MTERA

Midwest Tribal Energy Resources Association, Inc.

EPA Climate Pollution Reduction Grant

Comprehensive Climate Action Plan

Midwest Tribal Energy Resources Association

MTERA

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Boozhoo,

The Midwest Tribal Energy Resources Association (MTERA) is happy to announce the completion of the Comprehensive Climate Action Plan (CCAP), which specifically promotes policies, practices, and technologies that reduce pollution, create high-quality jobs, drive economic growth, and enhance the quality of life for all Midwest Tribes.

The CCAP has taken a long time to develop and will become a platform for regional Tribal climate action. The impact of having a holistic picture of energy emissions and usage will help Tribes to determine next steps for energy efficiency measures, clean energy deployment, and ultimately objectives towards energy sovereignty and independence.

Funded by the Environmental Protection Agency (EPA) Climate Pollution Reduction Grant (CPRG), this plan focuses on cutting harmful emissions, addressing environmental injustices, and empowering community-driven solutions in Midwest Tribal communities. This project and plan would not have been completed without the assistance of the EPA, which has further committed to the deployment of implementation funds to support initiatives and projects derived from the CCAP.

Thank you to the MTERA CCAP Team, Midwest Tribes, and the EPA for the great partnership and report. MTERA looks forward to all the great initiatives and work that will be derived from all of your hard work!

Miigwech! (Thank you)!

Sincerely,
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Acronyms

AC	Alternating Current
ASHP	Air Source Heat Pump
BAU	Business as Usual
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
WWTP	Wastewater Treatment Plant

Definitions

Business-as-Usual (BAU): A projection scenario of greenhouse gas emissions under the assumption that the current pattern of activity is maintained with no further Tribal actions.

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.

Decarbonization: The effort of reducing carbon dioxide emissions from a project or process.

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 GHGs 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 contributes 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.

1 Introduction

The Midwest Tribal Energy Resources Association (MTERA) has created this Comprehensive Climate Action Plan (CCAP) to promote policies, practices, and technologies that reduce pollution, create high-quality jobs, drive economic growth, and enhance the quality of life for all Midwest Tribes. Funded by the Environmental Protection Agency (EPA) Climate Pollution Reduction Grant (CPRG), this plan focuses on reducing harmful greenhouse gas (GHG) emissions, addressing environmental injustices, and empowering community-driven solutions in Midwest Tribal communities.

To maximize the grant's impact, MTERA partnered with eight Midwest Tribes, listed below. This plan's analysis is grounded in the data and insight from this eight-Tribe subset of EPA Region 5 Tribes. The results and strategies are designed to be broadly applicable to Tribes across the Midwest regardless of where each is at in their climate action planning process – providing insight on major sources of GHG emissions by sector, the relative emissions reduction impacts, benefits, and costs of measures, and the process towards their implementation.

Participating Tribes include:

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

These eight Tribes comprise nearly a quarter of all Midwest Tribes and are diverse in size, location, economic resources, energy resources, and population density. This variety enables them to serve as a representative sample, with findings adaptable to the unique circumstances of each Tribe in the region, providing meaningful insights into climate pollution reduction opportunities and benefits.

While several sections within this CCAP are a deep dive into the analysis of the eight participating Tribes, the findings and strategies from this CCAP are designed to be broadly applicable to Tribes throughout Michigan, Minnesota, and Wisconsin. Section 1.2: How to Read this Report & Summary of CCAP Sections provides an overview of each section and how it may be a helpful resource for Midwest Tribes in planning for implementing emissions reductions projects.

Based on the findings from this CCAP, MTERA has developed a GHG reduction measure tool that can be used by all Tribes in Michigan, Minnesota, and Wisconsin to provide estimates of GHG reductions and cost estimates associated with the specific priority measures identified in this CCAP. This tool is intended to support Midwest Tribes in developing a preliminary understanding of the impact and feasibility of potential emissions mitigation projects, which may include, but are not limited to: renewable energy, building and transportation electrification, and environmental planning and management.

This CCAP, the preceding Priority Climate Action Plan (PCAP), and the accompanying MTERA GHG reduction measure tool have been made available to all Tribes in EPA Region 5 through a public repository of MTERA CPRG resources on the MTERA website.

Please note that the results and strategies described in this CCAP, the preceding PCAP, and the accompanying MTERA GHG reduction measure tool may not be applicable to Tribes outside of Michigan, Minnesota, and Wisconsin due to regional differences in generation mixes.

1.1 CCAP Updates from PCAP

This CCAP builds upon the Priority Climate Action Plan (PCAP) submitted to the EPA in March of 2024 and provides substantive updates to previous PCAP sections (GHG Inventory, GHG Reduction Measures, Benefits Analysis, Authority to Implement, and Intersection with Other Funding Availability) as well as the integration of two new sections to guide Tribes through a comprehensive climate action planning process (GHG Emissions Projections & Targets and Workforce Planning Analysis).

Figure 1: Components of the Climate Action Planning Process (PCAP & CCAP)

1.2 How to Read this Report & Summary of CCAP Sections

This CCAP is a comprehensive document which provides detailed information pertaining to greenhouse gas accounting, projections of emissions into the future, in-depth technical descriptions of greenhouse reduction measures and their anticipated benefits, and guidance regarding implementation authority, funding, and workforce planning. Content in this report can be referenced to support project development for specific grant applications and can inform Tribal energy and sustainability planning efforts. In reading this report, we recommend making use of the "Bookmarks" feature on your PDF viewer to navigate to specific sections most of interest to your Tribe.

A summary of each CCAP section is included below. Hyperlinks are included for each section title to navigate directly to that section of the report.

- Section 2: GHG Inventory
  - This section provides useful metrics allowing Midwest Tribes to understand the typical breakdown of Tribal emissions across sectors (Buildings, Transportation, Waste, Agriculture & Land Use) and provides a comparison between direct Scope 1 and indirect Scope 2 emissions to identify key areas of focus for reduction measures.

- Additionally, a summary of GHG inventory data specific for each of the eight-Tribe subset is provided in Appendix A, which can inform targeted future decision-making on GHG reduction priorities customized to each Tribe.

- Section **3**: **GHG Emissions Projections & Targets**
  - This is a new section added to the CCAP which combines two important steps in climate action planning: the forecasting of emissions into the future and focusing in to set reduction targets. This analysis provides insight into expected emissions trends and helps Tribes visualize the scale and scope of actions required to meet ambitious reduction targets.
  - A business-as-usual (BAU) case is calculated which estimates how GHG emissions will be influenced based on external forces, with no additional actions taken by Tribes beyond current trends. Targets are established for the short-term 45% reduction in 2022 emissions baseline by 2030, as well as the long-term net zero emissions by 2050 milestone to provide a more ambitious future pathway. Graphics depict the individual and collective impact of each reduction measure type in reaching these 2030 and 2050 goals.
- Section **4**: **GHG Reduction Measures & Benefits**
  - For each GHG reduction measure, this section provides a description of the measure and a benefits analysis, detailing the various additional environmental, social, and economic benefits aside from GHG emissions, and may be helpful to review for Tribes considering a range of emissions reduction projects. To provide additional information on expected beneficial public health outcomes, additional quantitative analysis was undertaken for the most influential measures using EPA Tools AVERT & COBRA. Additional measure level details are provided in Appendix B while public health benefit methodology is further detailed in Appendix E
  - For each major category of reduction measures, summary tables are provided which detail the measure implementation quantities needed to meet 2030 and 2050 targets, the corresponding GHG reduction impact of each measure at these milestones for the eight-Tribe subset, and the estimated unitized cost per measure.
- Section **5**: **Co-Pollutant Emissions Inventory & LIDAC Census Tract Data**
  - This section, along with Appendix C, aggregates existing co-pollutant data for the eight-Tribe subset reported to the EPA through its National Emissions Inventory (NEI). This section quantifies the relevant Criteria Air Pollutants (CAPs) and Hazardous Air Pollutants (HAPs) that affect Tribal Member's public health, setting a baseline of co-pollutant emissions that are reduced by the CCAP GHG reduction measures. For more details on CAP and HAP reductions, see Appendix E.
- Section **6**: **Authority to Implement**
  - This section outlines for each category of measure the existing implementation authority of Tribes and the relevant statutory and regulatory considerations to be aware of. While Tribes have broad authority to implement GHG reduction measures through Tribal sovereignty, this section outlines various state and federal policies which may influence specific measure types to aid in Tribal implementation planning.
- Section **7**: **Intersection with Other Funding Availability**
  - This section outlines additional funding programs which are available to Tribes to pursue the objectives of the CCAP. Due to the wide variety, quantity, and scale of identified GHG reduction measures included within this climate action plan, it is integral that Tribes pursue funding opportunities from a variety of sources to support project implementation. It is worth noting that MTERA Tribes have successfully been awarded a number of grants outside of CPRG to support CCAP initiatives; these grants are highlighted in the Reduce Electricity Generation Emissions and Reduce Building Energy Emissions sections.

- Section **8**: **Workforce Planning Analysis**
  - This section outlines workforce related challenges and opportunities relating to GHG measure implementation. The analysis and resources contained in this section aim to ensure that economic benefits stemming from GHG reduction initiatives reach Tribal communities and support sustainable and equitable employment opportunities.

Ultimately, this CCAP serves as a tool for Midwest Tribes in both GHG reporting and climate action planning. The GHG analysis within Section 2 and Appendix A are guided by GHG Protocol accounting and reporting principles, including relevance, completeness, consistency, transparency, and accuracy.[1] The reduction measures within the CCAP are selected according to the guiding principles for climate action planning to be comprehensive, integrated, relevant, and actionable – based upon documented evidence and transparent and verifiable methodologies detailed in Appendix B.[2]

2 GHG Inventory

This GHG inventory is a record of quantified emissions by source for the eight-Tribe subset and helps Tribes understand sectors to prioritize for priority emission reduction measures. These emissions are measured in metric tons of carbon dioxide equivalent ($MTCO_2e$). CO_2e is a standardized measure used to compare the impact of different gases that trap heat in the atmosphere. In this report, the inventory is reporting the GHGs quantified from: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O).[3]

Starting in April of 2024, Arup distributed a revised RFI template to the eight-Tribe subset to fill in data collection gaps from the PCAP stage. Over the following weeks, Arup worked closely with staff from the eight-Tribe subset to integrate updated Building Energy, Transportation, Waste, and Agriculture & Land Use data – holding a series of meetings with Tribes to ensure that the best available data was integrated into the CCAP GHG inventory analysis.

Industrial sector emissions were not found to be a significant source across the participating Tribes based on available data. Operational data was collected that was representative of emissions for the 2022 baseline year. As differing levels of information were available from each Tribe, proxy data was used in cases where data inputs were not readily available. See Appendix A for additional details on the GHG Inventory Methodology, as well as an individual breakdown of emissions for each of the eight-Tribe subsets.

[1] *Global Protocol for Community-Scale Greenhouse Gas Inventories: An Accounting and Reporting Standard for Cities Version 1.1* (2021). World Resources Institute. Retrieved September 18, 2024, from https://ghgprotocol.org/sites/default/files/standards/GPC_Full_MASTER_RW_v7.pdf

[2] *Guiding Principles for City Climate Action Planning* (2015). United Nations Human Settlements Programme. Retrieved September 18, 2024, from https://e-lib.iclei.org/wp-content/uploads/2016/02/Guiding-Principles-for-City-Climate-Action-Planning.pdf

[3] Note: Emissions from fluorinated gases such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6) were not emitted in traceable amounts from information provided. For Tribes with information on refrigeration equipment quantities and usage, please refer to EPA Guidance on Direct Fugitive Emissions from Refrigeration, Air Conditioning, Fire Suppression, and Industrial Gases for reporting methodology best practices

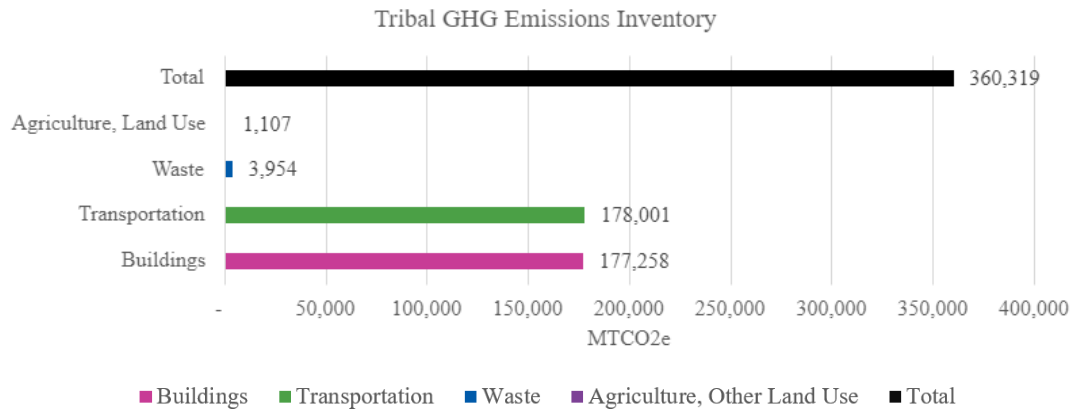

Figure 2: Tribal GHG Emissions Inventory

Cumulative GHG emissions from the eight-Tribe subset are 360,319 $MTCO_2e$. As shown in Figure 2, most of the emissions produced come from the Transportation and Buildings sectors, while less than 2% of emissions are from Waste and Agriculture & Land Use. Table 1 shows differences in the inventory parameters from the eight-Tribe subset specific to the boundary of inclusion by sector, population, area, and location.

Table 1: Tribal-Specific Inventory Information

	Area	Population[4]	State	Counties	Sectors Included	Sector-Level Details
Bad River	193 mi^2	1,423	Wisconsin	Ashland	Transportation, Buildings, Waste	Proxy transportation data using population; Tribal-owned buildings
Fond du Lac	155 mi^2	4,168	Minnesota	Carlton, St. Louis	Transportation, Buildings, Waste	Proxy transportation data using population; Tribal-owned commercial & all residences on Reservation
Grand Portage	75 mi^2	630	Minnesota	Cook	Transportation, Buildings, Waste	Tribal-sold transportation fuel data; Tribal-owned buildings
Ho-Chunk	N/A	5,334	Wisconsin	Dane, Jackson, Juneau, La Crosse, Monroe, Sauk, Shawano, Wood	Transportation, Buildings, Waste	Tribal-sold transportation fuel use data; Tribal-owned and Tribal-member buildings
Lac Courte Oreilles	120 mi^2	2,306	Wisconsin	Sawyer	Transportation, Buildings, Waste	Proxy transportation data; Tribal-owned buildings
Leech Lake	1,350 mi^2	11,456	Minnesota	Beltrami, Cass, Hubbard, Itasca	Transportation, Buildings, Waste	Proxy transportation data using population; Tribal- and Private Buildings on Reservation
Minnesota Chippewa	N/A	N/A	Minnesota	Cass	Buildings	Tribal headquarters buildings
Oneida	102 mi^2	4,648	Wisconsin	Brown, Outagamie	Transportation, Buildings, Waste	Proxy transportation data using Tribal-provided data on Tribal population-owned vehicles; Tribal-owned buildings

[4] Population for inclusion in greenhouse gas inventory as reported by Tribal representatives.

2.1 Summary Across Sectors

GHG emissions are classified as direct (Scope 1) and indirect (Scope 2) based on the level of control a reporting entity has over the emitting source. Figure 3 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. While this data represents the aggregate Scope 1 and 2 emissions across the eight-Tribe subset, some Tribes show a different balance of Scope 1 and 2 emissions. The majority of Scope 1 and 2 emissions are generated from buildings and vehicles. Scope 1 emissions are representative of vehicles with internal combustion engines (ICE) and buildings with fossil fuel (typically natural gas, fuel oil, or propane) space and water heating systems. Scope 2 emissions are representative of electricity use. Tribes that have a larger portion of Scope 1 emissions may have more ICE vehicles or fossil-fuel heating in their buildings, while Tribes that have a larger portion of Scope 2 emissions may have more buildings with electric heating systems or fewer ICE vehicles.

Scope 1 emissions can be reduced by implementing energy efficiency measures and electrifying combustion-based building systems and vehicles to reduce fuel usage, while Scope 2 emissions can be reduced by implementing energy efficiency measures to reduce electricity use and installing renewable energy electricity sources. In total, Transportation emissions are slightly higher than Buildings emissions at 49.4% and 49.2% respectively. Waste makes up 1.1% of total emissions, while Agriculture & Land Use makes up less than 1%. The majority of emissions for Buildings and Transportation emissions occurs from CO_2, whereas for Waste and Agriculture & Land Use, methane (CH_4) is often the most significant source of GHG emissions.

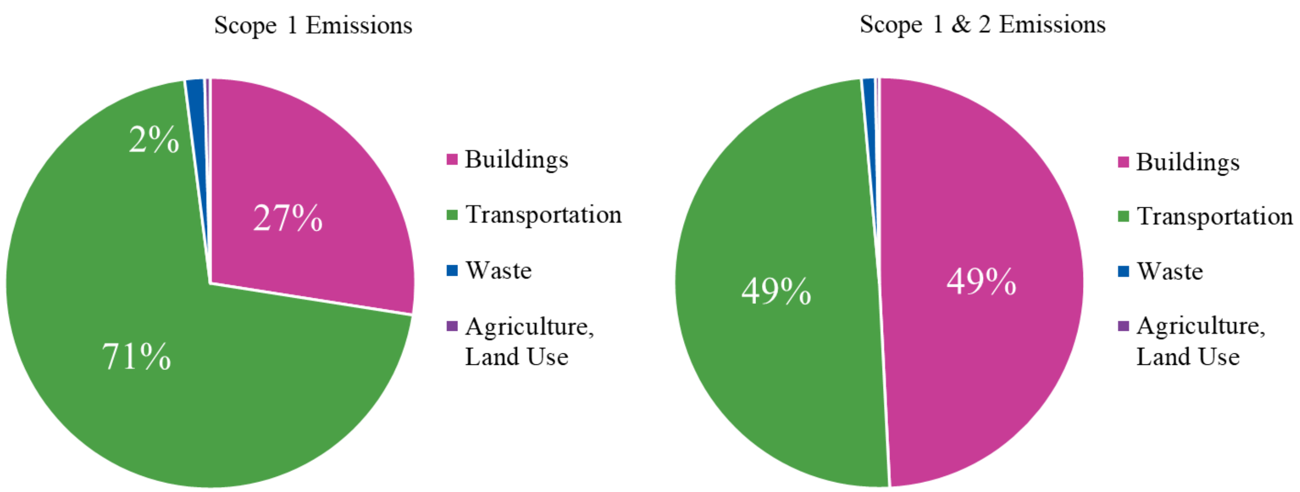

Figure 3: Summary of Emissions

2.2 Buildings

2.2.1 Summary of Major Emissions

Within Buildings, 55% of reported emissions are from commercial buildings and 45% are from single-family and multifamily residential. Common types of commercial buildings within the eight-Tribe subset include casinos, hotels and motels, retail spaces, healthcare, offices, police and fire stations, courthouses, community centers, schools, museums, and storage/warehouses. For this CCAP analysis, a similar building type mix is assumed to exist on the Reservations of all Tribes in the region.

Industrial sector emissions were not found to be a significant source across the Tribes based on available data. Figure 4 shows the split of Scope 1 and 2 emissions across the eight-Tribe subset within the Buildings sector. Scope 1 emissions come from on-site fossil fuel combustion, like natural gas or propane. Scope 2 emissions are associated with the electricity consumed by the buildings, resulting from the emissions from fossil fuels widely used in electric grid generation (e.g., gas and coal power plants). Figure 2 breaks down emissions by both emission source and property type. The percentage below each bar indicates the percent of buildings per type and highlights single-family homes as most prevalent and commercial buildings having the highest energy emissions per building.

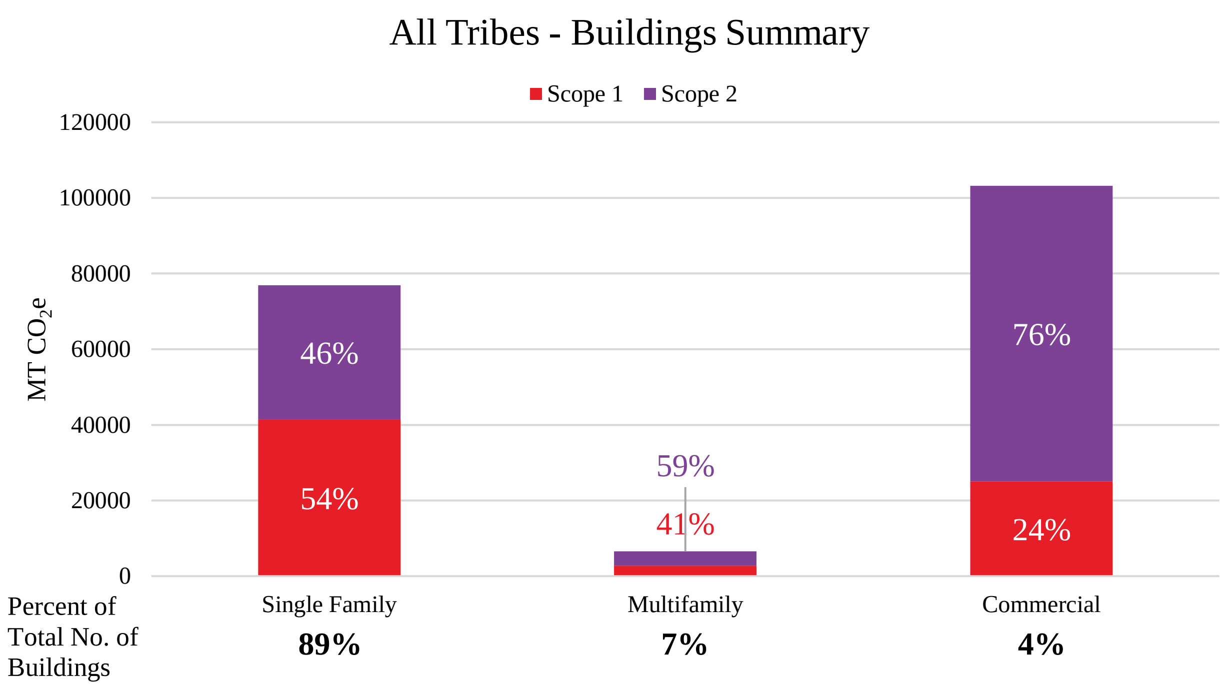

Figure 4: Building Emissions Summary

2.3 Transportation

2.3.1 Summary of Major Emissions

Transportation-related emissions are direct emissions from vehicles that burn fuel, like gasoline or diesel (i.e., Scope 1). Most of these emissions come from cars and buses. When actual data on fuel use wasn't available, emissions were estimated using proxy data. It should also be noted that at the time of reporting, no electric vehicles (EVs) were reported from the participating Tribes that would contribute to indirect emissions (Scope 2).

The following categories were used in the figure below to illustrate the sources of transportation-related emissions:

- On-road gasoline – passenger cars that run on gasoline
- Off-road gasoline – ATVs
- On-road diesel - transit and school buses
- Waterborne – motorized boats
- Aviation – planes

Overall, as shown in Figure 5, the vast majority of Transportation sector emissions come from passenger cars that run on gasoline. As a result, transportation-related measures targeting gasoline powered passenger cars will have the greatest impact on overall transportation GHG emissions.

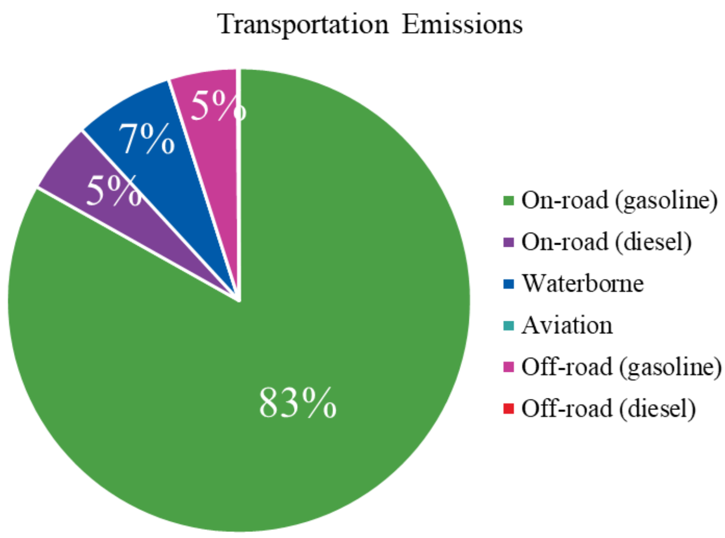

Figure 5: Transportation Emissions

2.4 Waste

2.4.1 Summary of Major Emissions

Waste emissions included data from burn barrels, landfills, people served by anaerobic wastewater, aerobic wastewater, and septic systems that make up the emissions in the Waste sector. For the eight-Tribe subset there are no landfills on site. Some Tribes have wastewater treatment facilities on Tribal land, while others have septic systems serving more remote homes. Wastewater emissions make up the majority of the Waste sector emissions shown in Figure 6.

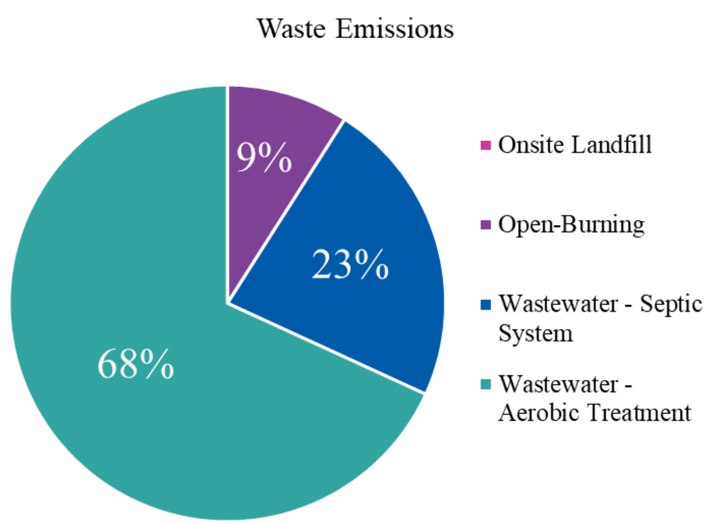

Figure 6: Waste Emissions

2.5 Agriculture & Land Use

2.5.1 Summary of Major Emissions

Reported Agriculture and land use emissions come from livestock. Only three of the eight-Tribe subset have livestock. Livestock production emits CH_4 through enteric fermentation and CH_4 and N_2O through manure management. Altogether, livestock emissions make up <1% of the total GHG emissions.

2.6 Processes for Improved Data Collection for Future Reporting

During the CCAP process, data collection continued from the initial reporting in the PCAP phase. This data collection process included meetings with individual Tribes and additional third-party information. While the PCAP phase included emissions from all sectors that are included in this report, additional data sources and updated information provided during the CCAP phase improved the GHG inventory accuracy. Examples of improved data collection include accounting for wastewater treatment systems, utility data for buildings that replaced proxy data estimates, state-level benchmarking program data, gathering data from leased commercial properties, and fuel data from sales at Reservation gas stations. As the Tribes work to reduce GHG emissions to meet their short- and long-term goals, regular GHG inventory reporting will be critical to track progress.

3 GHG Emissions Projections & Targets

GHG modeling is used to understand the future trajectory of emissions scenarios. This starts with the development of a business-as-usual (BAU) scenario that illustrates the future scenario without further intervention and then alternate scenarios which reduce the emissions trajectory in line with milestone targets. The milestones for this CCAP include short-term targets aiming to demonstrate impact from the implementation of reduction measures by 2030 and long-term targets aiming to demonstrate impact by 2050. The targets outlined here show pathways to a 45% reduction in GHG emissions by 2030 compared to the 2022 GHG inventory baseline, and net-zero emissions by 2050.

3.1 BAU Scenario

Three priority factors were considered in the development of the BAU scenario:

1. Population
2. Grid emissions
3. EV adoption rate

3.1.1 BAU Population Assumptions

Since GHG emissions are correlated to **population,** historical population data provided by MTERA was analyzed since U.S. Census Bureau data was determined to not be reliable. The U.S. Census Bureau notes that American Indians on Reservations were undercounted in 2020 census data, and the COVID-19 pandemic limited outreach efforts made in Tribal communities. Moreover, discussions with Tribes revealed varying trends within this region: some expected slight population growth, while others reported a decline. For consistency and to take a more conservative approach, representatives from the eight-Tribe subset agreed on an assumption of stable population with no growth in both the near- and long-term timelines. This meant that there was also no assumed increase in residential or commercial buildings, as well as no assumed changes to vehicle miles traveled (VMT) from population in the emissions projections.

3.1.2 BAU Grid Emissions Assumptions

Grid emissions data utilizes assumptions about how fossil fuels will be replaced with clean energy sources in the future, considering eminent federal and state grid decarbonization targets driving these emissions reductions. The State of Wisconsin has passed an executive order, Executive Order #38, which created an Office of Sustainability and Clean Energy and set a goal for ensuring all electricity consumed within the State of Wisconsin is 100% carbon-free by 2050. In Minnesota, the governor signed a bill, Senate File 4, to require Minnesota utilities to transition to 100% carbon-free electricity generation by 2040.

Most major electric utilities are outlining pathways to decarbonize electricity generation and support nationwide grid decarbonization. Xcel Energy plans to add 4,200 MW of wind, 400 MW of solar, and 600 MW of battery storage in Minnesota by 2030[4], and retire coal facilities by the same year. Great River Energy is a wholesale electric power cooperative that supplies electricity to 27 member cooperatives including those that serve Leech

Lake, Grand Portage, Fond du Lac, and the Minnesota Chippewa Tribe. Great River Energy has released an integrated resource plan that includes plans to build or acquire more than 1,200 MW of wind power, 200 MW of solar, and 200 MW of energy storage by 2037[5]. In Wisconsin, We Energies plans to cease coal plants by 2035, and invest $7 billion between 2024 and 2028 to develop 3,800 megawatts of renewable energy capacity[6]. These initiatives reflect significant investments in clean energy aligned with statewide decarbonization goals.

While the eight-Tribe subset in this CCAP are located within Minnesota and Wisconsin, these areas are covered by three different EPA grid regions. The EPA tracks environmental data from the electric grid through the Emissions and Generation Resource Integrated Database (eGrid) platform. These eGrid regions are based on transmission and utility service territories of power plants, not state boundaries. They help to demonstrate the mix of energy sources like coal, natural gas, and wind, and their emissions in different parts of the country. EPA eGrid regions often align with balancing authority areas, where a single entity is responsible for balancing the supply and demand of electricity. In some cases, eGrid regions can also encompass multiple balancing authorities or parts of them to better reflect the environmental attributes of electricity generation. The eGrid regions that this subset of eight MTERA Tribes lie within are Midwest Reliability Organization West (MROW), Midwest Reliability Organization East (MROE), and Reliability First Corporation West (RFCW), shown on the map below in Figure 7.

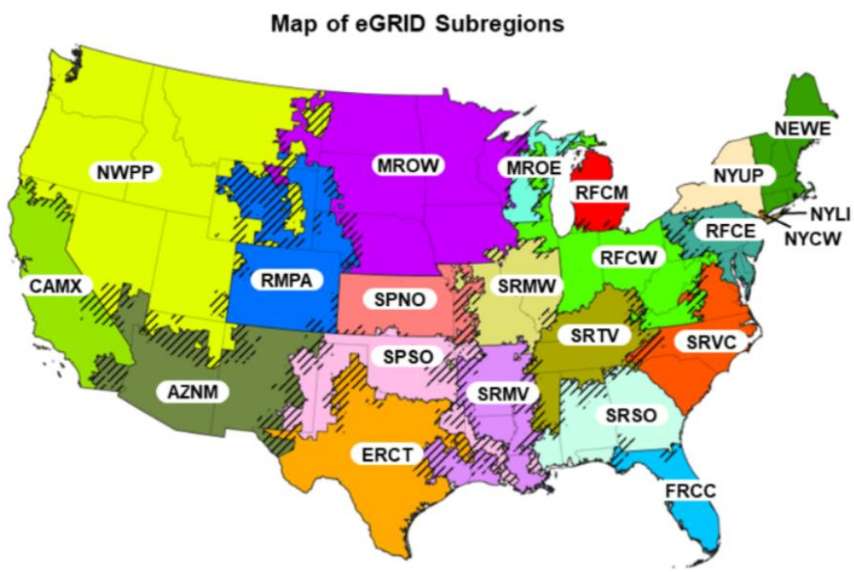

Figure 7: U.S. EPA eGrid Subregions[5]

[5] Crosshatching indicates that an area falls within overlapping eGRID subregions due to the presence of multiple electric service providers.

Each eGrid region has its own set of emission rates applicable to its regional grid electricity consumption. State and federal goals and regulations are anticipated to influence future electric grid decarbonization, but the timeline of implementation is undefined. Both Minnesota and Wisconsin have set clear goals for grid decarbonization by 2040 and 2050, respectively. Working collaboratively with the eight-Tribe subset, it was determined to use a more conservative approach aligned with historical grid decarbonization rates from 2005-2023 for BAU projections. This assumes that the grid will continue to decarbonize at the same linear average rate that it has historically for all three eGrid regions, as shown in Figure 8.

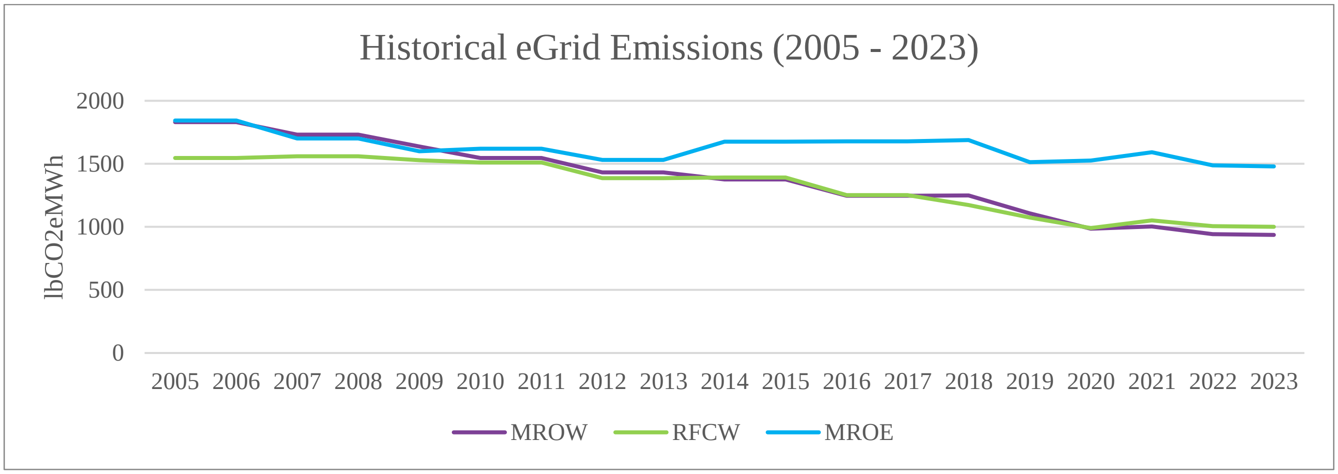

Figure 8: Historical eGrid Emissions (2005-2023)

The trendlines from the historic grid emissions rates were projected out to the year 2050 for use in the BAU scenario modeling. Figure 9 shows the projected emissions factors for each grid region through 2050, with the MROW region assumed to reach zero emissions by 2040 and RFCW by 2050. It should be noted that this analysis still results in significant grid emissions through 2050 for the MROE region, which represents 30% of electricity use across the eight-Tribe subset.

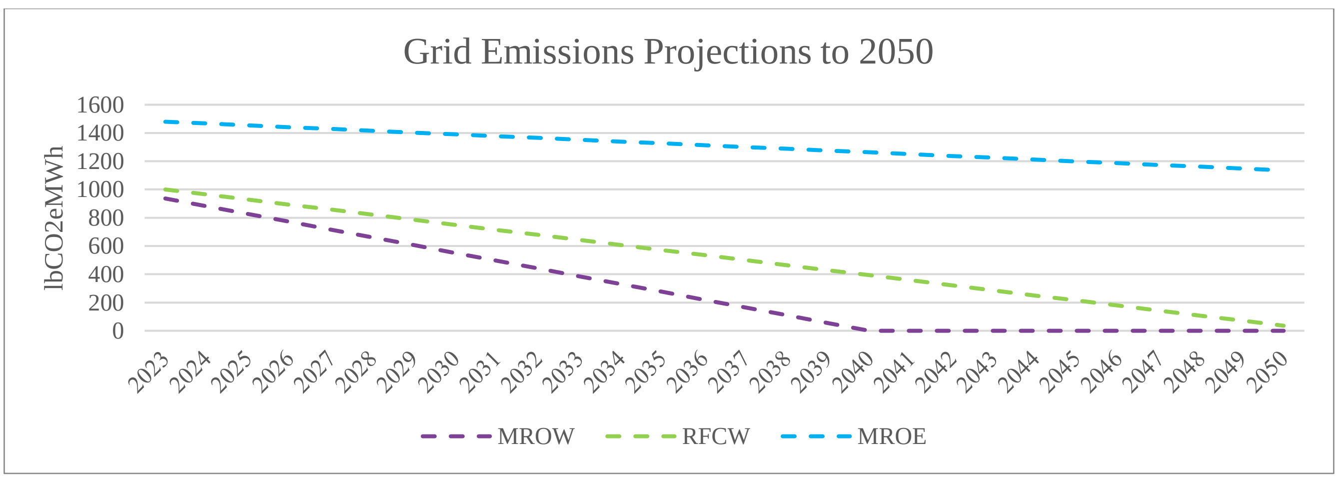

Figure 9: Grid Emissions Projections to 2050

3.1.3 BAU Electric Vehicle Adoption Assumptions

EV adoption of single-occupancy vehicles (SOVs) is expected to grow as charging infrastructure expands, and the combination of increased production from automakers and federal emissions mandates improve car availability and help lower costs. Both Minnesota and Wisconsin have released statewide goals for EV registration. In Minnesota's Statewide Multimodal Transportation Plan, targets are set for light-duty vehicles registered in Minnesota to be electric or another type of ZEV: 20% by 2030, and 65% by 2050[6].

These light-duty vehicle registrations are assumed to translate to SOV registrations. Wisconsin projects that 6.1% of the state's fleet will be electric by 2030, 31% by 2050[7]. These fleet goals are assumed to be representative of SOV electrification. For BAU projections, the midpoint of the two state goals were used for all Tribal SOV electrification. This assumes that 13.05% of SOVs will be EV by 2030, and 48% of SOVs will be EV by 2050.

To support these statewide goals, Minnesota has passed laws providing rebates for EV owners to make EVs more affordable for residents. The state has also allocated up to $2 million in one-time grants to Minnesota automobile dealers to offset the cost of infrastructure needed to support EV sales[8]. In Wisconsin, the federal government has allocated $23.3 million to support 53 fast-charging projects across the state to create a robust network of high-speed EV charging stations[9]. Oneida Casino is among the recipients in the first round of funding in Wisconsin. Wisconsin has a detailed Electric Vehicle Infrastructure Deployment Plan aimed at linking interstate highways, U.S. highways, and a state highway to ensure EV charging infrastructure reaches all corners of the state[10]. These initiatives collectively demonstrate a strong pathway to meet each states' EV adoption goals. The EV industry in both Wisconsin and Minnesota is experiencing robust growth, driven by consumer demand, expanding infrastructure, and strategic investments in manufacturing and technology. The number of new electric and hybrid vehicles in Minnesota and Wisconsin has significantly increased over the past decade and is expected to continue rising. Consequently, the used car market will also see a growing presence of electric and hybrid vehicles.

The BAU modeling, including stable population from 2022 levels, decreasing grid emissions factors, and increased EV adoption, result in a gradual decrease in emissions with zero GHG reduction measure actions from Tribes. This BAU projection is shown in Figure 10, showing GHG emissions by sector. The BAU scenario accounts for the emissions that will reduce regardless of any future implementation projects, but highlights the importance of further action and new renewable energy implementation short-term for maximum impact while the grid is mainly fossil fuel based.

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[6] *Statewide Multimodal Transportation Plan.* (2022, December). Minnesota Department of Transportation. Retrieved August 26, 2024, from https://www.minnesotago.org/final-plans/smtp-final-plan-2022

[7] *Wisconsin Electric Vehicle Infrastructure Plan*. (2023, August 1). Wisconsin Department of Transportation. Retrieved August 26, 2024, from https://wisconsindot.gov/Documents/projects/multimodal/2023weviplanupdatefinal.pdf

[8] https://mn.gov/commerce/energy/consumer/energy-programs/ev-dealer-certificate.jsp

[9] https://www.wpr.org/energy/over-50-locations-across-wisconsin-selected-for-federally-funded-ev-charging-stations

[10] https://experience.arcgis.com/experience/8405604ccc034f7c8c4e95e6776951a7

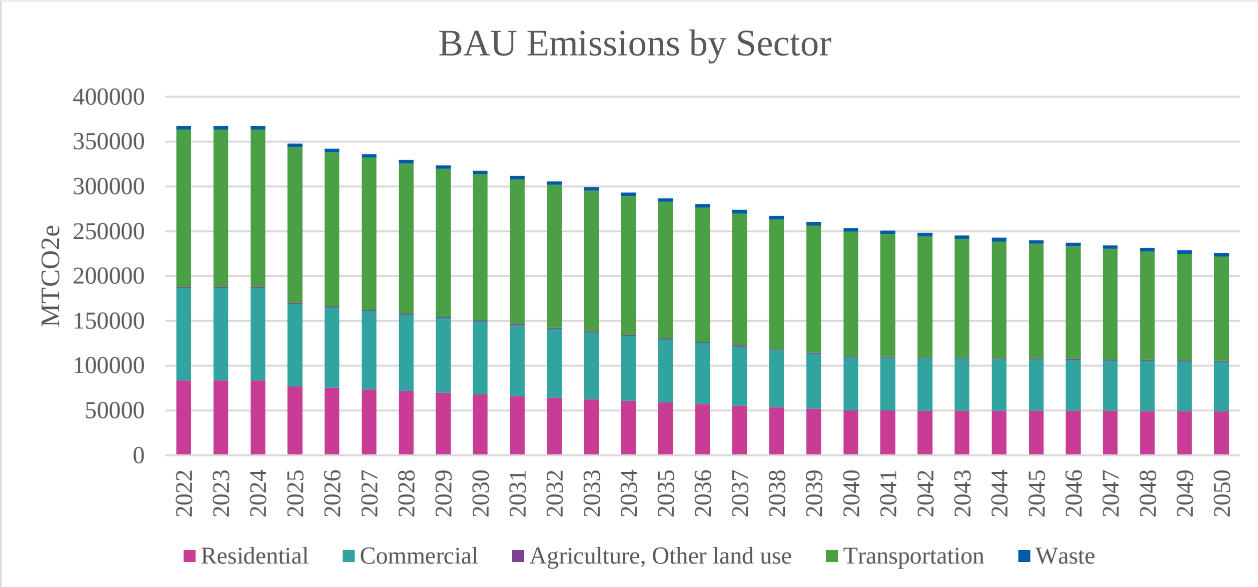

Figure 10: BAU Sector Emissions

3.2 Emission Reduction Targets & Implementation Projections

After consultation with Tribal representatives from the eight-Tribe subset, ambitious targets were selected for the CCAP: 45% reduction by 2030 relative to the 2022 baseline, and net-zero emissions by 2050. The stacked area and bar chart below in Figure 11 displays the BAU emissions in gray and proposed reduction measure impact by sector through 2050. This demonstrates the 45% reduction target by 2030, and the net-zero target by 2050 in comparison to the BAU scenario. Over time, the BAU scenario emissions show reductions, mostly from cleaner electricity generation on the grid. The CCAP reduction measures provide additional emissions reductions in conjunction with the projected BAU scenario. The reductions from Tribal-implemented renewable energy strategies are shown in light green, since they are additional to grid installed systems.

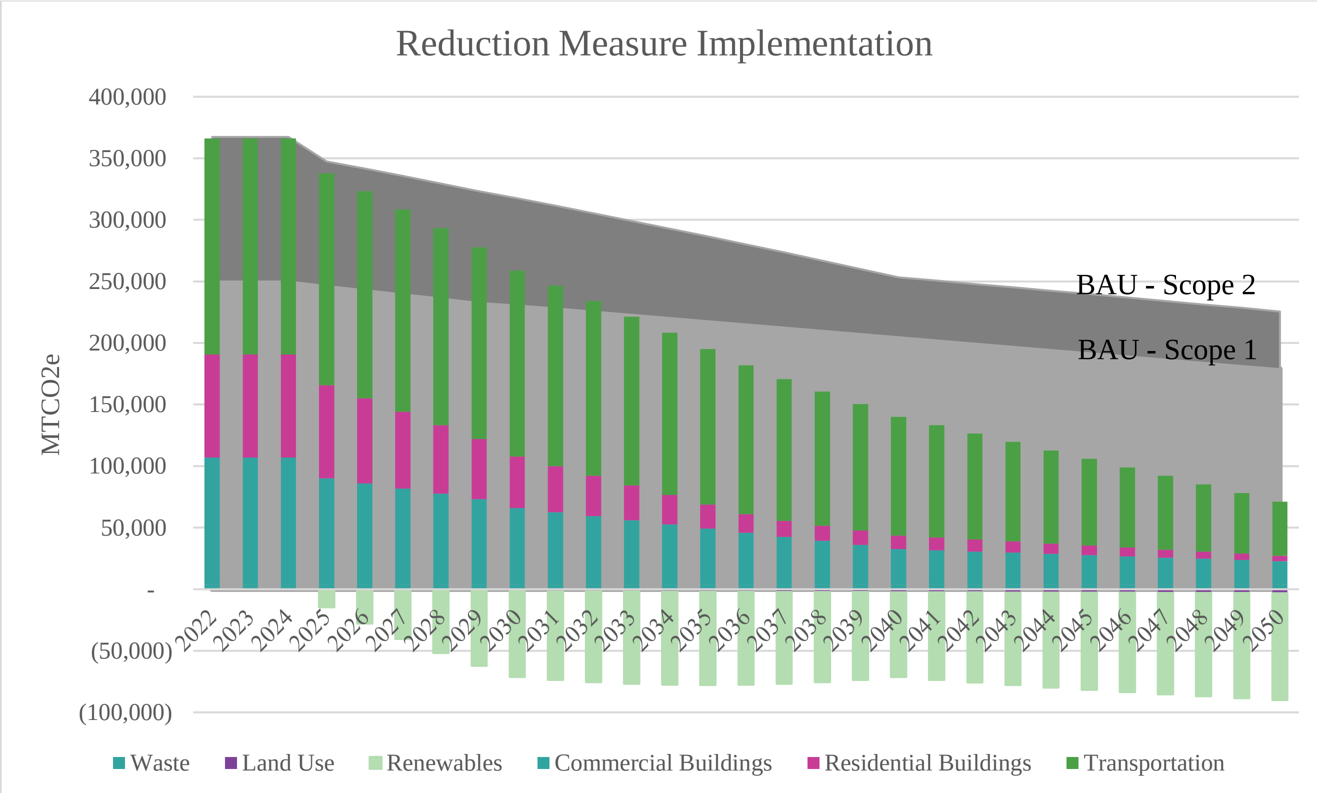

Figure 11: BAU and Reduction Measure Scenario through 2050

3.3 Methodology for Reduction Measure Projections

The impact of the CCAP strategies have been projected with GHG modeling tools that incorporate the various assumptions included in the section below. The PCAP set ambitious targets for GHG reduction measure implementation based on consultations with the Tribes, and these targets set initial goals. During the CCAP phase, the implementation goals were tweaked in accordance with state and national GHG reduction targets. Reduction measures that are included in the projections analysis include power sector measures, building energy efficiency measures and electrification, transportation measures, and land use measures. The forecasted measures detailed in the following sections are shown to meet a 45% reduction target by 2030 relative to 2022 emissions and show a net-zero target met by 2050. Sector-specific assumptions regarding the projections modeling are detailed below, with specific measure implementation details discussed in Appendix B. The waterfall diagram in Figure 12 and Figure 13 shows the impact of these strategies across sectors by 2030 and 2050, respectively. Baseline emissions from all Tribes in 2022 is the starting point, followed by an increase in emissions due to additional EVs. "BAU Reduction" refers to the reduction of electricity emissions due to our assumption that the electric grid will continue to follow historical decarbonization trends as detailed in Section 3.1.2. The following purple bars show the reduction in emissions by 2030 and 2050 due to individual sector reduction measures, including commercial and residential building measures, transportation, waste, land use, and renewables.

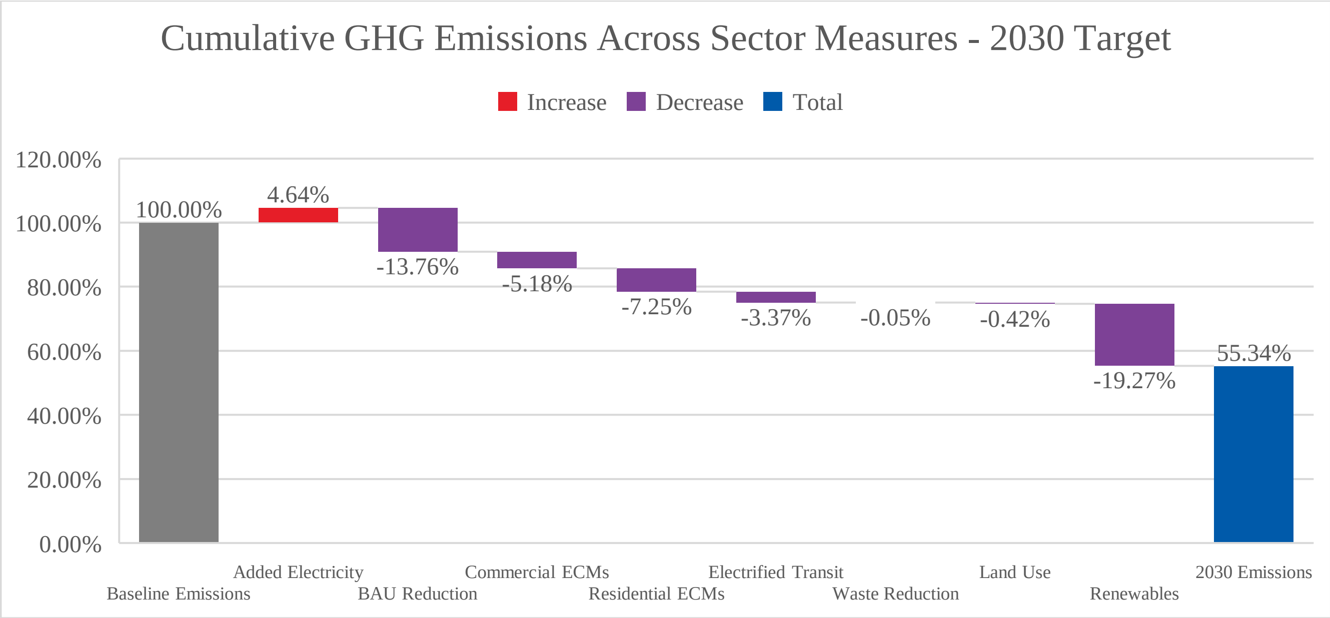

Figure 12: GHG Emissions Across Sector Measures – 2030 Target

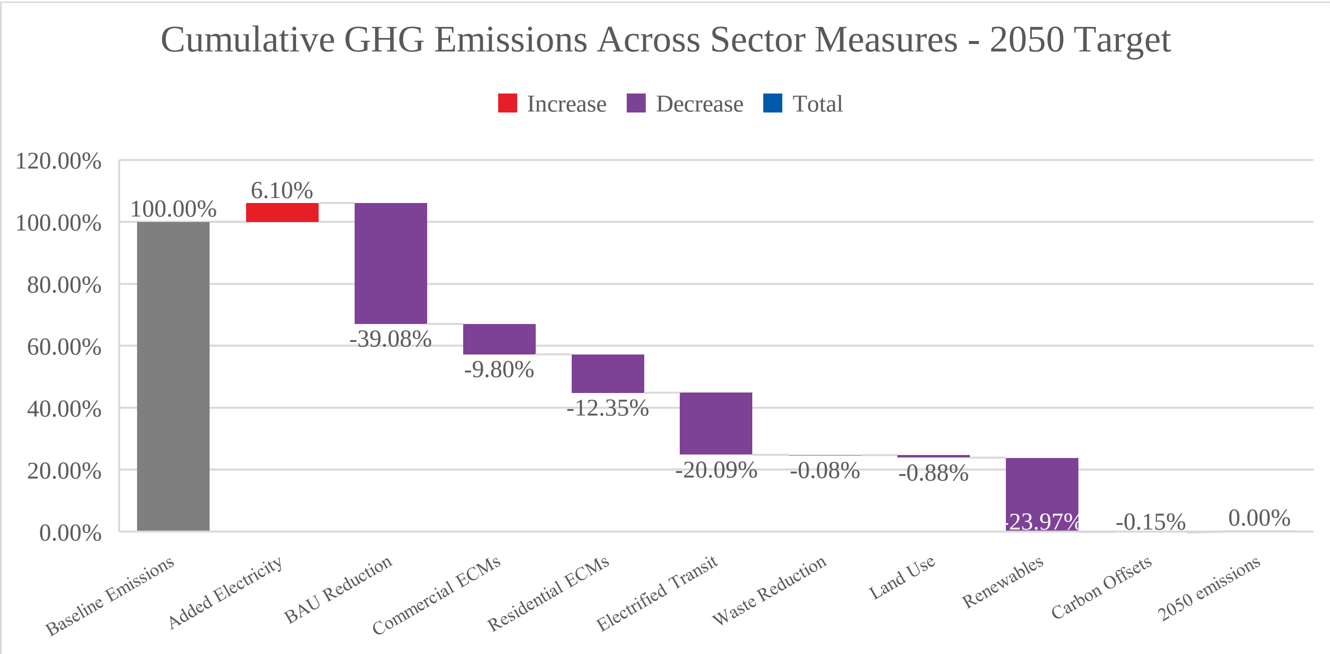

Figure 13: GHG Emissions Across Sector Measures – 2050 Target

4 GHG Reduction Measures & Benefits

This section outlines a comprehensive suite of 28 reduction measures across five categories:

1. Reduce Electricity Generation Emissions
2. Reduce Building Energy Emissions
3. Reduce Vehicle Emissions
4. Implement Environmental Management & Planning Techniques
5. Reduce Wastewater Emissions

For each measure, details are provided on measure descriptions, impacts in reaching GHG reduction targets on the short-term (2030) and long-term (2050), as well as associated benefits that could be realized by Tribal communities through implementation. The following bullet points outline the flow of this section and the purpose of each subsection:

- Each of the five categories of measures begins with a summary table of estimated measure costs, implementation quantities to meet short-term (2030) and long-term (2050) targets, and their resulting emissions reductions aggregated across the eight-Tribe subset. Appendix B: Reduction Measure Methodology includes further details for each measure, including baseline emissions, key assumptions, emissions methodology, emissions calculation, cost calculation, and cost methodology.
- Following the category summary tables are measure-level subsections which include descriptions of the GHG reduction measures and a discussion of environmental, social, and economic benefits and mitigation of potential disbenefits.
- To provide additional information on expected beneficial public health outcomes, additional quantitative analysis was undertaken for the most influential measures using EPA Tools AVERT (Avoided Emissions and Generation Tool) and COBRA (CO-Benefits and Risk Analysis). Measure implementation values pertaining to the eight-Tribe subset 2050 targets are inputted to determine the reduction in avoided air pollution, which then is used to estimate financial savings in the form of reduced healthcare costs and fewer days where work and school days are interrupted by sickness or hazardous air pollution. Appendix E provides further details on the methodology for calculating the public health benefits.
- Each measure section ends with a summary table providing a high-level qualitative evaluation of environmental, social and economic benefits. The benefit scores were assigned considering key guiding questions developed by Arup based on their experience in climate action planning. These key questions and further details on expected benefits are provided in Appendix F: Summary of Measure Community Benefits.

Table 2: Links to CCAP GHG Reduction Measures provides the full list of GHG reduction measures included within the CCAP. To navigate to a specific measure or category, click on the headings below to be directed to that section of the report.

Table 2: Links to CCAP GHG Reduction Measures

4.1 Reduce Electricity Generation Emissions	4.2 Reduce Building Energy Emissions	4.3 Reduce Vehicle Emissions	4.4 Implement Environmental Management and Planning Techniques	4.5 Reduce Wastewater Emissions
4.1.1.1 Install Solar PV	4.2.1.1 Electrify Heating Equipment	4.3.1.1 Increase Transit Service	4.4.1 Sequester Carbon Through Plants	4.5.1 Install Low-Flow Toilets
4.1.1.2 Install Wind Energy	4.2.1.2 Install High-Efficiency Appliances	4.3.1.2 Increase Ridesharing	4.4.2 Preserve Wetlands	4.5.2 Install Low-Flow Fixtures
4.1.1.3 Install Geothermal Heating and Cooling	4.2.1.3 Conduct Building Weatherization Retrofits	4.3.1.3 Develop Active Transport Network	4.4.3 Develop Green Infrastructure	4.5.3 Reduce GHG Emissions from Wastewater Treatment Plants
4.1.1.4 Install Hydropower	4.2.1.4 Upgrade Interior & Exterior Lighting to LEDs	4.3.2.1 Electrify Bus Fleet and Provide Charging Infrastructure	4.4.4 Implement Responsible Development and Zoning Policies	
4.1.2 Increase Energy Resilience through Microgrids	4.2.1.5 Install Smart Thermostats	4.3.2.2 Provide Alternative Fuel Buses (Biodiesel, CNG, LNG, Propane)	4.4.5 Implement a Recycling Program	
	4.2.2.1 Adopt Green Building Standards for Major Renovations	4.3.2.3 Electrify SOVs and Provide Charging Infrastructure	4.4.6 Implement a Composting Program	
		4.3.2.4 Electrify ATVs, Boats, and Tractors	4.4.7 Reduce Fertilizer Emissions	

4.1 Reduce Electricity 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. Through the MTERA EPA Solar For All award, all Midwest Tribes may receive approximately $1 million per Tribe to deploy Tribally-owned residentially-benefitting solar projects, in addition to storage and necessary upgrades. All projects deployed through this program will be built between 2024 and 2029. This funding award was considered in developing solar renewable energy targets for the 2030 and 2050 targets.

4.1.1 Renewable Energy Development

The following table summarizes the resulting GHG emissions reductions for the eight-Tribe subset from the 2030 and 2050 implementation targets of the renewable reduction measures. It also includes the measure cost on a per kW or MW basis for reference.

Table 3: Renewable Energy Measures- Summary of Cost and Emissions Reductions

Reduction Measure	Measure Description	Measure Cost[11]	Eight-Tribe Subset 2030 Target		Eight-Tribe Subset 2050 Target	
			Measure Implementation Quantity	$MTCO_2e$ Reduced	Measure Implementation Quantity	$MTCO_2e$ Reduced**
Install distributed and community-scale renewables (PV, geothermal, wind)	Distributed & community - scale solar	$2,944,000/MW for 0.5MW to 20MW system $2,106,000/MW for 20MW and above system	2 MW*	1,009	37MW	12,203
	Distributed wind turbines	$8,425,000/MW for under 500kW system $3,270,000/MW for 0.5MW to 20MW system $1,750,000/ MW for 20MW and above system	2 MW*	2,727	5 MW	3,220
	Geothermal heat pumps	$25,000 for 5 ton unit per SF home or MF unit $115,000 for 23 ton unit per commercial building	10% of all buildings	10,783	10% of all buildings	13,295

[11] Cost data sourcing and assumptions can be found in Appendix B.

Reduction Measure	Measure Description	Measure Cost[11]	Eight-Tribe Subset 2030 Target		Eight-Tribe Subset 2050 Target	
			Measure Implementation Quantity	$MTCO_2e$ Reduced	Measure Implementation Quantity	$MTCO_2e$ Reduced**
Implement utility-scale renewables	Solar PV	$467,000/MW	8 MW*	4,037	13 MW	3,173
	Wind	$1,750,000/MW	8 MW*	10,909	45 MW	28,983
	Hydropower	$257,400/MW	10 MW	12,375	10 MW	5,845
Install solar & storage microgrids	Solar PV paired with 4-hour storage	$2,944,000/MW	(15) 10 MW microgrids	38,840	(30) 10 MW microgrids	36,688

*Note that for the same installed capacity of solar PV and wind, wind has a higher estimated emissions reduction due to its higher assumed capacity factor (40%[12] vs. 25%[13] for solar PV) – which corresponds to the total amount of time that wind turbines or solar PV are able to generate energy based on when the wind is blowing and the sun shining. For more details, see Appendix B.

**2050 GHG Emissions are lower on a per MW basis due to increasing grid decarbonization. For more details, see Appendix B.

Benefit Analysis

Renewable energy projects can strengthen Tribal sovereignty by providing benefits across economic, social, environmental, and cultural focus areas, as depicted in Figure 14 below.[14]

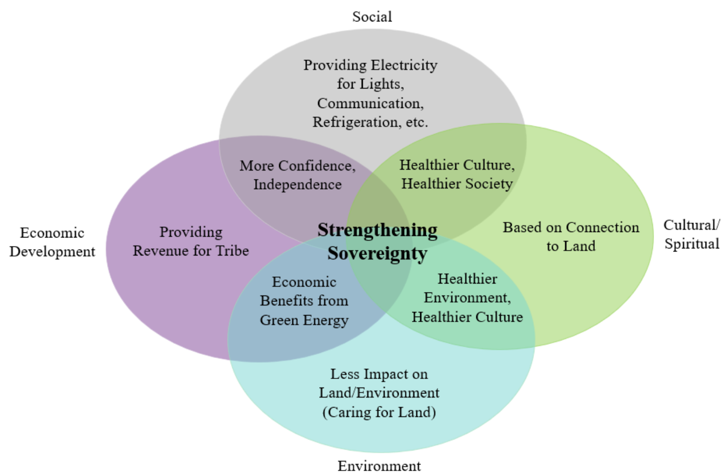

Figure 14: Categories of Renewable Energy Benefits for Tribal Nations

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

[13] *Southwestern states have better solar resources and higher solar PV capacity factors*. (2019, June 12). U.S Energy Information Administration. Retrieved September 16, 2024, from https://www.eia.gov/todayinenergy/detail.php?id=39832

[14] 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

These projects provide opportunities to generate, use, and sell clean energy, resulting in healthier indoor and outdoor air quality as well as revenue to re-invest in community priorities. Renewables can power daily energy use with clean energy with less harm to natural lands than fossil fuels. Better environmental quality and care for the land helps enable Tribal members to continue recreation or manage other culturally significant uses of the land.

Improved air quality, in particular, is one of the largest impacts of renewable energy. In addition to contributing to climate change, burning fossil fuels emits pollutants that cause poor air quality. 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, increased emergency room visits, increased hospitalizations, and fatalities.[15] [16]

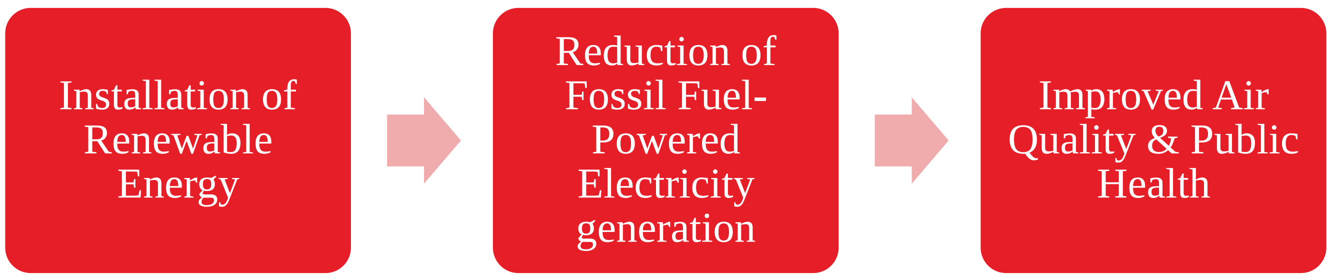

Figure 15: Health Benefits of Renewable Electricity Generation

As shown in Figure 15, renewable energy (which does not directly emit carbon or pollutants) can reduce the dependence on fossil fuels for electricity generation, significantly improving air quality. By reducing air pollution, renewable energy reduces incidences of disease and hospital visits. It improves the quality of life for Tribal Members, especially children, Elders, and those with pre-existing health condition who are most vulnerable.

Additionally, implementing renewable energy leads to more local job creation to install, maintain, and operate these energy systems. In both Wisconsin and Minnesota, clean energy jobs now make up the majority (>50%) of available energy sector jobs, with electric power generation jobs growing 5.4 and 6.9%, respectively in each state.[17] Researchers with the non-profit Union for Concerned Scientists have shown that for each unit of electricity generated, more jobs are created in renewable sources than from fossil fuels.[18]

Renewable generation should be thoughtfully implemented to mitigate disbenefits so that unintended issues, such as lack of proper training, do not hinder long term success. This may include the inclusion of training and workforce development opportunities from federal grants and local programs through utilities and other energy agencies. Care should be taken to avoid energy development that may be disruptive to culturally significant land within Reservations.

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

[16] *Renewable Energy and Empowering Indigenous Communities.* (2023, September 20). ENERGY5. Retrieved February 8, 2024, from https://energy5.com/ renewable-energy-and-empowering-indigenous-communities#anchor-0

[17] Energy Employment By State 2024. (2024). U.S Department of Energy. Retrieved February 8, 2024, from https://www.energy.gov/sites/default/files/2024-08/USEER%202024%20States%20Final.pdf; includes jobs in transmission and distribution.

[18] *Benefits of Renewable Energy Use.* (2017, December 20). Union of Concerned Scientists. Retrieved February 9, 2024. From https://www.ucsusa.org/resources/benefits-renewable-energy-use

Specific benefits and mitigation of potential disbenefits are outlined for the different types of renewable energy systems below.

4.1.1.1 Install Solar PV

Measure Description:

Solar energy is a form of renewable energy that uses photovoltaics (PV) to generate power by absorbing energy from sunlight and converting it to electrical energy through semiconductor materials. The generation potential of solar PV systems on single-family homes and multifamily buildings was calculated using the PVWatts Calculator.[19] An average solar irradiance, representing the amount of sunlight reaching a solar panel, is based on weather data from Duluth, MN and Wausau, WI. Solar generation implementation targets are set at various PV system scales, with distributed systems being less than 2MW, community-scale systems consisting of 500kW to 20MW and utility-scale systems at greater than 20MW.

Benefit Analysis:

Solar PV systems continue to get cheaper, making them more cost-effective to implement. In certain areas, Tribes can also sell excess solar energy produced back to the larger utility grid, which provides additional cost savings.

Energy generated from solar PV systems can reduce energy coming from fossil fuel combustion, resulting in decreased air pollutants, improved air quality, and better public health in Tribal communities. The total health savings of installing solar PV systems are quantified below, including cost savings due to avoided emergency room visits, avoided illness treatments, reduced mortality rates, and fewer work/school days missed due to poor health.

Table 4: Annual Health Impacts of Solar Measure Implementation[20]

Reduction Measure	Total Health Effects Savings (Low-High Estimate)	Total Asthma Symptoms/Onset Savings	Minor Restricted Activity Days, School Days, and Workdays Saved (Total)	Savings in Total Activity/School/Workdays
Install 37 MW of distributed & community - scale solar PV	$288,000-$474,000	$8,000	15	$10,000
Install 13 MW of utility-scale solar PV	$118,000-$194,000	$5,000	6	$4,000

Solar PV infrastructure has a high upfront cost, but the increase in funding programs and rebates from legislation like the Inflation Reduction Act can help Tribes offset initial capital costs. Furthermore, solar energy is not available at all times of day, so it cannot be relied on to provide continuous baseload power. Investments in other energy resources paired with storage can mitigate any gaps in clean energy production, ensuring Tribes have access to clean power around the clock.

Large-scale solar requires a large land area, which could be home to wildlife habitats. Tribes should conduct environmental site assessments and wildlife studies to mitigate impacts on local wildlife.

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

[20] These estimates are annual aggregate savings across Minnesota and Wisconsin and were determined using the EPA's Avoided Emissions and Generation Tool (AVERT) and CO-Benefits Risk Assessment (COBRA) -see Appendix E for further details.

Table 5: High-Level Summary of Environmental, Social and Economic Benefits[21]

	Environmental	Social	Economic
Install Solar PV	●○○	●○○	●●◐

4.1.1.2 Install Wind Energy

Measure Description:

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 residential scale with system sizes of 2MW or less, community scale wind turbines (500kW to 20MW in size), and utility scale wind turbines (system sizes of over 20MW). This measure assumes a capacity factor of 40%, in accordance with the Department of Energy's Land-Based Wind Market Report: 2023 Edition.[22]

Benefits Analysis:

Like solar, wind is also becoming less costly to implement. Wind production is possible during times of day when solar is unavailable, so it can help solve some of the gaps in solar production. In certain contexts, wind energy can also co-exist with agricultural land uses, as the area under turbines can still be utilized for agricultural production.

Electricity generation from wind also reduces reliance on energy from fossil fuels, resulting in quantifiable public health benefits. The total health savings of installing wind energy ranges from $613,000-$1,016,000/yr, due to avoided emergency room visits, avoided illness treatments, reduced mortality rates, and fewer work/school days missed due to poor health. Savings specific to asthma symptoms and treatment and quantities of days of school, work and activity saved as a result of improved environmental quality and public health are also included. These estimates are annual aggregate savings across Minnesota and Wisconsin and were determined by inputting 2050 measure implementation quantities for the eight-Tribe subset into the EPA's Avoided Emissions and Generation Tool (AVERT) and CO-Benefits Risk Assessment (COBRA) - see Appendix E for further details.

Table 6: Annual Health Impacts of Wind Energy Measure Implementation[23]

Reduction Measure	Total Health Effects Savings (Low-High Estimate)	Total Asthma Symptoms/Onset Savings	Minor Restricted Activity Days, School Days, and Workdays Saved (Total)	Savings in Total Activity/School/Work days
Install 50 MW of wind energy	$614,000-$1,016,000	$12,000	32	$21,00

Since wind energy is not available at all hours, requiring the use of other energy resources in tandem to provide clean energy at all times. Similar to solar, Tribes should conduct environmental site assessments and wildlife studies to mitigate impacts on local wildlife from land conversion.

[21] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

[22] *Land-Based Wind Market Report: 2023 Edition.* (2023). Department of Energy Office of Energy Efficiency and Renewable Energy. (R. Wiser & M. Bolinger, Authors). Retrieved January 9, 2024, from https://www.energy.gov/sites/default/files/2023-08/land-based-wind-market-report-2023-edition.pdf

[23] These estimates are annual aggregate savings across Minnesota and Wisconsin and were determined using the EPA's Avoided Emissions and Generation Tool (AVERT) and CO-Benefits Risk Assessment (COBRA) -see Appendix E for further details.

Table 7: High-Level Summary of Environmental, Social and Economic Benefits[24]

	Environmental	Social	Economic
Install Wind Energy	●○○	●○○	●●◐

4.1.1.3 Install Geothermal Heating and Cooling

Measure Description:

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. For large development projects involving mixed uses of buildings located close each other, such as a casino, hospital, or a large residential building– a networked geothermal system could be considered for the efficient routing of heat, cooling, and electricity between a "district" of buildings."

Benefits:

Geothermal systems are highly efficient, even when compared to renewable sources. They are available at all times of the day,[25] helping solve the gaps in production of other renewable sources. For Tribal Members concerned about availability, geothermal heating and cooling alleviate concerns about reliability.

Geothermal systems require more effort to install (given additional drilling and development of these sites), which can bring additional costs and labor. However, geothermal costs little to operate once implemented, which can generate cost savings in the long-term. These systems require specific types of soil and site conditions to be installed, so further analysis is needed to understand the most ideal sites to implement geothermal.

Table 8: High-Level Summary of Environmental, Social and Economic Benefits[26]

	Environmental	Social	Economic
Install Geothermal Heating and Cooling	●◐○	●○○	●○○

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[24] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

[25] *Geothermal FAQs.* (n.d.) Geothermal Technologies Office, Office of Energy Efficiency and Renewable Energy. Retrieved January 9, 2024, from https://www.energy.gov/eere/geothermal/geothermal-faqs#:~:text=These%20factors%20mean%20that%20geothermal%20can%20balance%20intermittent#:~:text=These%20factors%20mean%20that%20geothermal%20can%20balance%20intermittent

[26] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

4.1.1.4 Install Hydropower

Measure Description:

Hydropower is a renewable source of energy that generates power from the use of a dam or other diversion that alters the natural flow of a river. Hydropower uses turbines and generators to convert the 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.[27]

Benefits Analysis:

Hydropower is considered more reliable and predictable than solar and wind energy, making it another option for Tribal Members concerned about reliability. Only dependent on water flow, hydropower can be flexible to adjust to local electricity demand and is easy to maintain once in operation. Hydropower is particularly useful where Tribes have access to rivers and lakes with ample flow.

Hydropower has the potential to disrupt patterns of local wildlife and river ecosystems, and it can be affected by climate change, local water conditions and strength of current. Conducting hydrology studies and wildlife studies in anticipation of newly installed hydropower can ensure it does not disrupt sensitive water bodies and ecosystems.

Table 9: High-Level Summary of Environmental, Social and Economic Benefits[28]

	Environmental	Social	Economic
Install Hydropower	●○○	●○○	●◐○

4.1.2 Increase Energy Resilience through Microgrids

Measure Description:

Energy resilience refers to the ability to provide reliable electricity during periods where access to the grid is interrupted due to natural disasters or other disruptive events. Solar microgrids collect, store, and distribute energy generated by solar PV. 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 use later on. Microgrids are able to 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.

Microgrids can be installed on the building-level through distributed systems typically less than 2MW, at the community scale serving a group of buildings through a system size ranging from 500 kW to 20MW, or at the utility-scale with systems over 20MW serving a larger area. For this analysis, community-scale microgrids of 10MW solar and 5MW battery storage are modeled to reflect ambitious Tribal goals for large-scale microgrid development.

Benefits Analysis:

Renewable energy development with energy storage helps alleviate many concerns about solar energy reliability by storing excess power for later use. These systems can help Tribes foster energy independence and sovereignty by generating their own energy and relying less on the electric grid. The addition of storage and microgrid controls allows Tribes to maintain power and "island" from the grid during power outages. Tribes can also discharge the battery during times of high energy cost, reducing utility bills.

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

[28] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

The ability to keep power running helps minimize disruptions to daily life and ensure Tribal members have access to power, heating, and cooling, even in extreme weather events or other disruptions to power. In more remote areas, microgrids can also be cheaper to install compared to upgrading and expanding existing electrical infrastructure. Especially for any critical Tribal facilities and infrastructure, solar and storage can ensure Tribal members do not lose access to important services and see energy cost savings from optimized battery use.

Given the large upfront cost of battery systems, Tribes can seek out grants or incentive programs to provide financial support. Early collaboration with utilities is also critical to connecting storage and related controls so Tribes can realize the resilience benefits as soon as installation occurs.

The total health savings of installing utility-scale solar and storage ranges from $1,177,200-$1,826,600/yr due to avoided emergency room visits, avoided illness treatments, reduced mortality rates, and fewer work/school days missed due to poor health. Savings specific to asthma symptoms and treatment and quantities of days of school, work and activity saved as a result of improved environmental quality and public health are also included.

Table 10: Annual Health Impacts of Utility Solar and Storage Measure Implementation.[29]

Reduction Measure	Total Health Effects Savings (Low-High Estimate)	Total Asthma Symptoms/Onset Savings	Minor Restricted Activity Days, School Days, and Workdays Saved (Total)	Savings in Total Activity/School/Workdays
Install 300 MW of utility-scale solar and 150 MW of storage capacity	$1,177,000-$1,827,000	$44,000	61	$47,000

Table 11: High-Level Summary of Environmental, Social and Economic Benefits[30]

	Environmental	Social	Economic
Increase Energy Resilience through Microgrids	●◐○	●○○	●○○

4.2 Reduce Building Energy Emissions

The following measures include energy efficiency and electrification measures for residential and commercial buildings. For each measure, the reduction in GHG comes from reducing energy across building energy uses including heating, water heating, cooling, lighting, and equipment. Through the MTERA EPA Community Change Grant award, all Midwest Tribes may receive approximately $140,000 per Tribe annually for three years to support energy efficiency and weatherization upgrades in homes in each Tribe's service area. All projects deployed through this program will be built between 2024 and 2027. Additionally, through the DOE Tribal Home Electrification and Appliance Rebates Program, all Midwest Tribes may access allocations of up to $14,000 per eligible household to support energy efficiency and weatherization upgrades. All projects deployed through this program will be built between 2023 and 2029. These funding awards were considered in developing building energy efficiency and electrification upgrades implementation goals for the 2030 and 2050 targets.

The following table summarizes the resulting GHG emissions reductions for the eight-Tribe subset from the 2030 and 2050 implementation targets of the building energy reduction measures It also includes the measure cost on a per building basis for reference.

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[29] These estimates are annual aggregate savings across Minnesota and Wisconsin and were determined using the EPA's Avoided Emissions and Generation Tool (AVERT) and CO-Benefits Risk Assessment (COBRA) -see Appendix E for further details.

[30] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

Table 12: Building Energy Measures – Summary of Cost and Emissions Reductions

Reduction Measure	Measure Description	Measure Cost	Eight-Tribe Subset 2030 Target		Eight-Tribe Subset 2050 Target	
			Measure Implementation Quantity	$MTCO_2e$ Reduced	Measure Implementation Quantity	$MTCO_2e$ Reduced
Electrify heating equipment	Residential buildings retrofit to heat pumps	$20,400/ building	50% of buildings	28,090	90% of buildings	62,241
	Commercial buildings retrofit to heat pumps	$43,071/ building	50% of buildings	25,827	90% of buildings	57,410
Install high-efficiency appliances	Residential buildings upgrade appliances	$11,422/building	60% of buildings	2,464	100% of buildings	9,130
Install weatherization – insulation and weatherstripping	Single-family homes & multifamily buildings implement air sealing & insulation	$4,782/building	60% of buildings	2,208	100% of buildings	4,537
	Commercial buildings install roof & wall insulation, window films	$14,300/building	60% of buildings	2,940	100% of buildings	6,145
Retrofit interior lighting to LEDs	Interior & exterior lighting of all residential buildings to LEDs	$143/building	60% of buildings	788	100% of buildings	3,250
	100% of interior & exterior lighting of all commercial buildings to LEDs	$5,250/building	60% of buildings	3,098	100% of buildings	6,194
Install smart thermostats	60% of residential buildings install smart thermostats	$435/building	60% of buildings	1,498	100% of buildings	4,718
	60% of commercial buildings install smart thermostats	$1,000/building	60% of buildings	3,908	100% of buildings	7,914

Reduction Measure	Measure Description	Measure Cost	Eight-Tribe Subset 2030 Target		Eight-Tribe Subset 2050 Target	
			Measure Implementation Quantity	$MTCO_2e$ Reduced	Measure Implementation Quantity	$MTCO_2e$ Reduced
Adopt green building standards for major renovations	15% of buildings undergo major renovation projects	*	15% of buildings	4,000	*	*

*No hard costs or 2050 targets were calculated for the green building standards due to variability of existing and future building stock, regulations, and policy strategy. See Appendix B for more details.

4.2.1 Building Retrofits & Energy Conservation Measures

Benefits Analysis: Building retrofits and energy conservation measures result in reduced energy bills for Tribal members. Tribal members may experience a high energy burden – when a significant amount of household income is spent on energy bills. A report from the Midwest Energy Efficiency Alliance highlights how households who identified as Native American on the census have an average energy burden that is 45% higher than non-Hispanic white households.[31] Energy cost savings can reduce inequitable energy burdens and provide more disposable income for Tribal members. The World Resources Institute estimates that every $1 spent on building energy efficiency results in $2 saved in energy distribution costs,[32] resulting in less utility costs being passed onto customers. Energy efficiency can also support local job creation for installation professionals, with the American Council for an Energy-Efficient Economy estimating that every $1M spent on energy efficiency upgrades can result in the creation of up to 17 jobs.[33]

Building energy efficiency also supports a community's resilience to climate change and extreme weather events. If a storm or extreme heat event occurs and disrupts the power supply, energy efficient buildings can last longer on the same amount of backup power as less-efficient buildings. As climate change makes the electric grid more volatile, building energy efficiency can reduce baseload on the grid and minimize power disruptions that limit Tribal members ability to work, learn, or access services.

A reduction in energy use and resulting air quality improvements from these measures also significantly improve health outcomes for Tribal communities. As shown in the table below, if all energy efficiency measures are implemented by 2050, $615,000-960,500/yr of cost savings are expected across Minnesota and Wisconsin annually related to reduced emergency room visits, illness treatment, mortality rates, and increased work/school days.

[31] Garza, L. Y., Anderson, C., Caloras, A., & Wazowicz, M. (2022, September). *First to Reside, Last to Benefit: A Study of Midwestern Tribal Efficiency* [White paper]. Midwest Energy Efficiency Alliance. Retrieved February 9, 2024, from https://www.mwalliance.org/sites/default/files/meea-research/first_to_reside_last_to_benefit-_a_study_of_midwestern_tribal_efficiency_0.pdf

[32] Becqué, R., Mackres, E., Layke, J., Aden, N., Liu, S., Managan, K., Nesler, C., Mazur-Stommen, S., Petrichenko, K., & Graham, P. (n.d.). *Accelerating Building Efficiency: Eight Actions for Urban Leaders. World Resources Institute*. Retrieved February 8, 2024, from https://publications.wri.org/buildingefficiency/

[33] *How Does Energy Efficiency Create Jobs?* (n.d.). American Council for an Energy-Efficient Economy. Retrieved August 26, 2024, from https://www.aceee.org/files/pdf/fact-sheet/ee-job-creation.pdf

Table 13: Annual Health Impacts of Energy Efficiency Measure Implementation.[34]

Reduction Measure	Total Health Effects Savings (Low-High Estimate)	Total Asthma Symptoms/Onset Savings	Minor Restricted Activity Days, School Days, and Workdays Saved (Total)	Savings in Total Activity/School/Workdays
Reduce energy consumption by 301,000 MWh via energy efficiency improvements	$615,000-$961,000	$23,000	32	$24,000

Ensuring Tribal Members have access and ongoing support from existing energy efficiency and rebate programs is key to implementing these retrofits and realizing the numerous financial, resilience, and health-related benefits. Public agencies should look to increase funding and staffing capacity of energy efficiency programs, given the increasing demand and necessity. Hiring requirements and training opportunities geared towards Tribal members can guarantee Tribes directly benefit from job creation from energy efficiency implementation.

4.2.1.1 Electrify Heating Equipment

Measure Description:

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.

Benefits Analysis:

Replacing gas-fired heating equipment with electric heat pumps improves indoor air quality by reducing emissions from combustion within homes, reducing hospital visits, respiratory illness, and disruptions to work and learning for Tribal members.

Since heat pumps provide both heating and cooling, they can bring cooling to homes or buildings without air conditioning at no additional cost or labor. Especially as heatwaves become more common across the U.S., cooling can be a lifesaving feature, particularly for vulnerable groups like children and the Elders, who are most impacted by heat-induced illnesses.

Since all-electric heat pumps rely on the energy grid, if the power goes out, Tribes should simultaneously implement clean energy storage for backup power to minimize disruptions to daily life. Tribes can also consider which public buildings could function as cooling/resilience centers to ensure Tribal Members can access critical services even in power outages.

Depending on the relative costs of electricity compared with heating fuels, electrification can sometimes result in increased utility bills. Some of the ways to minimize the potential for cost increases resulting from electrification of heat include:

1. Prioritize electrification of buildings that currently use more expensive and higher GHG fuels for heating, such as propane and fuel oil, as opposed to natural gas;

[34] These estimates are annual aggregate savings across Minnesota and Wisconsin and were determined using the EPA's Avoided Emissions and Generation Tool (AVERT) and CO-Benefits Risk Assessment (COBRA) -see Appendix E for further details.

2. Where feasible, consider geothermal systems, which have lower operating costs than air source heat pumps (but higher installation costs, which can be offset with incentives);
3. Combine electrification measures with weatherization to minimize heating needs (see Section 4.2.1.3 Conduct Building Weatherization Retrofits);
4. Reduce electricity expenditures by taking advantage of incentives to install for on-site renewable electricity;
5. Explore potential use of a lower-cost "heat-pump tariff" with the electric utility.

Table 14: High-Level Summary of Environmental, Social and Economic Benefits[35]

	Environmental	Social	Economic
Electrify Heating Equipment	●○○	●○○	●◐○

4.2.1.2 Install High-Efficiency Appliances

Measure Description:

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.

Benefits Analysis:

High-efficiency appliances can be more durable, leading to less required maintenance and lower operating costs overall. Upgrading to high-efficiency appliances can provide residents an opportunity to choose all-electric alternatives (heat pumps, electric dryers, etc.), leading to additional decarbonization benefits. To offset the high upfront cost of replacing appliances, Tribes can take advantage of programs that offer rebates and incentives for appliance replacement.

Table 15: High-Level Summary of Environmental, Social and Economic Benefits[36]

	Environmental	Social	Economic
Install High-Efficiency Appliances	●○○	◐○○	●◐○

4.2.1.3 Conduct Building Weatherization Retrofits

Measure Description:

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.

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[35] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

[36] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

Benefits Analysis:

Weatherization measures can improve insulation, which lowers energy bills from reduced heating load and improves the thermal comfort of building occupants, leading to improved wellbeing, satisfaction, and productivity.[37] Contractors implementing retrofits should recognize an appropriate level of weatherization to ensure the ventilation of indoor air pollutants and prevent moisture build up and mold growth.[38]

Table 16: High-Level Summary of Environmental, Social and Economic Benefits[39]

	Environmental	Social	Economic
Conduct Building Weatherization Retrofits	●○○	●○○	●●○

4.2.1.4 *Upgrade Interior & Exterior Lighting to LEDs*

Measure Description:

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.

Benefits Analysis:

LEDs are often cheaper than alternative lightbulbs, making it a more cost-effective retrofit on top of additional energy savings. Uniform, consistent lighting from LEDs can reduce visual fatigue, thereby improving focus, productivity, and safety. Compared to CFL bulbs, LEDs are significantly more durable, lasting 3-5x longer than CFL bulbs,[40] and contain no mercury. While low risk to adults, mercury exposure from CFLs can be more harmful to pets and children, making LEDs a safer option.

Table 17: High-Level Summary of Environmental, Social and Economic Benefits[41]

	Environmental	Social	Economic
Upgrade Interior and Exterior Lighting to LEDs	●○○	◐○○	●◐○

4.2.1.5 *Install Smart Thermostats*

Measure Description:

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.

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[37] *Multiple Benefits of Energy Efficiency*. (2019). IEA, Paris. Retrieved August 26, 2024, from https://www.iea.org/reports/multiple-benefits-of-energy-efficiency.

[38] *Energy, Weatherization and Indoor Air Quality*. (2024, August 13). U.S EPA. Retrieved August 26, 2024, from https://www.epa.gov/indoor-air-quality-iaq/energy-weatherization-and-indoor-air-quality.

[39] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

[40] "LED Lighting." Office of Energy Saver. Retrieved September 20, 2024, from https://www.energy.gov/energysaver/led-lighting/.

[41] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

Benefits Analysis:

Smart thermostats allow users to remotely monitor energy use, allowing greater control and flexibility while saving energy. Residents can understand their energy consumption patterns, helping them make informed behavior changes, such as adjusting pre-sets or turning off heating or cooling even when not home. Smart thermostats can create or suggest schedules that adjust for ideal temperatures for when people are home, away, or asleep. To offset the high upfront cost of replacing thermostats, Tribes can take advantage of programs that offer rebates and incentives.

Table 18: High-Level Summary of Environmental, Social and Economic Benefits[42]

	Environmental	Social	Economic
Install Smart Thermostats	●○○	●○○	●◐○

4.2.2 Introduce New Building Standards

4.2.2.1 Adopt Green Building Standards for Major Renovations

Measure Description:

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 have more insulation, better window constructions, and can be all-electric.

Benefits Analysis:

Green building standards provide comprehensive strategies that result in energy efficiency, water conservation, and improved air quality. Green buildings improve health, thermal comfort, and occupant happiness by integrating daylighting, using healthier materials that don't generate toxins, and improving access to greenspace or other site amenities (such as bike parking). While green building strategies may result in higher upfront costs, they are cost-effective in the long term due to lower operating costs from energy and water use reduction as well as increased property values from implementing desirable sustainability strategies.

Table 19: High-Level Summary of Environmental, Social and Economic Benefits[43]

	Environmental	Social	Economic
Adopt Green Building Standards	●◐○	●○○	●○○

[42] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

[43] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

4.3 Reduce Vehicle Emissions

The following table summarizes the resulting GHG emissions reductions for the eight-Tribe subset from the 2030 and 2050 implementation targets of the vehicle mode shift measures.

4.3.1 Mode Shift

Table 20: Vehicle Measures – Summary of Cost and Emissions Reductions

<table>
<tr><th rowspan="2">Reduction Measure</th><th rowspan="2">Measure Description</th><th rowspan="2">Measure Cost</th><th colspan="2">Eight-Tribe Subset 2030 Target</th><th colspan="2">Eight-Tribe Subset 2050 Target</th></tr>
<tr><th>Measure Implementation Quantity</th><th>$MTCO_2e$ Reduced</th><th>Measure Implementation Quantity</th><th>$MTCO_2e$ Reduced</th></tr>
<tr><td>Increase transit service</td><td>Mode shift to bus</td><td>*</td><td rowspan="3">5% of VMT reduction due to mode shift</td><td rowspan="3">936</td><td rowspan="3">10% of VMT reduction due to mode shift</td><td rowspan="3">14,798</td></tr>
<tr><td>Influence ridesharing</td><td>Mode shift to rideshare</td><td>*</td></tr>
<tr><td>Develop active transport network</td><td>Mode shift from SOVs to biking/walking</td><td>*</td></tr>
</table>

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

Benefits Analysis:

Supporting mode shift through alternate transit options can lead to healthier communities through reduction of vehicles on the road and related congestion. One study puts the cost of congestion in the Twin Cities region of Minnesota at $2.6B every year due to lost time, wasted fuel, safety issues (such as car crashes), and pollution.[44] Reducing car traffic reduces air pollution, provides major cost savings, makes roadways safer for existing users, and allows Tribal members to spend more time engaging in work, learning, or leisure.

Increasing transit accessibility and mode shift in some cases can increase property values in transit-connected areas, which supports economic development but may increase housing costs for lower-income Tribal members. Rent control measures and engagement with the community to avoid displacement can alleviate these concerns. Furthermore, in implementing mode shift, communities should ensure safety improvements are in place to keep cyclists, pedestrians, and public transit users safe from any car traffic.

[44] *White Paper #1: The Negative Effects of Traffic Congestion on the Twin Cities and the State of Minnesota.* (2020, January 27). Metropolitan Council. Retrieved February 8, 2024, from https://metrocouncil.org/Transportation/System/Highways/Congestion/Mobility-Needs-Analysis/The-Negative-Effects-of-Traffic-Congestion.aspx

4.3.1.1 Increase Transit Service

Measure Description:

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[45] (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.

Benefits Analysis:

Public transportation can be cheaper than the cost of car ownership and maintenance, especially when gas and diesel costs are high. Employers may offer incentives to people taking public transit, further providing cost savings. Increasing service can also increase the mobility of lower-income community members, who are more likely to take transit. Commuters on public transit can also make productive use of their time on transit for work or rest.

Last-mile considerations, which involve someone getting from transit to their final destination, should be a priority in transit planning to minimize long commute times and low uptick. Pairing transit service with other mode shift measures, implementing bike or scooter sharing, and coordinating across transit providers to improve connections can ensure Tribal members can seamlessly and efficiently use transit to commute.

Table 21: High-Level Summary of Environmental, Social and Economic Benefits[46]

	Environmental	Social	Economic
Increase Transit Service	●○○	●●○	●○○

4.3.1.2 Increase Ridesharing

Measure Description:

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.[47] This calculation uses the baseline emissions associated with gasoline-powered SOVs and assumes 10% of the Tribal population shifts to rideshare vehicles.

Benefits Analysis:

Carpooling and rideshare participants can significantly reduce the cost of their commute and car ownership by sharing fuel and maintenance costs. Engaging in carpooling can improve connections and social networks between neighbors or employees as they coordinate transportation. Increased rideshare demand can support rideshare driving jobs in the gig economy. Employers or Tribal governments may offer incentives to people engaging in carpool or rideshare, providing even more cost savings to drivers.

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[45] *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

[46] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

[47] 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

Table 22: High-Level Summary of Environmental, Social and Economic Benefits[48]

	Environmental	Social	Economic
Increase Ridesharing	◐○○	●○○	●○○

4.3.1.3 *Develop Active Transport Network*

Measure Description:

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).[49] In order to quantify this measure across all Tribes, a 10% mode shift to active transport was assumed.

Benefits Analysis:

For those who are physically able, active transportation measures like biking and walking are a boost to physical and mental health. Improving physical activity can reduce underlying risk of chronic diseases (heart disease and, diabetes), obesity, anxiety, and cognitive ability.[50] By investing in adequate bicycle and pedestrian infrastructure, Tribal members can integrate regular movement into the process of commuting and improve physical and mental health. Active transportation networks connected to downtown corridors or city centers can also boost economic productivity and social activity along those corridors. Providing e-bike options can also allow for greater uptake of active transportation to those less physically able.

Table 23: High-Level Summary of Environmental, Social and Economic Benefits[51]

	Environmental	Social	Economic
Develop Active Transport Network	◐○○	●●◐	●○○

4.3.2 Introduce Electric & Alternative Fuel Vehicles

The following table summarizes the resulting GHG emissions reductions for the eight-Tribe subset from the 2030 and 2050 implementation targets of the vehicle electrification measures. It also includes the measure cost on a per charger and vehicle basis for reference.

[48] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

[49] *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.

[50] *Physical Inactivity*. (2022, September 8). Centers for Disease Control and Prevention. Retrieved February 8, 2024, from https://www.cdc.gov/chronicdisease/resources/publications/factsheets/physical-activity.htm

[51] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

Table 24: Electric & Alternative Fuel Vehicle Measures – Summary of Cost and Emissions Reductions[52]

Reduction Measure	Measure Description	Measure Cost*	Eight-Tribe Subset 2030 Target		Eight-Tribe Subset 2050 Target	
			Measure Implementation Quantity	$MTCO_2e$ Reduced	Measure Implementation Quantity	$MTCO_2e$ Reduced
Electrify SOV vehicles & provide charging infrastructure	Assumes single-occupancy vehicles are converted to EVs	$2,400/charger, 10 EVs/public charger	20% of SOVs	17,780	100% of SOVs	133,184
Convert bus fleet to electricity, hydrogen, or lower-emission fuels**	Assumes buses have been replaced with electric buses	$70,000/charger, $175,000/bus	75% of bus fleet	5,680	100% of bus fleet	8,912

***** See Appendix B for more details on cost estimates.

**For CCAP projections, bus conversion to EVs has been prioritized over low-emission vehicles. For details on hydrogen and lower-emission fuel buses, see Appendix B.

Benefits Analysis:

Zero-emission vehicles (ZEVs) for both buses and single-occupancy vehicles do not use fossil fuels or have tailpipe emissions, which lead to significant avoided air pollution, noise pollution, and improved health outcomes related to asthma, lung disease, cardiovascular disease, and hospital visits.

Vehicle electrification is another area of significant job growth across vehicle & charger maintenance and charger installation, particularly when charging stations are located along popular driving routes. According to the International Council on Clean Transportation, 160,000 jobs in charging infrastructure are likely to be created between 2024 and 2032.[53] Charging stations offer an opportunity for other businesses and retail to develop around them or support businesses connected to gas stations in this transition. Nationwide, the EV sector is growing rapidly, with the DOE showing clean vehicle employment increasing 11.4% in 2023.[54] These new jobs should be paired with accessible training programs and local hiring requirements to make sure these high-quality jobs stay local.

[52] These estimates are annual aggregate savings across Minnesota and Wisconsin and were determined using the EPA's Avoided Emissions and Generation Tool (AVERT) and CO-Benefits Risk Assessment (COBRA). -see Appendix E for further details.

[53] Bui, Anh, Logan Pierce, Pierre-Louis Ragon, Arijit Sen, And Peter Slowik (ICCT), And Taylor Waites (International Brotherhood of Electrical Workers). (2024 January). *Charging Up America: The growth of United States electric vehicle charging infrastructure jobs*. International Council on Clean Transportation. Retrieved September 9, 2024, from https://theicct.org/wp-content/uploads/2024/01/ID-28-%E2%80%93-U.S.-infra-jobs-report-letter-70112-ALT-v6.pdf

[54] *United States Energy & Employment Report 2024*. (2024). U.S. Department of Energy Office of Energy Jobs Retrieved September 9, 2024, from https://www.energy.gov/sites/default/files/2024-08/2024%20USEER%20FINAL.pdf

4.3.2.1 Electrify Bus Fleet and Provide Charging Infrastructure

Measure Description:

Electric buses result in much lower GHG emissions than diesel-burning buses; not only do they have tailpipe emissions, but as the electric grid continues to decarbonize, the emissions associated with powering electric buses will continue to decrease.

Benefits Analysis:

Electric buses reduce or eliminate the need to for fossil-fuel powered buses, resulting in far less pollutants and improved air quality. The total health savings from avoided air pollution due to electric buses ranges from $19,500-$27,400/yr due to avoiding emergency room visits, illness treatments, reduced mortality rates, and less work/school days missed due to poor health.

Table 25: Annual Health Impacts of Electric Bus Measure Implementation.[55]

Reduction Measure	Total Health Effects Savings (Low-High Estimate)	Total Asthma Symptoms/Onset Savings	Minor Restricted Activity Days, School Days, and Workdays Saved (Total)	Savings in Total Activity/School/Workdays
Add 71 EV school buses and 58 EV transit buses to transportation infrastructure	$20,000-$27,000	$800	1	$900

While the upfront cost of electric buses is a significant barrier, cost savings from fueling with electricity instead of diesel can range from 30% to 75%, helping reduce ownership costs over the bus lifetime.[56]

Table 26: High-Level Summary of Environmental, Social and Economic Benefits[57]

	Environmental	Social	Economic
Electrify Bus Fleet and Provide Charging Infrastructure	●○○	●○○	●○○

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

Measure Description:

"Alternative fuel buses" refer 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 carbon emissions into the atmosphere than a diesel engine.

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[55] These estimates are annual aggregate savings across Minnesota and Wisconsin and were determined using the EPA's Avoided Emissions and Generation Tool (AVERT) and CO-Benefits Risk Assessment (COBRA). Conducted under the assumption that clean energy capacity will also increase to fit the needs of increased EV capacity - see Appendix E for further details.

[56] *Ready for Work* (n.d.) Union of Concerned Scientists. Retrieved September 7, 2024, from https://www.ucsusa.org/sites/default/files/2019-12/ReadyforWorkFullReport.pdf

[57] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

Benefits Analysis:

While ethanol, CNG, and propane are not as widely available, these fuels are currently cheaper than gasoline or diesel on a nationwide average, resulting in fuel cost savings in operating alternative fuel buses. Biodiesel production in particular can use waste cooking oil, which reduces landfill waste by repurposing it into a more sustainable feedstock.

Table 27: High-Level Summary of Environmental, Social and Economic Benefits[58]

	Environmental	Social	Economic
Provide Alternative Fuel Buses	◐○○	◐○○	◐○○

4.3.2.3 Electrify SOVs and Provide Charging Infrastructure

Measure Description:

In order to influence adoption of EVs among passenger vehicles, Tribal governments can invest in EV charging infrastructure. In order to calculate emissions associated with this measure, the emissions from gasoline-powered cars were compared to the emissions associated with EVs for the equivalent number of miles traveled.

Benefits Analysis:

Electric SOVs reduce or eliminate the need for fossil-fuel powered SOVs, resulting in far less pollutants and improved air quality. Electric SOVs also decrease maintenance cost due to regenerative braking (which reduces brake wear), fewer fluid changes, and fewer overall mechanical components than a conventional fuel engine. The total health savings from electrifying SOVs ranges from $221,500-$361,400/yr due to avoiding emergency room visits, illness treatments, reduced mortality rates, and less work/school days missed due to poor health.

Table 28: Annual Health Impacts of Single Occupant EV Measure Implementation.[59]

Reduction Measure	Total Health Effects Savings (Low-High Estimate)	Total Asthma Symptoms/Onset Savings	Minor Restricted Activity Days, School Days, and Workdays Saved (Total)	Savings in Total Activity/School/Workdays
Add 36,000 EV single-occupant vehicles to transportation infrastructure	$222,000-$361,000	$7,000	12	$8,000

While the upfront cost of EVs can be a significant barrier, the long-term cost ownership is often cheaper than gas- or diesel-powered vehicles. When accounting for federal tax credits, many EV models are cheaper to own and finance over their lifetime in most states (including Minnesota and Wisconsin).[60]

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[58] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

[59] These estimates are annual aggregate savings across Minnesota and Wisconsin and were determined using the EPA's Avoided Emissions and Generation Tool (AVERT) and CO-Benefits Risk Assessment (COBRA). Conducted under the assumption that clean energy capacity will also increase to fit the needs of increased EV capacity - see Appendix E for further details.

[60] *Most Electric Vehicles Are Cheaper to Own Off the Lot Than Gas Cars.* (2022, May). Energy Innovation. Retrieved July 24, 2024, from https://energyinnovation.org/wp-content/uploads/2022/05/Most-Electric-Vehicles-Are-Cheaper-Off-The-Lot-Than-Gas-Cars.pdf

Table 29: High-Level Summary of Environmental, Social and Economic Benefits[61]

	Environmental	Social	Economic
Electrify SOVs and Provide Charging Infrastructure	●○○	◐○○	●○○

4.3.2.4 *Electrify ATVs, Boats, and Tractors*

Measure Description:

Electrifying all-terrain vehicles (ATVs) is challenging due to limited options in the current market and mechanical issues with cleaner fuel blends. However, electric Utility Task Vehicles (UTVs) are available for purchase and growing in market value. Electric UTVs have the benefit of lower operations and maintenance costs, though they offer shorter ranges compared to non-electric UTVs.[62]

Electrifying boats is possible but expensive, with most electric options being luxury models. Smaller, more affordable electric fishing boats are limited, and gas-powered boats are significantly more affordable. Alternatively, decarbonization from boating can be achieved by switching to E10 fuel, which can reduce carbon emissions by up to 13%.[63]

Electrifying tractors is currently impractical, with most electric and hydrogen models still in development. Using cleaner fuels like B100 biodiesel is the most viable way to reduce tractor emissions. However, older tractor models (pre-2002) may require fuel system modifications to use B100 fuel, which can reduce emissions by up to 74%.[64] Overall, switching to cleaner fuel blends is the most accessible solution for reducing GHG emissions from ATVs, boats, and tractors.

Benefits:

Tribes should monitor the availability of electrified ATVs and boats for eventual implementation as well as available state and federal rebates and incentives as these technologies become market ready.

Table 30: High-Level Summary of Environmental, Social and Economic Benefits[65]

	Environmental	Social	Economic
Electrify ATVs, Boats, and Tractors	◐○○	◐○○	**Negative impact**

[61] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

[62] *Global Market Insights*, "Electric UTV Market Size - By Power Range (Below 10 kW, 10-30 kW, Above 30 kW), By Application (Utility, Sports, Recreation, Military), By Price (Below USD 20,000, USD 20,000-30,000, Above USD 30,000) & Forecast 2024 – 2032," Global Market Insights, Retrieved July 18, 2024, https://www.gminsights.com/industry-analysis/electric-utility-terrain-vehicle-utv-market?utm_source=globenewswire.com&utm_medium=referral&utm_campaign=Paid_globenewswire.

[63] Maria Muñoz et al., "Bioethanol Blending Reduces Nanoparticle, PAH, and Alkyl-and Nitro-PAH Emissions and the Genotoxic Potential of Exhaust from a Gasoline Direct Injection Flex-Fuel Vehicle," *Environmental Science & Technology* 50 (2016): 11853-11861, Retrieved July 26, 2023, https://doi.org/10.1021/acs.est.6b02606.

[64] United States Department of Energy, "Biodiesel Benefits and Considerations," Alternative Fuels Data Center, Retrieved July 18, 2024, https://afdc.energy.gov/fuels/biodiesel-benefits.

[65] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

4.4 Implement Environmental Management and Planning Techniques

The following table summarizes the resulting GHG emissions reductions for the eight-Tribe subset from the 2030 and 2050 implementation targets of the environmental management and planning measures that are outlined in. It also includes the measure cost on a per planting or planted area basis for reference.

Table 31: Environmental Management & Planning Measures – Summary of Cost and Emissions Reductions

Reduction Measure	Measure Description	Measure Cost	Eight-Tribe Subset 2030 Target		Eight-Tribe Subset 2050 Target	
			Measure Implementation Quantity	$MTCO_2e$ Reduced	Measure Implementation Quantity	$MTCO_2e$ Reduced
Sequester carbon through plants	Trees planting	$300/tree	100,000 trees	1,202	200,000 trees	2,404
	Shrub planting	$0.5/sf	500,000 sf	37	1,000,000 sf	74
	Grassland restoration	$1,000/acre	100 acres	158	300 acres	473
Develop green infrastructure	Development of bioswales	$0.50/sf	500,000 sf	113	1,000,000	227
Implement responsible development & zoning policies**	20% of population affected by responsible development	*	*	4,000	*	*

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

**Responsible development and zoning policies were not included in projections analysis due to limited data on planned future development in the short- and long-term timelines for the Tribes. Recycling and composting programs were not included in projections analysis.

4.4.1 Sequester Carbon Through Plants

Measure Description:

The carbon sequestration potential of planting trees, grasses, and shrubs was calculated using the Climate Positive Design's Pathfinder tool[66] which provided carbon sequestration rates, which were used to assume appropriate values for the generalized plant types.

[66] *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.

Benefits Analysis:

Planting trees, shrubs, and grasses near community buildings provide shade and localized cooling, which can support safer recreation or work outside on hot days and naturally cool buildings, reducing energy use from air conditioning. Additional shade can also be lifesaving during heat waves, especially for children and Tribal members who work outdoors, spend more time outdoors, and are more susceptible to heat illness. Additional plant cover can also absorb stormwater and reduce flooding, minimizing disruption to roadways and walkways as well as reducing costs of potential property and infrastructure damage. Adjacent to transportation corridors, planting can also be acoustic barrier to surrounding areas and limit noise pollution.

Table 32: High-Level Summary of Environmental, Social and Economic Benefits[67]

	Environmental	Social	Economic
Sequester Carbon Through Plants	●●○	●○○	○○○

4.4.2 Preserve Wetlands

Measure Description:

Wetlands are a carbon sink that sequester and store CO_2. When wetlands are developed, they release large amounts of stored carbon, further exacerbating climate change and making it crucial to preserve and protect them[68]. The overall carbon sequestration potential of wetlands is dependent upon many factors, including surrounding CO_2 emissions, soil type, and vegetation type[69]. When wetlands are located in areas where there are persistent and elevated carbon emissions, the wetlands become net emitters of CO_2, methane, and nitrous oxide. Wetlands that are located in peatland and are forested capture more carbon than those located in mineral soils that are non-forested. Due to these multiple location-based variables, further analysis of the wetlands located within Tribal Lands are needed to quantify their specific GHG reduction potential.

Benefits Analysis:

Wetlands have many other benefits ranging from environmental health, community resilience, and biodiversity. They improve water quality due to their natural ability to filter and absorb pollutants, sediments, and nutrients. Wetlands also retain floodwater and reduce the impact of storms, which is a crucial ecosystem service in light of increasing extreme weather events due to climate change. Wetlands are also full of biodiversity, providing habitats for many endangered species.[70] Wetland preservation can also maintain water quality and protect biodiversity and plants important to Tribal cultural practices.[71]

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[67] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

[68] *Carbon Sequestration in Wetlands*. (2019). Minnesota Board of Water and Soil Resources. Retrieved August 26, 2024, from https://bwsr.state.mn.us/carbon-sequestration-wetlands

[69] Kolka, R., C. Trettin, W. Tang, K. Krauss, S. Bansal, J. Drexler, K. Wickland, R. Chimner, D. Hogan, E. J. Pindilli, B. Benscoter, B. Tangen, E. Kane, S. Bridgham, and C. Richardson (2018). Chapter 13: Terrestrial wetlands. *Second State of the Carbon Cycle Report (SOCCR2): A Sustained Assessment Report*. Retrieved August 26, 2024, from https://doi.org/10.7930/SOCCR2.2018.Ch13. https://carbon2018.globalchange.gov/downloads/SOCCR2_Ch13_Terrestrial_Wetlands.pdf

[70] *Incorporating Wetland Restoration and Protection in Planning Documents*. (2023, November 1). US EPA. Retrieved August 26, 2024, from https://www.epa.gov/wetlands/incorporating-wetland-restoration-and-protection-planning-documents

[71] *Protecting Waters and Wetlands in Indian Country: A Guide for Developing Tribal Wetland Management Programs*. (2022, December). U.S Environmental Protection Agency. Retrieved August 26, 2024, from https://www.epa.gov/system/files/documents/2022-12/Final_Tribal_Wetlands_Guide_Rev_121422.pdf

Table 33: High-Level Summary of Environmental, Social and Economic Benefits[72]

	Environmental	Social	Economic
Preserve Wetlands	●●○	●○○	○○○

4.4.3 Develop Green Infrastructure

Measure Description:

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 through plant growth.

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, perennial grasses were used to calculate carbon sequestration impact.

Benefits Analysis:

Similar to wetlands, green infrastructure, such as bioswales and strategic landscaping of trees and shrubbery, can decrease stormwater runoff and damage to infrastructure, improving Tribal community resilience to extreme weather. Green infrastructure can also have a cooling effect, minimizing exposure to heat and related illness.

Table 34: High-Level Summary of Environmental, Social and Economic Benefits[73]

	Environmental	Social	Economic
Develop Green Infrastructure	●●○	●○○	○○○

4.4.4 Implement Responsible Development and Zoning Policies

Measure Description:

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. Responsible development and zoning policies were not included in projections analysis due to limited data on planned future development in the short- and long-term timelines for the Tribes.

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[72] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

[73] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

Benefits:

Transit oriented development (TOD) overall helps to reduce commute time and driving distances to key services and opportunities, which can improve accessibility of these opportunities and strengthen social connections. Fewer cars on the road going shorter distances helps decrease risk of road injuries. TOD can also encourage more active modes of transit, which improves physical mobility, mental health, and well-being from time spent outdoors. TOD planning must consider the need to preserve affordability in its developments to limit displacement of existing community members.[74]

Table 35: High-Level Summary of Environmental, Social and Economic Benefits[75]

	Environmental	Social	Economic
Implement Responsible Development and Zoning Policies	●◐○	●●◐	◐○○

4.4.5 Implement a Recycling Program

Measure Description:

Collecting recycling from residents and businesses diverts waste from landfills and therefore reduces carbon dioxide and methane emissions from anaerobic decomposition. Recycling also reduces the emissions associated with extracting and processing raw materials that can be replaced by recycled materials in manufacturing, further reducing industrial energy and air pollution. Recycling programs were not included in the projections analysis as all municipal solid waste for Tribes is managed off Tribal lands and therefore is considered part of Scope 3 emissions. Baseline GHG inventories account only for Scope 1 and 2 emissions.

Benefits Analysis:

Recycling helps minimize waste that contributes to litter or goes into landfills, which can emit pollutants that contaminate groundwater and contribute to air pollution. Recycling also improves resource efficiency by reducing the need to extract raw materials and disrupt natural environments as a result. Recycling programs create jobs such as the collection and sorting of recycling, as well as processing and manufacturing of recycled materials.

Table 36: High-Level Summary of Environmental, Social and Economic Benefits[76]

	Environmental	Social	Economic
Implement a Recycling Program	●○○	○○○	●◐○

[74] *Why TOD Matters*. (n.d.). Institute for Transportation & Development Policy. Retrieved August 27, 2024, from https://tod.itdp.org/why-tod-matters.html

[75] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

[76] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

4.4.6 Implement a Composting Program

Measure Description:

A composting program transforms food waste into nutrient-rich soil, which promotes soil health in farms and gardens and reduces the need for synthetic fertilizers. Composting food waste reduces the amount of waste that is sent to landfills, which also reduces carbon dioxide and methane emissions from anaerobic decomposition. While composting produces some carbon dioxide emissions, it is significantly lower than the emissions from a landfill. Composting programs were not included in the projections analysis as all municipal solid waste for Tribes is managed off Tribal Lands and therefore is considered part of Scope 3 emissions. Baseline GHG inventories account only for Scope 1 and 2 emissions.

Benefits Analysis:

Composting helps minimize waste going into landfills, which can emit pollutants that contaminate groundwater and contribute to air pollution. Compost programs can generate local jobs for collecting and processing compostable materials. Compost can be used in local farming practices, reducing fertilizer costs and improving soil quality on Tribal-owned farms. Compost facility managers should implement safety precautions for operating equipment and strategies to minimize odor to the surrounding community.

Table 37: High-Level Summary of Environmental, Social and Economic Benefits[77]

	Environmental	Social	Economic
Implement a Composting Program	●○○	○○○	●◐○

4.4.7 Reduce Fertilizer Emissions

Measure Description:

Organic fertilizers and manure substantially mitigate GHG emissions compared to synthetic fertilizers, with organic fertilizers reducing nitrous oxide (N_2O) emissions by 96% and manure by over 99%[78]. Synthetic fertilizers significantly contribute to GHG emissions both in their manufacturing process, which accounts for about 2% of global energy use, and in their use when applied to soil[79]. Though synthetic fertilizers are nutrient-rich and beneficial for crop growth, they contribute to GHG emissions through volatilization (emission of ammonia gas) and denitrification (release of nitrogen gases in soil and water). These emissions are intensified by certain application methods and environmental conditions, such as extreme heat and wind. Furthermore, only about 50% of the nitrogen in synthetic fertilizers is absorbed by crops during the growing season[80]. The excess nitrogen is susceptible to runoff, which negatively affects local ecosystems through nitrogen pollution in waterways. Organic fertilizers, despite their lower nutrient content and higher costs, release nitrogen more slowly, resulting in fewer emissions. Manure is the cheapest alternative of the three and adds microbes to the soil and increases fertility. However, manure may not provide enough nutrients for a larger volume of crops due to its lower nitrogen content compared to organic fertilizers. Fertilizer programs were not included in the projections analysis as it was determined to be a minor reduction in emissions as agriculture and other land use accounts for less than 1% of total emissions of the eight-Tribe subset.

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[77] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

[78] Download the Tribal Greenhouse Gas Inventory Tool. (2024, February 5). U.S. Environmental Protection Agency. Retrieved August 26, 2024, from https://www.epa.gov/statelocalenergy/tribal-greenhouse-gas-inventory-tool

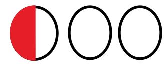
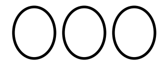
[79] Walling, E., & Vaneeckhaute, C. (2020). *Greenhouse gas emissions from inorganic and organic fertilizer production and use: A review of emission factors and their variability.* Journal of Environmental Management, 276, 111211. Retrieved August 26, 2024, from https://doi.org/10.1016/j.jenvman.2020.111211

[80] Millar, N. (2015, October 19). *Management of nitrogen fertilizer to reduce nitrous oxide emissions from field crops.* MSU Extension. Retrieved August 27, 2024, from https://www.canr.msu.edu/resources/management_of_nitrogen_fertilizer_to_reduce_nitrous_oxide_emissions_from_fi

Benefits Analysis:

Reducing synthetic fertilizer use can decrease nutrient runoff into waterways, which improves water quality, supporting healthy waterways and allowing for recreation or other culturally significant uses of water bodies. Improved soil quality from organic fertilizers and manure can lead to better crop outcomes and ecosystem health.

Table 38: High-Level Summary of Environmental, Social and Economic Benefits[81]

	Environmental	Social	Economic
Reduce Fertilizer Emissions			

4.5 Reduce Wastewater Emissions

The following table summarizes the resulting GHG emissions reductions for the eight-Tribe subset from the 2030 and 2050 implementation targets of the wastewater reduction measures. It also includes the measure cost on a per fixture or building basis for reference.

Table 39: Wastewater Reduction Measures – Summary of Cost and Emissions Reductions

Reduction Measure	Measure Description	Measure Cost	Eight-Tribe Subset 2030 Target		Eight-Tribe Subset 2050 Target	
			Measure Implementation Quantity	$MTCO_2e$ Reduced	Measure Implementation Quantity	$MTCO_2e$ Reduced
Install Low-Flow Toilets	Install low-flow toilets for residential & commercial buildings	$343/toilet	60% of fixtures	178	100% of fixtures	296
Install Low-Flow Fixtures*	Single-family & multifamily buildings install low-flow fixtures	$30/building	60% of buildings	1,171	100% of buildings	4,319

*This measure is also included within Section 4.2.1: Building Retrofits & Energy Conservation Measures since low-flow fixtures (sinks & showers) reduce building energy usage in addition to wastewater.

** Quantifying this reduction measure requires an in-depth level of analysis and is highly dependent on the unique wastewater treatment plants and equipment that the Tribes have and was not included in the projection analysis.

Benefits Analysis: Wastewater can contain a number of harmful chemicals, and if improperly treated, wastewater runoff can pollute soil and water bodies, which can harm wildlife, make drinking water or recreation activities unsafe, and contaminate waterways and crops. Minimizing wastewater can protect local water and food quality for Tribal members and protect local species from potentially life-threatening contamination.

[81] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

4.5.1 Install Low-Flow Toilets

Measure Description:

On average, toilets make up 24% of a home's water use.[82] Low-flow toilets reduce the water used per flush, thus reducing a home's water use and wastewater production. Given the emissions associated with treating wastewater, a reduction upstream in wastewater leads to a reduction in emissions.

Benefits Analysis:

Low-flow toilets can lead to lower water bills for Tribal members served by a potable water utility. Reducing potable water demand is especially important to conserving water resources and improving resilience to extreme weather events that may threaten water supply.

Table 40: High-Level Summary of Environmental, Social and Economic Benefits[83]

	Environmental	Social	Economic
Install Low-Flow Toilets	◐○○	○○○	●○○

4.5.2 Install Low-Flow Fixtures

Measure Description:

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. Low-flow fixtures not only help conserve water and lower water bills, but also reduce GHG emissions and costs through reduced water heating and reducing the overall volume of wastewater treatment.

Benefits Analysis:

Low-flow fixtures can lead to lower water bills for Tribal members served by a potable water utility. Similar to low-flow toilets, reducing potable water demand is especially important to conserving water resources and improving resilience to extreme weather events that may threaten water supply.

Table 41: High-Level Summary of Environmental, Social and Economic Benefits[84]

	Environmental	Social	Economic
Install Low-Flow Fixtures	◐○○	○○○	●○○

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[82] *Residential (Including Multi-family).* Alliance for Water Efficiency. Retrieved July 19, 2024 from https://www.allianceforwaterefficiency.org/resources/residential#.

[83] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

[84] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

4.5.3 Reduce GHG Emissions from Wastewater Treatment Plants

Measure Description:

Wastewater treatment plants (WWTPs) are major sources of methane (CH_4) and nitrous oxide (N_2O) emissions, which are respectively 28 times and 265 times more potent GHGs than carbon dioxide[85]. Aerobic WWTPs can lower methane emissions by installing anaerobic biomass digesters, which also produce useful byproducts like fertilizer and biogas but can be expensive to install and maintain. Reducing N_2O emissions are more challenging due to the lack of proven technologies[86]. However, studies show that separation of black water, grey water, and food waste at the municipal system level can increase treatment efficiency, nutrient recovery, and biogas yield. Combining water source separation systems with recycling nutrients on farmlands can decrease potential N_2O emissions by as much as 60%[11]. Quantifying this reduction measure requires an in-depth level of analysis and is highly dependent on the unique wastewater treatment plants and equipment that the Tribes have. Therefore, this reduction measure was not included in the projections analysis.

Benefits Analysis:

Anaerobic digestors help decrease odor and other pathogens and produce biogas which can be used as renewable energy for building energy or transportation fuel. Along with odor reduction, this leads to lower GHG emissions and improves the air quality and quality of life of surrounding neighborhoods and communities[87]. Retrofitting a WWTP can lead to greater climate resilience, as extreme storms and flash floods can contaminate water due to combined sewage overflows[88]. These upgrades also improve the quality of wastewater treatment, leading to cleaner water and lower risk of waterborne diseases, which improves public health and results in cleaner rivers and lakes.

Table 42: High-Level Summary of Environmental, Social and Economic Benefits[89]

	Environmental	Social	Economic
Reduce GHG Emissions from Wastewater Treatment Plants	◐ ○ ○	◐ ○ ○	**Negative impact**

[85] Mojtaba Maktabifard et al. (2023). *Net-zero carbon condition in wastewater treatment plants: A systematic review of mitigation strategies and challenges*. Renewable and Sustainable Energy Reviews 185 1, Retrieved July 16, 2024, from https://doi.org/10.1016/j.rser.2023.113638.

[86] RTI International et al. (2019). *Global Non-CO2 Greenhouse Gas Emission Projections & Marginal Abatement Cost Analysis: Methodology Documentation*. Retrieved July 17, 2024, from https://www.epa.gov/sites/default/files/2019-09/documents/nonco2_methodology_report.pdf.

[87] *Learning About Biogas Recovery.* (2024, May). U.S Environmental Protection Agency. Retrieved July 17, 2024, from https://www.epa.gov/agstar/learning-about-biogas-recovery

[88] Clean Water Program San Mateo. (2019). Wastewater Treatment Plant *Nutrient Removal and Wet Weather Flow Management Upgrade and Expansion Project*. Retrieved September 23, 2024, from https://cleanwaterprogramsanmateo.org/wwtp/

[89] See Appendix F: Summary of Community Benefits for more details on methodology on assignment of high-level benefit scores.

5 Co-Pollutant Emissions Inventory & LIDAC Census Tract Data

5.1 Co-Pollutant Emissions Inventory

In addition to reducing GHG emissions, the priority measures included in this CCAP 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 subsets. Further details of how reductions in these co-pollutants lead to significant benefits to Tribal communities are included in Section 4: GHG Reduction Measures & Benefits, as well as Appendix E.

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-Tribe subset included within this CCAP, Fond du Lac is the only Tribe with facility-level data from the NEI pertaining to the Cloquet Carlton County Airport, which CCAP measures are not likely to influence. This analysis uses county-level data for the counties which best represent the Tribal jurisdictions for the eight-Tribe subset as shown in Table 43.

Table 43: 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[90]	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 C 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 building retrofit measures, as well as “Miscellaneous Non-Industrial Not Elsewhere Classified” – pertaining to “Fluorescent Lamp Breakage” due to 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 44 was determined for the Co-Pollutant Emissions Inventory, as well as a table presenting this info by Tribe, please see Appendix C.

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

[90] 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 44: NEI Base Year Co-Pollutant Emissions Inventory (Total Metric Tons Across Eight-Tribe Subset)

Type of Pollutant	Sub-type of Pollutant	Quantity (Metric Tons)
CAP	Ammonia	700
	Carbon Monoxide	40,700
	Nitrogen Oxides	4,550
	Volatile Organic Compounds	5,600
	Sulfur Dioxide	200
	PM10 Primary	6,000
	PM2.5 Primary	5,800
	Total CAP	**63,550**
HAP	**Total HAP (see Appendix C for full list)**	**1,850**
CAP + HAP Total		**65,400**

5.2 LIDAC Census Tract Data (CEJST & EJScreen)

Tribes are not required to complete Low-Income and Disadvantaged Communities (LIDAC) Analysis as part of CPRG requirements 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 the 35 Midwest Tribes in EPA Region 5 as of February 2024 is included in Appendix D.

6 Authority to Implement

The Midwest Tribal Energy Resources Association has reviewed existing statutory and regulatory authorities to implement each priority measure continued in this CCAP. 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.

6.1 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.

6.2 Tribal Authority to Implement Priority Measures: Reduce Emissions from Electricity Generation

There is a variety of federal, state, and utility policies that impact Tribal authority to implement reduction measures associated with reducing emissions from electricity 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 Midwest Tribes' authority to implement renewable energy development and energy resilience measures. For all reduction measures covered under the goal of reducing emissions from electricity generation, progress will be tracked by quantifying increases in clean electricity 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 45: 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
		Electrify ATV/UTVs, boats, and tractors
	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
		Preserve wetlands
		Develop green infrastructure
		Implement responsible development & zoning policies
		Implement a recycling program
		Implement a composting program
		Reduce fertilizer emissions
REDUCE WASTEWATER EMISSIONS	Building Retrofits & Water Efficiency	Install low-flow toilets
		Install low-flow fixtures
	Wastewater Treatment	Reduce GHG emissions from wastewater treatment plants

6.2.1 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, Native American 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 PUCs 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 46: 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 110% of average annual usage or 550 kW, whichever is smaller	Systems must be sized under 40 kW	Systems generally must be sized under 20 kW and serviced by an IOU or Municipal utility, with a few utilities choosing to increase this threshold
		Install multifamily facility-scale renewables (PV, geothermal, wind)	Systems must be sized at 110% of average annual usage or 550 kW, whichever is smaller	Systems must be sized under 40 kW	Systems generally must be sized under 20 kW and serviced by an IOU or Municipal utility, with a few utilities choosing to increase this threshold
		Install commercial facility-scale renewables (PV, geothermal, wind)	Systems must be sized at 110% of average annual usage or 550 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, with a few utilities choosing to increase this threshold
		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 6.2.1	See Section 6.2.1	See Section 6.2.1
	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

GOAL	STRATEGY	REDUCTION MEASURE	TRIBAL AUTHORITY TO IMPLEMENT *IF NOT EXERCISING SOVEREIGNTY THROUGH PUC OR TUA FORMATION		
			Michigan	Minnesota	Wisconsin
		Develop clean energy microgrids	See Section 6.2.1	See Section 6.2.1	See Section 6.2.1

6.2.1.1 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 110% of a facility's annual electricity usage, *or* 550 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 10% of their peak load, with at least 50% of the cap reserved for systems under 20 kW and up to 50% of the cap reserved for systems between 20 kW and 550 kW. Municipal utilities and electric cooperatives are not required to participate in the Distributed Generation Program and may develop their 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.

6.2.1.2 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 with some exceptions in utility service areas where a system size cap based on annual electricity usage applies. 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.

6.2.1.3 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. A few utilities have voluntarily chosen to increase this 20 kW threshold; WE Energies has a 300-kilowatt (kW) threshold, Xcel Energy and Madison Gas & Electric have 100 kW thresholds, and all other Wisconsin utilities regulated by the Public Service Commission of Wisconsin have a 20-kW threshold. 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, with a few exceptions for utilities who have voluntarily chosen to increase this threshold. 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.

6.2.2 Authority to Implement: Reduce Energy Consumption from Buildings

Table 47: 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.

6.2.3 Authority to Implement: Reduce Energy Emissions from Vehicles

Table 48: 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
		Electrify ATV/UTVs, boats, and tractors
	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.

6.2.4 Authority to Implement: Implement Low-Emissions Land-Use Planning Techniques

Table 49: Low-Emission Land-Use Planning Techniques

ENVIRONMENTAL MANAGEMENT & PLANNING TECHNIQUES	Land Use	Sequester carbon through plants
		Preserve wetlands
		Develop green infrastructure
		Implement responsible development & zoning policies
		Implement a recycling program
		Implement a composting program
		Reduce fertilizer emissions

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.

6.2.5 Authority to Implement: Reduce Wastewater Emissions

REDUCE WASTEWATER EMISSIONS	Building Retrofits & Water Efficiency	Install low-flow toilets
		Install low-flow fixtures
	Wastewater Treatment	Reduce GHG emissions from wastewater treatment plants

Tribes have full authority to implement wastewater emission reduction and management techniques on Tribally-owned land. For all reduction measures aimed at reducing wastewater emissions through improved management and planning, progress will be tracked by quantifying the emissions reductions achieved through these activities.

7 Intersection with Other Funding Availability

Many of the priority measures included in this CCAP expand upon or complement existing programs. MTERA 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 50: Additional Funding Opportunities

Funding Opportunity	Description	Timeline	Applicable Measure Goal
DOE Tribal Clean Energy Planning and Development Grant	$25M for the planning, assessing, and developing clean energy projects on Tribal Buildings or Tribal Lands. See https://www.mtera.org/mtera-informational-webinar-doe-tribal-clean-energy-grant for more info	January 23, 2025	Reduce emissions from electricity generation
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 May 31, 2025	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 is available with up to $14,000 per home. Every Tribe received an allocation.	Applications accepted on a rolling basis until May 31, 2025	Reduce energy consumption from buildings (residential and commercial)
Philanthropy funding	Various sources	Depends on foundation and specific opportunity	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 2025 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	Likely opens Q1 2025 and is an annual program	Reduce emissions from electricity generation

Funding Opportunity	Description	Timeline	Applicable Measure Goal
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. 30-70% of project costs. Stackable with USDA/other funds.	Comment period has closed.	Reduce emissions from electricity generation

8 Workforce Planning Analysis

Workforce development is crucial to the success of this CCAP, as it ensures that Tribal communities have the necessary skills and capacity to implement key strategies for reducing greenhouse gas emissions, advancing renewable energy, and building resilience. By investing in workforce training in critical sectors such as renewable energy, building energy efficiency, and sustainable transportation, Tribes can address existing skill shortages while creating high-quality jobs that drive economic growth. This development not only supports the successful implementation of climate initiatives, but also strengthens Tribal nations' ability to achieve long-term sustainability goals, improve community resilience, and enhance the overall quality of life for Tribal members.

8.1 Overview of Workforce Planning

Workforce development is crucial for addressing skills gaps, driving economic growth, and supporting job creation in sectors like renewable energy, construction, and technology. By equipping individuals with the necessary training, workforce development ensures a steady supply of skilled labor, fostering innovation and competitiveness. Additionally, it promotes economic mobility and equity by providing marginalized communities with access to job opportunities, reducing inequality, and expanding participation. Workforce development also enhances adaptability to technological advancements, supporting sustainable growth and community resilience. However, climate initiatives face significant challenges which require comprehensive solutions. Removing workforce barriers are essential to advancing climate action and achieving long-term sustainability goals. The following sections detail key workforce challenges and outline potential strategies and solutions to overcome them.

8.2 Workforce Challenges

The successful implementation of climate initiatives is currently being threatened by significant workforce challenges, including a shortage of skilled workers in critical sectors such as renewable energy, building energy efficiency, and sustainable transportation. These challenges are further compounded by gaps in education and training, as well as barriers to workforce participation, such as limited access to transportation, housing, childcare, and broadband. Together, these obstacles undermine efforts to advance climate action and achieve long-term sustainable development goals, highlighting the urgent need for strategic solutions to build a capable and resilient workforce.

Table 51: Workforce Challenges

Challenge Area	Description
Workforce Shortage: Renewable Energy	There is a significant shortage of workers skilled in installing and maintaining renewable energy systems such as solar, wind, and geothermal across many counties. This shortage poses a risk of delaying critical renewable energy projects that are essential for reducing GHG emissions and meeting climate goals.
Workforce Shortage: Energy Efficiency	There is a critical need for skilled construction workers to retrofit buildings for energy efficiency such as installing heat pumps, smart thermostats, and weatherization. However, many regions are facing a shortage of trained workers in this area, which is hindering efforts to enhance building energy efficiency and reduce emissions.

Challenge Area	Description
Workforce Shortage: Transportation	There is a pressing need for technicians skilled in EV maintenance and EV infrastructure development, but the transportation sector currently lacks sufficient workers to meet the growing demands of vehicle electrification. This shortage, coupled with a high reliance on personal vehicles and a limited workforce in transportation and warehousing, presents significant challenges to expanding EV infrastructure.
Education and Training	Many areas including and surrounding Tribal communities experience lower levels of higher educational attainment, resulting in a gap in specialized training needed for renewable energy, sustainable construction, and environmental management. Additionally, the lack of workforce development programs to align skills with the demands of renewable energy and climate action initiatives further exacerbates this challenge.
Workforce Population	The declining and aging workforce population is intensifying labor shortages, especially in sectors vital for climate action. In rural areas, this aging workforce and population decline present significant challenges in maintaining a sufficient labor force to support climate initiatives and advance projects to reduce emissions.
Barriers to Full Workforce Participation	Barriers to workforce participation include limited transportation options, high housing costs, lack of childcare, and insufficient broadband access, all of which disproportionately impact rural areas and further restrict workforce engagement.

8.3 Workforce Solutions and Strategies

To address workforce challenges hindering climate initiatives, targeted training programs across key sectors are essential. In renewable energy, collaborating with local institutions to offer training in solar, wind, and geothermal systems will help build a skilled workforce. For building retrofitting and energy efficiency, specialized training in energy-efficient construction and incentives for retrofitting are vital. In the transportation sector, training programs for EV maintenance and infrastructure development, backed by industry partnerships, will support vehicle electrification. Additionally, enhancing education through partnerships with colleges and addressing barriers like access to transportation, housing, childcare, and broadband will encourage broader workforce participation and the successful implementation of climate initiatives.

Table 52: Workforce Solutions and Strategies

Solution Area	Description
Workforce Development Programs: **Renewable Energy**	A solution to address the shortage of skilled workers in renewable energy is to develop targeted training programs focused on solar, wind, and geothermal energy installations. This can be achieved by partnering with local education institutions, trade schools, and renewable energy organizations to develop specialized training programs that provide hands-on experience in renewable energy system installation and maintenance. To incentivize participation, job placement opportunities or apprenticeships can be offered. Additionally, government grants or subsidies can be provided to companies that offer on-the-job training and upskilling opportunities in renewable energy fields.
Workforce Development Programs: **Energy Efficiency**	A solution to address the shortage of skilled workers in energy efficiency-focused construction is to expand training and apprenticeship programs in this area. This can be achieved by collaborating with construction unions and local education institutions to offer specialized courses in retrofitting techniques, such as heat pump installation, smart thermostats, and weatherization. To further encourage participation, these trainings should be offered at low or no-cost, and incentives such as meals, transportation subsidies, or child care support can also be offered.
Workforce Development Programs: **Transportation**	A solution to address the shortage of skilled technicians for EVs is to establish EV-specific technician training programs. This can be achieved by collaborating with automotive industry leaders, EV manufacturers, and local colleges to design certification programs focused on EV maintenance and charging infrastructure installation. Additionally, providing funding for EV-related apprenticeships and scholarships, particularly in regions with high reliance on personal vehicles, can help boost local workforce capabilities in this growing field.

Solution Area	Description
Increased Education and Training Opportunities	To address barriers in education and training, partnerships can be formed between local governments, educational institutions, and private sector employers to align curricula with the skills needed for jobs supporting the implementation of GHG reduction measures. Additionally, offering scholarships, internships, and mentorship programs for students and workers will help ensure they gain the expertise required to succeed in fields critical to climate action.
Increase Workforce Population	A solution to address labor shortages in sectors critical to climate action is to attract younger workers while retaining experienced older workers. This can be achieved by introducing flexible work arrangements and phased retirement plans, allowing older workers to remain engaged while gradually transitioning responsibilities to younger employees. Additionally, programs aimed at attracting younger populations – such as offering housing incentives, relocation assistance, and competitive compensation packages, particularly in rural and underserved areas – can help build a sustainable and robust workforce for climate initiatives.
Reduce Barriers to Full Workforce Participation	A solution to enhance workforce participation is to address infrastructure and service gaps that limit access to job opportunities. This can be achieved by expanding affordable housing options in regions where high housing costs hinder workers' ability to relocate. Increasing access to childcare services, particularly through subsidies or public-private partnerships in rural areas, will further encourage workforce participation. Additionally, investing in rural broadband infrastructure will facilitate remote work and improve access to education and job training. Enhancing public transportation networks or introducing alternative commuting solutions, such as ridesharing programs, can also boost workforce mobility.

9 Conclusion

MTERA's CCAP charts an ambitious course of action for Midwest Tribes to reduce GHG emissions while also realizing significant community benefits affecting the natural environment, public health, and economic development. This CCAP highlights the need for climate-related funding on the state and federal level to support Tribal implementation of clean, efficient and electrified projects in support of future generations that are inheriting decisions made this decade. The reduction measures provide a wide array of actionable, near-term projects, and also establishes a long-term pathway for reaching net-zero emissions by 2050. The targets and reduction measures detailed within this plan depict only a partial list of the climate-related goals and initiatives across the participating eight-Tribe subset and is not an exhaustive list of all the ongoing sustainability efforts within MTERA. In addition to project implementation, an agreed upon cadence of annual GHG inventory reporting should be established to track progress, share lessons learned, and scale success.

Appendix A

GHG Inventory Methodology

A.1 Summary Across Sectors

Table 53 provides a summary of all Scope 1 and 2 Tribal emissions for the eight-Tribe subset, split between sectors.

Table 53: Total Tribal GHG Emissions Inventory[91]

	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**	**68621**	**3804**	**11791**	**14576**	**19996**	**7328**	**3969**	**7133**	**24**
		CO2	67651	2983	11776	14547	19926	7319	3962	7116	24
		CH4	2.18	0.14	0.25	0.42	0.88	0.16	0.11	0.23	0.00
		N2O	0.37	0.03	0.03	0.07	0.17	0.02	0.02	0.04	0.00
	Transportation	**CO2e**	**177112**	**10054**	**21750**	**20387**	**61483**	**41474**	**8614**	**13352**	**0**
		CO2	175786	10006	21637	20182	61002	41179	8570	13209	0
		CH4	25.57	0.51	1.33	4.89	10.00	4.95	0.49	3.41	0.00
		N2O	2.30	0.13	0.28	0.26	0.76	0.59	0.11	0.18	0.00
	Waste	**CO2e**	**3179**	**139**	**127**	**417**	**0**	**2341**	**80**	**76**	**0**
		CO2	350	0	0	344	0	1	4	2	0
		CH4	71.66	3.52	3.21	1.80	0.00	59.33	1.93	1.88	0.00
		N2O	3.11	0.15	0.14	0.09	0.00	2.56	0.08	0.08	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**	**117397**	**1987**	**23299**	**22424**	**26725**	**30652**	**3799**	**8459**	**51**
		CO2	116463	1974	23153	22193	26606	30313	3774	8399	51
		CH4	14.08	0.20	2.17	3.55	1.83	5.03	0.38	0.92	0.01
		N2O	2.04	0.03	0.32	0.50	0.26	0.75	0.05	0.13	0.00
Scope 1+2	Stationary	**CO2e**	**186018**	**5791**	**35090**	**37000**	**46721**	**37981**	**7769**	**15592**	**75**
		CO2	184114	4957	34929	36739	46532	37632	7736	15514	75
		CH4	16.27	0.34	2.41	3.97	2.71	5.19	0.49	1.15	0.01
		N2O	2.41	0.06	0.35	0.56	0.43	0.77	0.07	0.17	0.00
	Transportation	**CO2e**	**177112**	**10054**	**21750**	**20387**	**61483**	**41474**	**8614**	**13352**	**0**
		CO2	175786	10006	21637	20182	61002	41179	8570	13209	0
		CH4	25.57	0.51	1.33	4.89	10.00	4.95	0.49	3.41	0.00
		N2O	2.30	0.13	0.28	0.26	0.76	0.59	0.11	0.18	0.00
	Waste	**CO2e**	**3179**	**139**	**127**	**417**	**0**	**2341**	**80**	**76**	**0**
		CO2	350	0	0	344	0	1	4	2	0
		CH4	71.66	3.52	3.21	1.80	0.00	59.33	1.93	1.88	0.00
		N2O	3.11	0.15	0.14	0.09	0.00	2.56	0.08	0.08	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

A.2 Data Table (All Sectors)

Key data used for the development of the GHG Inventory is summarized in Table 54 below and represents totals across the eight-Tribe subset. For each data input, a mix of Tribal-provided information and proxy calculations were used, depending on the Tribe.

[91] MCT refers to Minnesota Chippewa Tribe

Table 54: Summary of GHG Emissions Sources Across Tribes

Sector	Sub-sector	GHG Emissions source	Input Value	Unit
Buildings	Residential Single-family	Building Nat Gas	2,459,260	Annual therms of NG
		Building LP	3,797,296	Annual gallons of LP
		Building Fuel Oil (Res No. 5)	268,636	Annual gallons of Fuel Oil
		Building Wood	1,958	Annual cords of wood
	Multifamily Residential	Building Nat Gas	337,541	Annual therms of NG
		Building LP	157,149	Annual gallons of LP
		Building Fuel Oil (Res No. 5)	2,156	Annual gallons of Fuel Oil
	Commercial Buildings	Building Nat Gas	3,711,257	Annual therms of NG
		Building LP	939,295	Annual gallons of LP
		Building Fuel Oil (No. 2)	175	Annual gallons of Fuel Oil
	Industrial Buildings	Building Nat Gas	0	Annual therms of NG
		Building LP	4,331	Annual gallons of LP
		Building Fuel Oil (No. 2)	0	Annual gallons of Fuel Oil
Transportation	On-road	On-road (gasoline)	16,788,908	Annual gallons of gasoline
		On-road (diesel)	780,154	Annual gallons of diesel
	Waterborne Navigation	Waterborne Navigation	1,385,759	Annual gallons of gasoline
	Aviation	Aviation	0	Annual gallons of jet fuel
	Off-road (tractors, ATVs, etc.)	Off-road (gasoline)	921,696	Annual gallons of gasoline
		Off-road (diesel)	15,128	Annual gallons of diesel
Waste		Disposal of solid-waste	0	Metric tons of MSW sent to landfill annually
		Waste open-burning	10,346	# burn barrels
		Septic Tanks	2,879	Population Served
		Aerobic Treatment	12,521	Population Served
Agriculture, Other land use		Livestock	719	# of cattle (Bison)
Electricity	Residential Buildings		73,385	Annual MWh
	Multifamily Buildings		6,624	Annual MWh
	Commercial Buildings		133,881	Annual MWh
	Industrial Buildings		84	Annual MWh
	On-road	EVs	82	Annual MWh

A.3 Buildings

A.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 EPA's (EPA) eGRID regions' emissions factors. Table 55 shows which eGRID region was used for each Tribe's electric utilities; Arup used these associated emissions factors from 2021.

Table 55: 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%)

A.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.

A.3.2.1 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.

For single-family homes, if utility data was not provided, the U.S. Energy Information Administration (EIA) 2020 Residential Energy Consumption Survey (RECS)[93] 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.

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

[93] *2020 Residential Energy Consumption Survey*. (2020). U.S. Energy Information Administration. Retrieved February 24, 2024, from https://www.eia.gov/consumption/residential/data/2020/

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 Tribe 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.

A.3.2.2 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.

For multifamily homes, if utility data was not provided, the Building Performance Database (BPD)[94] 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 footage of each multifamily building per Tribe.

A.3.2.3 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.

If utility data was not provided, the U.S. EIA 2018 Commercial Buildings Energy Consumption Survey (CBECS)[95] 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 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.

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

[95] *2018 Commercial Buildings Energy Consumption Survey*. (2018). U.S. EIA. Retrieved February 24, 2024, from https://www.eia.gov/consumption/commercial/data/2018/

A.3.3 Methodology for B3 Benchmarking Data

Two of the eight-Tribe subsets had data with Minnesota B3 Benchmarking, which is maintained and updated by these Tribes.

The "Annual Usage by Site" data was downloaded as an Excel file from B3 Benchmarking tool online. All buildings that were classified as "decommissioned" and with "0 kbtu" energy use was deleted from the dataset. The dataset includes an indication of "Percent completeness" in which a 100% complete datapoint includes meter usage data from all twelve months in a year. The data points that are 95% complete or above are used to benchmark by unique building type to get electric, natural gas, and propane EUI where possible. This benchmarked EUI was then used to scale up all building datapoints by square footage to calculate annual electric, natural gas, and propane where applicable.

Fond du Lac has data ranging from 2010 – 2019, whereas Leech Lake has data ranging from 2007-2021. For the buildings with datapoints that are above 95% complete, the most recent year of complete data is used to represent the energy use of that building. For remaining buildings, the year of data used is determined by the most complete datapoint, and then the most recent datapoint. Next, the annual energy use by benchmarked EUI was compared to the provided incomplete energy use. When the energy use by benchmarking was greater than the incomplete datapoint, the scaled-up energy use data is used instead of the incomplete datapoint.

For the remaining buildings, the percent of completeness was used to scale up the provided energy use data to 100%. This last method is unideal, as energy use may fluctuate greatly from month-to-month, and this method does not account for outdoor weather impact. However, since these datapoints are all above 80% complete, it is more accurate than using the incomplete datapoint.

To summarize the data, the buildings are categorized as either commercial, industrial, transportation, or multifamily residential. This categorization is used to develop the summary tables below, which includes relevant information for the GHG inventory.

Table 56: Fond du Lac B3 Benchmarking Data Summary

	COUNT	Total Electricity (MWh)	Total Electricity (kWh)	Total Nat Gas (therms)	Total Propane (gals)
Commercial	23	45,462	36,332	36,331,508	1,190,568
Multifamily Residential	3	16,612	428	428,388	10,914

Table 57: Leech Lake B3 Benchmarking Data Summary

	COUNT	Total Electricity (MWh)	Total Electricity (kWh)	Total Nat Gas (therms)	Total Propane (gals)
Commercial	68	11,074	753,016	21,354	21,353,758
Industrial	1	2,500	2,500	84	84,491
Transportation	5	3,457	17,283	82	82,412

A.4 Transportation

A.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 CCAP 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[96] 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[97] to calculate the gallons of fuel used to travel the annual average miles traveled per vehicle as shown in Figure 16.

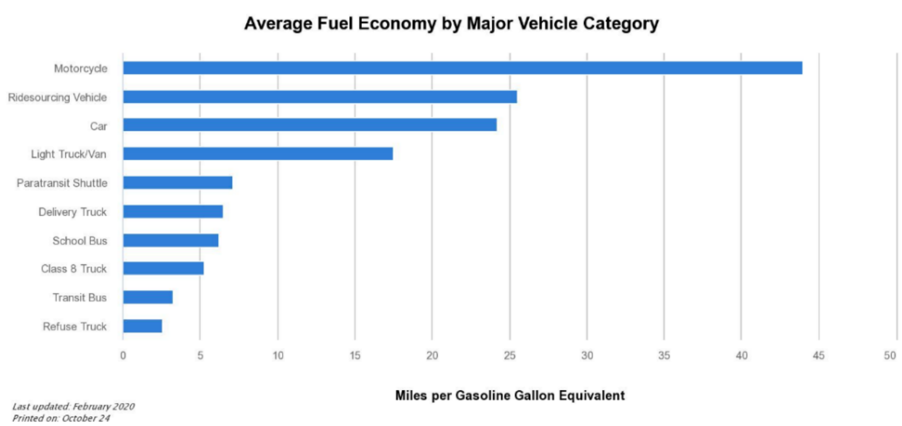

Figure 16: Average Fuel Economy by Vehicle

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.

$$Annual\ Gallons\ of\ Diesel = \frac{(\#\ of\ Vehicle)(Annual\ VMT)}{Vehicle\ MPG^{98}}$$

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

[97] *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

[98] *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 (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[99] and Wisconsin[100] 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.

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

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

[100] *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

A.5 Waste

A.5.1 Summary of Major Emissions

The amounts of sources of GHG emissions within the waste sector across all Tribes is summarized in Table 58:

Table 58: 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
Fond du Lac	10,170	0	0	0	300
Grand Portage	1	0	0	50	580
Ho-Chunk	17	0	0	10,632	1,348
Lac Courte Oreilles	50	0	337	0	528
Leech Lake	0	0	0	0	0
Minnesota Chippewa	0	0	0	0	0
Oneida	0	0	0	576	500

A.5.2 Methodology for Proxy Data

In this GHG inventory for the CCAP, 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[101]. This gave assumptions for the fraction of solid waste that was food, garden waste, paper, wood, textiles, and metals.

[101] *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

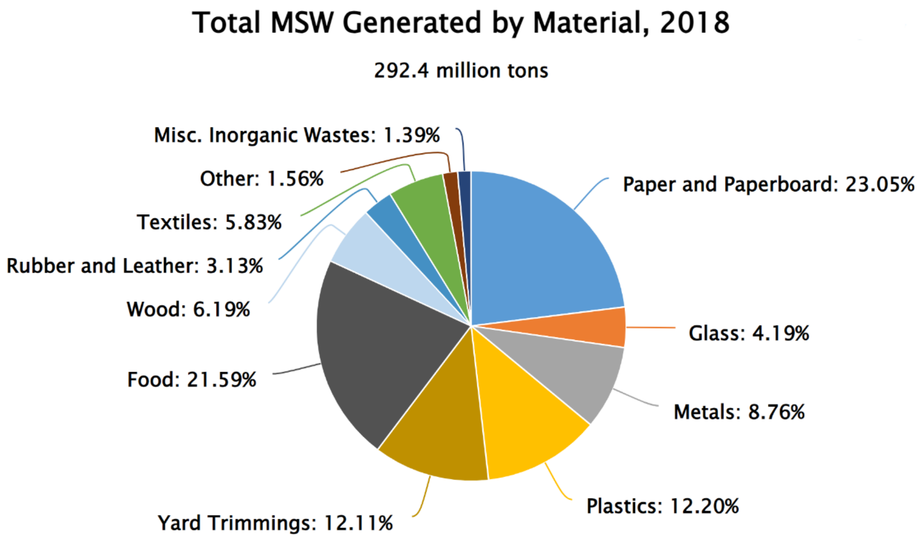

Figure 17: EPA MSW Make Up

A.5.2.1 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 commercial sources – and uncompacted, giving an approximate density of 275 lbs./cubic yard[102]. Using the EPA's default heat content ratio of 9.953 MMBtu/short ton of waste[103], 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.

A.5.2.2 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[104] 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[105], corresponds with a centralized aerobic wastewater treatment system. Using these factors, Arup calculated the CH_4 emissions associated with the Tribal population.

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[102] *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

[103] *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

[104] 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

[105] 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

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[106]. Using these values, as well as the U.S. annual protein supply per capita, 117 grams of protein/day[107], 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.

[106] 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

[107] *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

Reduction Measure Methodology

Appendix B provides further details regarding measure methodology, including emissions and cost calculations and overall assumptions. Data pertaining to the eight-Tribe subset is included to further detail the methodology used to determine the values for estimates of GHG reductions and costs included within Section 4 of the CCAP report: Priority GHG Reduction Measures.

B.1 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. For the projections, the grid emissions factors from each of the (3) grid regions were used. Trendlines of historical emissions data for each grid region was used to project a linear decarbonization of each grid region. The unique emissions factors from each grid region were applied to the electricity usage from each region. Table 59 shows the eGRID regions used for the Tribes' inventories and reduction measures.

Table 59: EPA eGRID Regions for Tribes

eGRID Region	Tribes
MROW	Leech Lake, Grand Portage, Fond du Lac, Bad River, Lac Courte Oreilles
MORE	Ho-Chunk, Oneida (assumed 75% of electricity)
RFCW	Oneida (assumed 25% of electricity)

B.1.1 Projections Assumptions

The projections include a renewable target of 10 MW of wind, 10 MW of solar, and 10 MW of hydropower installed by 2030, and 50 MW of solar energy, 50 MW of wind generation, and 10 MW of hydropower installed by 2050. These projections help the Tribes meet their net-zero 2050 target by using emission-free electricity. As the electric grid decarbonizes outside of Tribal land and control, as shown previously in Figure 9, additional renewable energy installation has a lower impact on emissions reductions. The impact of renewables' ability to reduce greenhouse emissions decreases over time as the electric grid decarbonizes to meet state and federal goals. This emphasizes the importance of installing new renewables in the short term to take advantage of clean electricity while the grid alternative has a higher emissions factor.

B.1.2 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.[108] 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.

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

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.

Key assumptions:

- 50% of single-family homes install 4 kW solar array; 4,451 single-family homes
- 25% of multifamily buildings install a 50 kW solar array; 170 multifamily buildings
- 50% of commercial buildings install a 50 kW solar array; 220 commercial buildings
- Utility-solar: 13 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. An average solar irradiance was used between data pertaining to Duluth, MN and Wausau, WI in the PVWatts software.

Emissions Calculation:

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

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

The methodology was done for 4 kW arrays on single-family homes, 50 kW arrays on multifamily and commercial buildings, and 13 MW of utility-scale solar.

Cost Estimate:

Cost assumptions are sourced from the National Renewable Energy Lab (NREL)'s Quarterly Cost Benchmark Report (2023)[109] , 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 benchmarks including modules, inverters, Energy Balance of System, Structural Balance of System, and soft costs.

$$Cost\ per\ kW*Size\ of\ system*Number\ of\ systems=total\ cost$$

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[109] 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.

B.1.3 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 residential scale with system sizes of 2MW or less, community-scale wind turbines (500kW to 20MW in size), and utility-scale wind turbines (system sizes of over 20MW). This measure assumes a capacity factor of 40%, in accordance with the DOE's Land-Based Wind Market Report: 2023 Edition[110].

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: 45 MW wind farms are installed
- Distributed wind:
  - 5% of single-family homes install a 4 kW wind turbine; 445 homes
  - 5% of multifamily buildings install a 50 kW wind turbine; 33 buildings
  - 10% of commercial buildings install a 50 kW wind turbine; 45 buildings
- Capacity factor: 40%

Emissions Methodology:

Translating the 40% capacity factor from DOE data[111] 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:

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

This same calculation methodology was followed for distributed wind at the residential scale.

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

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

Cost Calculation:

Cost assumptions are sourced from the National Renewable Energy Lab (NREL)'s Cost of Wind Energy Review (2022)[112] 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 electricity generation.

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

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

B.1.4 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 60.

Table 60: Geothermal Reduction Measure Assumptions

	Percent of Application	Number of Buildings/ MF Units	Building Typology Emissions Factor	Geothermal System Size
Single-Family	10%	890	4.30 metric tons CO_2e/building	5 tons/building
Multifamily	10%	113	2.32 metric tons CO_2e/unit	5 tons/unit
Commercial	10%	44	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[113]. 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 55 Btuh/sf for heating was applied based on industry experience, with representative building square footage 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.

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112 Stehly, T., Duffy, P., and Hernando, D. M. (2023, December). *2022 Cost of Wind Energy Review.* NREL Transforming Energy. Retrieved January 5, 2 024, from https://www.nrel.gov/docs/fy24osti/88335.pdf

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

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[114]. 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.

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

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

Cost Methodology: The Minnesota Geothermal Heat Pump Association, estimates geothermal heat pump systems cost approximately $5,000/ton, before incentives[115]. This rate is applied to single-family, multifamily, and commercial buildings.

Cost Calculation:

$$\left(\frac{\$5{,}000}{ton}\right) * \left(System\ size\ (tons)\right) * (\#single\ family\ buildings) = \boldsymbol{Total\ Cost}$$

B.1.5 Hydropower

Hydropower is a renewable source of energy that generates power from the use of a dam or other diversion that alters the natural flow 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" at scales between 100 kW and 30 MW[116].

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.

[114] 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

[115] *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/

[116] Water Powers Technologies Office. (n.d.). *Types of Hydropower Plants*. Office of Energy Efficiency and Renewable Energy. Retrieved January 5, 202 4, from https://www.energy.gov/eere/water/types-hydropower-plants

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%[117]. Emissions reductions for (5) 2 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:

1. 10 MW Hydroelectric systems are installed
2. Hydroelectric capacity factor: 36.3%

Emissions Calculation:

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

Cost Methodology:

Cost assumptions are sourced from the National Renewable Energy Lab (NREL)'s Hydropower Cost Tool[118]. 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 electricity generation.

Cost Calculation:

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

B.2 Energy Resilience

B.2.1 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 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. Building level solar, paired with Battery Energy Storage Systems (BESS), are designed for smaller-scale installations.

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.

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[117] *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

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

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 time 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[119]. 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:

1. Battery storage is paired with on-site solar
2. 4 hours of storage per battery
3. 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.
4. 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:

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

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

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

Cost Calculation:

Cost assumptions are sourced from the National Renewable Energy Lab (NREL)'s Quarterly Cost Benchmark Report (2023)[120] Costs provided $4,702/kW for residential: below 500kW, $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.

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

[120] 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.

$$Cost\ per\ kW * Size\ of\ system * Number\ of\ systems = total\ cost$$

B.3 Reducing Emissions from Building Energy Consumption

B.3.1 Building Retrofits & Energy Conservation Measures

B.3.1.1 Projections Assumptions

Energy efficiency measures across both the commercial and residential building stock are compared to a 2022 baseline energy usage. The reduction measures modeled include weatherization, installation of high-efficiency appliances in residential buildings, heating electrification, lighting retrofits to LEDs, low-flow water fixtures in residential buildings, and installing smart thermostats. The emissions reduction from these measures assumes a 60% implementation across all commercial and residential buildings by 2030, and 100% implementation across all commercial and residential buildings by 2050. The methodology to quantify emissions reductions for each of these reduction measures is clarified in Section 4.2 - Reduce Building Energy Emissions. The projections assume measure implementation beginning in 2025, with a linear adoption from 0% in 2024 to 60% in 2030, and then to 100% in 2050.

B.3.1.2 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.

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 61.

Table 61: 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**	

1. 60% of buildings retrofit to heat pumps, which results in ~5500 single-family homes, ~860 multi-family units, and ~460 commercial buildings undergoing this measure
2. 1 heat pump per residential unit
3. 1 system per commercial building
4. 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 value 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[121], 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 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:

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

Emissions Reduction from each fuel use conversion:

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

$$= 100\% *\ [baseline\ tribal\ energy\ use\ (kWh) - energy\ use\ from\ Electrified\ system\ (kWh)]\ /\ baseline\ tribal\ energy\ use\ (kWh)$$

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

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

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

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

[121] 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/

This savings % calculation is replicated for each combustion heating source– giving highest values for fuel oil heating (82%), followed by wood heating (79%), natural gas (76%), and propane (76%). 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; that value was **79% -** 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.

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

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

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[122]. 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:

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

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

B.3.1.3 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.

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[122] 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

Key Assumptions:

1. 60% of residential buildings install high-efficiency appliances, which results in ~5500 single-family homes and ~860 multifamily units undergoing this measure
2. Includes the following appliances: refrigerator, dishwasher, washing machine, clothes dryer, and air conditioning unit
3. Only one of each appliance type assumed per home/unit
4. Average Scope 2 emissions/residential unit used as scaling factor from the GHG Inventory

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.[123]

$$Energy\ savings\ per\ appliance = Energy\ savings\ from\ installing\ high\ efficiency\ appliances\ (\%) * appppliance\ \%\ contribution\ to\ overall\ Residential\ Electricity$$

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

Table 62: Energy Savings from Appliances

Appliance	Energy Savings from Installing Higher-Efficiency Appliances	Appliance's Contribution to Scope 2 Energy[124]	Total Energy Savings for Electricity
Refrigerator	12.0%[125]	0.7%	0.1%
Dishwasher	9.0%[126]	7.9%	0.7%
Washing Machine	25.0%[127]	0.5%	0.1%
Clothes Dryer	20.0%[128]	4.3%	0.9%
Air Conditioning	20.0%76F114F129	19.4%	3.9%
		Total Measure Savings	**6%**

[123] *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

[124] ibid

[125] *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

[126] ibid

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

[128] ibid

[129] *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.

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:

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

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.[130] The reported installed cost of each appliance per home is the following:

Table 63: Cost of Appliance Upgrades

Appliance	Reported Installed Cost for Upgrade ($ per appliance)[131]
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:

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

B.3.1.4 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.

[130] 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

[131] ibid

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[132] and fuel savings[133] from each upgrade was downloaded for 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,[134] and 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 fuel savings in TBtu are then converted to carbon emissions savings in kgCO2e using an EPA emissions factor.[135] Finally, total savings are converted to metric tons CO2e.

Emissions Calculation (residential):

$$\underline{Residential\ Buildings}$$

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

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132 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

133 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

134 *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

135 *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

Emissions Methodology (commercial):

For commercial lighting upgrades, state-level NREL SLOPE data on annual electricity[136] and fuel savings[137] from each upgrade were applied for the states 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):

$$\underline{Commercial\ Buildings}$$

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

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.[138]

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.[139] 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:

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

B.3.1.5 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.

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[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%5D&layer=comstock.electricity-savings-potential&year=2012&res=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%5D&layer=comstock.gas-savings-potential&year=2012&res=state

[138] 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

[139] *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

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
- 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[140] and fuel savings[141] 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,[142] 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):

$$\underline{Residential\ Buildings}$$

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

[140] 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

[141] 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

[142] *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[143] and fuel savings[144] 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):

$$\underline{Commercial\ Buildings}$$

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

Cost Methodology: The basis of cost for weatherization of single-family homes comes from a Lawrence Berkeley National Laboratory database[145] 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)
- 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 multi-family (MF) unit is 2/3rds the cost due to shared building envelope ($3,188/unit).

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[143] 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

[144] 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

[145] 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

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:

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

B.3.1.6 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 at higher temperatures during the summer and lower temperatures during the winter to avoid cooling or heating the space more than necessary – and can be programmed to reduce space conditioning after 6 pm, 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%.[146] The Scope 1+2 emissions from all residential (single-family and multi-family) 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:

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

[146] *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

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.[147] 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.[148] Assuming one thermostat per building or unit, the cost is scaled up by number of buildings taking on this measure.

Cost Calculation:

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

B.3.2 Introduce New Building Standards

B.3.2.1 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 HVAC (heating, ventilation, and air conditioning) and MEP (mechanical, electrical, plumbing) systems that are more efficient, have more insulation, better window constructions, and can be all-electric.

Baseline emissions: This measure was not included in the projections analysis. As discussed in the body of the report in Section 3.1 Business-As Usual (BAU) Case, the projections analysis assumed stable population from 2022 levels projected through 2050. Due to this assumption, the uncertainty of future development led the analysis to omit the new green building standards measure from the projection calculations.

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[149] and 21.6% for Wisconsin[150] estimated by the US DOE.
- 15% of buildings undergo major renovation projects that must adopt state Green Building Standards

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[147] *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

[148] 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

[149] *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

[150] *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

Table 64: Emissions Factors by Building 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 the 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:

$$\begin{aligned} &Carbon\ Reduction \\ &= \left\{(amount\ of\ residential\ units) * \left(residential\ building\ emissions\ factor\,\frac{MT\ CO2e}{unit}\right)\right. \\ &+ (amount\ of\ commercial\ buildings) \\ &\left. * \left(commercial\ building\ emissions\ factor\,\frac{MT\ CO2e}{building}\right) * (\%\ emissions\ savings\ )\right\} \end{aligned}$$

Cost: The cost of this measure has not been quantified, as it relies on Tribal-specific details relating to existing building stock, and building renovation regulations and policy strategy that can vary greatly between Tribes.

B.4 Reducing Vehicle Emissions

B.4.1 Projections Assumptions

B.4.1.1 Bus Electrification

All diesel transit and school buses located on Tribal Land account for a total of 2.7 million vehicle miles traveled (VMT) in the 2022 baseline year. This number is inclusive of transit and school bus VMT. This data was either provided directly by Tribes or calculated based on diesel fuel sold data and the assumption of an average 6.2 mpg for buses. The adoption of zero-emission electric buses is modeled as a steady phase-out of diesel VMT and assumes 75% of diesel buses are replaced with electric buses between 2025 and 2030, and 100% of diesel buses replaced with electric by 2050. Emissions include those from diesel-burning buses that remain on the road as well as emissions from the electricity grid powering the new electric buses. There is no assumed electrification of buses in the BAU case.

B.4.1.2 SOV Electrification

Single occupancy vehicles (SOV) accounts for 350,62,311 VMT in the 2022 baseline. VMT data for single-occupancy vehicles was either calculated using gasoline fuel sold data and 24.2 miles per gallon on average, in accordance with DOE's Alternative Fuels Data Center[151]. If gasoline fuel sold data was not available, VMT was calculated using county-level VMT data that was scaled to the Tribe's population. The BAU case accounts for a level of EV adoption in line with the Minnesota and Wisconsin state targets. The reduction measure accounts for a boosted level of adoption. As described in Section 3.1: BAU Scenario, 13.05% of SOVs will be EV by 2030, and 48% of SOVs will be EV by 2050 with no additional measure implementation. The implementation of this reduction measure boosts EV adoption to 20% of SOV EVs by 2030 and 100% by 2050. Emissions projections calculations for the SOVs include both emissions from internal combustion engines that remain and emissions from grid-supplied electricity for EVs traveling the same average distance.

It is important to note that the Federal Corporate Average Fuel Economy (CAFE) standards were not used in the BAU case for improving fuel efficiency or to assume a decrease in the carbon intensity of gas-powered vehicles. The CAFE standards are federal mandates that require vehicle manufacturers to increase their annual average fuel efficiency (mpg) across their fleets (inclusive of both EVs and fossil-fueled vehicles). Internal combustion engines have started to plateau in efficiency, so we assume here that vehicle manufacturers will produce more EVs to improve average fleet MPG and MPGe to comply with CAFE standards.

Reduction measures that affect VMT were combined in projections to assume a 5% reduction in overall VMT by 2030 and a 10% reduction in VMT by 2050. These reduction measures include increasing ride-sharing, developing an active transportation network, and increasing transit service.

[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

B.4.2 Mode Shift

B.4.2.1 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 GHG emissions per passenger mile than an average single-occupancy vehicle[152] (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[153] and Wisconsin Departments of Transportation[154] 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[155] was used to calculate annual gallons of gasoline.

Key assumptions:

- 5% 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:

$$Baseline\ emissions * \%\ adoption * \%\ emissions\ saving\ from\ mode\ shift = GHG\ reduction$$

Cost: The cost of this measure has not been quantified due to the variability in each Tribe's existing transit infrastructure and the different methods of implementation that will be unique to each project.

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[152] *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

[153] *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

[154] 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

[155] *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

B.4.2.2 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-occupancy vehicles for trips[156]. 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[157] and Wisconsin Departments of Transportation[158] 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[159] was used to calculate annual gallons of gasoline.

Key assumptions:

- 5% 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:

$$Baseline\ emissions * \%\ adoption * \%\ emissions\ saving\ from\ mode\ shift = GHG\ reduction$$

Cost: The cost of this measure has not been quantified 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[160]. However, other methods of implementation can be used including rebates, or marketing and launching an incentive program to encourage adoption.

B.4.2.3 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. According to Transportation Research Part A: Policy and Practice, a peer-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)[161]. In order to quantify this measure across all Tribes, a 30% mode shift to active transport was assumed.

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[156] 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

[157] *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

[158] 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

[159] *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

[160] *How much does it cost to build a ridesharing app?* (n.d.). Crowdbotics. https://www.crowdbotics.com/ cost-to-build-app-type/ridesharing-app

[161] *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.

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 [162] and Wisconsin Departments of Transportation [163] 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 [164] was used to calculate annual gallons of gasoline.

Key assumptions:

- 5% of drivers of single-occupancy vehicles mode shift from driving to modes of active transport

Emissions Reduction Calculation:

$$Baseline\ emissions * \%\ adoption * \%\ emissions\ saving\ from\ mode\ shift = GHG\ reduction$$

Cost: The cost of this measure has not been quantified 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 [165].

B.4.3 Introduce Vehicle Electrification & Alternative Fuel Vehicles

B.4.3.1 Electrify Bus Fleet & Provide Charging Infrastructure

Note that the CCAP measure assumes full electric bus fleet conversion.

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 [166], 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 [167]. 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.

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[162] *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

[163] 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

[164] *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

[165] 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

[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

[167] *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

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 buses were assumed to have 6.2 mpg, in accordance with DOE's Average Fuel Economy report [168], updated in February 2020. Using this methodology for the inventory, the total baseline number of gallons of diesel is 866,670 gallons.

Key assumptions:

- Existing buses all run on diesel
- Fuel economy for diesel buses is 6.2 miles per gallon [169] (mpg)
- Electric buses have efficiency of 1.5 kWh/mile [170]
- 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:

$$Emissions\ saved = Emissions\ from\ onroad\ diesel - emissions\ from\ EV\ buses - emissions\ from\ remaining\ diesel\ buses$$

$$Emissions\ saved = \left\{(percent\ adoption) * (Baseline\ number\ of\ gallons\ of\ diesel) * (Diesel\ mpg) * \left(electric\ bus\ \frac{kWh}{mile}\right) * (grid\ emissions\ factor)\right\} + \{remaining\ gallons\ of\ diesel * diesel\ emissions\ factor\}$$

Cost Calculation:

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 [171]. 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 [172]. 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.

$$(Number\ of\ electric\ buses * cost\ per\ bus) + (Number\ of\ chargers * cost\ per\ charger) = total\ measure\ cost$$

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[168] *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

[169] Ibid

[170] *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

[171] *The state of sustainable fleets.* (2022). Retrieved January 5, 2024, from https://cdn.stateofsustainablefleets.com/2022/state-of-sustainable-fleets-2022-report.pdf

[172] *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

B.4.3.2 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 $lbCO_2e$ into the atmosphere than a diesel engine. The EPA releases an Emissions Factors for GHG Inventories document annually, and the most recent (2023) [173] 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 [174].

Emission 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:

$$1\ MTCH_4 = 28\ MTCO_{2e}, 1\ MTN_2O = 265\ MTCO_{2e}$$

Table 65: 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 buses were assumed to have 6.2 mpg, in accordance with DOE's Average Fuel Economy report [175], 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 [176] (mpg)

[173] *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

[174] *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

[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

- An average CO_2e emissions factor per gallon of alternative fuel was used

Emissions Reduction Calculation:

$$\begin{aligned} Emissions\ saved \\ &= Emissions\ from\ onroad\ diesel - \ emissions\ from\ alternative\ fuel\ buses \\ &- emissions\ from\ remaining\ diesel\ buses \end{aligned}$$

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.[177] Biodiesel bus pricing is $91,350 from the Oregon School Bus Electrification Cost Comparison Tool.[178]

$$(Number\ of\ alternative\ fuel\ buses * average\ cost\ per\ bus) = total\ measure\ cost$$

B.4.3.3 Electrify SOV & Provide Charging Infrastructure

The second reduction measure related to vehicle electrification is providing EV infrastructure to influence EV adoption among passenger vehicles. 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[179]. 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[180]. 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[181] and Wisconsin Departments of Transportation[182] 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[183] was used to calculate annual gallons of gasoline.

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[177] *The state of sustainable fleets.* (2022). Retrieved January 5, 2024, from https://cdn.stateofsustainablefleets.com/2022/state-of-sustainable-fleets-2022-report.pdf

[178] *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

[179] *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

[180] *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

[181] *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

[182] 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

[183] *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

Key assumptions:

- Fuel economy of passenger vehicles is 24.2 mpg [184]
- Electric passenger vehicle efficiency is 0.35 kWh/mile [185]

Emissions Reduction Calculation:

$$Emissions\ saved = Emissions\ from\ onroad\ gasoline - emissions\ from\ EVs - emissions\ from\ remaining\ gasoline\ cars$$

$$Baseline\ gasoline\ emissions - \{(percent\ adoption) * (Baseline\ number\ of\ gallons\ of\ gasoline) * (Passenger\ vehicle\ mpg) * (electric\ vehicle\ efficiency) * (grid\ emissions\ factor)\} - \{(remaining\ gallons\ of\ diesel * diesel\ emissions\ factor)\}$$

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 [186]. Costs of EVs themselves are not included within the calculation.

$$(Number\ of\ chargers * cost\ per\ charger) = total\ measure\ cost$$

B.4.3.4 Electrify ATVs, Boats, and Tractors

Though this measure is not quantified in the CCAP, key metrics on GHG reduction potential and costs are included for Tribes who are interested in pursuing this measure.

Baseline emissions: The Scope 1 off-road gasoline emissions are the baseline for electrification of ATVs and is typically calculated using an estimation of the percent of population with an ATV. The Scope 1 off-road diesel emissions are the baseline for electrification of tractors and is calculated using the number of tractors and annual distance traveled. The Scope 1 waterborne navigation emissions are the baseline for electrification of boats and is typically calculated using an estimation of the percent of population with a boat and annual distance traveled.

Key Assumptions:

- Fuel economy of ATVs is 20 mpg (gas)
- Fuel economy of Boats is 4 mpg (gas)
- Fuel economy of Tractors is 7 mpg (diesel)
- Electric UTV vehicle efficiency ranges from 0.15 - 0.33 kWh/mi

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[184] Ibid

[185] *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

[186] *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

- Switching to E10 fuel for boats results in 13% reduction in emissions[187]
- Switching to B100 fuel for tractors results in a 74% reduction in emissions[188]

Calculations: Tribes are encouraged to use formulas provided in *Electrify SOV & Provide Charging Infrastructure* section in B.4.3.3 and adapt to specific chosen UTV models or apply the emissions reduction percentage from more efficient fuels to baseline emissions for boats and tractors.

Cost Estimate: The cost of electric UTVs ranges from $22,000 - $35,000 per vehicle and may require additional charges for electricity based on utility rates in the region. Switching to E10 fuel and B100 fuel also depends on regional fuel sales rates. Tractors that were manufactured before 2002 may require fuel system modifications to use B100 fuel, and an alternative to avoid these upgrades would be to use B5 diesel fuel[104].

[187] Maria Muñoz et al., "Bioethanol Blending Reduces Nanoparticle, PAH, and Alkyl-and Nitro-PAH Emissions and the Genotoxic Potential of Exhaust from a Gasoline Direct Injection Flex-Fuel Vehicle," Environmental Science & Technology 50 (2016): 11853-11861, July 26, 2023, https://doi.org/10.1021/acs.est.6b02606.

[188] United States Department of Energy, "Biodiesel Benefits and Considerations," Alternative Fuels Data Center, Accessed July 18, 2024, https://afdc.energy.gov/fuels/biodiesel-benefits.

B.5 Environmental Management & Planning Techniques

B.5.1 Projections Assumptions

The carbon sequestration of planting trees, restoring plants and wetlands and implementing green infrastructure were considered as additional reduction measures. Projections included an estimate of new plantings as part of environmental management and planning. These included planting 100,000 trees, restoring 500,000 sf of plants, implementing 500,000 sf of bioswales and 100 acres of wetland preservation by 2030. The 2050 target included planting 200,000 trees, 1,000,000 sf of plant restoration, implementing 1,000,000 sf of bioswales, and restoring 300 acres of wetlands across the Tribes.

B.5.2 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 [189] 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.

Key assumptions:

Table 66: 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 measure amounts are converted to CO_2e sequestration in metric tons/year using the sequestration potentials above and added together to get a 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.

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[189] *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.

$$Total\ Carbon\ Sequestration, Plants = \left\{\left(annual\ carbon\ sequestration\ factor \frac{kgCO2e}{plant\ amount}\right) * (amount\ of\ plants) * (conversion\ factor\ as\ needed) * \left(conversion\ factor \frac{MT}{kg}\right)\right\}$$

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 [190] (for medium-sized trees, 5-9 feet tall), $25/shrub, [191] and $0.50/sq. ft. of sod. [192]

$$Total\ Cost\ (\$) = \left(\frac{\$300}{tree} * \#trees\right) + \left(\frac{\$25}{shrub} * \#shrubs\right) + \left(\frac{\$0.50}{sq.ft.} * \#\ sq.ft.\right)$$

B.5.3 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 [193] 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 [194]. 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:

- 1,000,000 sf of bioswales

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[190] 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/

[191] *How Much Does Landscape Installation Cost?* (n.d.). Home Advisors. Retrieved January 22, 2023, from https://www.homeadvisor.com/cost/landscape/install-landscaping/

[192] 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/

[193] *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.

[194] Ibid

Calculation:

The measure amount is converted to CO_2e sequestration in metric tons/year using the sequestration potential per year above.

$$\underline{Grass\ Carbon\ Sequestration}$$

$$f(grass) = \left\{\left(annual\ carbon\ sequestration\ factor\,\frac{kgCO2e}{m2}\right) * \left(conversion\ factor\,\frac{m2}{sq.ft.}\right) * (area\ of\ grass\ planted\ sq.ft.) * \left(conversion\ factor\,\frac{MT}{kg}\right)\right\}$$

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.[195]

$$\left(\frac{\$0.50}{sq.ft.} * \#\ sq.ft.\right) = \boldsymbol{Total\ Cost}$$

B.5.4 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[196]. 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[197] and Wisconsin Departments of Transportation[198] 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[199] was used to calculate annual gallons of gasoline.

[195] 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/

[196] 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

[197] *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

[198] 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

[199] *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

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:

$$\underline{Reduction\ in\ CO2e\ from\ Zoning\ Policies}$$

$$\{(\%\ reduction\ in\ VMT) * (\%\ of\ population\ affected\ by\ zoning) * (baseline\ emissions\ from\ on-road\ gasoline\ in\ MT\ CO2e)\}$$

Cost Estimate: The cost of this measure has not been quantified and this measure is not included within the projections analysis 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.

B.5.5 Wetland Preservation and Restoration

Though this measure is not quantified in the CCAP or included within the projections analysis due to lack of detailed wetland data from Tribes, key metrics on GHG reduction potential and costs are included for Tribes who are interested in pursuing this measure. According to the *Second State of the Carbon Cycle Report (SOCCR2), Chapter 13 – Terrestrial Wetlands,* Table 67 provides values for net carbon stored as carbon dioxide and net carbon emitted as methane in various types of wetlands. Wetlands can be forested or non-forested and comprised of peatland or mineral soil. These factors affect the amount of carbon stored and released[200].

Table 67: Carbon Stored and Emitted by Various Types of Wetlands

Table 13B.3. Flux Density Factors Used to Estimate Net Ecosystem Exchange and Methane Fluxes from Freshwater Wetlands in the Conterminous United States[a–d]

Flux	Organic Soil		Mineral Soil	
	Forested	Nonforested	Forested	Nonforested
NEE (g CO_2-C per m^2 per Year)	−120.97 (45.60)	−134.97 (42.53)	−66.99 (23.55)	−102.15 (34.43)
CH_4 (g CH_4-C per m^2 per Year)	8.90 (5.24)	23.58 (3.13)	26.93 (7.95)	26.09 (3.60)

Notes

a) Negative net ecosystem exchange (NEE) indicates net transfer to the ecosystem.
b) Standard error in parentheses.
c) Source: Appendix 13B Supplement: Carbon Pools and Fluxes, p. 561.
d) Key: CO_2, carbon dioxide; CH_4, methane; g, gram; C, carbon.

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

[200] **Kolka**, R., C. **Trettin**, W. Tang, K. Krauss, S. Bansal, J. Drexler, K. Wickland, R. Chimner, D. Hogan, E. J. Pindilli, B. Benscoter, B. Tangen, E. Kane, S. Bridgham, and C. Richardson (2018). Chapter 13: Terrestrial wetlands. *Second State of the Carbon Cycle Report (SOCCR2): A Sustained Assessment Report*. https://doi.org/10.7930/SOCCR2.2018.Ch13. https://carbon2018.globalchange.gov/downloads/SOCCR2_Ch13_Terrestrial_Wetlands.pdf

Key Assumptions:

To calculate how much net carbon is stored in the wetland, the negative net ecosystem exchange per area, which indicates sequestration, and methane emitted per area are converted to kgCO2e per area in the table below. These two values are then added to get the total kgCO2e emitted per area. When calculated for each wetland type, one can see that only the Forested Peatland is estimated to sequester more carbon than it emits.

Table 68: Calculation of Net Carbon Stored or Emitted by Various Types of Wetlands

Formulas	X	X_1=X*(44/12)/1000	Y	Y_1=Y*(16/12)/1000	Y_2=Y_1*28	Z = X_1+Y_2
	gC/m² stored as CO_2	**kgCO_2e/m² stored**	**gC/m² emitted as CH_4**	**kg CH_4/m² emitted**	**kgCO_2e/m² emitted**	**Net kgCO_2e/m²**
Non-forested peatland	-134.97	-0.49	23.58	0.0314	0.88	0.39
Forested Peatland	**-120.97**	**-0.44**	**8.9**	**0.0119**	**0.33**	**-0.11**
Non-forested mineral soil	-102.15	-0.37	26.09	0.0348	0.97	0.60
Forested mineral soil	-66.99	-0.25	26.93	0.0359	1.01	0.76
Average	-106.27	-0.39	21.375	0.0285	0.80	0.41

Calculation:

$$Total\ Carbon\ Savings\ from\ Wetland\ Preservation = \left\{(Acres\ of\ Wetland) * \left(Area\ Conversion\ Factor\ \frac{m^2}{acres}\right) * (\%\ of\ wetland\ preserved) * \left(Wetland\ Specific\ Net\ CO2e\ Exchange\ Factor\ \frac{kgCO2e}{m^2}\right) * \left(Carbon\ Conversion\ Factor\ \frac{tonnes\ CO2e}{kgCO2e}\right)\right\}$$

Cost Estimate: Though the cost of restoring and preserving wetlands varies greatly by type of wetland and location, the USDA has developed a map of the cost per acre of restoration and preservation in different regions of the United States. This map can be used to find estimated cost of wetland per acre ($/acre in 2015 dollars), summarized in Table 69 below[201].

Table 69: Cost Estimate of Wetland Preservation

	Cost / Acre
Minnesota	$1,000
Wisconsin	$1,600
Michigan	$1,600

[201] Hanson, L. (2015, April 10). *Costs of restoring and preserving wetlands vary across the United States*. USDA Economic Research Service. Retrieved August 26, 2024, from https://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=78124

B.5.6 Organic Fertilizers and Manure

To quantify the impact of fertilizer alternatives, this reduction measure compares the N_2O emissions between synthetic fertilizer, organic fertilizer, and manure, summarized in the table below[202]. This measure was not included in the projections analysis as limited information was available on the specific fertilizers currently used by Tribes.

Table 70: Fertilizer Emissions by Type

Fertilizer Type	Fertilizer Application N_2O Emissions (MT CO_2e)
Synthetic Fertilizer	7.18
Organic Fertilizer	0.25
Manure	0.03

Cost Estimation: Typical organic fertilizers are about $2-$3 per pound and typical manure is about $0.25 - $0.50 per pound when purchased from a Home Depot in the Midwest.

[202] Download the Tribal Greenhouse Gas Inventory Tool. (2024, February 5). U.S. Environmental Protection Agency. https://www.epa.gov/statelocalenergy/download-tribal-greenhouse-gas-inventory-tool

B.6 Reducing Waste

B.6.1 Implement a Recycling Program

To quantify the impact of a recycling program, this reduction measure targets mixed paper, mixed plastic, and aluminum can waste. Waste characterization data from Minnesota[203] and Wisconsin[204] were utilized to determine the total annual tons of these waste categories. Michigan's[205] data on annual tons of recycled paper, plastic, and aluminum can waste, representing 20% of total waste, was used to back-calculate the total waste in these categories. This total waste was then divided by census population data corresponding to the year of each waste characterization study and recycled waste data, yielding a per capita waste generation scaling factor for each Tribe based on their state. This scaled total tons of waste serves as the baseline waste generated for this reduction measure.

Tribal Members can input the percentage of waste recycled into the MTERA GHG reduction tool, which then calculates the proportion of baseline waste to be recycled. The EPA's "Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM)" provides material-specific emissions reduction factors for recycling[206]. These factors primarily account for the reduction in "upstream" carbon emissions, including those from raw material acquisition, manufacturing, and transportation, which are avoided through recycling. The emissions reduction factors are applied to each waste category to calculate total emissions savings from recycling.

Baseline emissions: Recycling programs were not included in the projections analysis as all municipal solid waste for Tribes is managed off Tribal lands and therefore is considered part of Scope 3 emissions. Baseline GHG inventories account only for Scope 1 and 2 emissions.

Key Assumptions:

Table 71: Waste Characteristics by State

	Minnesota (2013)*	Wisconsin (2020)	Michigan (2001)*
Tons of Paper Waste	285,400	924,900	3,562,630
Tons of Plastic Waste	192,600	745,600	203,120
Tons of Aluminum Can Waste	12,000	29,100	434,915

[203] *Understanding solid waste*. (2024). Minnesota Pollution Control Agency. Retrieved August 26, 2024, from https://www.pca.state.mn.us/air-water-land-climate/understanding-solid-waste

[204] SCS Engineers. (2021, June 11). *2020-2021 Wisconsin Statewide Waste Characterization Study*. Wisconsin Department of Natural Resources. Retrieved August 26, 2024, from https://www.cityofmadison.com/streets/programs/documents/WA_2020-2021StatewideWasteCharacterizationStudy.pdf

[205] Clore, C. (2001, December 1). *Michigan Recycling Measurement Project: Annual Collection and Diversion of Municipal Solid Waste*. Michigan Recycling Coalition. Retrieved August 26, 2024, from https://www.michiganrecycles.org/wp-content/uploads/2018/01/MRMRCollectionandDiversion.pdf

[206] *Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM)*. (2023, December). U.S. EPA Office of Resource Conservation and Recovery. Retrieved August 26, 2024, from https://www.epa.gov/system/files/documents/2024-01/warm_management_practices_v16_dec.pdf

	Minnesota (2013)*	Wisconsin (2020)	Michigan (2001)*
Population	5,414,722[207]	5,896,271[208]	10,034,113[209]
Paper Scaling Factor (tons/person)	0.05	0.16	0.36
Plastic Scaling Factor (tons/person)	0.04	0.13	0.02
Aluminum Scaling Factor (tons/person)	0.002	0.005	0.043

***These sources are the most recent state-wide and publicly available studies of waste characterization in Minnesota and Michigan. It is recommended that these numbers be updated according to more current available studies when possible.*

Table 72: CO_2e Savings from Recycling

	Total GHG Reductions (MT CO_2e/Ton of Material Recovered)[210]
Mixed Paper	3.55
Mixed Plastics	0.93
Aluminum Cans	9.13

Calculation:

$$\begin{aligned}
&Total\ Carbon\ Savings\ from\ Recycling \\
&= \left\{(Tribal\ Population) * \left(Paper\ Scaling\ Factor\ \frac{tons}{person}\right) * (\%\ of\ waste\ recycled) \right. \\
&\left. * \left(CO2e\ savings\ from\ Recycling\ Paper \frac{MTCO2e}{tons}\right)\right\} \\
&+ \left\{(Tribal\ Population) * \left(Plastic\ Scaling\ Factor\ \frac{tons}{person}\right) * (\%\ of\ waste\ recycled) \right. \\
&\left. * \left(CO2e\ savings\ from\ Recycling\ Plastic \frac{MTCO2e}{tons}\right)\right\} \\
&+ \left\{(Tribal\ Population) * \left(Aluminum\ Can\ Scaling\ Factor\ \frac{tons}{person}\right) \right. \\
&\left. * (\%\ of\ waste\ recycled) * \left(CO2e\ savings\ from\ Recycling\ Aluminum\ Cans \frac{MTCO2e}{tons}\right)\right\}
\end{aligned}$$

[207] *Our Changing Population: Minnesota*. (2022, July). USA Facts. Retrieved August 26, 2024, from https://usafacts.org/data/topics/people-society/population-and-demographics/our-changing-population/state/minnesota/?endDate=2022-01-01&startDate=2012-01-01

[208] *Our Changing Population: Wisconsin*. (2022, July). USA Facts. Retrieved August 26, 2024, from https://usafacts.org/data/topics/people-society/population-and-demographics/our-changing-population/state/wisconsin/?endDate=2022-01-01&startDate=2020-01-01

[209] *Our Changing Population: Michigan.* (2022, July). USA Facts. Retrieved August 26, 2024, from https://usafacts.org/data/topics/people-society/population-and-demographics/our-changing-population/state/michigan/?endDate=2022-01-01&startDate=2020-01-01

[210] *Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM)*. (2023, December). U.S. EPA Office of Resource Conservation and Recovery. Retrieved August 26, 2024, from https://www.epa.gov/system/files/documents/2024-01/warm_management_practices_v16_dec.pdf

Cost Estimate: A cost-effective way to implement recycling is to subscribe to an existing recycling service. Weekly or biweekly collection services are common for either single- or double-sorted processing. Since it is easiest for households and businesses to provide all of their recycling in one bag, it is recommended to subscribe to a double-sorted processing, as that would ensure optimal recycling to occur. EPA cost estimates from 2016 for these various recycling programs are included in Table 73 below[211].

Table 73: Cost of Recycling in the US (2016)

	$/ton
Once a week – twice sorted	141
Every other week – twice sorted	103
Once a week – once sorted	139
Every other week – once sorted	89

B.6.2 Implement a Composting Program

This measure focuses on transforming food waste into nutrient-rich soil through composting, which enhances soil health in agricultural and horticultural applications and reduces reliance on synthetic fertilizers. Composting food waste also reduces the volume of waste directed to landfills, thereby decreasing carbon dioxide and methane emissions associated with anaerobic decomposition. Although composting generates some carbon dioxide emissions, these are substantially lower than those from landfill operations[212].

To quantify emissions savings from composting food waste, the baseline amount of food waste generated by a Tribe is calculated. The total annual food waste for Minnesota, Wisconsin, and Michigan in 2022 is obtained by aggregating the food waste from landfill, incineration, and dumping, as reported by ReFED's publicly available Food Waste Monitor. ReFED, a national nonprofit organization contracted by state governments, analyzes and visualizes state-wide food waste data[213]. This total annual food waste at the state level is then divided by the 2022 population in each state to derive a per capita scaling factor, which is subsequently applied to the Tribe's population to estimate baseline tons of food waste.

Tribal members input the percentage of food waste to be composted into the tool, which then calculates the proportion of baseline food waste to be composted. According to a composting study by the California EPA and California Air Resources Board, composting reduces emissions by 82% compared to landfilled organic waste[214]. The net savings per ton from composting organic waste rather than landfilling is used to calculate total emissions savings from the Tribal baseline tons of food waste.

Table 74: Emissions Reduction from Composting

Composting emissions per ton feedstock	0.07 MT CO_2e/ton
Landfilled organic waste emissions per ton waste:	0.385 MT CO_2e/ton
Percent Savings from Composting	82%

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211 *Collection Costs*. (2016, February 21). US EPA Archives. Retrieved August 26, 2024, from https://archive.epa.gov/wastes/conserve/tools/localgov/web/html/collection.html

212 *Composting Food Waste: Keeping a Good Thing Going*. (2020, October). US EPA. Retrieved August 26, 2024, from https://www.epa.gov/snep/composting-food-waste-keeping-good-thing-going

213 *ReFED: Our mission*. (n.d.). ReFED. Retrieved August 26, 2024, from https://refed.org/about/who-we-are/#mission

214 *Method For Estimating Greenhouse Gas Emission Reductions From Diversion Of Organic Waste From Landfills To Compost Facilities*. (2017, May). California Environmental Protection Agency. Retrieved August 26, 2024, from https://ww2.arb.ca.gov/sites/default/files/classic/cc/waste/cerffinal.pdf

Baseline emissions: Composting programs were not included in the projections analysis as all municipal solid waste for Tribes is managed off Tribal lands and therefore is considered part of Scope 3 emissions. Baseline GHG inventories account only for Scope 1 and 2 emissions.

Key Assumptions:

Table 75: Waste Characteristics by State

	Minnesota (2013)	Wisconsin (2020)	Michigan (2022)
Tons of Food Waste	617,870[215]	642,300[216]	1,136,500[217]
Population	5,717,184[218]	5,892,539[219]	10,034,113[220]
Food Waste Scaling Factor (tons/person)	0.108	0.109	0.113

Calculation:

$$Total\ Carbon\ Savings\ from\ Composting = \left\{(Tribal\ Population) * \left(Food\ Scaling\ Factor\ \frac{tons}{person}\right) * (\%\ of\ food\ waste\ recycled) * \left(CO2e\ savings\ from\ Composting\ Food\ \frac{MTCO2e}{tons}\right)\right\}$$

Cost Estimate: A cost-effective way to implement composting is to subscribe to an existing composting service. The cost would be either weekly or biweekly collection services, and for compost bins. The prices for these services vary greatly across different organizations and is best determined on the localized level.

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[215] *1.4 million Food Waste Tons were generated in All Sectors across Minnesota in 2022*. (2023, November 2). ReFED. Retrieved August 26, 2024, from https://insights-engine.refed.org/food-waste-monitor?break_by=destination&indicator=tons-waste&state=MN&view=detail&year=2022

[216] *2.96 million Food Waste Tons were generated in All Sectors across Wisconsin in 2022*. (2023, November 2). ReFED. Retrieved August 26, 2024, from https://insights-engine.refed.org/food-waste-monitor?break_by=destination&indicator=tons-waste&state=WI&view=detail&year=2022

[217] *2.4 million Food Waste Tons were generated in All Sectors across Michigan in 2022*. (2023, November 2). ReFED. Retrieved August 26, 2024, from https://insights-engine.refed.org/food-waste-monitor?break_by=destination&indicator=tons-waste&state=MI&view=detail&year=2022

[218] *Our Changing Population: Minnesota*. (2022, July). USA Facts. Retrieved August 26, 2024, from https://usafacts.org/data/topics/people-society/population-and-demographics/our-changing-population/state/minnesota/?endDate=2022-01-01&startDate=2012-01-01

[219] *Our Changing Population: Wisconsin*. (2022, July). USA Facts. Retrieved August 26, 2024, from https://usafacts.org/data/topics/people-society/population-and-demographics/our-changing-population/state/wisconsin/?endDate=2022-01-01&startDate=2020-01-01

[220] *Our Changing Population: Michigan.* (2022, July). USA Facts. Retrieved August 26, 2024, from https://usafacts.org/data/topics/people-society/population-and-demographics/our-changing-population/state/michigan/?endDate=2022-01-01&startDate=2020-01-01

B.7 Reducing Wastewater Emissions

B.7.1 Installation of Low-Flow Toilets

Low-flow toilets contain a mechanism to reduce the water use per toilet flush, reducing wastewater and related emissions. This measure currently applies to residential homes only.

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

Emissions Methodology: The basis of emissions reductions from low-flow toilets come from an EPA source on WaterSense toilets.[221] The flow rate savings between standard and low-flow toilets (in gallons per minute) was utilized to understand water savings per toilet.

Table 76: Low-Flow Toilet Water Savings

	Low Flow (gpm)	Standard Flow (gpm)	Saved gpm	Savings %
Toilets	1.28	1.6	0.32	**20%**

$$Percent\ Water\ Savings = 100\% * \left\{ \frac{\left(Standard\ flow\ rate \frac{gallons}{minute} - low - flow\ rate \frac{gallons}{minute} \right)}{Standard\ flow\ rate \frac{gallons}{minute}} \right\}$$

According to a 2016 study on Residential End Uses of Water by the Water Research Foundation (summarized by the Alliance for Water Efficiency),[222] toilets typically make up 24% of a single-family home's water use, leading to the final estimate of GHG reduction as 24% of total water use multiplied by the 20% water savings for a total of 4.8% water savings.

The number of single-family homes and multifamily units upgraded is multiplied by the average wastewater emissions per building (used as a scaling factor for approximate baseline emissions), then multiplied by the percent reduction (20% emissions) and the proportion of water consumption from toilets (24%) to generate metric tons of CO_2 saved from water use.

Key Assumptions:

1. 60% of residential buildings install low-flow fixtures, which results in ~5340 single-family homes and ~680 multifamily units undergoing this measure
2. Toilets are ~24% of a single-family home's water use
3. 4 units or "homes" per multifamily building
4. 1 toilet upgrade costs ~$343 (fixture + labor)

[221] *Residential Toilets.* (2024, June 3). WaterSense, Environmental Protection Agency. Retrieved July 19, 2024, from https://www.epa.gov/watersense/showerheads

[222] *Residential (Including Multi-family).* Alliance for Water Efficiency. Retrieved July 19, 2024 from https://www.allianceforwaterefficiency.org/resources/residential#.

Emissions Calculation:

$$Emissions\ saved = \#\ of\ MF\ units\ and\ residential\ buildings * Wastewater\ \frac{emissions}{bldg} * \ 24\%\ of\ residential\ water\ use\ from\ toilets * 20\%\ hot\ water\ savings\ from\ low\ flow\ fixtures$$

Cost Methodology: The cost basis for this measure comes from a U.S. Housing and Urban Development (HUD) resource guide on retrofitting apartment buildings, which estimates a total cost of $343/toilet assuming wholesale cost of one pressure-assist toilet fixture and labor costs for a 1-hour installation[223].

Cost Estimate:

$$Cost\ per\ Home\ (\$) = \left(\frac{\$300}{fixture} + \left(\frac{\$43}{hour} of\ labor\right) * 1\ hour\right) = \frac{\$343}{home\ retrofit}$$

$$Total\ Cost\ (\$) = \frac{\$343}{retrofitted\ home\ or\ unit} * (\ homes + multifamily\ units)$$

B.7.2 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. This retrofit serves a dual purpose: (a) reduction of hot water demand and energy use, and (b) reduction of wastewater and associated GHG emissions.

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

Emissions Methodology: The basis of emissions reductions from low-flow fixtures come from EPA sources on faucets[224] and showerheads.[225] 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 77: 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%**

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[223] 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

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

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

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, as shown in the table below.

Table 78: 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 [226]	5,400	13,500	**86%**
Bathroom Faucets	700 [227]	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 & 32%) were weighted by their respective % of total hot water usage annually (86% and 14%).

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

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,[228] hot water heating typically makes up 15% of a building's Scope 1 & 2 Emissions[229], leading to the final estimate of GHG reduction as 15% of total emissions multiplied by the 22% hot water savings.

According to a 2016 study on Residential End Uses of Water by the Water Research Foundation (summarized by the Alliance for Water Efficiency),[230] sinks and showerheads typically make up 38% of a single-family home's water use, leading to the final estimate of GHG reduction as 38% of total water use multiplied by the 22% hot water savings for ~8% water savings.

Key Assumptions:

1. Low-flow fixtures include low-flow faucet aerators & low-flow showerheads
2. Water heating ~15% of Scope 1 & 2 residential emissions
3. Sinks and showerheads are ~38% of a single-family home's water use
4. 4 units or "homes" per multifamily building

[226] ibid

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

[228] 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

[230] *Residential (Including Multi-family).* Alliance for Water Efficiency. Retrieved July 19, 2024 from https://www.allianceforwaterefficiency.org/resources/residential#.

5. 2 showers and 4 faucets (6 fixtures) per single-family home

Emissions Calculation:

$$Building\ Emissions\ Saved = \left(\#\ of\ MF\ units\ and\ residential\ buildings * Scope\ 1\&2 \frac{emissions}{bldg} * 15\%\ of\ Scope\ 1\&2\ emissions\ from\ hot\ water\ heating * * 22\%\ hot\ water\ savings\ from\ low\ flow\ fixtures\right)$$

$$Wastewater\ Emissions\ saved = \left(\#\ of\ MF\ units\ and\ residential\ buildings * Wastewater\ \frac{emissions}{bldg} * 38\%\ of\ residential\ water\ use\ from\ faucets\ and\ showers * 22\%\ hot\ water\ savings\ from\ low\ flow\ fixtures\right)$$

Cost Methodology: The cost basis for this measure comes from a U.S. Housing and Urban Development (HUD) resource guide on retrofitting apartment buildings.[231] 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 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:

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

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

B.7.3 Optimizing Wastewater Treatment Plants (WWTP)

Quantifying this reduction measure requires an in-depth level of analysis and is highly dependent on the unique wastewater treatment plants and equipment specific to each Tribe. Therefore, this reduction measure was not included in the projections analysis.

Key Assumptions

- Optimization of the aeration mode and dissolved oxygen set-points of WWTP can decrease N_2O emissions by 35% - 50%[232]
- Installation of source separation system and recycling nutrients recovered from the WWTP can reduce N_2O emissions by up to 60%[233]

[231] 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

[232] Mojtaba Maktabifard et al., "Net-zero carbon condition in wastewater treatment plants: A systematic review of mitigation strategies and challenges," Renewable and Sustainable Energy Reviews 185 (2023): 1, Accessed July 16, 2017, https://doi.org/10.1016/j.rser.2023.113638.

[233] Mojtaba Maktabifard et al., "Net-zero carbon condition in wastewater treatment plants: A systematic review of mitigation strategies and challenges," Renewable and Sustainable Energy Reviews 185 (2023): 1, Accessed July 16, 2017, https://doi.org/10.1016/j.rser.2023.113638.

Cost Estimation: According to wastewater treatment plant manufacturers, such as SAMCO, the costs for retrofitting wastewater treatment plants can range from $500,000 to $1.5 million for a system that processes 150,000 gallons per day (GPD), including equipment, engineering, design, installation, and startup[234].

[234] *How Much Does a Wastewater Treatment System Cost?* (n.d.). SAMCO Tech. Retrieved August 26, 2024, from https://samcotech.com/cost-wastewater-treatment-system/

Appendix C

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 building retrofit measures, as well as "Miscellaneous Non-Industrial Not Elsewhere Classified" – pertaining to "Fluorescent Lamp Breakage" due to 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 proposed measures across the eight-Tribe subset.

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 79.

Minnesota Chippewa Tribe is not included within the Tribal total in Table 79 to prevent double-counting of the emissions associated with the Leech Lake, Grand Portage, and Fond du Lac Tribes. 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 80.

*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 79: Tribal Level CAP + HAP 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 80: 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
		Carbon Monoxide	1,555
		Nitrogen Oxides	85
		Volatile Organic Compounds	220
		Sulfur Dioxide	8
		PM10 Primary (Filt + Cond)	218
		PM2.5 Primary (Filt + Cond)	211
	HAP	**Sum of 25+ pollutants (see above for full list)**	**57**
	CAP/HAP	Lead Compounds	0.000

Appendix D

LIDAC (Low-Income Disadvantaged Communities) Census Tracts

The following census tract IDs were downloaded from the Climate and Economic Justice Screening Tool (CEJST) in February of 2024 for all counties with Tribal areas within the census tract and covers the 35 MTERA member Tribes in EPA Region 5 as of February of 2024.

Table 81: CEJST Census Tract IDs - MTERA Tribes as of Feb 2024

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

Census tract 2010 ID	County Name	State/Territory	Names of Tribal areas within Census tract
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

Census tract 2010 ID	County Name	State/Territory	Names of Tribal areas within Census tract
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

Census tract 2010 ID	County Name	State/Territory	Names of Tribal areas within Census tract
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

Census tract 2010 ID	County Name	State/Territory	Names of Tribal areas within Census tract
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

Census tract 2010 ID	County Name	State/Territory	Names of Tribal areas within Census tract
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

Census tract 2010 ID	County Name	State/Territory	Names of Tribal areas within Census tract
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 E

AVERT + COBRA Health Benefit Analysis

This Appendix provides health benefit analysis methodology using the Avoided Emissions and Generation Tool (AVERT) and the CO-Benefits and Risk Analysis (COBRA) Tool by the EPA. AVERT utilizes sector reduction measures presented in the CCAP and determines the emissions related impacts of implementing those measures over the specified region. This is accomplished through an hour-by-hour prediction of generation schedules, electricity demand, and electricity production to estimate the location and magnitude of emissions changes. The emissions outputs are then used as inputs in COBRA, which estimates monetary savings of health impacts from changing current emissions rates by assigning economic values to pollutant-health benefit relationships.

The Midwest region was selected for AVERT, not specific to one state or county. Each sector reduction measure was input individually for its own iteration to restrict variable interference (i.e. the impact of wind energy on efficiency improvements). The only measure that utilized two inputs was the “PV-plus-storage” category, which required utility scale solar to simulate effective storage capacity. Using the proposed sector reduction measure of (30) 10 MW microgrids across all Tribes, 300 MW of utility-scale solar was input in addition to 150 MW worth of solar storage to account for half of solar generation being devoted to storage operating 365 days a year with a 4hr battery system.

Both EV sector reduction measures – single-occupant vehicles and buses – were also input individually for their own iterations. This was conducted under the assumption that the implementation of new EV fleets will be accompanied by the expansion of clean energy capacity to charge these fleets. Table 82 displays each of these inputs to AVERT.

The below inputs were estimated based on meeting the Tribes’ net-zero 2050 goal. To meet this ambitious target, building energy efficiency measures were applied to 100% of the commercial and residential building stock, resulting in approximately 301,775 MWh of reduction. In the Power sector, new renewables are targeted to meet and surpass total electricity demand. This renewable target was split across distributed & community-scale solar, utility-scale solar, microgrids, and wind for the AVERT inputs. Additionally, the 2050 targets assume 100% conversion of buses and single-occupancy vehicles and bus fleets to all EVs. The numbers below are representative of the entire bus and SOV fleets.

Table 82: AVERT Inputs: 2050 Measure Targets

Sector Reduction Measure	Value	Units
Energy Efficiency	301,775	MWh
Distributed & Community Scale Solar Generation	37	MW
Utility Scale Solar Generation	13	MW
Wind Generation	50	MW
EV Buses (School, Transit)	(71, 58)	Number of vehicles
EV Single Occupant Vehicles	36,030	Number of vehicles
Microgrid Solar, Storage	300,150	MW

Prior to determining the changes in pollutant emissions, the level of aggregation was selected to be regional, and the source of emission was selected to be the power sector for electricity generation, efficiency and storage and the vehicle sector for all EV measures. Values for sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter ($PM_{2.5}$), volatile organic compounds (VOCs), and ammonia (NH_3) were output by change in short tons. Any positive values were increased emissions, and all negative values were decreased emissions as a result of the proposed sector reduction measures. Provided that all values were negative, Table 83 presents these inputs as positive reductions in emissions, as is reflected in the COBRA tool. This data was exported and filtered prior to being input into COBRA. All values from Minnesota and Wisconsin were extracted and totaled, with an additional sector-specific filter applied -- either “Fuel Combustion: Electric Utility” for all generation, storage and efficiency measures or “Highway Vehicles” for all transportation measures.

Table 83: AVERT Outputs/COBRA Inputs – Pollutant Emissions Reductions

Sector Reduction Measure	NO_x Emissions Reduction (tons)	SO_2 Emissions Reduction (tons)	$PM_{2.5}$ Emissions Reduction (tons)	VOCs Emissions Reduction (tons)	NH3 Emissions Reduction (tons)	Emissions Sector
Energy Efficiency	20.95	7.93	1.45	0.735	1.22	Fuel Combustion: Electric Utility
Distributed & Community Scale Solar Generation	4.38	1.54	0.292	0.154	0.264	Fuel Combustion: Electric Utility
Utility Scale Solar Generation	1.81	0.634	0.118	0.063	0.107	Fuel Combustion: Electric Utility
Wind Generation	8.91	3.503	0.619	0.305	0.505	Fuel Combustion: Electric Utility
EV Buses (School, Transit)	0.815	0	0	0.18	0.035	Highway Vehicles
EV Single Occupant Vehicles	2.37	0.134	0.186	5.52	1.76	Highway Vehicles
Microgrid Solar, Storage	40.7	13.8	2.75	1.46	2.53	Fuel Combustion: Electric Utility

For each sector reduction measure, the emissions outputs from AVERT were utilized to build a scenario in COBRA. Both Minnesota and Wisconsin were selected as the representative states, the appropriate sector was applied based on Table 83, and the emissions changes were input as either increases or reductions in tons. The scenario then provided the associated health savings in monetary value based on the changes in pollutant emissions. The health benefit outputs from COBRA include:

- Total health benefits (low and high estimates)
- Total mortality savings (low and high estimates)
- Infant mortality savings
- Asthma symptoms incidence and savings
- Hay fever/rhinitis incidence and savings
- Savings from emergency room and hospital visits
- Savings of nonfatal heart attacks
- Number of days gained for minor restricted activities, work, and school; monetary savings included
- Lung cancer incidence and savings
- Cardio-, cerebro- and peripheral vascular disease incidence and savings
- Alzheimer’s disease incidence and savings
- Parkinsons disease incidence and savings
- Stroke incidence and savings

Savings opportunities displayed in the below table were chosen and grouped based on highest savings and anticipated relevance for Tribal health and well-being. The total health benefits, asthma savings (from treatments and doctor visits), and days recovered for work, school, and minor activities are included in Table 84 as indicative of beneficial health impacts.

Table 84: COBRA Outputs - Health Benefits Savings

Sector Reduction Measure	Total Health Effects Savings (Low-High Estimate)	Total Asthma Symptoms/Onset Savings	Minor Restricted Activity Days, School Days, and Workdays Saved	Savings in Total Activity, School, and Workdays
Reduce energy consumption by 301,000 MWh via energy efficiency improvements	$615,000-$960,500	$22,500	32	$24,300
Install 37 MW of distributed & community-scale solar PV	$287,900-$473,600	$8,200	15	$9,800
Install 13 MW of utility-scale solar PV	$118,000-$194,100	$5,100	6	$4,000
Install 50 MW of wind energy	$613,800-$1,016,000	$12,300	32	$20,500
Add 71 EV school buses and 58 EV transit buses to transportation infrastructure	$19,500-$27,400	$830	1	$930
Add 36,000 EV single occupant vehicles to transportation infrastructure	$221,500-$361,400	$7,400	12	$7,800
Install 300 MW of utility-scale solar and 150 MW of storage capacity	$1,177,200-$1,826,600	$43,600	61	$47,200

Appendix F

Summary of Measure Community Benefits

Reduction measures can result in additional non-GHG benefits that support a community's sustainability, natural environment, public health, economic prosperity, and quality of life. Table 86 summarizes these additional benefits from the reduction measures and assigns a high-level qualitative scoring of the impact of these benefits from measure implementation. The qualitative community benefit scores were assigned considering the following key guiding questions developed by Arup based on their past experience in climate action planning and the weighted legend in Table 85.

Environmental

- Does it improve indoor or outdoor air quality?
- Does it protect or improve existing biodiversity and ecosystems through preservation or restoration?
- Does it increase the resilience or safety of Tribal members in responding to or recovering from extreme weather events or grid power outages?

Social

- Does it strengthen community connections and access to services?
- Does it support positive health benefits, such as improved physical or mental health?
- Does it help address environmental justice concerns (current or historical), such as improving access to clean energy while maintaining affordability for Tribal customers?

Economic

- Does it reduce energy or water bills and maintenance costs for owners, tenants and building occupants?
- Are there high initial cost barriers, or is it affordable and financially accessible to community members?
- Does it create local, well-paying, high-quality and secure jobs? Does it require additional training or programmatic support?
- Does it lead to other commerce opportunities from selling energy, monetizing services, use of by-products, etc.?

These additional reduction measure benefits are intended to provide a resource for Tribes to evaluate implementation plans across a variety of metrics and community priorities, in addition to GHG reduction potential. It captures other possible beneficial outcomes Tribal members would likely value and which can be highlighted when applying for grants and funding sources to implement emission reduction measures. A zero or negative score does not reflect a negative outcome but rather a measure with additional considerations needed to mitigate potential negative consequences. The individual tables included within each measure section reference the sum total of scores within the three Environmental, Social, and Economic categories.

Table 85: Legend for Community Benefit Summary Scores

Score	Interpretation
-1	Measure has potential for significant disbenefits if not properly mitigated
-0.5	Measure has potential for some disbenefits if not properly mitigated
0	Measure has neutral impact
0.5	Measure has more positive benefit(s) than negative
1	Measure will have strong positive benefit(s)

Table 86: Summary of Community Benefits

	Measures	Environmental			Social			Economic		
		Improved air quality & public health	Biodiversity, soil health, and habitat protection	Resilience to extreme weather (heat, storms, grid outages)	Increased connectivity to resources and community members	Improved physical health, mental health, and personal wellbeing	Environmental Justice	Affordability	Job creation	Economic development
Reduce Electricity Generation Emissions	Install Solar PV	1	-0.5	0.5	0	0	1	0.5	1	1
	Install Wind Energy	1	-0.5	0.5	0	0	1	0.5	1	1
	Install Geothermal Heating and Cooling	1	0	0.5	0	0	1	-0.5	0.5	0.5
	Install Hydropower	1	-0.5	0.5	0	0	1	0.5	0.5	0.5
	Install Solar Microgrids	1	-0.5	1	0	0	1	-0.5	1	0.5
Reduce Building Energy Emissions	Electrify Heating Equipment	0.5	0	0.5	0	0.5	0.5	0.5	1	0
	Install High-Efficiency Appliances	0.5	0	0.5	0	0	0.5	1	0.5	0
	Conduct Building Weatherization Retrofits	0.5	0	0.5	0	0.5	0.5	1	1	0
	Upgrade Interior and Exterior Lighting to LEDs	0.5	0	0.5	0	0	0.5	1	0.5	0
	Install Smart Thermostats	0.5	0	0.5	0	0.5	0.5	1	0.5	0
	Adopt Green Building Standards	0.5	0.5	0.5	0	0.5	0.5	0.5	0	0.5
Reduce Vehicle Emissions	Increase Transit Service	1	0	0	1	0	1	0.5	0.5	0
	Increase Ridesharing	0.5	0	0	0.5	0	0.5	0.5	0.5	0
	Develop Active Transportation Network	0.5	0	0	1	1	0.5	0.5	0	0.5
	Electrify Bus Fleet and Provide Charging Infrastructure	1	0	0	0	0	1	-0.5	1	0.5

	Measures	Environmental			Social			Economic		
		Improved air quality & public health	Biodiversity, soil health, and habitat protection	Resilience to extreme weather (heat, storms, grid outages)	Increased connectivity to resources and community members	Improved physical health, mental health, and personal wellbeing	Environmental Justice	Affordability	Job creation	Economic development
	Provide Alternative Fuel Buses	0.5	0	0	0	0	0.5	-0.5	0.5	0
	Electrify SOVs and Provide Charging Infrastructure	1	0	0	0	0	0.5	-0.5	1	0.5
	Electrify ATVs, Boats, and Tractors	0.5	0	0	0	0	0.5	-1	0	0
Implement Environmental Management & Planning Techniques	Sequester Carbon Through Plants	0.5	1	0.5	0	0.5	0.5	0	0	0
	Preserve Wetlands	0.5	1	0.5	0	0.5	0.5	0	0	0
	Develop Green Infrastructure	0.5	1	0.5	0	0.5	0.5	0	0	0
	Implement Responsible Development and Zoning Policies	1	0.5	0	1	0.5	1	0	0	0.5
	Implement a Recycling Program	0.5	0.5	0	0	0	0	0.5	0.5	0.5
	Implement a Composting Program	0.5	0.5	0	0	0	0	0.5	0.5	0.5
	Reduce Fertilizer Emissions	0.5	1	0	0	0	0.5	-0.5	0	0.5
Reduce Wastewater Generated	Install Low-Flow Toilets	0.5	0	0	0	0	0	0.5	0.5	0
	Install Low-Flow Fixtures	0.5	0	0	0	0	0	0.5	0.5	0
	Reduce GHG Emissions from Wastewater Treatment Plants	0.5	0	0	0	0	0.5	-1	0	0