), propane (0.8), wood stove (0.7), and electric heat pump (3.97). While there are electric resistance heating systems with a COP of 1.0, this reduction measure focuses on upgrading all existing combustion heating systems to heat pump systems, which are significantly more efficient than electrical resistance and combine both heating and cooling capabilities in one system.

To calculate the percent reduction in Scope 1 emissions, a given tribe's total natural gas (therms), fuel oil (gallons), propane (gallons), and wood stove (cords) calculated in the GHG Inventory are converted from their respective units to kWh usage so that the energy used for heating by different systems can be compared. The fuel usage for each fuel type becomes the baseline values to compare any reductions from electrification.

To calculate the energy needed for an electric heat pump to match the same amount of heating as the baseline fuel system, the energy used for each fuel type is multiplied by the respective fuel-based COP and divided by the electric heat pump COP. The electric heat pump COP used is 3.97[107], representative of high-performing heat pumps in the Midwest climate.

This energy use from electrification is then converted into kWh for comparison with the baseline. A percent reduction in energy use is calculated for each fuel type by comparing the baseline energy use and "electrified

---

[107] Reeg, L., and Mifsud, A. S. (2022, May 27). *Heat Pumps in Cold Places: Three Questions Wisconsinites Are Asking about Heat Pumps*. Retrieved January 5, 2024, from https://rmi.org/ three-questions-wisconsinites-are-asking-about-heat-pumps/

equivalent" energy use. This percent reduction of energy for each heating system conversion is equal to the percent reduction of emissions.

Emissions Calculations:

For each fuel type:

$$\begin{aligned} &Energy\ use\ for\ Electrified\ System(kWh)\ \ for\ each\ fuel\ type \\ &= Tribal\ energy\ use\ (source\ unit) * \frac{kWh\ equivalent}{source\ unit} * \frac{COP\ original\ heating\ system}{3.97\ (COP, heat\ pump)} \end{aligned}$$

Emissions Reduction from each fuel use conversion:

$$\%\ Emission\ Reduction, from\ converting\ each\ fuel\ based\ system = \%\ Energy\ Reduction\ from\ Electrification$$

$$\begin{aligned} &= 100\% *\ [baseline\ tribal\ energy\ use\ (kWh) \\ &\qquad - energy\ use\ from\ Electrified\ system\ (kWh)]\ /\ baseline\ tribal\ energy\ use\ (kWh) \end{aligned}$$

Example with Natural Gas (assuming 100,000 therms used annually):

$$\begin{aligned} &Energy\ use\ for\ Electrified\ System(kWh), for\ each\ fuel\ type \\ &= 100{,}000\ therms * \frac{29.3\ kWh}{1\ therm} * \frac{0.8}{3.97\ (COP, heat\ pump)} = \mathbf{590, 428}\ \boldsymbol{kWh} \end{aligned}$$

$$\begin{aligned} &\%\ Energy\ Reduction\ from\ Electrification \\ &= 100\% * \frac{\left[100{,}000\ therms * \frac{29.3\ kWh}{1\ therm} - 590{,}428\ kWh\ electrified\ quiavelent\right]}{100{,}000\ therms * \frac{29.3\ kWh}{1\ therm}} \end{aligned}$$

$$= \mathbf{80\%}\ \boldsymbol{savings\ for\ natural\ gas}$$

This savings % calculation is replicated for each combustion heating source– giving highest values for wood heating (99%), followed by fuel oil (89%), natural gas (80%), and propane (78%). The measure assumes a mix of baseline heating by fuel type, so the total percent reduction for the measure is an average of emissions reductions from electrifying heating equipment across all fuel types. The percent reduction for each Tribe based on their fuel usage reported in the GHG inventory was averaged across all Tribes for the PCAP; that value was **87% -** which is used as the overall % GHG reduction for heating electrification across all existing combustion heating sources.

For each Tribe, the amount of Scope 1 carbon emissions (metric tons CO_2e) per residential building and per commercial building (taken from the GHG inventory) are used as a scaling factor to calculate the total emissions that would occur as a baseline for reduction. Then, the average percent reduction specific to the Tribe across all heating types is used to calculate the metric tons of CO_2e that would be saved from electrification of those buildings.

$$\begin{aligned} &Total\ Emissions\ Reduced\ (MT\ CO2e) \\ &= Total\ Number\ of\ Buildings * \left(Scope\ 1\ building\ emissions\ factor \frac{MT\ CO2e}{building}\right) \\ &*\ \%\ Reduction \end{aligned}$$

$$\left[(5474\ homes + 860\ multifamily\ units) * \frac{4.0\ MT\ CO2e}{residential\ building} + (459\ commercial\ buildings) * \frac{28\ MT\ CO2e}{commercial\ building}\right] * 87\%\ Reduction = 33{,}311\ MT\ CO2e$$

Cost: In order to calculate cost, a case study of heat pump replacement in both a single-family home and commercial office building in Colorado was chosen to represent the cost per system [108]. The cost for a residential system (inclusive of installation) was $20,400, and the cost of a commercial system for a 28,000 sq. ft. building was $241,200. The residential cost was used as is, while the commercial cost was scaled down by square footage to get a cost per sq. ft, which was $8.61/sq. ft. The cost per sq. ft. was used to scale up the cost to the size of the default commercial building assumed in the GHG Inventory (5,000 sq. ft.).

Cost Estimate:

$$Total\ Cost, Residential\ (\$) = \frac{\$20{,}400}{heat\ pump} * \frac{1\ pump}{home}(\ homes + multifamily\ units)$$

$$\frac{\$20{,}400}{heat\ pump} * \frac{1\ pump}{home} * (5474\ homes + 860\ multifamily\ units) = \$\ \mathbf{129{,}000{,}000}$$

$$Total\ Cost, Commercial\ (\$) = \frac{\$8.61}{sq.ft} * 5000\ sq.ft. * \frac{1\ pump}{building} * no.commercial\ buildings$$

$$\frac{\$8.61}{sq.ft} * 5000\ sq.ft. * \frac{1\ pump}{building} * 459\ commercial\ buildings = \$\mathbf{19{,}800{,}000}$$

Installation of High-Efficiency Appliances

Residential electricity use is made up of many components, including appliances used daily for cooking, cleaning, and cooling. These appliances include refrigerators, dishwashers, washing machines, clothes dryers, and air conditioning, among others. Installing newer appliances that are more energy- and water-efficient or abide by higher efficiency standards and certifications, such as EnergyStar rating, can help conserve energy and reduce emissions.

Baseline emissions: All Residential Building (single-family and multifamily) Scope 2 Electricity emissions for the Tribes are the baseline for this measure.

Key Assumptions:

- 60% of residential buildings install high-efficiency appliances, which results in ~5500 single-family homes and ~860 multifamily units undergoing this measure
- Includes the following appliances: refrigerator, dishwasher, washing machine, clothes dryer, and air conditioning unit
- Only one of each appliance type assumed per home/unit
- Average Scope 2 emissions/residential unit used as scaling factor from the GHG Inventory

---

[108] Group14 Engineering, PBC. (2020, November). *Electrification of Commercial and Residential Buildings* [White paper]. Building Decarbonization Coalition. Retrieved January 5, 2024, from https://buildingdecarb.org/wp-content/uploads/Building-Electrification-Study-Group14-2020-11.09.pdf

Emissions Methodology: To estimate the emissions reductions for high-efficiency appliances, the energy savings from each appliance and percent contribution to residential electricity were used to generate a percent energy reduction per appliance, then summed to get an overall percentage estimate for total energy and therefore emissions reduction potential. The basis for energy savings per appliance came from the DOE's resources for various appliances (see table below), and an appliance's contribution to residential electricity used was sourced from the EIA's 2020 Residential Energy Consumption Survey.[109]

$$\begin{aligned} &Energy\ savings\ per\ appliance \\ &\qquad = Energy\ savings\ from\ installing\ high\ efficiency\ appliances\ (\%) \\ &\qquad * \ appppliance\ \%\ contribution\ to\ overall\ Residential\ Electricity \end{aligned}$$

$$Energy\ savings\ total = Sum\ (energy\ savings\ of\ each\ appliance)$$

Table 16: Energy Savings From Appliances

Appliance	Energy Savings from Installing Higher-Efficiency Appliances	Appliance's Contribution to Scope 2 Energy[110]	Total Energy Savings for Electricity
Refrigerator	12.0%[111]	0.7%	0.1%
Dishwasher	9.0%[112]	7.9%	0.7%
Washing Machine	25.0%[113]	0.5%	0.1%
Clothes Dryer	20.0%[114]	4.3%	0.9%
Air Conditioning	20.0%[115]	19.4%	3.9%
		Total Measure Savings	**6%**

Total baseline emissions are calculated from the input of total residential units upgraded multiplied by the average Scope 2 emissions/building (used as scaling factor) from the GHG Inventory. The emissions reduction potential was then applied to total GHG residential Scope 2 GHG emissions to get the metric tons of CO_2e saved.

Emissions Calculation:

---

[109] *Use of energy explained: Energy use in homes*. (2023, December 18). U.S. Energy Information Administration. Retrieved January 5, 2024, from https://www.eia.gov/energyexplained/use-of-energy/electricity-use-in-homes.php

[110] ibid

[111] *Consumer Guide to Kitchen Appliances*. (n.d.). Energy Saver, US Department of Energy. Retrieved January 5, 2024, from https://www.energy.gov/sites/default/files/2021-08/ES-KitchenAppliances_080221.pdf

[112] ibid

[113] *Laundry*. (n.d.). Energy Saver, US Department of Energy. Retrieved January 5, 2024, from https://www.energy.gov/energysaver/laundry

[114] ibid

[115] *Save Money and Stay Cool with an Efficient, Well-Maintained Air Conditioner* [Fact sheet]. (2022, June 30). Energy Saver, US Department of Energy. Retrieved January 5, 2024, from https://www.energy.gov/energysaver/articles/save-money-and-stay-cool-efficient-well-maintained-air-conditioner; used lowest value in estimated range of reductions to avoid overestimating for weatherization/energy savings measures.

$$\begin{aligned} &Emissions\ saved \\ &\quad = Number\ of\ residential\ housing\ units \\ &\quad * \left(Scope\ 2\ building\ emissions\ factor \frac{MT\ CO2e}{building}\right) * \%\ Electricity\ Savings\ (6\%) \end{aligned}$$

$$(5474\ homes + 860\ multifamily\ units) * \frac{4.4\ MT\ CO2e}{residential\ unit} * 6\% = 1590\ MT\ CO2e\ saved$$

Cost Methodology: The basis of cost for high-efficiency appliances comes from a Lawrence Berkeley National Laboratory database of residential retrofit cost data and resulting energy savings, which includes high-efficiency appliance upgrades.[116] The reported installed cost of each appliance per home is the following:

Table 17: Cost of Appliance Upgrades

Appliance	**Reported Installed Cost for Upgrade ($ per appliance)**[117]
Refrigerator	$1092
Dishwasher	$643
Washing Machine	$1791
Clothes Dryer	$1966
Air Conditioning	$5930
TOTAL	**$11,422**

In total, doing a full upgrade to higher-efficiency appliances costs $11,422/home, assuming only one of each appliance type per home. This is multiplied by the number of single-family homes and multifamily units undergoing this measure.

Cost Estimate:

$$Total\ Cost\ (\$) = \frac{\$11{,}422}{retrofitted\ home\ or\ unit} * (\ homes + multifamily\ units)$$

$$\frac{\$11{,}422}{retrofitted\ home\ or\ unit} * (5474\ homes + 860\ multifamily\ units) = \$\mathbf{72{,}300{,}000}$$

Installation of Low-Flow Fixtures

Low-flow fixtures are specifically designed plumbing components that help reduce the flow rate of water in order to reduce water waste in relevant applications, such as sink or kitchen faucets, and showerheads. Reducing water waste helps conserve water, which also reduces the amount of energy needed to heat water, providing energy and cost savings.

---

[116] Less, B. D., Walker, I. S., Casquero-Modrego, N., and Rainer, L. I. (2021, August). *The Cost of Decarbonization and Energy Upgrade Retrofits for US Homes*. Lawrence Berkeley National Laboratory. Retrieved January 22, 2024, from https://eta-publications.lbl.gov/sites/default/files/final_walker_-_the_cost_of_decarbonization_and_energy.pdf

[117] ibid

Baseline emissions: All Residential Building (single-family and multifamily) Scope 1+2 emissions for the Tribes are the baseline for this measure.

Emissions Methodology: The basis of emissions reductions from low-flow fixtures come from an EPA source on faucets[118] and showerheads.[119] The flow rate savings between standard and low-flow fixtures (in gallons per minute) was utilized to understand hot water savings per fixture.

$$Percent\ Hot\ Water\ Savings, for\ each\ fixture\ type$$
$$= 100\% * \left\{ \frac{\left(Standard\ flow\ rate\,\frac{gallons}{minute} - low - flow\ rate\,\frac{gallons}{minute} \right)}{Standard\ flow\ rate\,\frac{gallons}{minute}} \right\}$$

Table 18: Low-Flow Fixture Water Savings

	Low Flow (gpm)	Standard Flow (gpm)	Saved gpm	Savings %
Showerheads	2.0	2.5	0.5	**20%**
Bathroom Faucets	1.5	2.2	0.70	**32%**

To understand the total impact on annual hot water savings per residential unit, we first need to estimate the total % of hot water usage that comes from showerheads versus bathroom faucets, since each are used for different amounts of time throughout the year. Values of 86% for hot water usage from showerheads and 14% from faucets were back-calculated based on estimated annual water savings from the same EPA source and fixture flowrates.

Table 19: Percentage of Hot Water Savings by Fixture

	Saved gallons per Year	Total Min use (Based on saved gpm)	Annual Gal (based on standard gpm)	% of Total Hot Water Usage
Showerheads	2,700 [120]	5,400	13,500	**86%**
Bathroom Faucets	700 [121]	1,000	2,200	**14%**
Total Hot Water Use		6,400	15,700	

To determine total hot water % reduction, the weighted average of the fixture hot water savings (20 & 30%) were weighted by their respective % of total hot water usage annually (86% and 14%)

---

[118] *Bathroom Faucets*. (2023, May 8). WaterSense, Environmental Protection Agency. Retrieved November 20, 2024, from https://www.epa.gov/watersense/bathroom-faucets

[119] Showerheads. (2023, May 5). WaterSense, Environmental Protection Agency. Retrieved November 20, 2024, from https://www.epa.gov/watersense/showerheads

[120] ibid

[121] *Bathroom Faucets*. (2023, May 8). WaterSense, Environmental Protection Agency. Retrieved November 20, 2024, from https://www.epa.gov/watersense/bathroom-faucets

$$
\begin{aligned}
&Weighted\ Average\ Emissions\ Savings\ (\%) \\
&\qquad = \%\, reduction, low\ flow\ facuets * \%\, faucet\ contribution\ to\ hot\ water\ heating \\
&\qquad + \ \%\, reduction, low\ flow\ showerheads \\
&\qquad * \%\, showerhead\ contribution\ to\ hot\ water\ heating
\end{aligned}
$$

The weighted average calculation resulted in an estimate of 22% combined savings in hot water from the low-flow fixtures.

According to a 2018 study by the Center for Climate and Energy Solutions,[122] hot water heating typically makes up 15% of a building's Scope 1 & 2 Emissions[123], leading to the final estimate of GHG reduction as 15% of total emissions multiplied by the 22% hot water savings.

The number of buildings upgraded is multiplied by the average Scope 1 & 2 emissions per building (used as a scaling factor for approximate baseline emissions), then multiplied by the percent reduction (22% emissions) and the contribution of residential water heating emissions to Scope 1 and 2 emissions overall (15%) to generate metric tons of CO_2 saved from reduced hot water heating.

Key Assumptions:

- 60% of residential buildings install low flow fixtures, which results in ~5500 single-family homes and ~860 multifamily units undergoing this measure
- Low-flow fixtures include low-flow faucet aerators & low-flow showerheads
- Water heating ~15% of Scope 1 & 2 residential emissions
- 4 units or "homes" per multifamily building
- 2 showers and 4 faucets (6 fixtures) per single-family home

Emissions Calculation:

$$
\begin{aligned}
&Emissions\ saved \\
&\qquad = \#\ of\ MF\ units\ and\ residential\ buildings * Scope\ 1\&2 \frac{emissions}{bldg} \\
&\qquad * \ 15\%\ of\ Scope\ 1\&2\ emissions\ from\ hot\ water\ heating\ * \\
&\qquad * 22\%\ hot\ water\ savings\ from\ low\ flow\ fixtures
\end{aligned}
$$

$$
(5474\ homes + 860\ multifamily\ units) * \frac{5.9\ MT\ CO2e}{residential\ unit} * 15\% * 22\% = 1700\ MT\ CO2e\ saved
$$

Cost Methodology: The cost basis for this measure comes from a U.S. Housing and Urban Development (HUD) resource guide on retrofitting apartment buildings.[124] This resource estimates the cost of installing low-flow faucet aerators and low-flow showerheads at \$2/fixture retrofit and \$11/fixture retrofit, respectively. Assuming 2

---

[122] Leung, J. (2018, July). DECARBONIZING U.S. BUILDINGS. Center for Climate and Energy Solutions. Retrieved November 19, 2023, from https://www.c2es.org/wp-content/uploads/2018/06/innovation-buildings-background-brief-07-18.pdf

[124] Water Resources Engineering, Inc. (2002, May). *Retrofitting Apartment Buildings to Conserve Water*. HUD User, U.S. Department of Housing and Urban Development. Retrieved January 20, 2024, from https://www.huduser.gov/publications/pdf/Book2.pdf

showers and 4 faucets for a single-family home, the total cost is $30/home or unit. These costs include installation/labor (low level of effort required).

Cost Estimate:

$$Cost\ per\ Home\ (\$) = \left(\frac{\$2}{faucet}) * 4\ faucets + \frac{\$11}{showerhead} * 2\ showerheads\right) = \frac{\$30}{home\ retrofit}$$

$$Total\ Cost\ (\$) = \frac{\$30}{retrofitted\ home\ or\ unit} * (\,homes + multifamily\ units)$$

$$\frac{\$30}{retrofitted\ home\ or\ unit} * (5474\ homes + 860\ multifamily\ units) = \$\mathbf{190,000}$$

Interior & Exterior Lighting Upgrade to LEDs

LED light bulbs are the most efficient compared to available lightbulbs on the market, such as incandescent and CFL light bulbs. Switching to LED light bulbs is a relatively easy energy efficiency measure that has a significant impact on a building's energy use, particularly for commercial buildings.

Baseline emissions: All Residential Building (single family and multifamily) Scope 1+2 emissions for the Tribes are the baseline for residential lighting upgrades, and all Commercial Scope 1+2 emissions for the Tribes are the baseline for commercial lighting upgrades.

Key Assumptions:

- 100% of interior & exterior lighting of all buildings retrofit to LEDs; 9,124 single family buildings, 1433 multifamily units, 765 office buildings
- Both interior and exterior lighting upgrades are completed for commercial buildings
- Default commercial building is 5,000 SF (inclusive of square footage for exterior lighting)

Emissions Methodology (residential):

For residential lighting, state-level NREL SLOPE data on annual electricity [125] and fuel savings [126] from each upgrade was downloaded for the state of Minnesota and Wisconsin.

For residential lighting, the energy savings data available was for electricity (GWh/year) and fuel (TBtu/year). The number of housing units per state was obtained from the 2022 U.S. Census data, [127] and the both the electricity and fuel savings are divided by number of housing units to get a scaling factor that can be used with the number of units that are planned to receive lighting upgrades. The total electricity savings in MWh and total

---

[125] National Renewable Energy Laboratory. *Energy Efficiency – Single Family Home Electricity Savings Potential*. (n.d.). State and Local Planning for Energy. Retrieved December 12, 2023, from https://maps.nrel.gov/slope/data-viewer?filters=%5B%5D&layer=resstock.single-family-home-electricity-savings-potential&year=2017&res=state&energyBurdenPcnt=0.06&transportationBurdenPcnt=0.04&sviTheme=mn&sviPcntl=0

[126] National Renewable Energy Laboratory. *Energy Efficiency – Single Family Home Fuel Savings Potential*. (n.d.). State and Local Planning for Energy. Retrieved December 12, 2023, from https://maps.nrel.gov/slope/data-viewer?filters=%5B%5D&layer=resstock.single-family-home-fuel-savings-potential&year=2017&res=state&energyBurdenPcnt=0.06&transportationBurdenPcnt=0.04&sviTheme=mn&sviPcntl=0

[127] *QuickFacts: Michigan*. (n.d.). United States Census Bureau. Retrieved December 15, 2023, from https://www.census.gov/quickfacts/fact/table/MI; *QuickFacts: Minnesota*. (n.d.). United States Census Bureau. Retrieved December 15, 2023, from https://www.census.gov/quickfacts/fact/table/MN; *QuickFacts: Wisconsin*. (n.d.). United States Census Bureau. Retrieved December 15, 2023, from https://www.census.gov/quickfacts/fact/table/WI

fuel savings in TBtu are then converted to carbon emissions savings in kgCO2e using an EPA Emissions factor.[128] Finally, total savings are converted to metric tons CO2e.

Emissions Calculation (residential):

$$\underline{Residential\ Buildings}$$

$$\begin{aligned}
&Total\ Emissions\ Reduction, Residential\\
&= \Bigg\{(number\ of\ single\ family + (number\ of\ multifamily\ units))\\
&* \Bigg\{\left(\left(fuel\ savings\,\frac{tBtu}{house}\right) * \left(conversion\ factor\,\frac{MWh}{tBtu}\right)\right)\\
&+ \left(\left(electricity\ savings\,\frac{GWh}{house}\right) * \left(conversion\ factor\,\frac{MWh}{GWh}\right)\right)\Bigg\}\\
&* \left(conversion\ factor\ \frac{tonnes\ CO2e}{MWh}\right)\Bigg\}
\end{aligned}$$

$$\begin{aligned}
&Total\ Emissions\ Reduction, Residential\\
&= \Bigg\{(9{,}124 + 1433)\\
&* \Bigg\{\left(\left(-0.00000076\,\frac{tBtu}{house}\right) * \left(293{,}071\,\frac{MWh}{tBtu}\right)\right) + \left(\left(0.000368\,\frac{GWh}{house}\right) * \left(1{,}000\,\frac{MWh}{GWh}\right)\right)\Bigg\}\\
&* \left(0.550\ \frac{MT\ CO2e}{MWh}\right)\Bigg\} = \mathbf{840\ MT\ CO2e}
\end{aligned}$$

Emissions Methodology (commercial):

For commercial lighting upgrades, state-level NREL SLOPE data on annual electricity[129] and fuel savings[130] from each upgrade were applied for the state of Minnesota and Wisconsin.

For commercial lighting, the percent energy savings data available was for electricity (%) and fuel (%). The Scope 1 and Scope 2 emissions from all commercial buildings in the Tribe is divided by number of commercial buildings to get a scaling factor for each fuel type. This factor is then applied to the input number of buildings that are planned to receive lighting upgrades to calculate a baseline amount of carbon emissions from existing buildings. This baseline is multiplied by the electric and fuel percent savings to get total number of carbon emissions saved from lighting upgrades.

Emissions Calculation (commercial):

---

[128] *Emissions factors for greenhouse gas inventories.* (2023, September 12). EPA Center for Corporate Climate Leadership. https://www.epa.gov/system/files/documents/2023-03/ghg_emission_factors_hub.pdf

[129] National Renewable Energy Laboratory. *Energy Efficiency – Commercial Electricity Savings Potential.* (n.d.). State and Local Planning for Energy. Retrieved December 12, 2023, from https://maps.nrel.gov/slope/data-viewer?filters=%5B%5D&layer=comstock.electricity-savings-potential&year=2012&res=state

[130] National Renewable Energy Laboratory. *Energy Efficiency – Commercial Natural Gas Savings Potential.* (n.d.). State and Local Planning for Energy. Retrieved December 12, 2023, from https://maps.nrel.gov/slope/data-viewer?filters=%5B%5D&layer=comstock.gas-savings-potential&year=2012&res=state

Commercial Buildings

$$\begin{aligned} &Total\ Emissions\ Reduction, Commercial \\ &\quad = \Big\{(number\ of\ commercial\ buildings) \\ &\quad * \left(Scope\ 2\ building\ emissions\ factor \frac{MT\ CO2e}{building}\right) * (\%\ electricity\ savings)\Big\} \end{aligned}$$

$$Total\ Emissions\ Reduction, Commercial = \left\{(765) * \left(90\ \frac{MT\ CO2e}{building}\right) * (10\%)\right\} = \textbf{7,500 MT CO2e}$$

Cost Methodology: The basis of cost for residential interior lighting upgrades comes from a Lawrence Berkeley National Laboratory database of residential retrofit cost data and resulting energy savings, including a ~$144 median cost per home for lighting upgrades. [131]

For commercial lighting upgrades (both interior and exterior), the basis of cost was the median of the premium cost per square foot provided by the EPA, which was $1.05/sq. ft. [132] This cost was applied to a 5,000 square foot building for an estimated $5250 per commercial building for interior and exterior lighting upgrades.

Cost Estimate:

$$Total\ Cost\ (\$) = Cost\ per\ home\ or\ building\ *\ number\ of\ buildings$$

$$Total\ Cost, Residential\ (\$) = \frac{\$143.39}{home} * (5474\ homes + 1433\ multifamily\ units) = \$\mathbf{1,510,000}$$

$$Total\ Cost, Commercial\ (\$) = \frac{\$5,250}{building} * 459\ commercial\ buildings = \$\mathbf{4,016,250}$$

Building Weatherization Retrofits

Weatherization is a series of energy efficiency retrofits that apply to a building envelope to reduce air infiltration and increase thermal resistance, to protect the interior of the building from exterior weather and temperature. Reducing air infiltration and adding insulation allows for a more stable indoor temperature, and therefore reduces the heating and cooling loads for buildings. This leads to a significant amount of energy savings and emissions reduction.

Baseline emissions: All residential buildings (single-family and multifamily) Scope 1+2 emissions for the Tribes are the baseline for Residential Weatherization, and all Commercial Scope 1+2 emissions for the Tribes are the baseline for Commercial Weatherization.

Key Assumptions:

- 60% of buildings to weatherize; ~5,500 single-family homes, ~860 multifamily units, ~460 commercial buildings
- Default commercial building is 5,000 SF

---

[131] Less, B. D., Walker, I. S., Casquero-Modrego, N., & Rainer, L. I. (2021, August). *The Cost of Decarbonization and Energy Upgrade Retrofits for US Homes*. Lawrence Berkeley National Laboratory. Retrieved January 22, 2024, from https://eta-publications.lbl.gov/sites/default/files/final_walker_-_the_cost_of_decarbonization_and_energy.pdf

[132] *Rules of Thumb, Energy Efficiency in Buildings*. (2016, March). Environmental Protection Agency. Retrieved January 22, 2024, from https://www.epa.gov/sites/default/files/2016-03/documents/table_rules_of_thumb.pdf

- Based on MTERA observations that Tribal single-family homes are assumed to be less efficient than state averages, the increase in energy efficiency is expected to be 130% more than the standard residential calculation

Emissions Methodology (Residential): For residential weatherization, NREL SLOPE data on annual electricity[133] and fuel savings[134] from each upgrade were sourced for the state of Minnesota and Wisconsin.

For residential weatherization, the energy savings data available was for electricity (GWh/year) and fuel (TBtu/year), and for this study specifically the interventions of "air sealing," "drill-and-fill wall insulation," "low-e storm windows," "R-10 basement wall insulation," and "R-5 wall sheathing" were used to calculate total savings from weatherization. The number of housing units per state was obtained from the 2022 U.S. Census data,[135] and the electricity and fuel savings were divided by number of housing units to get a scaling factor that was applied to the number of houses that are planned to receive weatherization retrofits. The total electricity and fuel savings in MWh is then converted to carbon emissions savings in $kgCO_2e$ using the EPA Grid Emissions factor. Finally, total savings are converted to metric tons CO_2e.

Emissions Calculation (Residential):

$$\underline{Residential\ Buildings}$$

$$\begin{aligned}
&Total\ Emissions\ Reduction, Residential\\
&\quad = \left\{ (number\ of\ single\ family + (number\ of\ multifamily\ units)) \right.\\
&\quad * \left\{ \left(\left(fuel\ savings\ \frac{tBtu}{housing\ unit} \right) * \left(conversion\ factor\ \frac{MWh}{tBtu} \right) \right) \right.\\
&\quad + \left. \left(\left(electricity\ savings\ \frac{GWh}{house} \right) * \left(conversion\ factor\ \frac{MWh}{GWh} \right) \right) \right\}\\
&\quad * \left. \left(conversion\ factor\ \frac{tonnes\ CO2e}{MWh} \right) * (\%\ savings\ boost\ due\ to\ inefficiency) \right\}
\end{aligned}$$

$$\begin{aligned}
&Total\ Emissions\ Reduction, Residential\\
&\quad = \left\{ (5474\ homes + 860\ multifamily\ units) \right.\\
&\quad * \left\{ \left(\left(-0.000014\ \frac{tBtu}{housing\ unit} \right) * \left(293{,}071\ \frac{MWh}{tBtu} \right) \right) \right.\\
&\quad + \left. \left(\left(0.00061\ \frac{GWh}{house} \right) * \left(1{,}000\ \frac{MWh}{GWh} \right) \right) \right\} * \left. \left(0.550\ \frac{MT\ CO2e}{MWh} \right) * (130\%) \right\}\\
&\quad = \mathbf{21,800\ MT\ CO2e}
\end{aligned}$$

---

[133] National Renewable Energy Laboratory. *Energy Efficiency – Single Family Home Electricity Savings Potential*. (n.d.). State and Local Planning for Energy. Retrieved December 12, 2023, from https://maps.nrel.gov/slope/data-viewer?filters=%5B%5Dandlayer=resstock.single-family-home-electricity-savings-potentialandyear=2017andres=stateandenergyBurdenPcnt=0.06andtransportationBurdenPcnt=0.04andsviTheme=mnandsviPcntl=0

[134] National Renewable Energy Laboratory. *Energy Efficiency – Single Family Home Fuel Savings Potential*. (n.d.). State and Local Planning for Energy. Retrieved December 12, 2023, from https://maps.nrel.gov/slope/data-viewer?filters=%5B%5Dandlayer=resstock.single-family-home-fuel-savings-potentialandyear=2017andres=stateandenergyBurdenPcnt=0.06andtransportationBurdenPcnt=0.04andsviTheme=mnandsviPcntl=0

[135] *QuickFacts: Michigan*. (n.d.). United States Census Bureau. Retrieved December 15, 2023, from https://www.census.gov/quickfacts/fact/table/MI; *QuickFacts: Minnesota*. (n.d.). United States Census Bureau. Retrieved December 15, 2023, from https://www.census.gov/quickfacts/fact/table/MN; *QuickFacts: Wisconsin*. (n.d.). United States Census Bureau. Retrieved December 15, 2023, from https://www.census.gov/quickfacts/fact/table/WI

Emissions Methodology (Commercial): For both commercial weatherization, NREL SLOPE data on annual electricity [136] and fuel savings [137] from each upgrade we sourced for the state of Minnesota and Wisconsin.

For commercial weatherization, the percent energy savings data available was for electricity (%) and fuel (%), and for this study specifically the interventions of “add window film,” “upgrade roof insulation to R-30,” and “upgrade wall insulation to R-30” were used to calculate total savings from weatherization. The Scope 1 + Scope 2 emissions from all commercial buildings in the Tribe were divided by number of commercial buildings to get a scaling factor. This factor is then applied to the input number of buildings that are planned to receive weatherization retrofits to calculate a baseline amount of carbon emissions from existing buildings. This baseline is multiplied by the electric and fuel percent savings to get total number of carbon emissions saved from weatherization retrofits.

Emissions Calculation (Commercial):

$$\underline{\mathit{Commercial\ Buildings}}$$

$$\begin{aligned}&\mathit{Total\ Emissions\ Reduction, Commercial}\\&\quad= \left\{\left\{(\mathit{number\ of\ commercial\ buildings})\right.\right.\\&\quad\left. * \left(\mathit{Scope\ 1\ building\ emissions\ factor}\,\frac{\mathit{MT\ CO2e}}{\mathit{building}}\right) * (\%\ \mathit{fuel\ savings})\right\}\\&\quad+ \left\{(\mathit{number\ of\ commercial\ buildings}) * \left(\mathit{Scope\ 2\ building\ emissions\ factor}\,\frac{\mathit{MT\ CO2e}}{\mathit{building}}\right)\right.\\&\quad\left.\left. * (\%\ \mathit{electricity\ savings})\right\}\right\}\end{aligned}$$

$$\begin{aligned}&\mathit{Total\ Emissions\ Reduction, Commercial}\\&\quad= \left\{\left\{(459\ \mathit{buildings}) * \left(28\,\frac{\mathit{MT\ CO2e}}{\mathit{building}}\right) * (7.1\%)\right\}\right.\\&\quad\left.+ \left\{(459\ \mathit{buildings}) * \left(90\,\frac{\mathit{MT\ CO2e}}{\mathit{building}}\right) * (4\%)\right\}\right\} = \mathbf{3,200}\ \boldsymbol{MT\ CO2e}\end{aligned}$$

Cost Methodology: The basis of cost for weatherization of single-family homes comes from a Lawrence Berkeley National Laboratory database [138] of residential retrofit cost data and resulting energy savings, including the following sub-measures under basic weatherization:

- Attic/Floor Insulation (Attic/Insulate/Framed floor)
- Sealing Envelope (House/Seal/Envelope)

---

[136] National Renewable Energy Laboratory. *Energy Efficiency – Commercial Electricity Savings Potential*. (n.d.). State and Local Planning for Energy. Retrieved December 12, 2023, from https://maps.nrel.gov/slope/data-viewer?filters=%5B%5Dandlayer=comstock.electricity-savings-potentialandyear=2012andres=state

[137] National Renewable Energy Laboratory. *Energy Efficiency – Commercial Natural Gas Savings Potential*. (n.d.). State and Local Planning for Energy. Retrieved December 12, 2023, from https://maps.nrel.gov/slope/data-viewer?filters=%5B%5Dandlayer=comstock.gas-savings-potentialandyear=2012andres=state

[138] Less, B. D., Walker, I. S., Casquero-Modrego, N., and Rainer, L. I. (2021, August). *The Cost of Decarbonization and Energy Upgrade Retrofits for US Homes*. Lawrence Berkeley National Laboratory. Retrieved January 22, 2024, from https://eta-publications.lbl.gov/sites/default/files/final_walker_-_the_cost_of_decarbonization_and_energy.pdf

- Wall Simulation Walls/Insulate

These costs include both material and installation for weatherization. Using the cost of each measure and the source's reported breakdown of $/Floor Area, an average single-family home size was generated. The total reported sub-measure cost was summed to estimate the cost per residential home for weatherization ($4782/home). Assumption that cost per multifamily (MF) unit is 2/3rds the cost due to shared building envelope ($3,188/unit).

Similarly, using the $/Floor Area estimate for each sub-measure ($2.86/sq ft. total), the cost for commercial weatherization was estimated using the 5000 SF / building assumption, which comes out to ~$14,300/commercial building. The costs per building are then scaled up by the number of buildings within each type.

Cost Calculation:

$$Total\ Cost\ (\$) = Weatherization\ cost\ per\ home\ or\ building * number\ of\ buildings$$

$$Total\ Cost, Residential\ (\$) = \frac{\$4782}{home} * (5474\ homes) + \frac{\$3188}{MF\ unit} * (860\ multifamily\ units) = \mathbf{\$28,900,000}$$

$$Total\ Cost, Commercial\ (\$) = \frac{\$14{,}300}{building} * 459\ commercial\ buildings = \mathbf{\$6,560,700}$$

Smart Thermostat Installation

Smart programmable thermostats significantly affect energy use from heating and cooling by adjusting setpoints based on occupancy patterns. For example, office buildings can be set higher temperatures during the summer and lower temperature during the winter to avoid cooling or heating the space more than necessary – and can be programmed to reduce space conditioning after 6pm, when the building is likely to be empty. This reduction measure quantifies the reduction in emissions due to energy savings from installing smart programmable thermostats in buildings.

Baseline emissions: All Buildings Scope 1+2 emissions for the Tribes are the baseline for this reduction measure.

Key assumptions:

- 60% of buildings to install a smart thermostat; ~5,500 single-family homes, ~860 multifamily units, ~460 commercial buildings
- Default commercial building is assumed to be 5,000 SF
- Only 1 smart thermostat needed per building

Emissions Methodology: According to Energy Star, a smart thermostat installation can reduce emissions by 8%.[139] The Scope 1+2 emissions from all residential (single-family and multifamily) and commercial buildings in the Tribe is divided by number of residential and commercial buildings respectively to get a scaling factor. The number of buildings undergoing this measure is multiplied by the respective scaling factor (whether it is residential or commercial), then the percent energy savings to calculate the emissions reduction from smart thermostat installation.

Emissions Calculation:

---

[139] *Energy Efficiency Program Sponsor Frequently Asked Questions About ENERGY STAR Smart Thermostats*. (n.d.). Energy Star. Retrieved November 20, 2023, from https://www.energystar.gov/products/heating_cooling/smart_thermostats/smart_thermostat_faq

$$Total\ Emissions\ Reduction = \left\{(number\ of\ buildings) * \left(Scope\ 1+2\ building\ emissions\ factor\ \frac{MT\ CO2e}{building}\right) * (8\%\ energy\ savings)\right\}$$

$$Total\ Emissions\ Reduction, Residential + Commercial = \left\{(5474\ homes + 860\ multifamily\ units) * \left(\frac{8.2\ MT\ CO2e}{building}\right) * 8\%)\right\} + \left\{(459\ commercial\ buildings) * \left(\frac{16.9\ MT\ CO2e}{building}\right) * (8\%)\right\} = 8610\ MT\ CO2e\ saved$$

Cost Methodology: For residential thermostats, an estimate of $435/thermostat was used ($260 representing the median cost of a smart thermostat, and $175 representing a national average for installation costs); these costs were based off cost estimation done for proposed code changes to the 2021 International Energy Conservation Code to consider residential demand response measures and technologies.[140] For commercial thermostats, a study published in conjunction with New York State Energy Research and Development Authority (NYSERDA), New York's energy authority, provided a cost range from $750-$1250; the analysis uses $1000/thermostat, representative of the median cost.[141] Assuming one thermostat per building or unit, the cost is scaled up by number of buildings taking on this measure.

Cost Calculation:

$$Total\ Cost\ (\$) = Cost\ of\ 1\ thermostat\ per\ housing\ unit\ or\ building * number\ of\ relevant\ buildings$$

$$Total\ Cost, Residential\ (\$) = \frac{\$435}{home} * (5474\ homes + 860\ multifamily\ units) = \mathbf{\$2,760,000}$$

$$Total\ Cost, Commercial\ (\$) = \frac{\$1,000}{building} * 459\ commercial\ buildings = \mathbf{\$459,000}$$

Introduce New Building Standards

Adopt Green Building Standards for Major Renovations

Green building standards are a comprehensive way to upgrade building systems for greater energy efficiency. Implementing energy codes and minimum efficiency standards facilitates emissions reduction for existing buildings and new construction. Green buildings tend to have HVAC (heating, ventilation, and air conditioning) and MEP (mechanical, electrical, plumbing) systems that are more efficient, more insulation, better window constructions, and can be all-electric.

Baseline emissions: All Buildings Scope 1+2 emissions for the Tribes are the baseline for this reduction measure.

---

[140] *Residential Demand Response*. (n.d.). Building Energy Codes Program, Department of Energy Office of Energy Efficiency and Renewable Energy. Retrieved December 19, 2023, from https://www.energycodes.gov/sites/default/files/2021-10/Residential_Demand_Response.pdf

[141] Rovito, M., Savio, P., Subramony, G., and Duffy, L. (n.d.). *Advanced Thermostats for Small-to-Medium-Sized Commercial Buildings* [White paper]. ERS. Retrieved January 22, 2024, from https://www.ers-inc.com/wp-content/uploads/2017/02/Advanced-Thermostats-for-Commercial-Buildings.pdf

Key assumptions:

- Adoption of green building codes for major renovation projects save 15% energy usage, which is the average value between the 9.1% for Minnesota[142] and 21.6% for Wisconsin[143] estimated by the US DOE.
- 15% of buildings undergo major renovation projects that must adopt state Green Building Standards

Table 20: Emissions Factors by Buildings Type

	Number of Buildings or Units	**Emissions factor (Metric Tons CO_2e/Building or Unit)**
Single-Family Homes	1,367	8.5
Multifamily Units	215	8.5
Commercial	115	118

Emissions Methodology: The Scope 1+2 emissions from all buildings in the Tribe is divided by number of total number of buildings to get a scaling factor. This factor is used to calculate baseline emissions from the planned number of buildings to be renovated and adopt green building standards. The baseline emissions are then multiplied by the percent savings estimate from the DOE to calculate the emissions reduction from green building standards.

Emissions Calculation:

$$\begin{aligned} &Carbon\ Reduction \\ &= \left\{(amount\ of\ residential\ units) * \left(residential\ building\ emissions\ factor \frac{MT\ CO2e}{unit}\right)\right. \\ &+ (amount\ of\ commercial\ buildings) \\ &\left. * \left(commercial\ building\ emissions\ factor \frac{MT\ CO2e}{building}\right) * (\%\ emissions\ savings\ )\right\} \end{aligned}$$

$$\begin{aligned} Carbon\ Reduction = &\left\{(1367\ homes + 215\ multifamily\ units) * \left(8.5\ \frac{MT\ CO2e}{building}\right) + \right. \\ &\left. (115\ commercial\ buildings) * \left(118\ \frac{MT\ CO2e}{building}\right) * (15\%\ )\right\} = \mathbf{4{,}000\ MT\ CO_2e} \end{aligned}$$

Cost: The cost of this measure has not been quantified at this PCAP stage, as it relies on existing building stock, as well as building renovation regulatory and policy strategy that can vary greatly between Tribes.

---

[142] *Minnesota Can Save Energy, Money, and Mitigate the Effects of Climate Change through Building Energy Codes* [Fact sheet]. (2021, July). US Department of Energy. Retrieved February 5, 2024, from https://www.energycodes.gov/sites/default/files/2021-07/EED_1365_BROCH_StateEnergyCodes_states_MINNESOTA.pdf

[143] *Wisconsin Can Save Energy, Money, and Mitigate the Effects of Climate Change through Building Energy Codes* [Fact sheet]. (2021, July). US Department of Energy. Retrieved February 5, 2024, from https://www.energycodes.gov/sites/default/files/2021-07/EED_1365_BROCH_StateEnergyCodes_states_WISCONSIN.pdf

Reducing Vehicle Emissions

Mode Shift

Increase Transit Service

This reduction measure calculates emissions associated with mode shift from single-passenger vehicles to transit buses. According to the U.S. Department of Transportation (DOT), bus transit produces 33% less GHG emissions per passenger mile than an average single-occupancy vehicle[144] (SOV). This statistic was used to calculate emissions associated with a 10% mode shift to buses from single-occupancy vehicles. 10% of the baseline emissions from single-occupancy gasoline-powered vehicles was reduced by 33% to calculate the ultimate emissions reduction from this measure.

Baseline emissions: Scope 1 emissions associated with passenger-vehicle gasoline for the Tribes. The baseline amount of gasoline used for passenger vehicles in the Tribes was calculated using annual VMT census data from Minnesota[145] and Wisconsin Departments of Transportation[146] at the county level. The annual vehicle miles traveled was scaled by population to the Tribal population in that same county. If a Tribe is located with multiple county lines, an average VMT from those counties data was used. The Tribes VMT was used along with an average fuel efficiency of 24.2 mpg from DOE's average fuel economy[147] was used to calculated annual gallons of gasoline.

Key assumptions:

- 10% of drivers of single-occupancy vehicles mode shift from driving to public transit
- Bus transit produces 33% less GHG per passenger mile than the average SOV
- Passenger mile GHG % reduction results in a proportional Scope 1 emission reductions

Emissions Reduction Calculation:

$$Baseline\ emissions * \%\ adoption * \%\ emissions\ saving\ from\ mode\ shift = GHG\ reduction$$

$$(174{,}084\ MT\ CO2e) * 10\% * 33\% = 5{,}745\ MT\ CO2e$$

Cost: The cost of this measure has not been quantified at this PCAP stage due to the variability in each Tribe's existing transit infrastructure and the different methods of implementation that will be unique to each project.

Increase Ridesharing

Carpooling or ridesharing can significantly reduce emissions associated with single-occupancy vehicles. This reduction measure calculates emissions associated with mode shift from single-occupancy vehicles (SOVs) to rideshare vehicles. A study from the UC Berkeley Transportation Sustainability Research Center on "The Benefits of Carpooling" published in 2018 calculates a 5% reduction by carpooling rather than driving single-

---

[144] *Public transportation's role in responding to climate change.* (2010, January). U.S. Department of Transportation Federal Transit Administration. Retrieved January 5, 2024, from https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/PublicTransportationsRoleInRespondingToClimateChange2010.pdf

[145] *Vehicle miles traveled reports.* (n.d.). Minnesota Department of Transportation. Retrieved January 5, 2024, from https://www.dot.state.mn.us/roadway/data/reports/vmt/22_crs.pdf

[146] Zhang, M. (2022, November 17). *2021 vehicle miles of travel (VMT) by county*. Retrieved January 5, 2024, from https://wisconsindot.gov/Documents/projects/data-plan/veh-miles/vmt2021-c.pdf

[147] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

occupancy vehicles for trips[148]. This calculation uses the baseline emissions associated with single-occupancy gasoline-powered vehicles and assumes 50% of the Tribal population shifts from SOVs to rideshare vehicles.

Baseline emissions: Scope 1 emissions associated with passenger-vehicle gasoline for the Tribes. The baseline amount of gasoline used for passenger vehicles in the Tribes was calculated using annual VMT census data from Minnesota[149] and Wisconsin Departments of Transportation[150] at the county level. The annual vehicle miles traveled was scaled by population to the Tribal population in that same county. If a Tribe is located with multiple county lines, an average VMT from those counties data was used. The Tribes VMT was used along with an average fuel efficiency of 24.2 mpg from DOE's average fuel economy[151] was used to calculated annual gallons of gasoline.

Key assumptions:

- 50% of drivers of single-occupancy vehicles mode shift from driving to rideshare/carpooling
- Car-sharing produces 5% less GHG than the average SOV

Emissions Reduction Calculation:

$$Baseline\ emissions * \%\ adoption * \%\ emissions\ saving\ from\ mode\ shift = GHG\ reduction$$

$$(174{,}084\ MT\ CO2e) * 50\% * 5\% = 4{,}400\ MT\ CO2e$$

Cost: The cost of this measure has not been quantified at this PCAP stage due to the high variability depending on method of implementation. The cost of building a ridesharing app, such as Uber or Lyft can range from $50,000 – $80,000, according to a Crowdbotics report[152]. However, other methods of implementation can be used including rebates, or marketing and launching an incentive program to encourage adoption.

Develop Active Transport Network

This reduction measure calculates emissions associated with a mode shift from SOVs to an active transport mode such as walking, running, or biking. According to Transportation Research Part A: Policy and Practice, a per-reviewed scientific journal covering research on transportation policy, walking or cycling can save nearly 10% of CO_2e emissions from car travel (Assuming 41% of short car trips less than 3 miles avoided)[153]. In order to quantify this measure across all Tribes, a 30% mode shift to active transport was assumed.

Baseline emissions: Scope 1 emissions associated with passenger-vehicle gasoline for the Tribes. The baseline amount of gasoline used for passenger vehicles in the Tribes was calculated using annual VMT census data from

---

[148] Shaheen, S., Cohen, A., and Bayen, A. (2018). *The benefits of carpooling.* UC Berkeley Transportation Sustainability Research Center. Retrieved January 5, 2024, from https://escholarship.org/uc/ item/7jx6z631

[149] *Vehicle miles traveled reports.* (n.d.). Minnesota Department of Transportation. Retrieved January 5, 2024, from https://www.dot.state.mn.us/roadway/data/reports/vmt/22_crs.pdf

[150] Zhang, M. (2022, November 17). *2021 vehicle miles of travel (VMT) by county*. Retrieved January 5, 2024, from https://wisconsindot.gov/Documents/projects/data-plan/veh-miles/vmt2021-c.pdf

[151] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

[152] *How much does it cost to build a ridesharing app?* (n.d.). Crowdbotics. https://www.crowdbotics.com/ cost-to-build-app-type/ridesharing-app

[153] *Assessing the potential for carbon emissions savings from replacing short car trips with walking and cycling using a mixed GPS-travel diary approach.* (2019, May). Transportation Research Part A: Policy and Practice. Retrieved January 5, 2024, from https://www.sciencedirect.com/science/article/pii/S0965856417316117#:~:text=Taking%20into%20account%20individual%20travel,to%20existing%20walking%20and%20cycling.

Minnesota[154] and Wisconsin Departments of Transportation[155] at the county level. The annual VMT was scaled by population to the Tribal population in that same county. If a Tribe is located with multiple county lines, an average VMT from those counties data was used. The Tribes VMT was used along with an average fuel efficiency of 24.2 mpg from DOE's average fuel economy[156] was used to calculated annual gallons of gasoline.

Key assumptions:

- 30% of drivers of single-occupancy vehicles mode shift from driving to modes of active transport
- Active transport produces 10% less GHG than the average SOV

Emissions Reduction Calculation:

$$Baseline\ emissions * \%\ adoption * \%\ emissions\ saving\ from\ mode\ shift = GHG\ reduction$$

$$(174{,}084\ MT\ CO2e) * 30\% * 10\% = 5{,}200\ MT\ CO2e$$

Cost: The cost of this measure has not been quantified at this PCAP stage due to the variability in each Tribe's existing transportation infrastructure and the different methods of implementation that will be unique to each project. The Victoria Transport Institute evaluated some costs of active transportation improvements: bike lanes can cost between $10,000-$50,000/mile to modify existing roadways, sidewalks can cost between $20-$50/foot, and different materials for paths can vary widely in cost[157].

Introduce Vehicle Electrification & Alternative Fuel Vehicles

Electrify Bus Fleet & Provide Charging Infrastructure

Note that PCAP measure assumes half of total bus fleet converted to electric buses and the remaining half converted to alternative fuel. Therefore, the PCAP measure is the sum total of the electric bus fleet measure and the alternative fuel bus measure.

Electric buses result in much lower GHG emissions than diesel-burning buses; not only do they have zero tailpipe emissions, but as the electric grid continues to decarbonize, the emissions associated with powering electric buses will continue to decrease. If electric buses are powered 100% by on-site renewables, this would result in a full offset of baseline diesel emissions.

This reduction measure assumed an average grid emissions factor to calculate associated emissions. The baseline case for all buses within Tribes were assumed to run on diesel. In order to calculate the emissions associated with electrifying bus fleets, the miles per gallon (mpg) of the vehicles was conservatively assumed to be 6.2, based on data released by the U.S. DOE on average fuel economy for school buses[158], last updated in February 2020. The annual miles traveled based on this mpg and gallons of diesel from the gallons of diesel from the GHG inventory were used to calculate kWh by assuming electric buses would have an efficiency of 1.5

---

[154] *Vehicle miles traveled reports.* (n.d.). Minnesota Department of Transportation. Retrieved January 5, 2024, from https://www.dot.state.mn.us/roadway/data/reports/vmt/22_crs.pdf

[155] Zhang, M. (2022, November 17). *2021 vehicle miles of travel (VMT) by county*. Retrieved January 5, 2024, from https://wisconsindot.gov/Documents/projects/data-plan/veh-miles/vmt2021-c.pdf

[156] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

[157] Litman, T. (2023, November 19). *Evaluating active transport benefits and costs guide to valuing walking and cycling improvements and encouragement programs.* Victoria Transport Policy Institute. Retrieved January 5, 2024, from https://www.vtpi.org/nmt-tdm.pdf

[158] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

kWh/mile, based on data from the DOE's alternative fuels data center[159]. An average of the EPA eGRID emissions factors from both MROW and MROE were used to calculate emissions associated with the annual electricity used to power the converted EVs.

Baseline emissions: Scope 1 emissions associated with on-road diesel for the Tribes was the baseline for this reduction measure. Baseline diesel emissions were calculated for all Tribes by inquiring the number of buses (school and transit), annual number of trips, and average trip distance. Both school and transit bus were assumed to have 6.2 mpg, in accordance with DOE's Average Fuel Economy report[160], updated in February 2020. Using this methodology for the inventory, the total baseline number of gallons of diesel is 458,226 gallons.

Key assumptions:

- Existing buses all run on diesel
- Fuel economy for diesel buses is 6.2 miles per gallon[161] (mpg)
- Electric buses have efficiency of 1.5 kWh/mile[162]
- Electric buses would be powered with electricity, and the associated emissions are from an average grid emissions factor between MROW and MROE EPA eGRID regions

Emissions Reduction Calculation:

$$\begin{aligned} &\mathit{Emissions\ saved} \\ &\quad = \mathit{Emissions\ from\ onroad\ diesel} - \mathit{emissions\ from\ EV\ buses} \\ &\quad - \mathit{emissions\ from\ remaining\ diesel\ buses} \end{aligned}$$

$$\begin{aligned} &\mathit{Emissions\ saved} \\ &\quad = \Big\{(\mathit{percent\ adoption}) * (\mathit{Baseline\ number\ of\ gallons\ of\ diesel}) * (\mathit{Diesel\ mpg}) \\ &\quad * \left(\mathit{electric\ bus}\,\frac{kWh}{mile}\right) * (\mathit{grid\ emissions\ factor})\Big\} + \{\mathit{remaining\ gallons\ of\ diesel} \\ &\quad * \mathit{diesel\ emissions\ factor}\} \end{aligned}$$

$$\begin{aligned} &(4{,}684\ MTCO2e) - \left\{50\% * 458{,}226\ \mathit{gallons\ of\ diesel} * 6.2\ mpg * 1.5\,\frac{kWh}{mile} * \frac{1\ MWh}{1000\ kWh} * 1{,}213\,\frac{lbCO2e}{MWh}\right\} \\ &\quad - \{0\} = 1{,}100\ MT\ CO2e \end{aligned}$$

Cost Calculation:

---

[159] *Flipping the Switch on electric school buses: charging infrastructure: module 1.* (n.d.). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/vehicles/electric_school_buses_p4_m1.html#:~:text=A%20typical%20bus%20can%20travel,energy%20for%20every%20mile%20traveled

[160] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

[161] Ibid

[162] *Flipping the Switch on electric school buses: charging infrastructure: module 1.* (n.d.). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/vehicles/electric_school_buses_p4_m1.html#:~:text=A%20typical%20bus%20can%20travel,energy%20for%20every%20mile%20traveled

These cost assumptions assume the pricing of $175,000/bus for electric School Buses (Type A-B) from the 2022 State of Sustainable Fleets Report [163]. The bus charger cost assumes a slow plug-in charger at $70,000/charger, in line with the Maine DOT report: Transit Vehicle Electrification Best Practices [164]. These costs do not explicitly consider grid capacity and potential need for transmission infrastructure upgrades to support electric buses. The potential need for electric service upgrades is highly dependent on the number of buses, type of charger, and bus operating schedule, and would be examined on a case-by-case basis.

$$(Number\ of\ electric\ buses * cost\ per\ bus) + (Number\ of\ chargers * cost\ per\ charger) \\ = total\ measure\ cost$$

$$\left(45\ buses * \frac{\$175{,}000}{bus}\right) + \left(\frac{1\ bus\ charger}{7\ buses} * (91\ buses) * \frac{\$70{,}000}{charger}\right) = \$8.320{,}000$$

Provide Alternative Fuel Buses (Biodiesel, CNG, LNG, Propane)

Note that PCAP measure assumes half of total bus fleet converted to electric buses and the remaining half converted to alternative fuel. Therefore, the PCAP measure is the sum total of the electric bus fleet measure and the alternative fuel bus measure.

"Alternative fuel buses" refers to buses that run on fuels other than diesel. In this reduction measure, biodiesel, compressed natural gas (CNG), liquified natural gas (LNG), and propane were used. These fuels all run cleaner than diesel, releasing fewer lbCO₂e into the atmosphere than a diesel engine. The EPA releases an Emissions Factors for GHG Inventories document annually, and the most recent (2023) [165] was used to calculate emissions associated with using alternative fuels for buses. Initially, the emissions factor for diesel vehicles was used in the GHG inventory to calculate emissions associated with diesel-powered buses and heavy-duty trucks. The miles per gallon (mpg) for these vehicles was assumed to be 6.2, based on data released by the U.S. DOE on average fuel economy for school buses [166].

factor factors for propane, liquefied natural gas, CNG, and biodiesel were used to calculate the difference in emissions between a diesel-powered vehicle and alternative fuel vehicles. The difference in emissions was taken in metric tons for each alternative fuel. Hydrogen fuel cell vehicles have zero tailpipe emissions, so the reduction in emissions was the entire amount of otherwise diesel-powered vehicles.

$$Fuel\ Type: (gallons\ of\ fuel) * \left(\frac{CO2\ emissions\ factor}{gallons}\right) + (gallons\ of\ fuel) * (fuel\ economy) \\ * \left(\frac{CH4\ emissions\ factor}{mile}\right) * \left(\frac{CO2e}{CH4}\right) + \left(\frac{N2O\ emissions\ factor}{mile}\right) * \left(\frac{CO2e}{N2O}\right)$$

Assuming a 6.2 mpg fuel economy for buses and EPA 2020 GHG conversions:

$$1\ MTCH_4 = 28\ MTCO_{2e}, 1\ MTN_2O = 265\ MTCO_{2e}$$

---

[163] *The state of sustainable fleets.* (2022). Retrieved January 5, 2024, from https://cdn.stateofsustainablefleets.com/2022/state-of-sustainable-fleets-2022-report.pdf

[164] *Transit vehicle electrification best practices.* (n.d.). Maine DOT. Retrieved January 5, 2024, from https://www.maine.gov/mdot/climate/docs/Maine%20DOT%20Transit%20Vehicle%20Electrification%20Best%20Practices.pdf

[165] *Emissions factors for greenhouse gas inventories.* (2023, September 12). EPA Center for Corporate Climate Leadership. https://www.epa.gov/system/files/documents/2023-03/ghg_emission_factors_hub.pdf

[166] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

Table 21: Emissions of Specific Fuel Types

Fuel Type	$kgCO_2e$/ Gallon
LNG	4.9855
CNG	5.8599
Propane	5.6998
Biodiesel	9.5222

Baseline emissions: Scope 1 emissions associated with on-road diesel for the Tribes was the baseline for this reduction measure. Baseline diesel emissions were calculated for all Tribes by inquiring the number of buses (school and transit), annual number of trips, and average trip distance. Both school and transit bus were assumed to have 6.2 mpg, in accordance with DOE's Average Fuel Economy report [167], updated in February 2020. Using this methodology for the inventory, the total baseline number of gallons of diesel is 458,226 gallons.

Key assumptions:

- Existing buses all run on diesel
- Fuel economy for diesel buses is 6.2 miles per gallon [168] (mpg)
- An average CO_2e emissions factor per gallon of alternative fuel was used

Emissions Reduction Calculation:

$$\begin{aligned} &Emissions\ saved \\ &\quad = Emissions\ from\ onroad\ diesel - \ emissions\ from\ alternative\ fuel\ buses \\ &\quad - emissions\ from\ remaining\ diesel\ buses \end{aligned}$$

$$(4{,}684\ MTCO2e) - \{50\% * 458{,}226\ gallons\ of\ diesel) * \left(2{,}986\ MT\frac{CO2e}{gallon}\right\} - \{0\} = 900\ MT\ CO2e$$

Cost Calculation:

These cost assumptions assume the pricing of \$125,000/bus for natural gas school buses (Type A-B), and \$105,000 for propane school buses (Type C-D) from the 2022 State of Sustainable Fleets Report [169]. Biodiesel bus pricing is \$91,350 from the Oregon School Bus Electrification Cost Comparison Tool [170]. For the PCAP summary, these costs were averaged.

$$(Number\ of\ alternative\ fuel\ buses * average\ cost\ per\ bus) = total\ measure\ cost$$

$$\left(45\ buses * \frac{\$107{,}083}{bus}\right) = \$4{,}820{,}000$$

---

[167] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

[168] Ibid

[169] *The state of sustainable fleets.* (2022). Retrieved January 5, 2024, from https://cdn.stateofsustainablefleets.com/2022/state-of-sustainable-fleets-2022-report.pdf

[170] *The electric and alternative fuel school bus lifecycle cost analysis tool.* (n.d.). Oregon Department of Energy. Retrieved January 5, 2024, from https://www.oregon.gov/energy/energy-oregon/Documents/2022-Jan-14-School-Bus-Electrification-Cost-Comparison-Tool.xlsx

Electrify SOV & Provide Charging Infrastructure

The second reduction measure related to vehicle electrification is providing EV infrastructure to influence EV adoption among passenger vehicles. For the PCAP, 80% of single-occupancy vehicles (SOVs) were assumed to adopt EVs. In order to calculate emissions associated with this reduction, the emissions from gasoline-powered cars were compared to the emissions associated with EVs for the equivalent amount of miles traveled. The miles per gallon (mpg) for gasoline powered cars in the GHG inventory was assumed to be 24.2 in accordance with DOE's Alternative Fuels Data Center [171]. Using the gallons of gasoline from the GHG inventory and the average mpg, the annual VMT was calculated. The EVs were assumed to have an efficiency of 0.35 kWh/mile, in accordance with the DOE's methodology in their "eGallon" methodology, last updated January 2016 [172]. Using the annual VMT, EV efficiency, and percentage of SOVs replaced with EVs, the annual electricity used to power the EVs was calculated. Emissions associated with this electricity use were calculated using an average eGRID emissions factor from both MROW and MROE. Ultimately, the emissions reduction was calculated using the difference between emissions from gasoline powered cars and the emissions from electricity used for the EVs.

Baseline emissions: Scope 1 emissions associated with passenger-vehicle gasoline for the Tribes. The baseline amount of gasoline used for passenger vehicles in the Tribes was calculated using annual VMT census data from Minnesota [173] and Wisconsin Departments of Transportation [174] at the county level. The annual VMT was scaled by population to the Tribal population in that same county. If a Tribe is located with multiple county lines, an average VMT from those counties data was used. The Tribes VMT was used along with an average fuel efficiency of 24.2 mpg from DOE's average fuel economy [175] was used to calculated annual gallons of gasoline.

Key assumptions:

- 80% of existing drivers will replace gasoline vehicles with all-electric vehicles
- Fuel economy of passenger vehicles is 24.2 mpg [176]
- Electric passenger vehicle efficiency is 0.35 kWh/mile [177]

Emissions Reduction Calculation:

$$\begin{aligned} &Emissions\ saved \\ &\quad = Emissions\ from\ onroad\ gasoline - emissions\ from\ EVs \\ &\quad - emissions\ from\ remaining\ gasoline\ cars \end{aligned}$$

---

[171] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

[172] *eGallon*. (n.d.). U.S. Department of Energy. Retrieved January 5, 2024, from https://www.energy.gov/sites/prod/files/2013/06/f1/eGallon-methodology-final.pdf

[173] *Vehicle miles traveled reports*. (n.d.). Minnesota Department of Transportation. Retrieved January 5, 2024, from https://www.dot.state.mn.us/roadway/data/reports/vmt/22_crs.pdf

[174] Zhang, M. (2022, November 17). *2021 vehicle miles of travel (VMT) by county*. Retrieved January 5, 2024, from https://wisconsindot.gov/Documents/projects/data-plan/veh-miles/vmt2021-c.pdf

[175] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

[176] Ibid

[177] *eGallon*. (n.d.). U.S. Department of Energy. Retrieved January 5, 2024, from https://www.energy.gov/sites/prod/files/2013/06/f1/eGallon-methodology-final.pdf

$$\begin{aligned}&Baseline\ gasoline\ emissions\\&\qquad -\{(percent\ adoption)*(Baseline\ number\ of\ gallons\ of\ gasoline)\\&\qquad *(Passenger\ vehicle\ mpg)*(electric\ vehicle\ efficiency)*(grid\ emissions\ factor)\}\\&\qquad -\{(remaining\ gallons\ of\ diesel*diesel\ emissions\ factor)\}\end{aligned}$$

$$\begin{aligned}&(174{,}084\ MTCO2e\ )-\{80\%*19{,}750{,}141\ gallons\ of\ gasoline)*(24.2\ mpg)*\left(0.35\frac{kWh}{mile}\right)\\&\quad *\left(\frac{1\ MWh}{1{,}000\ kWh}\right)*\left(1{,}213\frac{lbCO2e}{MWh}\right)\left(\frac{1\ MT}{2{,}204\ lb}CO2e\right)\\&\quad -\{20\%*19{,}750{,}141\ gallons\ of\ gasoline*gasoline\ emissions\ factor\}\\&\quad =65{,}600\ MTCO2e\end{aligned}$$

Cost Calculation:

These cost assumptions assume the pricing of an average Level 1 charger equipment and installation costs of \$2,400/charger for EVs. This also assumes 1 EV per person, and assumes 10 EVs are served by public charger, in accordance with the DOE Costs associated with non-residential electrical vehicle supply equipment [178]. Costs of EVs themselves are not included within the calculation.

$$(Number\ of\ chargers*cost\ per\ charger)=total\ measure\ cost$$

$$2{,}882\ chargers*\left(\frac{\$2{,}400}{charger}\right)=\$6{,}920{,}000$$

Environmental Management & Planning Techniques

Sequester Carbon Through Plants

The carbon sequestration potential of planting trees, grasses, and shrubs was calculated by using the Climate Positive Design's Pathfinder tool [179] which provided carbon sequestration rates, which were used to assume appropriate values for the generalized plants.

For tree planting, the average of the sequestration potential for large deciduous and large evergreen trees (12.02 kgCO_2e/unit) in the Northern region of the U.S. was used. For grasses, the area of grass planted was multiplied by the sequestration potential of perennial grasses (0.794 kgCO_2e/m2). For shrubs, the number of shrubs was multiplied by the average of the sequestration of evergreen and deciduous shrubs of small, medium, and large sizes in the Northern region of the U.S (0.19 kgCO_2e/unit).

Baseline emissions: All Scope 1 and 2 emissions for the Tribes are the baseline for this reduction measure.

---

[178] *Costs associated with non-residential electric vehicle supply equipment.* (2015, November). U.S. Department of Energy, Energy Efficiency and Renewable Energy. Retrieved January 5, 2024, from https://afdc.energy.gov/files/u/publication/evse_cost_report_2015.pdf

[179] *Get started using the Pathfinder*. (n.d.). Climate Positive Design. Retrieved December 19, 2023, from https://climatepositivedesign.com/pathfinder/; this online tool and application requires a sign-in to access the tool and underlying values for this measure.

Key assumptions:

Table 22: Carbon Sequestration Potential of Specific Vegetation

	Amount	Carbon Sequestration Potential	Types
Trees	100,000 trees	$12.02\,\frac{kgCO2e}{tree}$	50% evergreen, 50% deciduous
Grass	1,000,000 sq.ft.	$0.794\frac{kgCO2e}{m2}$	Perennial grasses
Shrub	100,000 shrubs	$0.19\,\frac{kgCO2e}{tree}$	Small, medium, and large shrubs that are either deciduous or evergreen

Calculation:

The PCAP measure amounts are converted to CO_2e sequestration in metric tons/year using the sequestration potentials above and added together to get total of 1,295 $kgCO_2e$ sequestration across trees, grasses, and shrubs per year. The calculation below is applicable to all three plant types being used in this study.

$$
\begin{aligned}
&Total\ Carbon\ Sequestration, Plants \\
&\quad = \left\{\left(annual\ carbon\ sequestration\ factor\,\frac{kgCO2e}{plant\ amount}\right) * (amount\ of\ plants) \right. \\
&\qquad \left. * (conversion\ factor\ as\ needed) * \left(conversion\ factor\,\frac{MT}{kg}\right)\right\}
\end{aligned}
$$

$$
\begin{aligned}
Total\ Carbon\ Sequestration, Trees &= \left(12.02\,\frac{kgCO2e}{tree}\right) * 100{,}000\ trees * \left(0.001\,\frac{MT}{kg}\right) \\
&= \mathbf{1,200\ MT\ CO2e/year}
\end{aligned}
$$

Cost Estimate:

According to Lawn Love, a lawn care blog that is associated with a lawn care service company with over 2,000 cities across the United States, as well as other landscaping costing resources, the national average cost of planting trees, shrubs, and grass (including labor) is \$300/tree [180] (for medium-sized trees, 5-9 feet tall), \$25/shrub, [181] and \$0.50/sq. ft. of sod. [182]

$$
\begin{aligned}
Total\ Cost\ (\$) &= \left(\frac{\$300}{tree} * 100{,}000\ trees\right) + \left(\frac{\$25}{shrub} * 100{,}000\ shrubs\right) + \left(\frac{\$0.50}{sq.ft.} * 1{,}000{,}000\ sq.ft.\right) \\
&= \mathbf{\$32,500,000}
\end{aligned}
$$

---

[180] Nita, A. (2023, November 29). *How Much Does it Cost to Plant a Tree in 2024?* Lawn Love. Retrieved on January 22, 2024, from https://lawnlove.com/blog/cost-to-plant-tree/

[181] *How Much Does Landscape Installation Cost?* (n.d.). Home Advisors. Retrieved January 22, 2023, from https://www.homeadvisor.com/cost/landscape/install-landscaping/

[182] Toma, L. (2023, November 29). *How Much Does Sod Cost to Install in 2024?* Lawn Love. Retrieved on January 22, 2024, from https://lawnlove.com/blog/sod-cost/

Develop Green Infrastructure

Green infrastructure is a method of low-impact development that protects, restores, or mimics the natural water cycle. It reduces emissions by treating water naturally via rain gardens, bioswales, permeable pavements, and green streets. Stormwater can be treated through these methods rather than by a central wastewater treatment plant that collects runoff from hardscapes. Ultimately, this results in a reduction of energy used for water pumping and treatment. Additionally, bioswales provide carbon sequestration.

To quantify this reduction measure, bioswales were assumed to replace parking spots. While there are many different types of vegetation that can be used to develop a bioswale, the most common one is used to calculate carbon sequestration: Perennial Grasses. The Climate Positive Design Tool[183] was used to retrieve the average annual carbon sequestration per area (0.794 $kgCO_2e/m2$) for perennial grasses. This factor is used to calculate the resulting carbon sequestration from the planned bioswales[184]. This GHG reduction estimate is conservative, as there is the potential for additional energy savings for avoided wastewater treatment. Due to the variability and location-dependency of the specific wastewater treatment process by implementation location and Tribe, these additional GHG benefits were not quantified.

Baseline emissions: All Scope 1 and 2 emissions for the Tribes are the baseline for this reduction measure.

Key assumptions:

- 800,000 sf of bioswales

Calculation:

The PCAP measure amount is converted to CO_2e sequestration in metric tons/year using the sequestration potential per year above.

$$\underline{Grass\ Carbon\ Sequestration}$$

$$f(grass) = \left\{\left(annual\ carbon\ sequestration\ factor\,\frac{kgCO2e}{m2}\right) * \left(conversion\ factor\,\frac{m2}{sq.ft.}\right) * (area\ of\ grass\ planted\ sq.ft.) * \left(conversion\ factor\,\frac{MT}{kg}\right)\right\}$$

$$\left(0.794\,\frac{kgCO2e}{m2}\right) * \left(0.093\,\frac{m2}{sq.ft.}\right) * 800{,}000\ sq.ft.of\ grass * \left(0.001\,\frac{MT}{kg}\right) = \mathbf{60\ MT\ CO2e/year}$$

Cost Estimate:

According to Lawn Love, a lawn care blog that is associated with a lawn care service company with over 2,000 cities across the United States, the national average cost of planting grass (including labor) is \$0.50/sq. ft. of sod.[185]

$$\left(\frac{\$0.50}{sq.ft.} * 800{,}000\ sq.ft.\right) = \$\mathbf{400,000}$$

---

[183] *Get started using the Pathfinder*. (n.d.). Climate Positive Design. Retrieved December 19, 2023, from https://climatepositivedesign.com/pathfinder/; this online tool and application requires a sign-in to access the tool and underlying values for this measure.

[184] Ibid

[185] Nita, A. (2023, November 29). *How Much Does it Cost to Plant a Tree in 2024?* Lawn Love. Retrieved on January 22, 2024, from https://lawnlove.com/blog/cost-to-plant-tree/

Implement Responsible Development & Zoning Policies

Changing zoning to support more transportation-efficient land use patterns ultimately reduces VMT. Transportation emissions are reduced due to minimized driving distances from denser housing & increased proximity to commercial spaces. A reduction in VMT was assumed to be 11.6%, based on zoning changes from rural density to low-density suburban (small town/villages) taken from a study of National Household Transportation Survey data [186]. The reduction measure assumes that 20% of the total population of all Tribes is affected by responsible development. The VMT per driver used in the GHG inventory was used, and 20% of the population was assumed to have an 11.6% reduction in VMT. The resulting emissions associated with gasoline from that reduction in VMT was calculated as the emissions reduction for this measure.

Baseline emissions: Scope 1 emissions associated with passenger-vehicle gasoline for the Tribes. The baseline amount of gasoline used for passenger vehicles in the Tribes was calculated using annual VMT census data from Minnesota [187] and Wisconsin Departments of Transportation [188] at the county level. The annual VMT was scaled by population to the Tribal population in that same county. If a Tribe is located with multiple county lines, an average VMT from those counties data was used. The Tribes VMT was used along with an average fuel efficiency of 24.2 mpg from DOE's average fuel economy [189] was used to calculated annual gallons of gasoline.

Key assumptions:

- 20% of the total population is affected by zoning policy
- Baseline on-road gasoline emissions (Scope 1) is $174{,}084\ MT\ CO2e$
- Zoning requires an increase in density from rural to low-density suburban

Calculation:

$$\underline{Reduction\ in\ CO2e\ from\ Zoning\ Policies}$$

$$\{(\%\ reduction\ in\ VMT) * (\%\ of\ population\ affected\ by\ zoning) * (baseline\ emissions\ from\ on-road\ gasoline\ in\ MT\ CO2e)\}$$

$$\{(11.6\%) * (20\%\ ) * (\ 174{,}084\ MT\ CO2e)\} = 4{,}000\ MT\ CO2e$$

Cost: The cost of this measure has not been quantified at this PCAP stage due to the variability in each Tribe's existing development plans, zoning policy, and the different methods of implementation that will be unique to each project.

The priority measures within this PCAP not only reduce GHG emissions, but they also reduce co-pollutants, including HAP (Hazardous Air Pollutants) and CAP (Criteria Air Pollutants) to Tribal communities and surrounding areas. This analysis includes a baseline air pollution emissions inventory of co-pollutants for the counties associated with each Tribe.

---

[186] Cambridge Systematics, Inc. (2009, October). *Moving Cooler An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions – Technical Appendices*. Retrieved December 19, 2023, from https://s3.amazonaws.com/CEMS_Docs/SmartandGrowth.pdf

[187] *Vehicle miles traveled reports*. (n.d.). Minnesota Department of Transportation. Retrieved January 5, 2024, from https://www.dot.state.mn.us/roadway/data/reports/vmt/22_crs.pdf

[188] Zhang, M. (2022, November 17). *2021 vehicle miles of travel (VMT) by county*. Retrieved January 5, 2024, from https://wisconsindot.gov/Documents/projects/data-plan/veh-miles/vmt2021-c.pdf

[189] *Average fuel economy by major vehicle category*. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

Appendix D: Co-Pollutant Emissions Inventory

Though the 2020 National Energy Inventory (NEI) dataset includes emissions from many different sectors, this emissions inventory includes "Fuel Combustion" from building types "Commercial/Institutional" and "Residential" to account for PCAP building retrofit measures, as well as "Miscellaneous Non-Industrial Not Elsewhere Classified" – pertaining to "Fluorescent Lamp Breakage" due to PCAP lighting retrofit measures. Consistent with EPA guidance, base year inventories for the transportation sector were not provided.

The NEI dataset sources of emissions are categorized into three (3) levels of "Source Categorization Codes" (SCC). From the first level "Stationary Source Fuel Combustion" and "Miscellaneous Area Sources" are included, and from the second level the following sources are included: "Commercial/Institutional," "Fluorescent Lamp Breakage," and "Residential." For Level 3, the three sources that are *excluded* are "Bituminous/Subbituminous Coal," "Firelog," and "Anthracite Coal," and for Level 4, the sources that are *excluded* are "IC Engines," "Hydronic heater: outdoor," "Outdoor wood burning device, NEC (fire-pits, chimineas, etc.)," which are all sources of emissions not expected to be impacted through the PCAP measures across the eight (8) Tribes.

Finally, the pollutant categories that this inventory accounts for are CAP, HAP, and pollutants that classify as both (CAP/HAP). After the 2020 NEI dataset was filtered to include only building emissions sources, the sum of CAP, HAP, and CAP/HAP in metric tons across all counties aligning with the Tribes presented in Table 29.

Minnesota Chippewa Tribe is not included within the Tribal total in Table 23 to prevent double-counting of the emissions associated with the Leech Lake, Grand Portage, and Fond du Lac Bands. To stay consistent with the GHG Inventory for Minnesota Chippewa Tribe, which is limited to the Tribal Headquarters property in Cass County – a separate table with co-pollutant emissions inventory data specific to Cass County is provided in Table 24.

*Note that HAP Pollutants include:
1,3-Butadiene, Acetaldehyde, Acetophenone, Acrolein, Arsenic Compounds, Benzene, Beryllium Compounds, Cadmium Compounds, Catechol, Chromium Compounds, Cresol/Cresylic Acid (Mixed Isomers), Ethylbenzene, Formaldehyde, Hydroquinone, Manganese Compounds, Mercury Compounds, Naphthalene, Nickel Compounds, Mercury Compounds, Naphthalene, Nickel Compounds, Phenol, Polycyclic Organic Matter, Propionaldehyde, Selenium Compounds, Toluene, Xylenes (Mixed Isomers)

Table 23: Tribal Level Emissions

Tribal-level Emissions (Metric tons)										
			All Tribes	Oneida	Bad River	Lac Courte Oreilles	Grand Portage	Fond du Lac	Leech Lake	Ho-Chunk
Location	State		Minnesota & Wisconsin	Wisconsin	Wisconsin	Wisconsin	Minnesota	Minnesota	Minnesota	Wisconsin
	Counties		19 Associated Counties to 7 MTERA Tribes	Brown, Outagamie	Ashland	Sawyer	Cook	Carlton, St. Louis	Beltrami, Cass, Hubbard, Itasca	Dane, Jackson, Juneau, La Crosse, Monroe, Sauk, Shawano, Wood
Type of Pollutant	**CAP + HAP Total**		**65,419**	**10,042**	**995**	**2,038**	**370**	**13,802**	**11,122**	**27,050**
	CAP	**TOTAL CAP**	**63,560**	**9,744**	**960**	**1,966**	**361**	**13,470**	**10,854**	**26,204**
		Ammonia	670	152	7	11	2	108	76	315
		Carbon Monoxide	40,814	5,947	632	1,309	241	8,982	7,300	16,402
		Nitrogen Oxides	4,552	1,055	42	66	18	666	392	2,313
		Volatile Organic Compounds	5,561	784	86	179	34	1,259	1,032	2,186
		Sulfur Dioxide	221	35	4	7	1	42	37	95
		PM10 Primary (Filt + Cond)	5,927	892	95	197	33	1,223	1,025	2,461
		PM2.5 Primary (Filt + Cond)	5,815	879	95	197	32	1,190	991	2,432
	HAP	**Sum of 25+ pollutants* (see full list above)**	**1,859**	**298**	**34**	**72**	**9**	**332**	**268**	**846**
	CAP/HAP	Lead Compounds	0.011	0.0024	0	0	0	0.0035	0.0005	0.0047

Table 24: Minnesota Chippewa Tribe Co-Pollutant Baseline Inventory (Cass County)

Minnesota Chippewa Tribe - Cass County			
Type of Pollutant (Metric Tons)	**CAP + HAP Total**		**2,369**
	CAP	**TOTAL CAP**	**2,312**
		Ammonia	15.4
		Carbon Monoxide	1,554.8
		Nitrogen Oxides	85.1
		Volatile Organic Compounds	220.2
		Sulfur Dioxide	7.9
		PM10 Primary (Filt + Cond)	217.8
		PM2.5 Primary (Filt + Cond)	210.7
	HAP	**Sum of 25+ pollutants (see Appendix for full list)**	**57**
	CAP/HAP	Lead Compounds	0.000

Appendix E: LIDAC (Low Income Disadvantaged Communities) Census Tracts

The following census tract IDs were taken from the Climate and Economic Justice Screening Tool (CEJST) for all counties with Tribal areas within the census tract and covers all 35 MTERA member Tribes.

Census tract 2010 ID	County Name	State/Territory	Names of Tribal areas within Census tract
26003000100	Alger County	Michigan	Sault Ste. Marie
26005030500	Allegan County	Michigan	Match-e-be-nash-she-wish
26009960500	Antrim County	Michigan	Grand Traverse
26011970500	Arenac County	Michigan	Isabella
26013000100	Baraga County	Michigan	L'Anse
26013000200	Baraga County	Michigan	L'Anse
26019000500	Benzie County	Michigan	Grand Traverse
26021011300	Berrien County	Michigan	Pokagon of Potawatomi
26025002000	Calhoun County	Michigan	Huron Potawatomi
26025002800	Calhoun County	Michigan	Huron Potawatomi
26027001900	Cass County	Michigan	Pokagon of Potawatomi
26027002000	Cass County	Michigan	Pokagon of Potawatomi
26027002100	Cass County	Michigan	Pokagon of Potawatomi
26027002200	Cass County	Michigan	Pokagon of Potawatomi
26029000400	Charlevoix County	Michigan	Little Traverse Bay
26029000500	Charlevoix County	Michigan	Little Traverse Bay
26029000900	Charlevoix County	Michigan	Grand Traverse
26033970100	Chippewa County	Michigan	Bay Mills, Sault Ste. Marie
26033970200	Chippewa County	Michigan	Sault Ste. Marie
26033970500	Chippewa County	Michigan	Sault Ste. Marie
26033970600	Chippewa County	Michigan	Bay Mills, Sault Ste. Marie
26033970800	Chippewa County	Michigan	Sault Ste. Marie
26033971000	Chippewa County	Michigan	Sault Ste. Marie
26035000800	Clare County	Michigan	Isabella

26041970100	Delta County	Michigan	Little Traverse Bay
26041971100	Delta County	Michigan	Sault Ste. Marie
26047970100	Emmet County	Michigan	Little Traverse Bay
26047970200	Emmet County	Michigan	Little Traverse Bay
26047970300	Emmet County	Michigan	Little Traverse Bay
26047970400	Emmet County	Michigan	Little Traverse Bay
26047970500	Emmet County	Michigan	Little Traverse Bay
26047970600	Emmet County	Michigan	Little Traverse Bay
26047970800	Emmet County	Michigan	Little Traverse Bay
26051000800	Gladwin County	Michigan	Isabella
26053950100	Gogebic County	Michigan	Lac Vieux Desert
26055550102	Grand Traverse County	Michigan	Grand Traverse
26073000100	Isabella County	Michigan	Isabella
26073000200	Isabella County	Michigan	Isabella
26073000300	Isabella County	Michigan	Isabella
26073000400	Isabella County	Michigan	Isabella
26073000500	Isabella County	Michigan	Isabella
26073000600	Isabella County	Michigan	Isabella
26073000700	Isabella County	Michigan	Isabella
26073000900	Isabella County	Michigan	Isabella
26073940100	Isabella County	Michigan	Isabella
26073940200	Isabella County	Michigan	Isabella
26073940300	Isabella County	Michigan	Isabella
26073940400	Isabella County	Michigan	Isabella
26073940500	Isabella County	Michigan	Isabella
26073940600	Isabella County	Michigan	Isabella
26089970200	Leelanau County	Michigan	Grand Traverse
26095960200	Luce County	Michigan	Sault Ste. Marie
26097950100	Mackinac County	Michigan	Sault Ste. Marie
26097950200	Mackinac County	Michigan	Sault Ste. Marie

26097950400	Mackinac County	Michigan	Sault Ste. Marie
26097950500	Mackinac County	Michigan	Sault Ste. Marie
26101000400	Manistee County	Michigan	Little River
26101000500	Manistee County	Michigan	Little River
26101000600	Manistee County	Michigan	Little River
26103002800	Marquette County	Michigan	Sault Ste. Marie
26105950600	Mason County	Michigan	Little River
26109960100	Menominee County	Michigan	Hannahville
26109960200	Menominee County	Michigan	Hannahville
26111291400	Midland County	Michigan	Isabella
26111291700	Midland County	Michigan	Isabella
26113960400	Missaukee County	Michigan	Isabella
26131970100	Ontonagon County	Michigan	L'Anse Ontonagon
26131990100	Ontonagon County	Michigan	L'Anse Ontonagon
26159011300	Van Buren County	Michigan	Pokagon of Potawatomi
26159011400	Van Buren County	Michigan	Pokagon of Potawatomi
26159012000	Van Buren County	Michigan	Pokagon of Potawatomi
27001770100	Aitkin County	Minnesota	Mille Lacs
27001770400	Aitkin County	Minnesota	Mille Lacs
27001790501	Aitkin County	Minnesota	Mille Lacs
27005450100	Becker County	Minnesota	White Earth
27005450800	Becker County	Minnesota	White Earth
27005450900	Becker County	Minnesota	White Earth
27005940000	Becker County	Minnesota	White Earth
27007450300	Beltrami County	Minnesota	Leech Lake, Red Lake
27007450400	Beltrami County	Minnesota	Red Lake
27007450500	Beltrami County	Minnesota	Red Lake
27007940001	Beltrami County	Minnesota	Red Lake
27007940002	Beltrami County	Minnesota	Leech Lake
27017070100	Carlton County	Minnesota	Fond du Lac
27017070400	Carlton County	Minnesota	Fond du Lac

27017070500	Carlton County	Minnesota	Fond du Lac
27017070600	Carlton County	Minnesota	Fond du Lac
27017940000	Carlton County	Minnesota	Fond du Lac
27021940001	Cass County	Minnesota	Leech Lake
27021940002	Cass County	Minnesota	Leech Lake
27021960100	Cass County	Minnesota	Leech Lake
27021960200	Cass County	Minnesota	Leech Lake
27021960301	Cass County	Minnesota	Leech Lake
27023950300	Chippewa County	Minnesota	Upper Sioux
27029000100	Clearwater County	Minnesota	White Earth
27029000200	Clearwater County	Minnesota	White Earth
27029000300	Clearwater County	Minnesota	Red Lake
27031480100	Cook County	Minnesota	Grand Portage
27035950100	Crow Wing County	Minnesota	Mille Lacs
27035951600	Crow Wing County	Minnesota	Mille Lacs
27049080200	Goodhue County	Minnesota	Prairie Island
27049080400	Goodhue County	Minnesota	Prairie Island
27057070100	Hubbard County	Minnesota	Leech Lake
27057070300	Hubbard County	Minnesota	Leech Lake
27061480100	Itasca County	Minnesota	Bois Forte (Deer Creek), Leech Lake
27061480300	Itasca County	Minnesota	Leech Lake
27061480400	Itasca County	Minnesota	Leech Lake
27061480700	Itasca County	Minnesota	Leech Lake
27061940000	Itasca County	Minnesota	Leech Lake
27065480100	Kanabec County	Minnesota	Mille Lacs
27071790300	Koochiching County	Minnesota	Bois Fort (Nett Lake)
27071790500	Koochiching County	Minnesota	Bois Fort (Nett Lake), Bois Forte (Deer Creek), Red Lake
27077460300	Lake of the Woods County	Minnesota	Red Lake
27077460400	Lake of the Woods County	Minnesota	Red Lake

27087940100	Mahnomen County	Minnesota	White Earth
27087940300	Mahnomen County	Minnesota	White Earth
27089080100	Marshall County	Minnesota	Red Lake
27095970100	Mille Lacs County	Minnesota	Mille Lacs
27095970200	Mille Lacs County	Minnesota	Mille Lacs
27095970300	Mille Lacs County	Minnesota	Mille Lacs
27097780400	Morrison County	Minnesota	Mille Lacs
27107960100	Norman County	Minnesota	White Earth
27113090100	Pennington County	Minnesota	Red Lake
27115950400	Pine County	Minnesota	Mille Lacs
27115950500	Pine County	Minnesota	Mille Lacs
27115950600	Pine County	Minnesota	Mille Lacs
27115950800	Pine County	Minnesota	Mille Lacs
27119020900	Polk County	Minnesota	White Earth
27119021000	Polk County	Minnesota	Red Lake, White Earth
27125010100	Red Lake County	Minnesota	Red Lake
27127750100	Redwood County	Minnesota	Lower Sioux
27129790300	Renville County	Minnesota	Upper Sioux
27129790400	Renville County	Minnesota	Lower Sioux
27135970100	Roseau County	Minnesota	Red Lake
27135970400	Roseau County	Minnesota	Red Lake
27135970500	Roseau County	Minnesota	Red Lake
27137011100	St. Louis County	Minnesota	Fond du Lac
27137011200	St. Louis County	Minnesota	Fond du Lac
27137015500	St. Louis County	Minnesota	Bois Fort (Nett Lake), Bois Forte (Vermillion Lake)
27139080301	Scott County	Minnesota	Shakopee
27139080302	Scott County	Minnesota	Shakopee
27139080903	Scott County	Minnesota	Shakopee
27139080905	Scott County	Minnesota	Shakopee

27173970100	Yellow Medicine County	Minnesota	Upper Sioux
55001950202	Adams County	Wisconsin	Ho-Chunk
55001950400	Adams County	Wisconsin	Ho-Chunk
55003940000	Ashland County	Wisconsin	Bad River
55003950600	Ashland County	Wisconsin	Bad River
55003950800	Ashland County	Wisconsin	Bad River
55005000200	Barron County	Wisconsin	St. Croix
55005000300	Barron County	Wisconsin	St. Croix
55007960100	Bayfield County	Wisconsin	Red Cliff
55009000302	Brown County	Wisconsin	Oneida
55009020502	Brown County	Wisconsin	Oneida
55009020503	Brown County	Wisconsin	Oneida
55009020504	Brown County	Wisconsin	Oneida
55009021302	Brown County	Wisconsin	Oneida
55009021304	Brown County	Wisconsin	Oneida
55009021600	Brown County	Wisconsin	Oneida
55009940001	Brown County	Wisconsin	Oneida
55009940002	Brown County	Wisconsin	Oneida
55009940003	Brown County	Wisconsin	Oneida
55009940004	Brown County	Wisconsin	Oneida
55013970400	Burnett County	Wisconsin	St. Croix
55013970600	Burnett County	Wisconsin	St. Croix
55013970700	Burnett County	Wisconsin	St. Croix
55019950400	Clark County	Wisconsin	Ho-Chunk
55019950800	Clark County	Wisconsin	Ho-Chunk
55023960200	Crawford County	Wisconsin	Ho-Chunk
55025003100	Dane County	Wisconsin	Ho-Chunk
55025010501	Dane County	Wisconsin	Ho-Chunk
55025010502	Dane County	Wisconsin	Ho-Chunk
55025010600	Dane County	Wisconsin	Ho-Chunk

55025011401	Dane County	Wisconsin	Ho-Chunk
55035000100	Eau Claire County	Wisconsin	Ho-Chunk
55041950100	Forest County	Wisconsin	Forest County Potawatomi
55041950200	Forest County	Wisconsin	Forest County Potawatomi
55041950300	Forest County	Wisconsin	Forest County Potawatomi
55041950400	Forest County	Wisconsin	Mole Lake
55051180200	Iron County	Wisconsin	Bad River
55051180300	Iron County	Wisconsin	Lac du Flambeau
55053960100	Jackson County	Wisconsin	Ho-Chunk
55053960400	Jackson County	Wisconsin	Ho-Chunk
55057100400	Juneau County	Wisconsin	Ho-Chunk
55057100500	Juneau County	Wisconsin	Ho-Chunk
55057100700	Juneau County	Wisconsin	Ho-Chunk
55063010201	La Crosse County	Wisconsin	Ho-Chunk
55067960400	Langlade County	Wisconsin	Menominee
55067960500	Langlade County	Wisconsin	Menominee
55073001700	Marathon County	Wisconsin	Ho-Chunk
55075960200	Marinette County	Wisconsin	Forest County Potawatomi
55078940101	Menominee County	Wisconsin	Menominee
55078940102	Menominee County	Wisconsin	Menominee, Stockbridge Munsee
55081950100	Monroe County	Wisconsin	Ho-Chunk
55081950700	Monroe County	Wisconsin	Ho-Chunk
55083100300	Oconto County	Wisconsin	Forest County Potawatomi, Menominee
55083100500	Oconto County	Wisconsin	Menominee
55083100600	Oconto County	Wisconsin	Menominee
55085971002	Oneida County	Wisconsin	Lac du Flambeau
55087012901	Outagamie County	Wisconsin	Oneida
55087013100	Outagamie County	Wisconsin	Oneida
55087013300	Outagamie County	Wisconsin	Oneida
55087940000	Outagamie County	Wisconsin	Oneida
55095960100	Polk County	Wisconsin	St. Croix

55095960300	Polk County	Wisconsin	St. Croix
55111000100	Sauk County	Wisconsin	Ho-Chunk
55113100300	Sawyer County	Wisconsin	Lac Courte Oreilles
55113100400	Sawyer County	Wisconsin	Lac Courte Oreilles
55113100500	Sawyer County	Wisconsin	Lac Courte Oreilles
55113100700	Sawyer County	Wisconsin	Lac Courte Oreilles
55113940000	Sawyer County	Wisconsin	Lac Courte Oreilles
55115100200	Shawano County	Wisconsin	Menominee
55115100300	Shawano County	Wisconsin	Menominee
55115100600	Shawano County	Wisconsin	Menominee, Stockbridge Munsee
55115100700	Shawano County	Wisconsin	Menominee
55115100800	Shawano County	Wisconsin	Ho-Chunk
55123960200	Vernon County	Wisconsin	Ho-Chunk
55125940000	Vilas County	Wisconsin	Lac du Flambeau
55125950600	Vilas County	Wisconsin	Lac du Flambeau
55125950700	Vilas County	Wisconsin	Lac du Flambeau
55141010800	Wood County	Wisconsin	Ho-Chunk
55141010900	Wood County	Wisconsin	Ho-Chunk

Appendix F: References

2018 Commercial Buildings Energy Consumption Survey. (2018). U.S. EIA. Retrieved February 24, 2024, from https://www.eia.gov/consumption/commercial/data/2018/

2020 Residential Energy Consumption Survey. (2020). U.S. Energy Information Administration. Retrieved February 24, 2024, from https://www.eia.gov/consumption/residential/data/2020/

Annual Technology Baseline. (2022, July 21). *NREL Hydropower*. Retrieved January 5, 2024, from https://atb.nrel.gov/electricity/2022/hydropower

Assessing the potential for carbon emissions savings from replacing short car trips with walking and cycling using a mixed GPS-travel diary approach. (2019, May). Transportation Research Part A: Policy and Practice. Retrieved January 5, 2024, from https://www.sciencedirect.com/science/article/pii/S0965856417316117#:~:text=Taking%20into%20account%20individual%20travel,to%20existing%20walking%20and%20cycling.

Average fuel economy by major vehicle category. (2020, February 5). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/data/10310

Bathroom Faucets. (2023, May 8). WaterSense, Environmental Protection Agency. Retrieved November 20, 2024, from https://www.epa.gov/watersense/bathroom-faucets

Building Performance Database (BPD). (n.d.). US DOE. Retrieved February 24, 2024, from https://bpd.lbl.gov/

Cambridge Systematics, Inc. (2009, October). *Moving Cooler An Analysis of Transportation Strategies for Reducing Greenhouse Gas Emissions – Technical Appendices*. Retrieved December 19, 2023, from https://s3.amazonaws.com/CEMS_Docs/Smart+Growth.pdf

Consumer Guide to Kitchen Appliances. (n.d.). Energy Saver, US Department of Energy. Retrieved January 5, 2024 from https://www.energy.gov/sites/default/files/2021-08/ES-KitchenAppliances_080221.pdf

eGallon. (n.d.). U.S. Department of Energy. Retrieved January 5, 2024, from https://www.energy.gov/sites/prod/files/2013/06/f1/eGallon-methodology-final.pdf

Costs associated with non-residential electric vehicle supply equipment. (2015, November). U.S. Department of Energy, Energy Efficiency and Renewable Energy. Retrieved January 5, 2024, from https://afdc.energy.gov/files/u/publication/evse_cost_report_2015.pdf

Daily per capita protein supply. (n.d.). Our World in Data. Retrieved February 15, 2024, from https://ourworldindata.org/grapher/daily-per-capita-protein-supply?tab=chartandcountry=~USA

Default Heat Content for Energy Conversions. (n.d.). US EPA. https://www.epa.gov/system/files/ documents/2022-10/Default%20Heat%20Content%20Ratios%20for%20Help%20and%20User%20Guide%20%281%29.pdf

Department of Energy Office of Energy Efficiency and Renewable Energy. (2023). *Land-Based Wind Market Report: 2023 Edition* (R. Wiser & M. Bolinger, Authors).

Doorn, M., Towprayoon, S., Maria Manso Vieira, S., Irving, W., Palmer, C., Pipatti, R., and Wang, C. (2006). WASTEWATER TREATMENT AND DISCHARGE (Table 6.3). 2006 IPCC Guidelines for National Greenhouse Gas Inventories. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/ V5_6_Ch6_Wastewater.pdf

Doorn, M., Towprayoon, S., Maria Manso Vieira, S., Irving, W., Palmer, C., Pipatti, R., and Wang, C. (2006). WASTEWATER TREATMENT AND DISCHARGE (Table 6.4). 2006 IPCC Guidelines for National Greenhouse Gas Inventories. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/ V5_6_Ch6_Wastewater.pdf

Doorn, M., Towprayoon, S., Maria Manso Vieira, S., Irving, W., Palmer, C., Pipatti, R., and Wang, C. (2006). WASTEWATER TREATMENT AND DISCHARGE (Table 6.8, 6.10). 2006 IPCC Guidelines for National Greenhouse Gas Inventories. https://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/5_Volume5/ V5_6_Ch6_Wastewater.pdf

Emissions factors for greenhouse gas inventories. (2023, September 12). EPA Center for Corporate Climate Leadership. https://www.epa.gov/system/files/documents/2023-03/ghg_emission_factors_hub.pdf

Energy Efficiency Program Sponsor Frequently Asked Questions About ENERGY STAR Smart Thermostats. (n.d.). Energy Star. Retrieved November 20, 2023, from https://www.energystar.gov/products/heating_cooling/smart_thermostats/smart_thermostat_faq

EPA eGrid Emission Factors. (2022, January). Retrieved January 5, 2024, from https://www.epa.gov/egrid

Flipping the Switch on electric school buses: charging infrastructure: module 1. (n.d.). U.S. Department of Energy, Energy Efficiency and Renewable Energy, Alternative Fuels Data Center. Retrieved January 5, 2024, from https://afdc.energy.gov/vehicles/electric_school_buses_p4_m1.html#:~:text=A%20typical%20bus%20can%20travel,energy%20for%20every%20mile%20traveled

*Geo vs. Fossil Fuels: How does a Geothermal Heat Pump Stack up against fossil fuels? (*n.d.). Minnesota Geothermal Heat Pump Association. Retrieved February 5, 2024, from https://www.minnesotageothermalheatpumpassociation.com/geothermal/how-geo-compares/

Get started using the Pathfinder. (n.d.). Climate Positive Design. Retrieved December 19, 2023, from https://climatepositivedesign.com/pathfinder/

Group14 Engineering, PBC. (2020, November). *Electrification of Commercial and Residential Buildings* [White paper]. Building Decarbonization Coalition. Retrieved January 5, 2024, from https://buildingdecarb.org/wp-content/uploads/Building-Electrification-Study-Group14-2020-11.09.pdf

Highway Statistics 2019. (2019). US DOT Federal Highway Administration. Retrieved February 24, 2024, from https://www.fhwa.dot.gov/policyinformation/statistics/2019/

How much does it cost to build a ridesharing app? (n.d.). Crowdbotics. https://www.crowdbotics.com/ cost-to-build-app-type/ridesharing-app

How Much Does Landscape Installation Cost? (n.d.). Home Advisors. Retrieved January 22, 2023, from https://www.homeadvisor.com/cost/landscape/install-landscaping/

Laundry. (n.d.). Energy Saver, US Department of Energy. Retrieved January 5, 2024, from https://www.energy.gov/energysaver/laundry

Less, B. D., Walker, I. S., Casquero-Modrego, N., & Rainer, L. I. (2021, August). *The Cost of Decarbonization and Energy Upgrade Retrofits for US Homes*. Lawrence Berkeley National Laboratory. Retrieved January 22, 2024, from https://eta-publications.lbl.gov/sites/default/files/final_walker_-_the_cost_of_decarbonization_and_energy.pdf

Leung, J. (2018, July). *Decarbonizing U.S. Buildings*. Center for Climate and Energy Solutions. Retrieved November 19, 2023, from https://www.c2es.org/wp-content/uploads/2018/06/innovation-buildings-background-brief-07-18.pdf

Litman, T. (2023, November 19). *Evaluating active transport benefits and costs guide to valuing walking and cycling improvements and encouragement programs.* Victoria Transport Policy Institute. Retrieved January 5, 2024, from https://www.vtpi.org/nmt-tdm.pdf

Minnesota Can Save Energy, Money, and Mitigate the Effects of Climate Change through Building Energy Codes. (2021, July). US Department of Energy. Retrieved February 5, 2024, from https://www.energycodes.gov/sites/default/files/2021-07/EED_1365_BROCH_StateEnergyCodes_states_MINNESOTA.pdf

NREL PVWatts Calculator. (1999). NREL PVWatts. Retrieved January 5, 2024, from https://pvwatts.nrel.gov/

National Overview: Facts and Figures on Materials, Wastes and Recycling. (2023, November 22). US EPA. Retrieved February 24, 2024, from https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials

National Renewable Energy Laboratory. *Energy Efficiency – Commercial Electricity Savings Potential*. (n.d.). State and Local Planning for Energy. Retrieved December 12, 2023, from https://maps.nrel.gov/slope/data-viewer?filters=%5B%5D&layer=comstock.electricity-savings-potential&year=2012&res=state

National Renewable Energy Laboratory. *Energy Efficiency – Commercial Natural Gas Savings Potential*. (n.d.). State and Local Planning for Energy. Retrieved December 12, 2023, from https://maps.nrel.gov/slope/data-viewer?filters=%5B%5D&layer=comstock.gas-savings-potential&year=2012&res=state

National Renewable Energy Laboratory. *Energy Efficiency – Single Family Home Electricity Savings Potential*. (n.d.). State and Local Planning for Energy. Retrieved December 12, 2023, from https://maps.nrel.gov/slope/data-viewer?filters=%5B%5D&layer=resstock.single-family-home-electricity-savings-potential&year=2017&res=state&energyBurdenPcnt=0.06&transportationBurdenPcnt=0.04&sviTheme=mn&sviPcntl=0

National Renewable Energy Laboratory. *Energy Efficiency – Single Family Home Fuel Savings Potential*. (n.d.). State and Local Planning for Energy. Retrieved December 12, 2023, from https://maps.nrel.gov/slope/data-viewer?filters=%5B%5D&layer=resstock.single-family-home-fuel-savings-potential&year=2017&res=state&energyBurdenPcnt=0.06&transportationBurdenPcnt=0.04&sviTheme=mn&*sviPcntl*=0

Nita, A. (2023, November 29). *How Much Does it Cost to Plant a Tree in 2024?* Lawn Love. Retrieved on January 22, 2024, from https://lawnlove.com/blog/cost-to-plant-tree/

Public transportation's role in responding to climate change. (2010, January). U.S. Department of Transportation Federal Transit Administration. Retrieved January 5, 2024, from https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/PublicTransportationsRoleInRespondingToClimateChange2010.pdf

QuickFacts: Michigan. (n.d.). United States Census Bureau. Retrieved December 15, 2023, from https://www.census.gov/quickfacts/fact/table/MI

QuickFacts: Minnesota. (n.d.). United States Census Bureau. Retrieved December 15, 2023, from https://www.census.gov/quickfacts/fact/table/MN

QuickFacts: Wisconsin. (n.d.). United States Census Bureau. Retrieved December 15, 2023, from https://www.census.gov/quickfacts/fact/table/WI

Ramasamy, V., Zuboy, J., Woodhouse, M., O'Shaughnessy, E., Feldman,, D., Desai, J., Walker, A., Margolis, R. , & Basore, P. (2023, September). *U.S. solar photovoltaic system and energy storage cost benchmarks, with minimum sustainable price analysis: Q1 2023*. National Renewable Energy Laboratory.

Reeg, L., Henchen, M., Potter, C., & Stone, C. (2023, March 29). *Clean Energy 101: Geothermal Heat Pumps*. RMI. Retrieved February 5, 2024, from https://rmi.org/clean-energy-101-geothermal-heat-pumps

Reeg, L., & Mifsud, A. S. (2022, May 27). *Heat Pumps in Cold Places: Three Questions Wisconsinites Are Asking about Heat Pumps*. Rocky Mountain Institute. Retrieved January 5, 2024, from https://rmi.org/three-questions-wisconsinites-are-asking-about-heat-pumps/

Residential Demand Response. (n.d.). Building Energy Codes Program, Department of Energy Office of Energy Efficiency and Renewable Energy. Retrieved December 19, 2023, from https://www.energycodes.gov/sites/default/files/2021-10/Residential_Demand_Response.pdf

Roadway Data. (2022). Minnesota Department of Transportation. Retrieved February 24, 2024, from https://www.dot.state.mn.us/roadway/data/data-products.html#VMT

Rovito, M., Savio, P., Subramony, G., & Duffy, L. (n.d.). *Advanced Thermostats for Small-to-Medium-Sized Commercial Buildings* [White paper]. ERS. Retrieved January 22, 2024, from https://www.ers-inc.com/wp-content/uploads/2017/02/Advanced-Thermostats-for-Commercial-Buildings.pdf

Rules of Thumb, Energy Efficiency in Buildings. (2016, March). Environmental Protection Agency. Retrieved January 22, 2024, from https://www.epa.gov/sites/default/files/2016-03/documents/table_rules_of_thumb.pdf

Save Money and Stay Cool with an Efficient, Well-Maintained Air Conditioner [Fact sheet]. (2022, June 30). Energy Saver, US Department of Energy. Retrieved January 5, 2024, from https://www.energy.gov/energysaver/articles/save-money-and-stay-cool-efficient-well-maintained-air-conditioner

Shaheen, S., Cohen, A., & Bayen, A. (2018). *The benefits of carpooling.* UC Berkeley Transportation Sustainability Research Center. Retrieved January 5, 2024, from https://escholarship.org/uc/ item/7jx6z631

Showerheads. (2023, May 5). WaterSense, Environmental Protection Agency. Retrieved November 20, 2024, from https://www.epa.gov/watersense/showerheads

Stehly, T., Duffy, P., & Hernando, D. M. (2023, December). *2022 Cost of Wind Energy Review.* NREL Transforming Energy. Retrieved January 5, 2024, from https://www.nrel.gov/docs/fy24osti/88335.pdf

Table 6.07.B. Capacity Factors for Utility Scale Generators Primarily Using Non-Fossil Fuels.(n.d.). EIA Electric Power Monthly. https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_b

The electric and alternative fuel school bus lifecycle cost analysis tool. (n.d.). Oregon Department of Energy. Retrieved January 5, 2024, from https://www.oregon.gov/energy/energy-oregon/Documents/2022-Jan-14-School-Bus-Electrification-Cost-Comparison-Tool.xlsx

The state of sustainable fleets. (2022). Retrieved January 5, 2024, from https://cdn.stateofsustainablefleets.com/2022/state-of-sustainable-fleets-2022-report.pdf

Toma, L. (2023, November 29). *How Much Does Sod Cost to Install in 2024?* Lawn Love. Retrieved on January 22, 2024, from https://lawnlove.com/blog/sod-cost/

Transit vehicle electrification best practices. (n.d.). Maine DOT. Retrieved January 5, 2024, from https://www.maine.gov/mdot/climate/docs/Maine%20DOT%20Transit%20Vehicle%20Electrification%20Best%20Practices.pdf

Tsinnajinnie, L., & Begay-Campbell, S. (2006, August 25). *Benefits of Renewable Energy for Native Nations from the Environmental and Native Perspectives.* Retrieved February 8, 2024, from https://www.energy.gov/sites/prod/files/2016/01/f28/interns2006tsinnajinnie.pdf

US EPA,ORD. (2017, November 2*). Disease and Conditions* | US EPA. US EPA. https://www.epa.gov/report-environment/disease-and-conditions

Use of energy explained: Energy use in homes. (2023, December 18). U.S. Energy Information Administration. Retrieved January 5, 2024, from https://www.eia.gov/energyexplained/use-of-energy/electricity-use-in-homes.php

Vehicle miles traveled reports. (n.d.). Minnesota Department of Transportation. Retrieved January 5, 2024, from https://www.dot.state.mn.us/roadway/data/reports/vmt/22_crs.pdf

Water Powers Technologies Office. (n.d.). *Types of Hydropower Plants*. Office of Energy Efficiency and Renewable Energy. Retrieved January 5, 2024, from https://www.energy.gov/eere/water/types-hydropower-plants

Volume-to-Weight Conversion Factors. (2016, April). U.S. Environmental Protection Agency. https://www.epa.gov/sites/default/files/2016-04/documents/volume_to_weight_conversion_factors_memorandum_04192016_508fnl.pdf

Water Resources Engineering, Inc. (2002, May). *Retrofitting Apartment Buildings to Conserve Water*. HUD User, U.S. Department of Housing and Urban Development. Retrieved January 20, 2024, from https://www.huduser.gov/publications/pdf/Book2.pdf

*Wisconsin Can Save Energy, Money, and Mitigate the Effects of Climate Change through Building Energy Codes [*Fact sheet]. (2021, July). US Department of Energy. Retrieved February 5, 2024, from https://www.energycodes.gov/sites/default/files/2021-07/EED_1365_BROCH_StateEnergyCodes_states_WISCONSIN.pdf

Zhang, M. (2022, November 17). *2021 vehicle miles of travel (VMT) by county*. Retrieved January 5, 2024, from https://wisconsindot.gov/Documents/projects/data-plan/veh-miles/vmt2021-c.pdf