FEBRUARY 2024

# Priority Climate Action Plan

Climate pollution reduction grants

MINNESOTA

## Charge

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## Key definitions

**Climate Pollution Reduction Grants (CPRG) program:** a federal program providing $5 billion in grants[1] to states, local governments, Tribes, and territories to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air pollution.

**Comprehensive Climate Action Plan (CCAP):** a narrative report that provides an overview of the grantees' significant greenhouse gas sources/sinks and sectors, establishes near-term and long-term greenhouse gas emission reduction goals and provides strategies and identifies measures that address the highest priority sectors to help the grantees meet those goals.

**eligible entities:** Section 137(d)(1) of the Clean Air Act defines "eligible entities" under the CPRG program as states, air pollution control agencies, municipalities, Tribes, and groups of one or more of these entities.

**Greater Minnesota:** refers to the areas of the state of Minnesota outside of the Minneapolis-St. Paul metropolitan (Twin Cities) area.

**greenhouse gas inventory:** a list of emission sources and sinks and the associated emissions quantified using standard methods. Greenhouse gases included are carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride ($SF_6$)

**low-income and disadvantaged communities (LIDACs):** communities with residents that have low incomes, limited access to resources, and disproportionate exposure to environmental or climate burdens. Although the Inflation Reduction Act does not formally define LIDACs, EPA strongly recommends that grantees use the Climate and Economic Justice Screening Tool[2] and the Environmental Justice Screening and Mapping Tool[3] to identify LIDACs in their communities. These tools identify LIDACs by assessing indicators for categories of burden: air quality, climate change, energy, environmental hazards, health, housing, legacy pollution, transportation, water and wastewater, and workforce development.

**Priority Climate Action Plan (PCAP):** a narrative report that includes a focused list of near-term, high-priority, and implementation-ready measures to reduce greenhouse gas pollution and an analysis of greenhouse gas emissions reductions.

**metropolitan statistical area (MSA):** metropolitan statistical areas as defined by the U.S. Census 2020 MSA population. A list of eligible MSAs can be found in Appendix 15.2 in EPA's CPRG: Formula Grants for Planning, Program Guidance for States, Municipalities, and Air Control Agencies.[4]

**municipality:** EPA defines municipality for the Climate Pollution Reduction Grants as "a city, town, borough, county, parish, district, or other public body created by or pursuant to State law. Consistent with section 137(d)(1) of the Clean Air Act, a group of municipalities, such as a council of governments, may also be considered an eligible entity under this program in some cases." This definition can be

[1] EPA CPRG. https://www.epa.gov/inflation-reduction-act/climate-pollution-reduction-grants
[2] Climate and Economic Justice Screening Tool. https://screeningtool.geoplatform.gov
[3] Environmental Justice Screening and Mapping Tool, https://www.epa.gov/ejscreen
[4] CPRG: Formula Grants for Planning, Program Guidance for States, Municipalities, and Air Control Agencies, https://www.epa.gov/system/files/documents/2023-02/EPA CPRG Planning Grants Program Guidance for States-Municipalities-Air Agencies 03-01-2023.pdf

found in Section 4 in EPA's CPRG: Formula Grants for Planning, Program Guidance for States, Municipalities, and Air Control Agencies.[5]

**Tribes and territories:** Consistent with section 137(d)(1) of the Clean Air Act, groups of Tribes, including Tribal consortia and Tribal partnerships, may be considered an eligible entity under this program. Tribes, Tribal partnerships, and Tribal consortia can also participate as collaborating partners in planning efforts managed by lead organizations for states or metropolitan areas. More information can be found in EPA's CPRG Guidance for Tribes and Territories.[6]

## Acronyms and abbreviations

| | |
|---|---|
| AR4 | Fourth Assessment Report of the United Nations Intergovernmental Panel on Climate Change |
| AR5 | Fifth Assessment Report of the United Nations Intergovernmental Panel on Climate Change |
| BWSR | Board of Water and Soil Resources |
| CCAP | Comprehensive Climate Action Plan |
| CPRG | Climate Pollution Reduction Grants |
| $CO_2e$ | carbon dioxide equivalent |
| DEED | Department of Employment and Economic Development |
| DNR | Department of Natural Resources |
| EPA | Environmental Protection Agency |
| IPCC | Intergovernmental Panel on Climate Change |
| LIDAC | low-income and disadvantaged communities |
| MDA | Minnesota Department of Agriculture |
| MDH | Minnesota Department of Health |
| MMT | million metric tons |
| MnCIFA | Minnesota Climate Innovation Finance Authority |
| MnDOT | Minnesota Department of Transportation |
| MPCA | Minnesota Pollution Control Agency |
| MSA | metropolitan statistical area |
| PCAP | Priority Climate Action Plan |
| $PM_{2.5}$ | fine particulate matter |
| USDA | United States Department of Agriculture |

[5] CPRG: Formula Grants for Planning, Program Guidance for States, Municipalities, and Air Control Agencies, https://www.epa.gov/system/files/documents/2023-02/EPA CPRG Planning Grants Program Guidance for States-Municipalities-Air Agencies 03-01-2023.pdf

[6] CPRG Guidance for Tribes and Territories. https://www.epa.gov/system/files/documents/2023-02/EPA CPRG Planning Grants Program Guidance for Tribes-Tribal Consortia-Territories 03-01-2023.pdf

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# Introduction

The Minnesota Pollution Control Agency (MPCA) led the development of the state's Priority Climate Action Plan (PCAP) in collaboration with the Minnesota Department of Health (MDH), University of Minnesota Duluth, and the Climate Change Subcabinet. This plan is a deliverable of the Climate Pollution Reduction Grant (CPRG) program and builds on the state's climate change planning work, including and the state's greenhouse gas emissions inventory.[7]

This PCAP applies to the area within the boundaries of the state of Minnesota and focuses on climate change mitigation actions in four Climate Action Framework goal areas: Clean Transportation, Climate-Smart Natural and Working Lands, Clean Energy and Efficient Buildings, and Clean Economy.

## Climate Pollution Reduction Grants program overview

The EPA Climate Pollution Reduction Grant program[8] provides $5 billion in grants to states, local governments, Tribes, and territories to develop and implement ambitious plans for reducing greenhouse gas emissions and other harmful air pollution. Authorized under Section 60114 of the Inflation Reduction Act, this two-phase program provides $250 million for noncompetitive planning grants and $4.6 billion for competitive implementation grants.

The CPRG program is part of the Biden Administration's Justice40 initiative, which sets a goal that 40 percent of the benefits of certain federal investments flow to disadvantaged communities that are marginalized, underserved, and overburdened by pollution.

### Planning grants

MPCA accepted a planning grant on behalf of the state of Minnesota in June 2023. In addition to the state, the EPA awarded planning grants to the following entities within the geography of Minnesota:

- Shakopee Mdewakanton Sioux Community
- Mille Lacs Band of Ojibwe
- Midwest Tribal Energy Resources Association (MTERA) (covering a consortium of Tribal Nations in the region)
- Metropolitan Council (for the Minneapolis-St. Paul-Bloomington metropolitan statistical area)

EPA maintains a list of the lead organizations for planning grants.[9]

The planning grant includes three deliverables: the Priority Climate Action Plan (PCAP), a Comprehensive Climate Action Plan (CCAP), and a Status Report. For the state's planning grant, the deliverable deadlines are:

- PCAP: March 1, 2024
- CCAP: June 28, 2025
- Status Report: June 28, 2027

[7] Minnesota Climate Trends and Data. https://www.pca.state.mn.us/air-water-land-climate/climate-change-trends-and-data
[8] EPA Climate Pollution Reduction program. https://www.epa.gov/inflation-reduction-act/climate-pollution-reduction-grants
[9] CPRG Planning Grant Information. https://www.epa.gov/inflation-reduction-act/cprg-planning-grant-information

The PCAP provides a focused list of near-term, high-priority, implementation-ready measures to reduce climate pollution from greenhouse gas emissions. The PCAP requires the following elements:

- Greenhouse gas inventory
- Priority quantified greenhouse gas reduction measures
- Low-income and disadvantaged communities benefits analysis
- Review of authority to implement

The Comprehensive Climate Action Plan will consist of several key components, including a comprehensive greenhouse gas inventory, projections for greenhouse gas emissions, clearly defined greenhouse gas reduction targets, specified measures for greenhouse gas reduction, and a thorough benefits analysis covering the entire geographic scope and population addressed by the plan.

For more information about the planning phase, visit the EPA's CPRG Planning Grant Information page.[10]

## Implementation grants

The EPA launched two competitions in the implementation phase: a $4.3 billion general competition open to states, Tribes, territories, and municipalities, or coalitions of these entities, and a $300 million competition open to Tribes, territories, and coalitions of these entities. Eligible entities can apply for general competition funding through the CPRG program to implement projects included in an applicable PCAP submitted to EPA by March 1, 2024. Eligible entities applying or the Tribes and territories competition must submit applications to the EPA by May 1, 2024.

Projects must be described in an applicable PCAP to be eligible for CPRG implementation grants. An applicable PCAP geographically covers an entity and contains greenhouse gas reduction measures that the entity can implement. In some cases, multiple PCAPs may cover an entity. For example, an applicable state PCAP and an applicable metropolitan PCAP may each include measures that a particular municipality could implement. The municipality could reference measures from either or both PCAPs in its application.

Eligible entities, whether or not they received planning grants, can apply to implement measures outlined in applicable PCAPs. For the general competition, individual grants will range from $2 million to $500 million. For the Tribes and territories competition, awards will range from $1 million to $25 million.

Additional information on the implementation grants can be found on the EPA's CPRG implementation grants page.[11]

# State context

## Climate change executive order

Governor Walz and Lt. Gov. Flanagan built on years of climate change planning and action when they established the Climate Change Subcabinet by executive order[12] in 2019. The Subcabinet's role is to identify policies and strategies for climate mitigation and resiliency and meaningfully engage the public

[10] CPRG Planning Grant Information. https://www.epa.gov/inflation-reduction-act/about-cprg-planning-grant-information
[11] CPRG Implementation Grants Information. https://www.epa.gov/inflation-reduction-act/about-cprg-implementation-grants
[12] Minnesota Executive Order 19-37. https://mn.gov/governor/assets/2019_12_2_EO_19-37_Climate_tcm1055-412094.pdf

to ensure that those impacted by climate change have a voice in the process. The members of the Subcabinet are the executive leaders of the Minnesota Pollution Control Agency, Board of Water and Soil Resources (BWSR), Metropolitan Council, Environmental Quality Board, Minnesota Housing Finance Agency (Minnesota Housing), and departments of Commerce, Labor and Industry, Management and Budget, Employment and Economic Development (DEED), Agriculture (MDA), Public Safety, Natural Resources (DNR), Health (MDH), Transportation (MnDOT), and Administration. The executive order names the commissioner of the MPCA as the chair of the Subcabinet. The Subcabinet is supported by interagency staff teams that collaborate on climate engagement, policy development, analysis, implementation, and reporting.

The climate change executive order also created the Governor's Advisory Council on Climate Change. The advisory council works with the Climate Change Subcabinet to identify opportunities for, and barriers to, policies and strategies to reduce greenhouse gas emissions and increase climate resiliency. The council is comprised of up to 15 members appointed by the governor, and includes civic and community leaders, individuals with experience in business, agriculture, conservation, environmental protection, and other relevant stakeholders.

## Minnesota's Climate Action Framework

In September 2022, the Subcabinet published the Minnesota Climate Action Framework,[13] a plan that sets a vision for how the state will address and prepare for climate change. The framework broadly guides the direction of climate action toward a carbon-neutral, resilient, and equitable future for Minnesota and contains immediate, near-term actions, as well as key progress indicators with measurable targets.

The framework is organized into six goal areas:

- Clean Transportation – Connect all people through a safe, equitable, and sustainable transportation system
- Climate-Smart Natural and Working Lands – Manage our lands to reduce greenhouse gas emissions, enhance terrestrial carbon sinks, and sustain resilient landscapes
- Resilient Communities – Prepare communities with resources to build a more resilient future for themselves
- Clean Energy and Efficient Buildings – Expand the use of carbon-free energy and create healthy, comfortable buildings that are cheaper to operate and pollute less
- Healthy Lives and Communities – Protect the health and wellbeing of all Minnesotans in the face of climate change, especially those who live in the communities that are most affected
- Clean Economy – Build an economy that addresses climate change and creates equitable opportunities

## Greenhouse gas targets in Minnesota

In 2007, as part of the Next Generation Energy Act, the Minnesota Legislature adopted greenhouse gas emissions targets to reduce emissions 15% below 2005 levels by 2015, 30% by 2025, and 80% by 2050. In 2022, as part of the Climate Action Framework, Governor Walz and Lieutenant Governor Flanagan

[13] Minnesota Climate Action Framework, 2022. https://climate.state.mn.us/minnesotas-climate-action-framework

endorsed the state's economy-wide greenhouse gas goal to reduce emissions by 50% by 2030 and become net-zero by 2050. The Legislature adopted these statewide goals in 2023.[14] The Framework also contains goals within each chapter, including:

- Reduce greenhouse gas emissions from the transportation sector 80% by 2040
- By 2035, increase by 25% the amount of carbon sequestered and stored annually in natural and working lands, compared to 2014-2018 average levels
- By 2035, reduce greenhouse gas emissions from existing buildings by 50% compared to 2005 levels

The Next Generation Energy Act of 2007 also set a statutory goal for 25% renewable electricity by 2025. Minnesota achieved the goal eight years early. In the 2023 Minnesota Legislative Session, the Legislature acted on a priority measure included in the Climate Action Framework: Governor Walz signed a bill requiring 100% carbon-free electricity by 2040, with at least 55% coming from renewable sources.[15] The law sets interim targets: 80% carbon-free by 2030 and 90% by 2035, except for rural electric co-ops, which must only reach 60% by 2030. These requirements will create momentum for major changes in the energy sector.

## Low-income and disadvantaged communities in Minnesota

Equity and environmental justice are foundational to Minnesota's climate work. In fact, equity is one of the three pillars of the state's climate vision, as expressed in the Minnesota Climate Action Framework:

> Minnesotans acknowledge and address inequitable and inaccessible systems that contribute to some communities experiencing disproportionate climate change impacts; ensure fair distribution of the costs and benefits of action now and to future generations; and ensure meaningful participation in planning.[16]

Minnesota's Climate Action Framework also includes a goal to align state climate action with the principles of the Justice40 Initiative:

> By 2025, ensure at least 40% of the benefits of certain state and federal climate investments are in disadvantaged communities.[17]

For CPRG planning and implementation work, the state prioritizes benefits for low-income and disadvantaged communities (LIDACs) to fulfill its commitment to climate equity. LIDACs are areas, typically census tracts and census block groups, that the Climate Economic Justice Tool (CEJST)[18] and the EPA's Environmental Justice Screening and Mapping Tool (EJScreen)[19] have identified to be both low-income and disadvantaged based on meeting any of eight categories of burden. These categories relate to climate change vulnerability, health vulnerability, proximity to sources of hazardous pollution and waste, exposure to water pollution, heavy energy cost burden, historical housing underinvestment, proximity to high traffic pollution, linguistic isolation, poverty, unemployment, and others. To respect

[14] 2023 Minn. Statutes Chapter 216H, Section 02, Subdivision 1. https://www.revisor.mn.gov/statutes/cite/216H.02
[15] 2023 Minn. Statutes Chapter 216B, Section 1691. https://www.revisor.mn.gov/statutes/cite/216b.1691
[16] Minnesota Climate Action Framework. https://climate.state.mn.us/minnesotas-climate-action-framework
[17] Minnesota Climate Action Framework. https://climate.state.mn.us/sites/climate-action/files/Climate%20Action%20Framework.pdf. Pg. 57
[18] Climate Economic Justice Tool. https://screeningtool.geoplatform.gov/en/#3/33.47/-97.5
[19] EPA EJScreen. https://www.epa.gov/ejscreen

Tribal sovereignty and self-government and to fulfill federal trust and treaty responsibilities to Tribal Nations, lands of Federally Recognized Tribes are also designated as LIDACs.

Two hundred census tracts out of Minnesota's 1,338 census tracts are classified as LIDACs. Because census tract boundaries do not generally align with Tribal lands, portions of an additional 16 Minnesota census tracts are classified as LIDACS as these areas are within federally recognized Tribal lands. Roughly half of these census tracts are located within urban areas of the Twin Cities metropolitan area while the remainder are in Greater Minnesota. In total approximately 724,000 Minnesotans live in LIDACs, comprising 13% of the state's population. Appendix D contains a list of all Minnesota LIDACs.

# Greenhouse gas inventory

MPCA has developed a statewide inventory of major and minor sources of greenhouse gas emissions within Minnesota, including emissions associated with electricity generation occurring outside the state but necessary to meet in-state demand greater than in-state electricity generation. The most recent version of the inventory report is in Appendix A.

The MPCA greenhouse gas inventory has been in development for many years and serves many purposes. Beyond our ability to provide timely reports on progress toward statutory goals, the inventory contains information to support analysis and answer policy questions with confidence, credibility, and transparency.

MPCA used best practices and accounting principles to design the greenhouse gas inventory system. Tradeoffs between principles are sometimes required and create tension. In this context, MPCA strives to maximize the following criteria:

- Relevance: information is timely and appropriate for decision-making
- Completeness: all sources are included, and gaps are disclosed
- Consistency: methods, data sources, and boundaries are consistent to ensure estimates are comparable within the time series, with disclosed recalculations as necessary
- Transparency: methods, sources, and assumptions are documented and reported
- Accuracy: best practices are followed, and measures are taken to improve the inventory

## Inventory boundaries

To report on progress toward meeting the goals, the MPCA estimates the statewide baseline greenhouse gas emissions in 2005 and estimates emissions through the most recent year for which data is available. The inventory covers emissions of carbon dioxide ($CO_2$), methane ($CH_4$), nitrous oxide ($N_2O$), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride ($SF_6$). MPCA divides the inventory by economic sectors rather than the type of activity (e.g., energy, processes). The economic sectors used are transportation, electricity generation, industrial, commercial, residential, waste, and a category encompassing agriculture, forestry, and natural and working lands.

The most recent legislative report based on the statewide greenhouse gas inventory is in Appendix A. MPCA prepared this inventory using many supporting data resources and methods based primarily on

the EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks,[20] the Intergovernmental Panel on Climate Change (IPCC) 2006 Guidelines for National Greenhouse Gas Inventories[21] and 2019 Refinements,[22] and The Climate Registry's Local Government Operations[23] and General Reporting Protocol.[24]

Not all emissions are included in statewide emission totals. Ideally, all sources of greenhouse gas emissions from Minnesota would be inventoried and tracked. In practice, the inventory includes only those sources for which a well-developed scientific understanding of the physical and biological processes involved in the production and emission of greenhouse gases exists, and data must be available to support the estimation effort. Important emissions sources not currently included in the greenhouse gas inventory include many land-use sources of emissions and carbon sequestration. Within the limits of available data, methods, and models, MPCA aims to develop a progressively more comprehensive and accurate inventory over time.

## Data management and quality assurance

MPCA archives all the data used to generate the estimates. Where possible, MPCA maintains databases with information from multiple sources for quality control of input data and keeps a record of all methods, equations, conversions, and emissions factors used.

Generally, MPCA uses methods based on simplified equations that are easily applied and ensure replicable results. MPCA selects methods based on best international practice, conformity with EPA practice, data availability, and resource requirements.

MPCA updates and applies methods to the entire inventory where appropriate when new data, research, and guidance are available.

MPCA acquires data at the most local level possible. Facility-level data is preferable to sector-based survey data. Permitted facilities are only a portion of facilities operating in Minnesota, so MPCA must employ other methods to have a complete inventory. Aggregate fuel sales and use data fill in the remainder of information about stationary source energy consumption and emissions. State-level data is the most detail available for agricultural activities, residential energy and housing information, and other sources.

Where disaggregated data is necessary for decision-makers and the reported data is unavailable at this level of detail, MPCA models the data to the end-user level. Vehicle emissions are an example of modeled disaggregation; MPCA models these emissions using the Motor Vehicle Emission Simulator (MOVES[25]) based on vehicle registration data, vehicle miles traveled estimates, vehicle counts, and other related data.

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[20] EPA. Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2020. https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks

[21] IPCC. Guidelines for National Greenhouse Gas Inventories. https://www.ipcc.ch/report/2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/

[22] IPCC. 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. https://www.ipcc.ch/report/2019-refinement-to-the-2006-ipcc-guidelines-for-national-greenhouse-gas-inventories/

[23] California Air Resources Board, California Climate Action Registry, ICLEI, and The Climate Registry. 2010. Local Government Operations Protocol. Version 1.1. https://ww2.arb.ca.gov/sites/default/files/classic/cc/protocols/lgo_protocol_v1_1_2010-05-03.pdf

[24] The Climate Registry. General Reporting Protocol. https://theclimateregistry.org/registries-resources/protocols/

[25] EPA. Motor Vehicle Emission Simulator. Version MOVES3. https://www.epa.gov/moves

Program staff review the activity data for completeness, consistency, accuracy, and applicability before incorporating it into the inventory. The reviews vary, but include steps such as:

- Comparing fuel use trends to authoritative sources (e.g., Energy Information Administration)
- Reviewing facility-level activities for mistakes (e.g., misplaced units, exceeding design capacity)
- Researching survey data recommendations (e.g., agricultural census)
- Correcting revised data

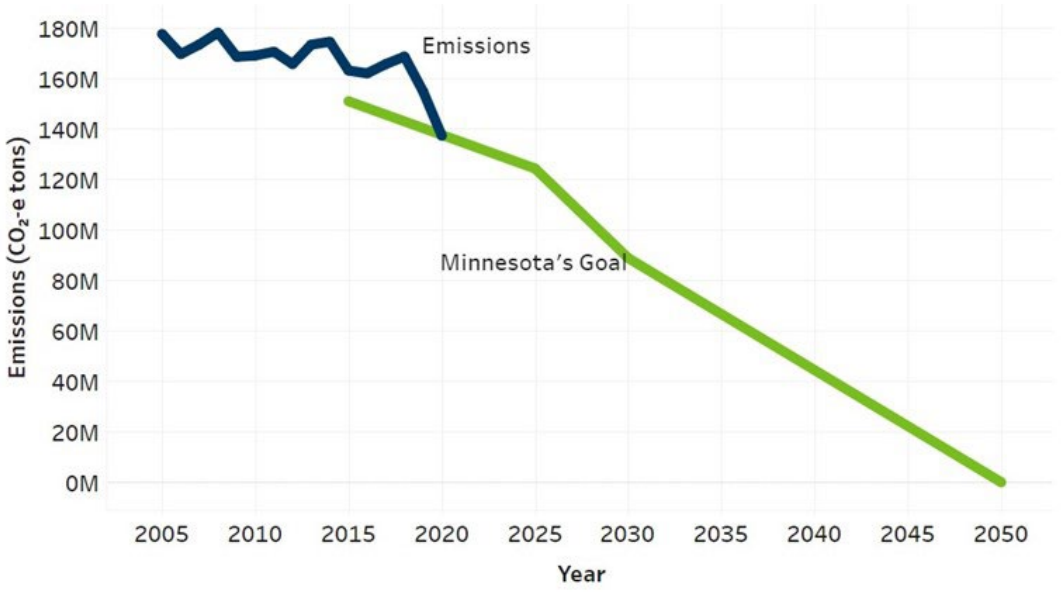
Significant differences identified as correct are noted (e.g., temporary shutdowns and closures). The process for compiling the inventory is continuously improved for efficiency, scope expansion, and incorporation of new methods.

## Minnesota greenhouse gas emissions

Recent emission reductions show that collaborative action can forge a path to achieving greenhouse gas reduction goals and reach net-zero emissions by 2050 (Figure 1). Minnesota's greenhouse gas emissions declined by 23% between 2005 and 2020. However, 2020 was atypical as individuals, organizations, and governments took action to reduce the impacts of the COVID-19 pandemic, causing disruptions across all parts of the economy and impacting Minnesota's greenhouse gas emissions.

While the pandemic certainly impacted those results, emissions across many sectors were already declining between 2018 and 2019. Based on other inventories published with more recent data,[26] emissions increased post-pandemic with the economic recovery but were lower than pre-pandemic levels. However, much work is still ahead to achieve our ambitious but necessary goals.

**Figure 1: Minnesota's greenhouse gas emissions from 2005-2020 and greenhouse gas reduction goals (short tons)**




[26] EPA. 2024. Draft US Inventory of Greenhouse Gas Emissions and Sinks: 1990-2022. https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks

Most greenhouse emissions occur as $CO_2$ from fossil fuel combustion, but other gases and sources are also important to track. Table 1 shows Minnesota's 2020 greenhouse gas emissions in million metric tons (MMT) of carbon dioxide equivalents ($CO_2e$) and the proportion of each gas to the total greenhouse gas emissions.

**Table 1: Greenhouse gas emissions in Minnesota by gas in 2020**

| Greenhouse gas | Emissions in 2020 (MMT $CO_2e$) | Percent of total emissions in 2020 |
|---|---|---|
| $CO_2$ | 86.8 | 70% |
| $CH_4$ | 17.7 | 14% |
| $N_2O$ | 17.5 | 14% |
| HFCs | 2.37 | 1.9% |
| PFCs | 0.043 | 0.03% |
| $SF_6$ | 0.041 | 0.03% |
| **Total** | **124.5** | |

Table 2 details greenhouse gas emissions for all economic sectors. Minnesota Statute 216H.01[27] requires the inventory to include emissions from electricity needed to meet Minnesota demand that exceeds the electricity generated in-state. While electricity is traded freely across state boundaries, this framework is useful for developing state policy. Electric utility sector emissions in Table 2 include emissions from out-of-state electricity generation to serve Minnesota demand.

Transportation is the sector with the highest emissions (26%), followed by agriculture, forestry, and land use (21%).

**Table 2: Greenhouse gas emissions (MMT $CO_2e$) by sector in Minnesota**

| Sector | Emissions in 2005 | Emissions in 2020 | Net change, 2005-2020 | Percent change, 2005-2020 | Percent of total emissions in 2020 |
|---|---|---|---|---|---|
| Electric utility | 52.0 | 23.7 | -28.2 | -54% | 19% |
| Transportation | 39.7 | 32.7 | -7.0 | -18% | 26% |
| Agriculture, forestry, and land use | 26.1 | 25.9 | -0.2 | -1% | 21% |
| Industrial | 16.1 | 18.4 | 2.3 | 14% | 15% |
| Residential | 8.0 | 9.1 | 1.1 | 14% | 7% |
| Commercial | 17.2 | 13.3 | -3.9 | -22% | 11% |
| Waste | 2.2 | 1.4 | -0.8 | -38% | 1% |
| **Total** | **161.3** | **124.5** | **-36.7** | **-23%** | |

Table 3 shows the emissions from the electricity sector without out-of-state electricity generation emissions.

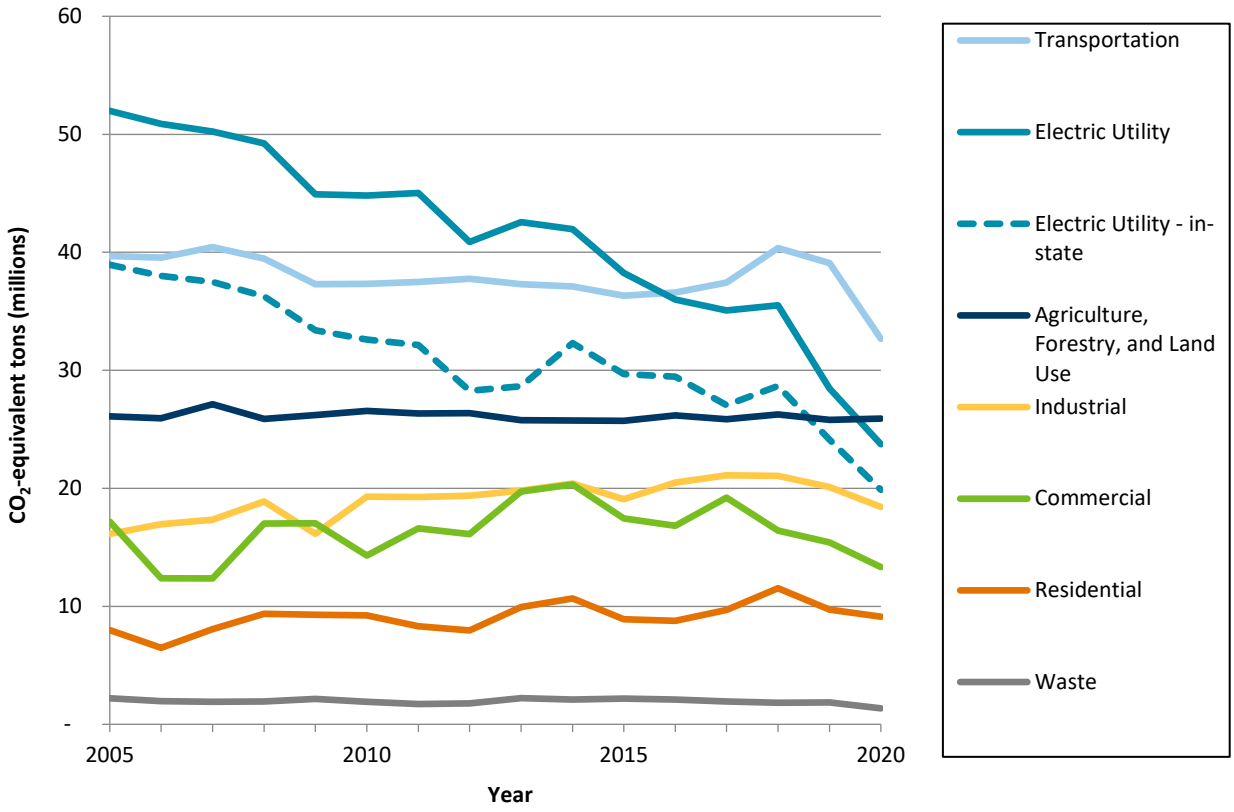
[27] Minn. Statutes 216H.01, https://www.revisor.mn.gov/statutes/cite/216H.01

**Table 3: Greenhouse gas emissions (MMT $CO_2e$) from the electric utility sector, excluding out-of-state emissions**

| Sector | Emissions in 2005 | Emissions in 2020 | Net change, 2005-2020 | Percent change, 2005-2020 | Percent of total emissions in 2020 |
|---|---|---|---|---|---|
| Electric utility – in-state generation | 38.9 | 19.9 | -19.1 | -49% | 16% |

Figure 2 shows greenhouse gas emissions trends over time by sector from 2005-2020.

**Figure 2: Greenhouse gas emissions (MMT $CO_2e$) by sector, 2005-2020**




A comparison of the Minnesota greenhouse gas inventory and the EPA Inventory of U.S. Greenhouse Gas Emissions by State for Minnesota is included in Appendix B.

## Approach to developing the PCAP

The state of Minnesota laid significant groundwork for climate action planning with Minnesota's Climate Action Framework, which served as a foundation for the PCAP. The framework was shaped by input from more than 3,000 Minnesotan's voices, 11 Tribal Nations that share Minnesota's geography, the Governor's Advisory Council on Climate Change, and the Climate Change Subcabinet. Opportunities for participation included:

- Public input via EngagementHQ, an online engagement platform where participants could read the draft framework materials, pose questions, and complete surveys to share their feedback
- Written comments submitted via email

The Climate Change Subcabinet and the Governor's Advisory Council on Climate Change jointly convened stakeholder workgroups organized around each of the chapters of the draft framework.

## PCAP engagement audiences and methods

For the PCAP, the CPRG team continued coordinating with Tribal Nations and engaging municipalities, state agencies, interested organizations, and individuals to inform greenhouse gas emissions reduction measures, community benefits, and workforce elements. Engagement and coordination actions and approaches included:

- **Interagency teams:** The CPRG team convened an interagency project team to help identify priority greenhouse gas reduction measures in multiple sectors. Additionally, the team worked closely with the Interagency Climate Steering Team, Senior Leaders Coordinating Team, Tribal Coordination Team, and Climate Change Subcabinet.
- **Engagement HQ online engagement platform and GovDelivery email list:** The CPRG team established an Engagement HQ platform, email list of 500+ representatives from local governments, Tribes, and other interested parties, and other methods for communicating with interested parties about the project.
- **Webinars:** The CPRG team held 9 public webinars from August 2023 to February 2024 to spread the word about CPRG, help ensure eligible entities were aware of their eligibility, identify priority actions from community members and eligible entities, and publicly share drafts, answer questions, and seek feedback on work products.
- **Project idea solicitation:** The CPRG team solicited climate mitigation project ideas to inform the PCAP, accepting ideas through the Engagement HQ site, email, and an online form.
- **Tribal-state government-to-government coordination:** The CPRG team offered government-to-government coordination with federally recognized Tribes and hired a CPRG Tribal-State Coordinator to coordinate with Tribal Nations. This coordinator, along with the Tribal liaisons from agencies involved in CPRG met one-on-one and in groups with staff and leaders from Tribal Nations. The CPRG team also presented at weekly calls between the Minnesota Governor's Office and Tribal leadership. The CPRG team attended a government-to-government forum with Tribal leaders to present about the CPRG opportunity, discuss Tribal climate action priorities, and explore ways to share information and work together.
- **MPCA Environmental Justice Advisory Group:** The CPRG team convened meetings with the group's climate subcommittee for feedback on processes, measures, and LIDAC benefits analysis. Membership consists of a diverse group of people from various parts of the state with a variety of backgrounds and skills. The group advises MPCA on implementing the agency's environmental justice framework, provides feedback on its effectiveness, and offers suggestions for future improvements. These efforts ensured the CPRG team was aligning with the environmental justice policies delineated by the Justice40 Initiative.
- **Community-based organization meetings:** The CPRG team met with community-based organizations serving LIDACs to build relationships, share information on the state's PCAP process, and solicit feedback on the measures and processes.
- **MDH Health Equity staff:** The CPRG team met with Health Equity Network Coordinators and Healthy Equity Strategists from the Minnesota Department of Health to review proposed measures, analyze benefits and disbenefits, and make recommendations to improve benefits for LIDACs. The Minnesota Health Equity Networks collaborate to connect, strengthen, and amplify health equity efforts and community issues using a regional and relational

approach. The coordinators bring experience, knowledge, and relationships with local public health, Tribal public health, and community organizations to address long-standing health equity issues.

- **Coordination with other CPRG planning grant recipients:** MPCA communicated with the Metropolitan Council, Mille Lacs Band of Ojibwe, Midwest Tribal Energy Resources Association, and Shakopee Mdewakanton through the PCAP development process to share data and information, ensure PCAP coverage of off-reservation lands, and discuss collaboration.
- **Past engagement efforts and findings:** The CPRG team identified findings and outcomes from past community engagement efforts of relevant programs and initiatives led by other state agencies and local governmental units.
- **No wrong door – open, transparent, and frequent communication:** The CPRG team upheld a "no wrong door" approach and transparency in all engagement efforts. The CPRG team accepted stakeholder input through all means, including one-on-one meetings, emails, phone calls, public webinars, surveys, and virtual forums on the Engagement HQ site. The CPRG team publicly presented updates and posted outlines, drafts, presentation slides, and recorded webinars on the Engagement HQ site throughout the development of the PCAP measures and solicited feedback from a wide range of stakeholders. The team adhered to plain language principles to provide concise, understandable information to the public.

## PCAP development process

At the forefront of the development process, the CPRG team applied central principles of the Justice40 Initiative to engage stakeholders and community involvement in order to address the intersectionality of underinvestment, environmental justice, and climate change on disproportionately impacted communities. MPCA offered a series of public webinars and facilitated coordination among state agencies, Tribal Nations, and stakeholders throughout the PCAP development process to develop and review priorities and proposed project ideas.

Summary of the PCAP development process:

- Climate Change Subcabinet goal teams identified greenhouse gas emission reduction measures in the Climate Action Framework and engaged sector stakeholders to indicate high-priority action categories. MPCA released these categories in a Draft Concepts document and solicited public feedback in October through an online engagement platform, in-person meetings with community groups, virtual meetings with state agencies, local governments, and interested individuals and organizations; as well as discussions with Tribal Nations.
- MPCA met with members of its Environmental Justice Advisory Group Climate Change Subcommittee at key points to collect feedback on the state's engagement and decision-making process and gather insights regarding potential measures and projects aimed at greenhouse gas emissions reductions, highlighting opportunities, gaps and concerns.
- MPCA opened a public survey to gather more specific project ideas within the priority categories. This survey garnered over 350 submissions from local governments, community-based organizations, state agencies, academic institutions, businesses, and interested individuals, spanning from general ideas to detailed project proposals. These proposed projects, as well as a coordination process with the 11 Tribal Nations that share Minnesota's geography, helped inform the measures that are now integrated into the PCAP.
- Using input from senior leaders at Climate Change Subcabinet agencies, Tribal Nations, and municipalities, MPCA narrowed the project list to develop draft PCAP measures that would be

implementable in the near-term, offered opportunities for greenhouse gas emissions reduction, and were not well covered by other funding opportunities. MPCA released a draft in early January for public comment.

- MPCA gathered over 100 comments on the draft PCAP through an online form, which included requests for adjustments to PCAP measures.

MPCA refined the PCAP using public input and strategic filtering to develop measures and analyses that reflect the opportunities and priorities of the state.

## Ongoing engagement

Minnesota's climate work is grounded in engagement and equity. As part of this larger effort, the CPRG team will continue to consistently include diverse linguistic, cultural, institutional, geographic, and other perspectives throughout the CPRG program. In addition to the methods and approaches described above, the CPRG team and the state's interagency climate teams more broadly are committed to ongoing and meaningful engagement with Tribal Nations, the MPCA Environmental Justice Advisory Group, MDH Health Equity staff, municipalities, and interested individuals and organizations.

As part of this ongoing commitment, the CPRG team will work to engage diverse linguistic, cultural, institutional, geographic, and other perspectives during the development of the Comprehensive Climate Action Plan, with a particular focus on engaging LIDACs. The voices of diverse Minnesotans will be fundamental to climate planning and implementation as the state continues to develop climate projects, programs, and policies as part of CPRG and beyond. Any project or program funded by CPRG implementation or planning funding will include meaningful engagement to help shape the development of those projects or programs. The MPCA is committed to providing accessible content and engaging LIDACs and others on specific projects and programs relevant to their communities to foster collaboration, incorporate community driven priorities, and track program benefits and disbenefits.

# Greenhouse gas reduction measures

Minnesota has ten priority measures for greenhouse gas reduction within four goal areas of the Climate Action Framework:

1. Clean transportation
    1.1. Accelerate the transition to low- and no-carbon fuels in vehicles and equipment
    1.2. Increase availability and adoption of clean travel options
2. Climate-smart natural and working lands
    2.1. Manage forests, grasslands, and wetlands for increased carbon sequestration and storage
    2.2. Accelerate soil health and nitrogen, livestock, and manure management practices that reduce greenhouse gas emissions and enhance carbon storage
    2.3. Invest in climate-smart local economies and emerging agricultural and forest technologies and products
3. Clean energy and efficient buildings
    3.1. Reduce greenhouse gas emissions from residential buildings by promoting energy efficiency, renewable energy, electrification, and lower-carbon design, materials, and fuels
    3.2. Reduce greenhouse gas emissions from commercial and public buildings by promoting energy efficiency, renewable energy, electrification, and lower-carbon design, materials, and fuels
4. Clean economy
    4.1. Increase industrial efficiency, transition to cleaner energy sources, and reduce process emissions; switch to climate-friendly refrigerants in commercial and industrial settings
    4.2. Develop cleaner fuel stocks and supporting infrastructure
    4.3. Promote waste prevention, reduction, and recycling

## 1. Clean transportation

### 1.1. Accelerate the transition to low- and no-carbon fuels in vehicles and equipment

**Description**

Increase adoption of light-duty electric vehicles and transition medium-duty, heavy-duty, and nonroad vehicles and equipment from diesel and gas to electricity or low-carbon fuels, with a focus on reducing co-pollutants in LIDACs.

Actions include:

1.1.1. Electrify light-duty vehicles and equipment, including sedans, light-duty trucks, maintenance vehicles, outdoor recreation-related vehicles, smaller machines, and groundskeeping equipment. Replace local, short-trip vehicles with lower-carbon alternatives, such as electric cargo bikes with or without trailers. Install supporting charging infrastructure. Provide planning, contracting, financial, technical, and workforce development assistance to facilitate this transition.

1.1.2. Improve equitable access to electric vehicle charging infrastructure by installing charging stations at multifamily housing sites, providing public chargers, and assisting low- and moderate-income households to charge vehicles at home. Focus on charging infrastructure and workforce development that would benefit LIDACs.

1.1.3. Transition fossil-fueled medium-duty, heavy-duty, and nonroad vehicles and engines away from fossil fuels toward low- and no-carbon-fueled alternatives, including but not limited to electricity, renewable natural gas, green hydrogen, green ammonia, and advanced biofuels. Vehicles and equipment include, but are not limited to, transit and school buses, heavy-duty and medium-duty trucks, terminal tractors, construction equipment, agricultural equipment, locomotives, ground and maritime freight equipment, landscaping and maintenance equipment, and generators. Plan and install supportive charging and fueling infrastructure at individual facilities to support fleet transition. Planning will involve workforce development for electric vehicle charging installation.

1.1.4. Plan and expand public charging infrastructure. Support regional coordination and workforce development for planning and building charging infrastructure, especially for medium- and heavy-duty electric vehicles.

### Implementation

The implementing agency may provide technical and planning assistance and offer incentives such as rebates and grants to encourage the purchase of vehicles and equipment and the installation of charging and fueling infrastructure. Implementing agencies may use CPRG funding to develop plans and procure vehicles, equipment, and associated charging infrastructure in their fleets. The implementing agency would engage communities, especially LIDACs, Tribal Nations, and relevant stakeholders in the development of related programs, policies, and projects.

**Implementing agency.** Any of the following implementing agencies could use this measure:

- State agencies, including but not limited to MnDOT, MPCA, DNR, MDA, DEED and Department of Administration
- Tribal Nations
- Municipalities including, but not limited to, cities, counties, regional development organizations, and port authorities

**Review of authority to implement.** Implementing agencies have the authority necessary to implement the measure; however, approvals may be required from planning commissions and elected leadership for specific projects.

**Implementation schedule and milestones.** For existing programs, implementing agencies could build on relationships and networks, following established program cycles. For incentive-based actions such as grants, a tentative schedule could be to develop requests for proposals by the end of 2024, accept applications in early 2025, and begin implementing projects in late 2025. The grant cycle may be repeated, as funding allows.

For collaborative buildout of regional charging infrastructure, a planning phase would be necessary in 2025, followed by implementation of projects in 2026.

**Geographic location.** Statewide, with additional focus on vehicles and equipment that operate in LIDACs, especially where criteria and hazardous air pollutants are high, and on charging infrastructure that serves LIDACs. Fobr medium- and heavy-duty vehicles, additional focus on key regional corridors.

**Metrics for tracking progress.** Metrics may include number of registered electric vehicles, regranting projects funded and impacts, carbon intensity of transportation fuels, greenhouse gas emissions from transportation, and air quality.

The Minnesota 2022 Statewide Multimodal Transportation Plan establishes a goal to decrease greenhouse gas emissions from the transportation sector by 30% by 2025, 50% by 2030, 65% by 2035, and 80% by 2040, from a 2005 baseline.[28]

### Intersection with other funding availability

Complementary funding sources include:

- Volkswagen settlement grants. Minnesota is using these funds to fund vehicle replacements and invest in electric vehicle charging stations.
- Federal and state-funded electric vehicle purchase rebates
- EPA's Clean School Bus program
- State electric school bus grants
- State grants to auto dealers to offset costs incurred to certify the dealer to sell electric vehicles
- Various electric utility programs
- Other local and Tribal funding sources may be available
- Complementary efforts funded by:
    - Diesel Emissions Reduction Act
    - Federal Highway Administration Congestion Mitigation and Air Quality Improvement Program
    - Carbon Reduction Program
    - Inflation Reduction Act Clean Ports
    - Federal Highway Administration Charging and Fueling Infrastructure Discretionary Grant
    - Inflation Reduction Act Alternative Fuel Vehicle Refueling Property Credit Direct Pay
    - Federal Highway Administration National Electric Vehicle Infrastructure program

### Estimate of greenhouse gas emissions reductions

**Near-term cumulative greenhouse gas emissions reductions (2025 to 2030):** 3.5 MMT $CO_2e$

**Long-term cumulative greenhouse gas emissions reductions (2025 to 2050):** 76.7 MMT $CO_2e$

**Methods and assumptions:** Estimation methods are discussed in Appendix C.

### LIDAC benefits analysis

**Impacted LIDACs and existing climate risks, impacts, and vulnerabilities:**

[10] Minn. Department of Transportation. 2022. Statewide Multimodal Transportation Plan https://minnesotago.org/final-plans/smtp-final-plan-2022

- LIDACs in urban areas tend to have to higher traffic proximity, leading to greater exposures to traffic crashes, air pollution and noise pollution, and higher temperature levels, which increases risks of premature mortality and morbidity.[29,30,31]
- LIDACs are more likely to have higher rates of zero-car households, lower access to jobs, goods, services, greenspace, and higher transportation cost burden.[32]
- LIDACs experience barriers to electric vehicle uptake due to high upfront costs, technological barriers, and low access to charging options (e.g., street parking).

**Estimated potential benefits and disbenefits of greenhouse gas emission reduction measures to LIDACs:**

- Increased vehicle electrification in LIDACs would reduce localized air pollution and traffic-generated noise, supporting multiple health benefits including improvements in mental and cognitive development, reduction in respiratory and cardiovascular health risks, decreased asthma rates, and fewer hospital admissions.
- Additional school bus electrification co-benefits include gains in academic performance, decreased energy costs, and quieter, more comfortable ride.[33]

## 1.2 Increase availability and adoption of clean travel options

### Description

Enhance the availability and adoption of clean travel options such as bicycling, walking, transit, and car-sharing as alternatives to single-occupancy vehicle use to promote health, provide equitable access to clean travel options, reduce vehicle miles traveled, and reduce noise, air, and water pollution.

Actions include:

1.2.1. Increase safety and accessibility for walking, biking, and rolling in communities, by deploying community-designed quick-build projects such as curb extensions to reduce street crossing distance or paths physically separated from vehicle traffic. Acquire land and/or rights of way for infrastructure.

1.2.2. Facilitate the adoption of e-bikes and e-cargo bikes through purchase incentives; mobility hubs; e-bike, scooter, and e-cargo bike-sharing systems; e-bike infrastructure (such as solar-powered shelters and separated paths); and charging networks. Increase adoption in LIDACs through navigator programs, convenient multimodal planning and payment applications, secure parking and charging facilities for e-bikes and e-cargo bikes, and strategic placement of bike-share sites, such as at multifamily residences.

1.2.3. Facilitate equitable access to transit and electric vehicle car-share programs in the Minneapolis-St. Paul-Bloomington metropolitan statistical area and in Greater Minnesota, including microtransit, on-demand transit models, and strategic car-share locations to serve LIDACs such as multifamily housing sites.

[29] Roll and McNeil, "Race and Income Disparities in Pedestrian Injuries."
[30] Khreis et al., "The Health Impacts of Traffic-Related Exposures in Urban Areas."
[31] Pratt et al., "Traffic, Air Pollution, Minority and Socio-Economic Status."
[32] Fleming, "Social Equity Considerations in the New Age of Transportation: Electric, Automated, and Shared Mobility."
[33] Trajano, "It's Electric: Better Health and Academics Through Zero-Emission School Buses."

1.2.4. Establish electrified public, micro-, and/or on-demand transit on Tribal reservations.

1.2.5. Increase adoption through navigator programs and other efforts that assist people with low technology literacy.

1.2.6. Increase commercial transportation efficiency to reduce vehicle miles traveled via community waste hauler coordination.

### Implementation

The implementing agency may provide technical and planning assistance; design and implement infrastructure projects within its jurisdiction; offer purchase incentives for e-bikes, e-cargo bikes, and scooters; organize transit, bike- and car-sharing, and navigator programs or contract for these services; and enact agreements with community waste haulers to coordinate routes that reduce vehicle miles traveled. The implementing agency may develop and fund programs to directly enact aspects of this measure. The implementing agency would engage communities, especially LIDACs, Tribal Nations, and relevant stakeholders in the development of related programs, policies, and projects.

**Implementing agency.** This measure could be utilized by any of the following implementing agencies:

- Tribal Nations
- State agencies, including MnDOT, MPCA, and MDH
- Municipalities including, but not limited to, cities, counties, regional development organizations, and port authorities

**Review of authority to implement.** Implementing agencies have the authority necessary to implement the measure; however, approvals may be required from planning commissions and elected leadership for specific projects.

**Implementation schedule and milestones.** Each action would require different implementation schedules and milestones; however, a general schedule may include a planning and public engagement phase in 2024 through 2025, followed by local approvals in the first half of 2026, and direct implementation by implementing agencies with the appropriate authority in mid-2026. Certain actions, such as navigator programs and quick-build projects, may follow an accelerated timeline.

**Geographic location.** Statewide, with additional focus on LIDACs to reduce co-pollutant emissions and provide greater access to walkable communities, e-bike programs, and electric vehicle car-sharing.

**Metrics for tracking progress.** Metrics include reduction in vehicle miles traveled, congestion mitigation, number of services available or projects funded, and usage statistics.

The Minnesota 2022 Statewide Multimodal Transportation Plan establishes a goal to decrease greenhouse gas emissions from the transportation sector by 30% by 2025, 50% by 2030, 65% by 2035, and 80% by 2040, from a 2005 baseline, and a goal for zero-emission vehicle registrations, increased job accessibility by bicycle and transit, and improved transit performance and service.[34]

### Intersection with other funding availability

Complementary funding includes:

[34] Minn. Dept. of Transportation. 2022. Statewide Multimodal Transportation Plan https://minnesotago.org/final-plans/smtp-final-plan-2022

- State subsidy for e-bike purchase passed by the legislature in 2023, charging stations, and statewide health improvement initiatives
- Mix of state, local, private, and philanthropic funds for electric vehicle car-share programs
- MnDOT's Active Transportation Program
- MnDOT's Safe Routes to School Program
- Congestion Mitigation and Air Quality Improvement Program
- Federal Highway Administration (FHWA) formula Carbon Reduction Program
- Federal Transit Administration (FTA) Transit Operating Programs for rural and small urban systems
- Other local and Tribal funding sources may be available

## Estimate of greenhouse gas emissions reductions

**Near-term cumulative greenhouse gas emissions reductions (2025 to 2030):** 3.5 MMT $CO_2e$

**Long-term cumulative greenhouse gas emissions reductions (2025 to 2050):** 16.1 MMT $CO_2e$

**Methods and assumptions:** Estimation methods are discussed in Appendix C.

## LIDAC benefits analysis

**Impacted LIDACs and existing climate risks, impacts, and vulnerabilities:**

- LIDACs in urban areas tend to have to higher traffic proximity, leading to greater exposures to traffic crashes, air pollution and noise pollution, and higher temperature levels.[35,36,37]
- LIDACs are more likely to have higher rates of zero-car households, lower access to jobs, goods, services, greenspace, and higher transportation cost burden, which increases risks of financial insecurity, housing instability, and stress.[38]
- LIDACs experience barriers to electric vehicle uptake due to high upfront costs and low access to charging options (e.g., street parking).

**Estimated potential benefits and disbenefits of greenhouse gas emission reduction measures to LIDACs:**

- Benefits of electric vehicle car-sharing include decreased fuel and car maintenance costs, reduced transportation cost burden, improved transportation reliability and mobility.[39] As noted above, increased use of electric vehicles in LIDACs can result in physical and mental health benefits from improved air quality and reduced noise pollution.
- Benefits of improved walkability and increased access to e-bicycles include improved physical and mental health due from reductions in vehicle miles traveled, noise pollution, and air pollution.
- Benefits also include improved mobility and access to goods, services, and jobs, and lower transportation costs, which are all predictors of health outcomes.

[35] Roll and McNeil, "Race and Income Disparities in Pedestrian Injuries."
[36] Khreis et al., "The Health Impacts of Traffic-Related Exposures in Urban Areas."
[37] Pratt et al., "Traffic, Air Pollution, Minority and Socio-Economic Status."
[38] Fleming, "Social Equity Considerations in the New Age of Transportation: Electric, Automated, and Shared Mobility."
[39] Johnson, "Feasibility Report: Electric Vehicle Car-Sharing Program for Use by Low and Mid Income Communities in North-Central Minnesota, USA."

# 2. Climate-smart natural and working lands

## 2.1. Manage forests, grasslands, and wetlands for increased carbon sequestration and storage

### Description

Protect and restore peatlands, increase grassland habitat and revegetate corridors, and manage urban and community forests and forestlands on public and private lands to promote carbon sequestration, biodiversity, energy conservation, cooling, water quality, resilience to catastrophic wildfire and drought, and other benefits.

Actions include:

2.1.1. Restore peatlands impacted by legacy drainage and other hydrologic disturbances on private, public (including tax-forfeit or county-held lands and School Trust lands), and Tribal Nation lands aimed at acquiring, restoring, and enhancing peatlands. Maintain irrecoverable carbon stocks in peatlands through enhanced protective measures on public lands; deployment of conservation easements and other tools to reduce the risk of habitat fragmentation on private lands; and wider landscape level measures to create buffer zones to reduce threats to peatlands from altered hydrology and other upstream impacts.

2.1.2. Increase diverse grassland habitat by identifying and revegetating habitat corridors within solar sites, utility corridors, road rights-of way, waterways, and neighborhoods.

2.1.3. Manage urban and community forests, forestlands, and other plantings such as living snow fences for carbon sequestration through tree production and planting, maintenance of tree canopy, and protection of heritage trees. Focus on efforts to manage tree canopy in LIDACs for benefits such as energy savings, risk reduction, air pollution, and mitigation of urban heat island effect.

### Implementation

The implementing agency may provide technical and planning assistance and offer financial incentives, such as tax incentives, cost-share, grants, and other forms of payment to manage, protect, and restore land to landowners and public entities. Alternatively, the implementing agency may develop and fund programs to directly enact aspects of this measure. The implementing agency would engage communities, especially LIDACs, Tribal Nations, and relevant stakeholders in the development of related programs, policies, and projects.

**Implementing agency.** This measure could be utilized by any of the following implementing agencies:

- Municipalities including, but not limited to, cities, counties, regional development organizations, and soil and water conservation districts
- Tribal Nations
- State agencies, including but not limited to the DNR, BWSR, MDA, MPCA, MnDOT, Department of Commerce, Public Utilities Commission, and MDH

**Review of authority to implement.** Implementing agencies have existing authority necessary to implement the measure on lands they manage; however, some actions may require land acquisition, management agreements, and easements. Additionally, approvals from planning commissions and elected leadership may be necessary for specific projects.

**Implementation schedule and milestones.** For existing programs, implementing agencies could build on relationships and networks, following established program cycles. For peatland and grassland projects, a possible implementation schedule could be to conduct planning, public outreach, and partner engagement in late 2024 and early 2025, hire contractors in mid-2025, and implement projects beginning in mid- to late-2025.

For forestry projects, implementing agencies could follow a similar schedule or accelerate implementation through local forestry initiatives.

Grant rounds could be managed on a regular cycle, which creates opportunities for continuous improvement and also allows new organizations to pursue the funding opportunity.

**Geographic location.** Statewide, with some additional focus on utility corridors, school trust lands, public lands, easements, regions where peat soils predominate, transition zones between pre-settlement prairie regions and forested regions, as well as areas where forest and peatland conversion to agriculture and pasture is prevalent.

**Metrics for tracking progress.** Metrics include acres restored, acres protected, and avoided conversion.

Minnesota's Climate Action Framework established a goal to increase by 25% the amount of carbon sequestered and stored annually in natural and working lands, compared to 2014-2018 average levels by 2035.[40]

### Intersection with other funding availability

Complementary funding sources include:

- State funding for peatland easement acquisition and restoration ($9M for easements and $1.5M for inventory improvements and restoration awarded by 2023 Legislature), Habitat Friendly Utilities program, ReLeaf community forestry program, shade tree replacement, MDH Statewide Health Improvement Partnership (SHIP) initiatives, and canopy monitoring
- Complementary federal funding from the U.S. Department of Agriculture (USDA) and U.S. Department of Interior
- Other local and Tribal funding sources may be available

### Estimate of greenhouse gas emissions reductions

**Near-term cumulative greenhouse gas emissions reductions (2025 to 2030):** 3.57 MMT $CO_2e$

**Long-term cumulative greenhouse gas emissions reductions (2025 to 2050):** 33.70 MMT $CO_2e$

**Methods and assumptions:** Estimation methods are discussed in Appendix C.

The greenhouse gas impacts of the specified actions are estimated individually and listed in Table 4.

[40] Minn. Climate Action Framework. 2022. https://climate.state.mn.us/minnesotas-climate-action-framework

**Table 4. Potential greenhouse gas reductions that could result from large-scale implementation of various climate-smart land use changes and improved management practices**

| Action | Potential reductions by 2030 (MMT $CO_2e$) | Potential reductions by 2050 (MMT $CO_2e$) |
|---|---|---|
| Rewet cropped peatlands | 0.302 | 6.237 |
| Rewet pastured and partially drained peatlands | 0.498 | 10.28 |
| Establish high-diversity grasslands in road and utility rights of way | 0.067 | 1.658 |
| Establish high-diversity grasslands adjacent to waterways | 0.008 | 0.207 |
| Establish high-diversity grassland habitat in place of lawns in neighborhoods | 0.021 | 0.523 |
| Better manage existing forests | 1.229 | 6.147 |
| Increase and better manage urban and community forests | 0.081 | 0.487 |
| Increase trees on the landscape via windbreaks, shelter belts, living snow fences, etc. | 1.360 | 8.160 |

## LIDAC benefits analysis

### Impacted LIDACs and existing climate risks, impacts, and vulnerabilities:

Due to racial residential segregation through explicit codification in laws and institutional practices, and historic disinvestment in segregated areas, urban LIDACs tend to have lower access to greenspace, and less tree coverage.[41,42,43] Inequities in greenspace and tree coverage exacerbate economic and health disparities, and amplify heat exposure. Amplified heat exposure due to urban heat islands can result in pronounced public health consequences, including heat stroke, dehydration, exacerbation of existing medical conditions, and increased mortality.[44,45]

In addition to heat exposure, inequitable greenspace access and tree coverage can worsen disparities in utility costs, violence, air quality, physical activity, and community connectivity, and many other social determinants of health.[46,47]

For the Tribal Nations that share Minnesota's geography, natural resources are of deep cultural and subsistence importance. As part of the treaties that ceded most of the land that is now Minnesota, the Anishinaabe and Dakota people retained rights to hunt, fish, and harvest from ceded lands and waters. The ability to exercise those treaty rights depends on clean water, air, and healthy ecosystems. Climate

[41] Kephart, "How Racial Residential Segregation Structures Access and Exposure to Greenness and Green Space."
[42] McDonald et al., "The Tree Cover and Temperature Disparity in US Urbanized Areas."
[43] "New Tool Helps Cities Preserve and Enhance Tree Canopy."
[44] Chakraborty et al., "Disproportionately Higher Exposure to Urban Heat in Lower-Income Neighborhoods."
[45] Sinha et al., "Modeling Lives Saved from Extreme Heat by Urban Tree Cover☆."
[46] Burley, "Green Infrastructure and Violence."
[47] Turner-Skoff and Cavender, "The Benefits of Trees for Livable and Sustainable Communities."

change disruption to these systems pose detrimental threats to the culture and lifeways of the Anishinaabe and Dakota people.[48]

**Estimated potential benefits and disbenefits of greenhouse gas emission reduction measures to LIDACs:**

Increasing greenspace and tree canopy coverage in LIDACs can have wide ranging benefits including reducing stress, improving mental health, increasing physical activity, reducing obesity rates, reducing asthma rates, improving social cohesion, reducing traffic speeds, reducing household expenditures on heating and cooling, reducing extreme heat exposure, and reducing neighborhood crime. [49]

Engaging communities in planning and implementation can increase the likelihood of long-term project success, empower communities and support career building opportunities and social cohesion.[50] Across the northern half of Minnesota, there is substantial overlap between large areas of peatland and LIDACs, including Tribal Nations and the 1854 Ceded Territory.[51] Peatland restoration, in partnership with Tribal communities, can advance Tribal communities' goals to increase carbon storage, reduce mercury methylation, and improve water quality. Data and research findings from this measure could be used by Tribal Nations for peatland management efforts on Tribal lands. Peatland restoration will mitigate flooding risks, and better protect groundwater and surface water quality.[52]

Tribal government staff have expressed interest and support for projects that protect and enhance carbon storage, reduce mercury methylation, and improve water quality; restoring peatlands advances those goals. Restoring peatlands in partnership with Tribal communities may help protect and restore culturally significant species. Protecting and restoring culturally significant species can have wide ranging benefits including improved cultural cohesion, improved financial security, and improved mental and physical health through preservation of subsistence harvesting traditions, spiritual relationships, ceremonies, language, and stories.[53,54]

Other potential benefits for LIDACs and Tribal communities include water security, preventing downstream flooding, fire risk reduction, decreased fish advisories, *manoomin* (wild rice) protection and restoration, relationship building with landowners and Tribal communities, and ecotourism.

[48] Stults et al., "Climate Change Vulnerability Assessment and Adaptation Plan: 1854 Ceded Territory Including the Bois Forte, Fond Du Lac, and Grand Portage Reservations."
[49] Ulmer et al., "Multiple Health Benefits of Urban Tree Canopy."
[50] Ilieva et al., "The Socio-Cultural Benefits of Urban Agriculture," April 23, 2022.
[51] Histosols mapping tool and EJScreen mapping tool
[52] Workplan provided by Minnesota Department of Natural Resources (DNR) & Minnesota Board of Water and Soil Resources (BWSR)
[53] GLIFWC Climate Change Team, "Aanji-Bimaadiziimagak o'ow Aki."
[54] "Expanding the Narrative of Tribal Health: The Effects of Wild Rice Water Quality Rule Changes on Tribal Health."

## 2.2. Accelerate soil health and nitrogen, livestock, and manure management practices that reduce greenhouse gas emissions and enhance carbon storage

### Description

Invest in climate-smart practices for soil health, manage nutrients to increase nitrogen use efficiency and reduce nitrous oxide emissions, and implement livestock and manure management practices that minimize nitrogen runoff and methane production.

Actions include:

2.2.1. Expand climate-smart practices for soil health, including cover crops, conservation tillage, agroforestry, prescribed grazing, silvopasture, transitioning marginal land to perennials, perennial crops, winter annual crops, and continuous living cover.

2.2.2. Support market development, specialized equipment needs, and other infrastructure needed for wide-scale adoption of climate-smart practices.

2.2.3. Implement nutrient management practices such as nitrification inhibitors, split nitrogen applications, and optimizing timing of fertilizer application, considering specific regional contexts for application timing and rates as appropriate.

2.2.4. Implement livestock management practices such grazing systems and feed management to reduce greenhouse gas emissions.

2.2.5. Reduce methane emissions through improved manure storage and handling. Specific practices include waste separation, waste storage facilities, as well as composting and anaerobic digestion facilities, both of which could accept diverse feedstocks.

2.2.6. Provide planning, workforce development, technical, and financial assistance, as necessary.

2.2.7. Develop a carbon intensity score registry and incentive program to accelerate adoption of climate-smart agricultural practices. The registry will be facilitated by a third-party entity and may be coordinated with other Midwestern states. A carbon intensity score registry links the carbon sequestration and emissions reduction benefits of sustainable and regenerative agricultural practices to the agricultural product, and they remain linked throughout the supply chain. The registry and incentive program achieves greenhouse gas reductions through market mechanisms that reward agricultural producers that lower their carbon intensity by using sustainable and regenerative agricultural practices.

2.2.8. Assist agricultural producers to evaluate their carbon intensity to allow them to get credit for implementing climate-smart agricultural practices.

### Implementation

The implementing agency may offer incentives, such as grants, cost-share, tax incentives, and payments, for implementation of climate-smart agricultural practices. The agency may offer incentives for market development and offer technical assistance programs with planning, implementation, and evaluation. The implementing agency would engage communities, especially LIDACs, Tribal Nations, and relevant stakeholders in the development of related programs, policies, and projects.

**Implementing agency.** This measure could be utilized by any of the following implementing agencies:

- State agencies including MDA, MPCA, BWSR, and DEED
- Tribal Nations
- Municipalities including, but not limited to cities, counties, regional development organizations, and soil and water conservation districts

**Review of authority to implement.** Implementing agencies have existing authority necessary to implement the measure. Some projects, such as anaerobic digesters, may require environmental review, permitting, and other approvals.

**Implementation schedule and milestones.** For climate-smart agricultural practices, implementing agencies could expand existing programs and build on relationships and networks to expand adoption, following established program cycles. For new programs, a planning and engagement phase in late 2024 and early 2025 would be necessary to develop requests for proposals. The implementing agency could publish a request for proposals and accept applications during 2025 and funded projects could begin implementation beginning in late 2025 or 2026. Grant rounds could be managed on a regular cycle, which creates opportunities for continuous improvement and also allows new organizations to pursue the funding opportunity. For projects that require design and permitting (e.g., manure storage facilities), study, or development of a new framework, additional time may be needed before projects begin.

**Geographic location.** Statewide, with additional focus on food and farm systems, agricultural regions, areas of concentrated livestock operations with high nitrate levels in the ground water, drinking water supply management areas, areas of groundwater depletion, wastewater treatment facilities, hog or dairy farms, manure or food waste digestors, meat packaging facilities, and creameries.

**Metrics for tracking progress.** Metrics include greenhouse gas emissions reductions, carbon sequestration, and acres and projects enrolled.

Minnesota's Climate Action Framework[55] established two relevant goals:

- Reduce annual greenhouse gas emissions in the working lands sector by 25% from 2018 levels by 2035.
- Increase by 25% the amount of carbon sequestered and stored annually in natural and working lands, compared to 2014-2018 average levels by 2035.

### Intersection with other funding availability

Complementary funding sources include:

- BWSR Soil Health Staffing and Delivery Grants
- BWSR Watershed-Based Implementation Funding
- MDA Continuous Living Cover Grant
- MDA Soil Health Equipment Grants
- MDA Minnesota Agricultural Water Quality Certification Program
- MDA Agricultural Growth, Research, and Innovation (AGRI) Livestock Investment Grant
- MDA Agricultural Growth, Research, and Innovation (AGRI) Value-Added Grant Program

[55] Minn. Climate Action Framework. 2022. https://climate.state.mn.us/minnesotas-climate-action-framework

- MDA Down Payment Assistance Grant
- MDA Emerging Farmer Technical Assistance Grant
- Minnesota Clean Water, Land and Legacy Amendment Funds
- Complementary federal funds including:
  - USDA NRCS Regional Conservation Partnership Program funds
  - USDA NRCS Environmental Quality Incentives Program (EQIP)
  - USDA Conservation Reserve Program
  - Inflation Reduction Act Investment Tax Credits and Production Tax Credits
  - Other federal conservation and stewardship programs
  - Other local and Tribal funding sources may be available

## Estimate of greenhouse gas emissions reductions

**Near-term cumulative greenhouse gas emissions reductions (2025 to 2030):** 11.01 MMT AR4 $CO_2e$

**Long-term cumulative greenhouse gas emissions reductions (2025 to 2050):** 71.80 MMT AR4 $CO_2e$

The greenhouse gas impacts of the specified actions are estimated individually and listed in Table 5.

**Table 5. Potential cumulative greenhouse gas reductions that could result from large-scale implementation of various climate-smart agricultural practices**

| Action | Potential reductions by 2030 (MMT $CO_2e$) | Potential reductions by 2050 (MMT $CO_2e$) |
|---|---|---|
| Agroforestry | 0.275 | 1.651 |
| Prescribed grazing | 0.800 | 4.800 |
| Silvopasture | 0.437 | 2.622 |
| Conservation tillage (full till to no-till) | 0.648 | 3.241 |
| Conservation tillage (full till to reduced till) | 0.318 | 1.592 |
| Perennial crops | 0.939 | 4.695 |
| Cover crops/winter annual crops | 1.212 | 6.058 |
| Nitrification inhibitors | 2.758 | 13.788 |
| Split nitrogen applications | 1.025 | 5.124 |
| Feed additives for ruminants | 0.483 | 10.143 |
| Composting manure and food scraps | 1.013 | 7.762 |
| Manure roofs and covers | 0.306 | 1.530 |
| Anaerobic digesters | 0.800 | 8.800 |

**Methods and assumptions.** To estimate the total emissions reduction potential, we estimated the amount of acreage to which each practice could reasonably be applied by 2030, given the current crop and animal agriculture in the state and the readiness of various technologies and markets. We multiplied each acreage by emission factors from peer-reviewed scientific literature. We determined that 2,000,000 acres each of nitrification inhibitors and split nitrogen application could be implemented; 1,000,000 acres each of winter cover crops, no-till, reduced-till could be implemented; 500,000 acres of perennial crops within a crop rotation could be implemented; 200,000 acres of prescribed grazing could be implemented; and 100,000 acres each of agroforestry and silvopasture could be implemented. Complete estimation methods are discussed in Appendix C.

## LIDAC benefits analysis

**Impacted LIDACs and existing climate risks, impacts, and vulnerabilities:**

Areas of southeastern Minnesota have unsafe concentrations of nitrate in groundwater. State agencies and local partners are working together to address this issue. Nitrate is a particular concern for those who get their drinking water from private wells in eight counties in southeastern Minnesota: Olmsted, Goodhue, Dodge, Wabasha, Fillmore, Mower, Winona, and Houston. These counties include LIDACs and some of the vulnerable townships may overlap with these LIDACs. Mitigation of nitrate contamination is costly and places disproportionate burdens on households that rely on private wells for drinking water. Costs are also higher per capita for small public water systems. Consuming too much nitrate can affect how blood carries oxygen and can cause methemoglobinemia.[56]

There is substantial room for manure applications to be handled better and protect health, especially by avoiding drinking water supply management areas and geologically sensitive recharge areas for private wells.[57]

While nitrate concerns have come to the forefront in southeastern Minnesota, Tribal Nations across the state are also impacted by agricultural practices on surrounding lands, resulting in loss of forest cover, increased nutrient runoff, and excessive groundwater consumption in some areas.

**Estimated potential benefits and disbenefits of greenhouse gas emission reduction measures to LIDACs:**[58]

If implemented in a way that prioritizes implementation in LIDACs, this measure would increase the likelihood of emerging farmers and low-income farmers benefitting from additional income and accessible technical assistance, as well as receiving grants.

Benefits of implementing soil health and nitrogen, livestock, and manure management practices in and around LIDACs include:

- Improved water quality through a reduction in nutrient runoff, sediment, soil loss, and phosphorous loss, which protects water recreation, fishing, and aquatic habitats.
- Improved soil health through soil structure and organic matter content, which is key for agricultural resiliency. Healthy soils better infiltrate precipitation, increase water-holding capacity, and maintain plant-available water during periods of dryness, which mitigates extreme weather events, and flooding, and protects food security.
- Increasing land access and economic opportunity by supporting emerging and beginning farmers to transition to climate-smart agricultural practices on owned or rented land.

Potential co-benefits of expanding organics management infrastructure such as composting and anaerobic digesters include reduced fossil fuel use, improved soil health, reduced nitrogen runoff, improved water quality, avoidance of the health and environmental harms from landfill leachates contaminating groundwater, and economic opportunities, including building a circular economy, construction job opportunities, and revenue for operators and municipalities.

[56] Minn. Department of Health, "Nitrate in Drinking Water."
[57] MDH Hydrologist interview
[58] Benefits identified through workplans and discussions with MDA and MDH staff

Potential disbenefits and public concerns regarding anaerobic digesters include the risk of manure spill during transport, odors, and increases in truck traffic due to transport. The context specific design and placement of the anaerobic digester can minimize these disbenefits. For example, siting near manure and food scrap sources minimizes transport distances and spill risk, and replacing uncovered manure lagoons with enclosed facilities can reduce odors, rather than increase them. Anaerobic digester planning and placement should involve community engagement and strategies to avoid potential LIDAC disbenefits.

## 2.3. Invest in climate-smart local economies and emerging agricultural and forest technologies and products

### Description

Build climate-smart local food systems, develop markets for long-lived wood products and waste wood, and produce and use biochar.

Actions include:

2.3.1. Build climate-smart local food systems that reduce greenhouse gas emissions from food production, processing, packaging, transportation, storage, retail, and food preparation. Offer planning, technical, and financial assistance; community engagement and education; and workforce development to support implementation.

2.3.2. Coordinate with Tribal governments and grants to Tribal Nations to implement climate-smart food systems projects that reduce greenhouse gas emissions while advancing indigenous food sovereignty.

2.3.3. Expand funding for projects that buy local food from disadvantaged and emerging farmers, distribute food to underserved communities and provide financial and technical assistance to local food producers.

2.3.4. Develop markets for long-lived wood products to store more carbon, such as construction lumber and furniture. Incentivize beneficial uses for waste wood, such as millwork, mulch, and biochar. Support workforce development planning and resources for new industries.

2.3.5. Promote the production and use of biochar from wood waste and other sources for various environmental and economic benefits, including mitigation of landfill methane, soil health improvement, carbon offset credits, and remediation of soil contamination. Support workforce development planning and resources for this new industry.

### Implementation

The implementing agency may provide technical and planning assistance and offer grants and other incentives for resources, market development, and workforce development. Alternatively, the implementing agency may develop and fund programs or projects to directly enact aspects of this measure. The implementing agency would engage communities, especially LIDACs, Tribal Nations, and relevant stakeholders in the development of related programs, policies, and projects.

**Implementing agency.** This measure could be utilized by any of the following implementing agencies:

- State agencies including DNR, MPCA, MnDOT, MDH, MDA, DEED and Department of Corrections
- Tribal Nations

- Municipalities including, but not limited to, cities, counties, and regional development organizations

**Review of authority to implement.** Implementing agencies have existing authority necessary to implement the measure. Some projects, such as biochar production facilities, may require environmental review, permitting, or other approval processes.

**Implementation schedule and milestones.** For existing programs, implementing agencies could build on relationships and networks, following established program cycles. For new programs an implementation schedule could look like: Conduct planning and engagement in late 2024 and early 2025, developing requests for proposals and accepting proposals through mid-2025. Award funds in late 2025 or 2026 and begin implementation in 2026. Grant rounds could be managed on a regular cycle, which creates opportunities for continuous improvement and also allows new organizations to pursue the funding opportunity. Some projects may require additional time for permitting and standards development before implementation.

Biochar industry standards to ensure quality and reliable products for users could be developed to support the expansion of the production and use of biochar. Standards could be developed in late-2024 through early 2025.

**Geographic locations.** Statewide, with additional focus on LIDACs.

**Metrics for tracking progress.** Metrics may include greenhouse gas emissions reductions, carbon sequestration, projects enrolled, waste redirected and avoided, food rescued, and methane captured.

Minnesota's Climate Action Framework established a goal to increase by 25% the amount of carbon sequestered and stored annually in natural and working lands, compared to 2014-2018 average levels by 2035.[59] However, actions in this section will reduce emissions accounted for in the agriculture, waste, transportation, and energy sectors.

### Intersection with other funding availability

Complementary funding sources include:

- MDA Local Food Purchase Assistance Program
- The Good Acre's Local Emergency Assistance Farmer Fund (LEAFF)
- State funding for woodland owners
- Minnesota Forestry Association Call Before You Cut Program
- Complementary federal funds including:
  - USDA Environmental Quality Incentives Program (EQIP)
  - USDA Conservation Stewardship Program
  - Federal funding for woodland owners
  - Other local and Tribal funding sources may be available

### Estimate of greenhouse gas emissions reductions

**Near-term cumulative greenhouse gas emissions reductions (2025 to 2030):** 4.8 MMT $CO_2e$

[59] Minn. Climate Action Framework. 2022. https://climate.state.mn.us/minnesotas-climate-action-framework

**Long-term cumulative greenhouse gas emissions reductions (2025 to 2050):** 66.2 MMT $CO_2e$

**Methods and assumptions.** Estimation methods are discussed in Appendix C.

## LIDAC benefits analysis

### Impacted LIDACs and existing climate risks, impacts, and vulnerabilities:

Food systems impact the affordability, availability, access, quality, stability, cultural acceptability, and healthfulness of the food environments in LIDACs. Strong evidence ties racial and socioeconomic disparities to inequities in food security, diet quality and healthfulness, obesity, and diet-related disease.[60]

### Estimated potential benefits and disbenefits of greenhouse gas emission reduction measures to LIDACs:

For build local food systems projects:

- Improved coordination and efficiencies of local and regional food systems can support financial security and economic mobility for small and mid-sized local food producers.
- Building local food systems can improve food security and healthy, culturally acceptable food access in LIDACs, thereby improving overall physical and mental health and reducing diet-related illness and mortality.
- Expansion of community-based agriculture, especially when co-created with LIDACs, can produce wide-ranging community level co-benefits, including engaged and cohesive communities, reduced ethnocentrism, multicultural integration, increased civic engagement, self-determination, strengthened cultural identity, improved mental health, decreased stress, increased physical activity, healthy nutrition knowledge, improved community safety, and increased access to greenspace.[61]

For production and use biochar projects:

Biochar-amended soils enhance crop growth and yield via several mechanisms: expanded plant nutrient and water availability through increased use efficiencies, improved soil quality, and suppression of soil and plant diseases. Reducing the amounts of waste diverted to landfills, and the associated adverse environmental impacts of landfills, tends to bring particular benefits to LIDACS because landfills have been shown to tend to be co-located with LIDACs.[62]

Biochar composition and properties vary considerably with feedstock and pyrolysis conditions. Improper processes and preparation methods could result in harmful components, including environmentally persistent free radicals, dioxins, and per- and polyfluoroalkyl substances (PFAS).[63] Incorporating research and developing guidelines and quality standards will help growers use biochar safely and effectively.[64]

[60] Neff et al., "Food Systems and Public Health Disparities."
[61] Ilieva et al., "The Socio-Cultural Benefits of Urban Agriculture," April 23, 2022.
[62] Cannon, 2020. "Examining Rural Environmental Injustice: An Analysis of Ruralness, Class, Race, and Gender On the Presence of Landfills Across the United States." Journal of Rural and Community Development, 15(1), 89-114.
[63] Xiang et al., "Potential Hazards of Biochar."
[64] Stakeholder input

# 3. Clean energy and efficient buildings

## 3.1. Reduce greenhouse gas emissions from residential buildings by promoting energy efficiency, renewable energy, electrification, and lower-carbon design, materials, and fuels

**Description**

Accelerate home decarbonization and clean indoor air initiatives through a combination of technologies and strategies by using incentives, design, and navigation support, focusing efforts in LIDACs.

Actions include:

3.1.1. Decarbonize residential buildings through voluntary programs by combining multiple technologies and approaches, including energy efficiency, renewable energy and fuels, refrigerant replacement, and electrification of cooking, heating, clothes drying, and hot water heating. For example, implement service panel upgrades and technologies that improve energy efficiency and reduce emissions such as heat pumps. Include networked geothermal systems, which could include residential and commercial buildings.

3.1.2. Increase access to home decarbonization resources through tiered financial incentives, rebates, pre-weatherization assistance, home energy audits, healthy home assessments, efficiency retrofitting, and workforce training for weatherization and electrification.

3.1.3. Expand energy navigator programs to serve communities across the state. Focus efforts specifically on disadvantaged residents living in manufactured home parks, public housing, rental units, reservations, and affordable multi-family and single-family homes.

3.1.4. Conduct community-scale decarbonization block-by-block to reach the residents that will benefit most from energy savings and improvement of indoor air quality. Promote community involvement in planning for residential decarbonization. Install microgrid technology tailored to local community needs. Install system upgrades, such as transformers, that are necessary to electrify specific LIDAC communities.

3.1.5. Design new buildings using green building principles, energy sources, materials, and techniques.

3.1.6. Pair decarbonization with clean indoor air strategies, especially in LIDAC areas with high criteria air pollutants and hazardous air pollutants.

3.1.7. Conduct pre-weatherization work to enable Weatherization Assistance Program activities.

3.1.8. Incorporate climate resiliency aspects to prepare homes and residents to withstand climate impacts. For example, install heat pump cooling and rooftop solar and battery storage.

3.1.9. Educate residents about residential decarbonization technologies and strategies through a variety of methods, including demonstration sites.

3.1.10. Engage with other states, sector stakeholders, members of the public, and decision makers to share strategies, learn from other efforts, and identify ways to enhance and expand efforts.

## Implementation

The implementing agency may provide technical, workforce development, and planning assistance and offer grants, loans, tax rebates and credits, and other incentives to facilitate implementation of strategies. Alternatively, the implementing agency may develop and fund programs or projects to directly enact aspects of this measure for public buildings. The agency may establish and expand navigator and educational programs to enable expanded participation and create learning collaborations among jurisdictions to accelerate implementation of residential decarbonization. The implementing agency would engage communities, especially LIDACs, Tribal Nations, and relevant stakeholders in the development of related programs, policies, and projects.

**Implementing agency.** This measure could be utilized by any of the following implementing agencies:

- State agencies including MPCA, Minnesota Housing, MDA, DEED, Department of Commerce
- Municipalities including, but not limited to, cites, counties, and regional development organizations
- Tribal Nations

**Review of authority to implement.** Implementing agencies have existing authority necessary to implement the measure. Some projects may require local permits.

**Implementation schedule and milestones.** Implementation would depend on the scale and scope of work. For existing programs, implementing agencies could build on relationships and networks, following established program cycles. A tentative schedule for residential decarbonization programs is as follows: conduct planning and engagement in late 2024 to early 2025, develop requests for proposals for third-party implementers in mid-2025, disburse funds in late 2025 or 2026, and begin implementing projects in 2026. Grant rounds could be managed on a regular cycle, which creates opportunities for continuous improvement and also allows new organizations to pursue the funding opportunity. Actions that may be implemented through existing programs could have accelerated timelines.

**Geographic location:** Statewide, with a focus on LIDACs.

**Metrics for tracking progress.** Metrics may include greenhouse gas emissions reductions, energy consumption, appliances replaced, homes enrolled, new construction meeting standards, engagement, and infrastructure installed.

Minnesota's Climate Action Framework established related goals:[65]

- By 2035, reduce greenhouse gas emissions from existing buildings by 50% compared to 2005 levels.
- By 2030, reduce energy use by 10% compared to 2005 levels.

## Intersection with other funding availability

Complementary funding sources include:

- Minnesota pre-weatherization program
- Minnesota Climate Innovation Finance Authority
- Minnesota Department of Commerce Conservation Improvement Program

[65] Minn. Climate Action Framework. 2022. https://climate.state.mn.us/minnesotas-climate-action-framework

- MPCA Project Stove Swap
- Minnesota Housing Impact Fund
- Minnesota Housing Rehab Loan Program
- Minnesota Housing Home Improvement Fix-Up Fund
- Minnesota Housing Consolidated Request for Proposals
- Minnesota Housing Publicly Owned Housing Program
- Minnesota Housing Rental Rehabilitation Deferred Loan
- Minnesota Housing Community Stabilization Program
- Rebate and incentive programs offered by electric and gas utilities
- Local funding sources for building financing and cost-share, such as Minneapolis 0% loan financing for single-family homes and Minneapolis Green Cost Share for designated multi-family Naturally Occurring Affordable Housing (NOAH)
- Xcel Partners in Energy Program
- Complementary federal funding, including:
  - Department of Energy Buildings Upgrade Prize
  - EPA Environmental Justice Collaborative Problem Solving Grant
  - EPA Solar for All
  - Inflation Reduction Act rebates and credits for home energy upgrades
  - Federal weatherization assistance program
  - Inflation Reduction Act Direct Pay
  - Other local and Tribal funding sources may be available

## Estimate of greenhouse gas emissions reductions

**Near-term cumulative greenhouse gas emissions reductions (2025 to 2030):** 1.9 MMT $CO_2e$

**Long-term cumulative greenhouse gas emissions reductions (2025 to 2050):** 58.4 MMT $CO_2e$

**Methods and assumptions.** Estimation methods are discussed in Appendix C.

## LIDAC benefits analysis

**Impacted LIDACs and existing climate risks, impacts, and vulnerabilities:**

LIDACs face a range of climate vulnerabilities related to residential conditions including heat risk disparities,[66] high energy cost burden, and poor indoor air quality, all of which are important predictors of health. [67,68,69] Weatherization and other energy efficiency programs can mitigate these conditions but often have limited reach within LIDACs due to high upfront cost, language, time, and other barriers such as split incentives between property owners and renters.[70, 71]

[66] Gabbe, Mallen, and Varni, "Housing and Urban Heat."
[67] Siddique et al., "Beyond the Outdoors."
[68] Ferguson et al., "Exposure to Indoor Air Pollution across Socio-Economic Groups in High-Income Countries."
[69] Tsoulou et al., "Residential Indoor Air Quality Interventions through a Social-ecological Systems Lens."
[70] MDH Health Equity Network Coordinator meeting
[71] Xu and Chen, "Energy Efficiency and Energy Justice for U.S. Low-Income Households."

The threat of extreme heat exposure in the summer months is rising. Heat exposure has pronounced public health consequences, including heat stroke, dehydration, exacerbation of existing medical conditions, and increased premature mortality.[72]

**Estimated potential benefits and disbenefits of greenhouse gas emission reduction measures to LIDACs:**

Benefits to upgrading correctional facilities include reduced mortality, heat stroke, respiratory illnesses and lung diseases, reduced healthcare costs, reduced spread of illness and disease, and improved mental health for inmates and staff.

Navigator programs in partnership with community-based partners will be important to help overcome knowledge, access, language, and trust barriers to increase LIDAC participation in energy efficiency, weatherization and renewable opportunities.[73] Increasing access and participation in these programs will have numerous co-benefits for LIDACs statewide including affordable energy costs, improved energy security, improved financial security, increased resilience to climate change, reducing extreme heat-induced health risks, and improved health through reductions in indoor air pollutants.

## 3.2. Reduce greenhouse gas emissions from commercial and public buildings by promoting energy efficiency, renewable energy, electrification, and lower-carbon design, materials, and fuels

### Description

Accelerate commercial and public building decarbonization through energy efficiency, renewable energy, and electrification; expand and improve district heating and cooling; implement local geothermal networks to reduce greenhouse gas emissions; and support workforce development, especially in LIDACs.

Buildings include, but are not limited to schools, government buildings, commercial properties, small business districts, hospitals and health care facilities, university buildings, mixed use developments including residential, resiliency hubs, community centers, and ice arenas and other recreational buildings.

Actions include:

3.2.1 Decarbonize existing commercial and public buildings by combining multiple technologies and approaches including: energy efficiency, energy recovery, energy storage, renewable energy and fuels, refrigerant replacement, and electrification. Eligible activities include, but are not limited to energy audits, HVAC and electrical upgrades, solar panel and battery installations, transitioning to low-temperature water heating systems, local geothermal networks, and district heating and cooling systems.

3.2.2 Pair decarbonization with clean indoor air strategies and climate resiliency.

3.2.3 Design new buildings that leverage third-party verified certification platforms, such as LEED and SB 2030, using green building principles, energy sources, materials, and techniques.

[72] Chakraborty et al., "Disproportionately Higher Exposure to Urban Heat in Lower-Income Neighborhoods."
[73] Stakeholder input

3.2.4 Engage with other states, sector stakeholders, members of the public, and decision-makers to share strategies, learn from other efforts, and identify ways to enhance and expand efforts.

3.2.5 Educate and assist building owners and renters (about commercial and public building decarbonization technologies and strategies through a variety of methods, including demonstration sites.

3.2.6 Work with small businesses to take action to decarbonize their business and its activities.

### Implementation

The implementing agency may provide technical and planning assistance and offer grants, loans, tax rebates and credits, and other incentives to facilitate implementation of strategies. Alternatively, the implementing agency may develop and fund programs or projects to directly enact aspects of this measure for public buildings. The agency may establish a navigator and educational programs to enable expanded participation and collaborate with other jurisdictions to exchange information. The implementing agency would engage communities, especially LIDACs, Tribal Nations, and relevant stakeholders in the development of related programs, policies, and projects.

**Implementing agency.** This measure could be utilized by any of the following implementing agencies:

- State agencies, including the Department of Commerce, Department of Corrections, Department of Human Services, Department of Veterans Affairs, DEED, Minnesota Housing, MPCA, and Department of Administration
- Municipalities, including, but not limited to, cities, counties, and regional development organizations
- Tribal Nations

**Review of authority to implement.** Implementing agencies have authority necessary to implement the measure. Some projects may require local permits and approvals.

**Implementation schedule and milestones.** Implementation would depend on the scale and scope of work. For existing programs, implementing agencies could build on relationships and networks, following established program cycles. A tentative schedule for commercial and public building decarbonization programs is as follows: conduct planning and engagement in late 2024 to early 2025, develop requests for proposals for third-party implementers in mid-2025, disburse funds in late 2025 or 2026, and begin implementing projects in 2026. Grant rounds could be managed on a regular cycle, which creates opportunities for continuous improvement and also allows new organizations to pursue the funding opportunity. Actions that may be implemented through existing programs could have accelerated timelines.

**Geographic location:** Statewide, with a focus on LIDACs.

**Metrics for tracking progress.** Metrics may include greenhouse gas reductions, commercial and public buildings enrolled, equipment installations, energy consumption, and engagement.

Minnesota's Climate Action Framework established related goals:[74]

[74] Minn. Climate Action Framework. 2022. https://climate.state.mn.us/minnesotas-climate-action-framework

- By 2035, reduce greenhouse gas emissions from existing buildings by 50% compared to 2005 levels.
- By 2030, reduce energy use by 10% compared to 2005 levels.

### Intersection with other funding availability

Complementary funding sources include:

- Minnesota Climate Innovation Finance Authority
- Minnesota Department of Commerce school building controls grants
- Minnesota Department of Commerce Conservation Improvement Program
- Minnesota Housing Publicly Owned Housing Program
- Utility rebates from electric and natural gas utilities
- Proposed Xcel Energy Community Ground Source Heat Pump demonstration project
- Jobs and business development programs, including community development corporations, community economic development, and economic development agencies
- Complementary federal funding including:
  - Inflation Reduction Act 179D Commercial Building Energy-Efficiency Tax Deduction
  - Inflation Reduction Act Direct Pay
  - USDA Small Community Facilities Grant
  - USDA Rural Development Funds
  - Other local and Tribal funding sources may be available

### Estimate of the quantifiable greenhouse gas emissions reductions

**Near-term cumulative greenhouse gas emissions reductions (2025 to 2030):** 1.4 MMT $CO_2e$

**Long-term cumulative greenhouse gas emissions reductions (2025 to 2050):** 48.0 MMT $CO_2e$

**Methods and assumptions.** Estimation methods are discussed in Appendix C.

### LIDAC benefits analysis

**Impacted LIDACs and existing climate risks, impacts, and vulnerabilities:**

The threat of extreme heat exposure in the summer months is rising. Heat exposure has pronounced public health consequences, including heat stroke, dehydration, exacerbation of existing medical conditions, and increased premature mortality.[75]

High temperatures correlate with increased violence among the incarcerated.[76] Nine Minnesota correctional facilities do not have air conditioning. In 2023, record breaking heat led to staffing shortages and an inmate protest against the conditions at a Stillwater correctional facility.[77] As temperatures rise with climate change, extreme heat poses increasing risks to the health and safety of inmates and staff.

[75] Chakraborty et al., "Disproportionately Higher Exposure to Urban Heat in Lower-Income Neighborhoods."
[76] Mukherjee and Sanders, "The Causal Effect of Heat on Violence."
[77] Yang, "People in Prison Struggle to Survive Unrelenting Heat without Air Conditioning."

In addition to correctional facilities, Minnesota is responsible for housing people in state hospitals and veterans homes. Many of these facilities are aging and could substantially reduce their greenhouse gas emissions through deep energy retrofits while at the same time improving the air quality, usability, and longevity of these facilities.

**Potential benefits and disbenefits of greenhouse gas emission reduction measures to LIDACs:**

- Energy-efficient community centers operating as cooling centers can protect LIDACs from heat exposure related health outcomes.
- Energy-efficient public buildings are more cost-effective and can help to reduce the tax burden and costs for water services.
- Projects to accelerate energy efficiency, decarbonization, and electrification of commercial buildings in LIDACs can reduce operation and maintenance costs, increase productivity and economic mobility for disadvantaged business enterprises, improve working environments (e.g., air quality, temperature control, reduced noise, improved lighting), and job creation. Achieving LIDAC benefits will require prioritization of commercial buildings in LIDACs.

# 4. Clean economy

## 4.1. Increase industrial efficiency, transition to cleaner energy sources, and reduce process emissions; switch to climate-friendly refrigerants in commercial and industrial settings

### Description

Transition industrial buildings and processes to clean energy sources, improve energy efficiency, expand energy recovery from wastewater and waste heat, and replace high-global warming potential refrigerants with climate-smart refrigerants in commercial and industrial settings.

Actions include:

4.1.1. Transition to clean industrial energy sources, materials, processes and products by replacing or upgrading coal, natural gas boilers and heat systems with electric boilers, heat pumps, heat recovery, renewable natural gas, green hydrogen, green ammonia, or other renewable fuels and advanced technologies.

4.1.2. Incorporate anaerobic digestion into new or existing industrial facilities, ensuring the on-site or distributed use of renewable biogas as a displacement for fossil fuels.

4.1.3. Upgrade equipment to use low-global warming potential refrigerants in commercial and industrial settings.

4.1.4. Evaluate and implement energy efficiency upgrades.

4.1.5. Expand energy and heat recovery from wastewater and waste heat, implementing measures including, but not limited to, district heating, combined heat and power, and anaerobic digestion.

4.1.6. Provide technical and financial assistance to businesses to reduce emissions. Evaluate industrial uses and work with businesses to reduce the use of fossil fuels.

4.1.7. Expand workforce training and development programs for energy-efficiency and renewable energy services and the design, installation, and operation of advanced technologies.

4.1.8. Provide technical and financial assistance for small business owners and municipalities to advance climate actions in this sector.

4.1.9. Reduce process emissions by changing product specifications and production processes to those that reduce embodied carbon, for example, lower-temperature asphalt production and direct reduced iron. Support development of markets for these products.

4.1.10. Provide focused technical assistance and financial tools to achieve significant reductions from the state's top industrial emitters.

4.1.11. Provide technical assistance and financial tools to support targeted action across specific types of industrial facilities, such as food processing.

### Implementation

The implementing agency may provide technical and planning assistance and offer incentives, such as grants, loans, tax credits, and financing to support assessments, design, retrofitting, and construction of facilities. The agency may directly fund improvements to public facilities and equipment in its jurisdiction. The implementing agency would engage communities, especially LIDACs, Tribal Nations, and relevant stakeholders in the development of related programs, policies, and projects.

**Implementing agency.** This measure could be utilized by any of the following implementing agencies:

- State agencies including the Department of Commerce, MPCA, DEED, and MnCIFA
- Tribal Nations
- Municipalities including, but not limited to, cities, counties, regional development organizations, and port authorities

**Review of authority to implement.** Implementing agencies have existing authority necessary to implement the measure; however, barriers exist for implementing waste heat recovery from wastewater treatment plants. Permitting and approvals may be required for specific projects.

**Milestones for obtaining implementing authority.** Draft legislation is being discussed for the 2024 session to clarify state statutes and remove hurdles to recovering waste heat from wastewater treatment plants. The Minnesota Legislature meets annually so authorities not granted in a given session could be pursued the following year.

**Implementation schedule and milestones.** A tentative schedule for establishing an industrial program is as follows: conduct hiring, planning, and engagement in late 2024 to early 2025, develop requests for proposals in mid-2025, select grantees and disburse funds in late 2025 or 2026, and begin implementing projects in 2026. Grant rounds could be managed on a regular cycle, which creates opportunities for continuous improvement and also allows new organizations to pursue the funding opportunity. Some projects may require feasibility studies, design, permitting, and environmental review, which would add to the timeline.

**Geographic location:** Statewide, with a focus on LIDACs.

**Metrics for tracking progress.** Metrics may include greenhouse gas emissions, energy consumption, energy efficiency, industrial partners enrolled and projects completed, and engagement.

Minnesota's Climate Action Framework established related goals: [78]

- By 2030, reduce thermal greenhouse gas emissions by at least 20%, compared to 2005 levels.
- By 2030, reduce energy use by 10% and total waste heat and waste electricity by 15%, compared to 2005 levels.

### Intersection with other funding availability

Complementary funding sources include:

- MPCA Small Business Environmental Improvement Loan Program
- Utility conservation improvement programs
- Complementary federal funding, including Department of Energy planning and engineering grant ($700K) for Duluth district heating system tied into the wastewater treatment plant
- Other local and Tribal funding sources may be available

### Estimate of greenhouse gas emissions reductions

**Near-term cumulative greenhouse gas emissions reductions (2025 to 2030):** 8.9 MMT $CO_2e$

**Long-term cumulative greenhouse gas emissions reductions (2025 to 2050):** 73.5 MMT $CO_2e$

**Methods and assumptions.** Estimation methods are discussed in Appendix C. Minnesota's Climate action framework established related goals: [79]

- By 2030, reduce thermal greenhouse gas emissions by at least 20%, compared to 2005 levels.
- By 2030, reduce energy use by 10% and total waste heat and waste electricity by 15%, compared to 2005 levels.

### LIDAC benefits analysis

**Impacted LIDACs and existing climate risks, impacts, and vulnerabilities:**

LIDACs are more likely to be near industrial areas and be exposed to environmental hazards such as fine particulates ($PM_{2.5}$), diesel particulate matter, toxic releases to air, and traffic.[80]

**Potential benefits and disbenefits of greenhouse gas emission reduction measures to LIDACs:**

- For projects that increase alternative energy use with diesel generator retirements, cogeneration, thermal storage, expand and improve district heating infrastructure in LIDACs near industrial areas with current high levels of $PM_{2.5}$, diesel particulate matter, toxic releases to air, and proximity to traffic, benefits may include reduced localized air and noise pollution, and energy savings passed on to consumers.
- For projects that expand energy recovery from wastewater and waste heat, benefits may include offsetting natural gas use within LIDAC communities resulting in reduced emissions, reductions in energy costs, and reductions in heat island effect due to less industrial heat/emissions dissipated into the environment/surrounding communities.
- If projects incorporate workforce development in LIDACs for implementation, communities could benefit from job creation.

[78] Minn. Climate Action Framework. 2022. https://climate.state.mn.us/minnesotas-climate-action-framework
[79] Minn. Climate Action Framework. 2022. https://climate.state.mn.us/minnesotas-climate-action-framework
[80] Mohai et al., "Racial and Socioeconomic Disparities in Residential Proximity to Polluting Industrial Facilities."

## 4.2. Develop cleaner fuel stocks and supporting infrastructure

### Description

Generate renewable natural gas from anaerobic digestion of waste products and landfill gas capture, build a low-carbon aviation fuel supply chain, and produce green hydrogen, ammonia, and fertilizer.

Actions include:

4.2.1. Generate renewable natural gas from anaerobic digestion and landfill gas capture, supporting facilities to transform organic waste into renewable energy, providing grants for methane digesters in feedlots, and creating programs to encourage anaerobic digestor development for renewable natural gas and fuels.

4.2.2. Build a supply chain for low-carbon feedstocks that supports decarbonization of aviation fuel

4.2.3. Develop a regulatory framework for carbon sequestration pipelines and hydrogen fuel in Minnesota.

4.2.4. Produce green hydrogen, ammonia, and fertilizer by leveraging state funding for green hydrogen hubs, creating grant programs for manufacturing green fertilizers, and establishing production-based incentives for green ammonia.

4.2.5. Provide planning, workforce development, technical, and financial assistance, as necessary.

### Implementation

The implementing agency may provide technical and planning assistance and offer incentives, such as grants, tax credits, and financing to support assessments, design, retrofitting, and construction of facilities. Alternatively, the implementing agency may directly fund a publicly owned facility. The implementing agency would engage communities, especially LIDACs, Tribal Nations, and relevant stakeholders in the development of related programs, policies, and projects.

**Implementing agency.** This measure could be utilized by any of the following implementing agencies:

- State agencies including MDA, MPCA, DNR, MDH, Public Utilities Commission, Department of Commerce, MnDOT, DEED and Environmental Quality Board
- Municipalities including, but not limited to, cities, counties, and regional development organizations
- Tribal Nations

**Review of authority to implement.** There is existing authority for permitting of anaerobic digesters and pipelines for carbon dioxide and certain nonpetroleum gas products. Some economic aspects of hydrogen production are already regulated on a state level; however, additional regulatory frameworks for carbon sequestration, and hydrogen production would be needed.

**Milestones for obtaining implementing authority.** The needed regulatory frameworks could be developed in two to three years, depending on the need for legislative action and the extent of rulemaking required.

**Implementation schedule and milestones.** For anaerobic digesters and landfill gas capture, hiring and planning for a grant program could begin in 2024, with development of a request for proposals ready in 2025. The implementing agency could publish a request for proposals and accept applications **in** 2025 and award funds in late 2025. Grant rounds could be managed on a regular cycle, which creates

opportunities for continuous improvement and also allows new organizations to pursue the funding opportunity. Projects could begin to be implemented in 2026. Design and permitting of facilities may extend this timeline.

For actions that require regulatory action, the implementing agency could seek legislative action in early 2025, followed by 18-24 months of rulemaking. Requests for proposals could then be developed in early- to mid-2027, with projects awarded funds in late 2027 and implementation beginning in 2028. The Minnesota Legislature meets annually so authorities not granted in a given session could be pursued the following year.

**Geographic location.** Statewide, with additional focus on benefiting LIDACs through jobs and economic development.

**Metrics for tracking progress.** Metrics may include projects proposed and operating, fuel and energy generated, greenhouse gas emissions avoided.

### Intersection with other funding availability

Complementary funding sources include:

- Department of Energy Heartland Hydrogen Hub
- MnCIFA
- MDA Green Fertilizer Grants
- Minnesota Sustainable Aviation Fuel Tax Credit
- Inflation Reduction Act tax credits
- Bond financing
- Other local and Tribal funding sources may be available

### Estimate of the quantifiable greenhouse gas emissions reductions

**Near-term cumulative greenhouse gas emissions reductions (2025 to 2030):** 2.2 MMT $CO_2e$

**Long-term cumulative greenhouse gas emissions reductions (2025 to 2050):** 53.4 MMT $CO_2e$

**Methods and assumptions.** Estimation methods are discussed in Appendix C.

### LIDAC benefits analysis

**Impacted LIDACs and existing climate risks, impacts, and vulnerabilities:**

Landfills are linked to major forms of environmental harms, such as groundwater contamination, production of greenhouse gases, and accumulation of toxins in human and natural systems. The presence of landfills has been shown to be co-located in LIDACs.[81]

**Potential benefits and disbenefits of greenhouse gas emission reduction measures to LIDACs:**[82]

Potential benefits of generating renewable natural gas from anaerobic digestion and landfill gas capture include reduced fossil fuel use, improved soil health, reduced nitrogen runoff, improved water quality, reduced landfill expansion and avoidance of the health and environmental harms from landfill leachates

[81] Cannon, "Examining Rural Environmental Injustice: An Analysis of Ruralness, Class, Race, and Gender On the Presence of Landfills Across the United States."

[82] Benefits and disbenefits identified through workplans and discussions with MDA and MDH staff

contaminating groundwater, and economic opportunities, including building a circular economy, construction job opportunities, and revenue for operators and municipalities.

Potential disbenefits and public concerns identified regarding anaerobic digesters include the risk of manure spill during transport, odors, and increases in truck traffic due to transport. The context specific design and placement of anaerobic digesters can minimize these disbenefits. For example, siting facilities near manure and food scrap sources minimizes transport distances and spill risk, and replacing uncovered manure lagoons with enclosed facilities can reduce odors, rather than increase them. Anaerobic digester planning and placement should involve community engagement and strategies to avoid potential LIDAC disbenefits.

## 4.3. Promote waste prevention, reduction, and recycling

### Description

Reduce greenhouse gas emissions by preventing waste, waste management, increasing opportunities for reuse and recycling, and promoting zero waste practices, a circular economy, and climate-smart development.

Actions include:

4.3.1 Reduce methane emissions from food waste via waste prevention strategies (e.g., meal planning, consumer education campaigns, proper food storage, upcycling of food to new products, the use of food inventory software, and surplus food donation), dehydrating or processing food scraps for animal feed, composting, or other means.

4.3.2 Support source-separated organics collection and processing infrastructure.

4.3.3 Increase access to organics collection in LIDACs, especially in multifamily dwellings.

4.3.4 Support markets, collection, processing infrastructure for recyclable materials (including finished compost) and products made with recycled materials, especially in Greater Minnesota, as well as workforce development.

4.3.5 Implement policies to reduce waste, such as through Extended Producer Responsibility and the elimination of single use plastics and plastics materials that cannot be recycled locally.

4.3.6 Offer grants to promote waste prevention, reuse, and recycling and for sustainable procurement. Work with industries to develop and implement plans for waste reduction, such as the tourism and hospitality industries. Promote education and financial analysis tools to calculate total cost of ownership when procuring goods and services.

4.3.7 Support businesses in the development of new products that incorporate recycled materials, promote a circular economy, and minimize the impact of waste.

### Implementation

The implementing agency may provide technical and planning assistance and offer grants, loans, tax rebates and credits, and other incentives to facilitate implementation of strategies. Alternatively, the implementing agency may develop and fund programs or projects to directly enact aspects of this measure for public facilities and lands. The agency may establish programs and projects to address aspects of this measure, such as public education and awareness campaigns. The implementing agency would engage communities, especially LIDACs, Tribal Nations, and relevant stakeholders in the development of related programs, policies, and projects.

**Implementing agency.** This measure could be utilized by any of the following implementing agencies:

- Tribal Nations
- State agencies, including MPCA, MDA, MDH, Board of Animal Health, and DEED
- Municipalities including, but not limited to, cities, counties, and regional development organizations

**Review of authority to implement.** Implementing agencies have the authority to implement programs and projects for education, grants, and county solid waste plans. Specific programming such as extended producer responsibility, requesting additional grant funds, or creating new policies that require entities to follow new procedures would require legislative action. This would require the state legislature to pass bills, in order for the bill to apply to the whole state, or a local unit of government to pass a bill, which would only impact that area. At this time there is legislation for reducing the amount of packaging materials in MInnesota. However, it is unclear if this will be passed this legislative session. The Right to Repair bill was passed in Minnesota during the last session which will make reusing and repairing products much easier. Over $20 million in funding was also passed for sustainable materials and solid waste management programs to reduce greenhouse gas emissions. Enacting new policies would require approvals.

**Milestones for obtaining implementing authority.** Implementing agencies could seek appropriate authorities from the Minnesota Legislature during the 2024 or 2025 Legislative Sessions. The Minnesota Legislature meets annually so authorities not granted in a given session could be pursued the following year. If local authority is needed for policies, these approvals could be obtained on a faster timeline.

**Implementation schedule and milestones.** For existing programs, implementing agencies could build on relationships and networks, following established program cycles. For new programs, a planning and engagement phase in late 2024 and early 2025 would be necessary to develop requests for proposals. The implementing agency could publish a request for proposals and accept applications in 2025 and funded project could begin implementation in late 2025 or 2026. Grant rounds could be managed on a regular cycle, which creates opportunities for continuous improvement and also allows new organizations to pursue the funding opportunity. For projects that require design and permitting, study, or policy development, additional time may be needed before projects begin.

**Geographic location**. Statewide, with additional focus on LIDACs.

**Metrics for tracking progress.** Metrics may include greenhouse gas emissions reduced, waste recycled or composted, waste reduction, recycling capacity, food recovery and diversion, projects implemented, and engagement.

Related goals include:[83]

- Reduce waste production in the Twin Cities metropolitan area in 2030 by 15% compared to current projections.
- Establish curbside organics collection in all cities with a population greater than 5,000 by 2030.
- Each of the seven counties in the Twin Cities metropolitan area must recycle a minimum of 75% (by weight) of total municipal solid waste they generate by 2030.

[83] MPCA. Metropolitan Solid Waste Management Policy Plan 2022-2042. https://www.pca.state.mn.us/sites/default/files/w-sw7-22.pdf

- Each of the Greater Minnesota counties must recycle a minimum of 35% (by weight) of total municipal solid waste they generate by 2030.

### Intersection with other funding availability

Complementary funding sources include:

- MPCA Prevention of Wasted Food Grants
- MPCA Environmental Assistance Loans
- The Governor's Select Committee on Recycling and the Environment (SCORE) funds
- MDH Statewide Health Improvement Partnership funds
- Other local and Tribal funding sources may be available

### Estimate of the quantifiable greenhouse gas emissions reductions

**Near-term cumulative greenhouse gas emissions reductions (2025 to 2030):** 7.02 MMT $CO_2e$

**Long-term cumulative greenhouse gas emissions reductions (2025 to 2050):** 35.08 MMT $CO_2e$

**Methods and assumptions.** Estimation methods are discussed in Appendix C.

- Reduce waste production in the Metro Area by 15% compared to current projections.
- Establish curbside organics collection in all cities with a population greater than 5,000 by 2030.
- Each of the seven counties in the Metro Area must recycle a minimum of 75% (by weight) of total municipal solid waste they generate by 2030.
- Each of the Greater Minnesota counties must recycle a minimum of 35% (by weight) of total municipal solid waste they generate by 2030.

### LIDAC benefits analysis

**Impacted LIDACs and existing climate risks, impacts, and vulnerabilities:**

Landfills are linked to major forms of environmental harms, such as groundwater contamination, production of greenhouse gases, and accumulation of toxins in human and natural systems. The presence of landfills has been shown to be co-located in LIDACs.[84]

Food security insecurity affects LIDACs across the state and since the outset of the COVID-19 pandemic, food insecurity has been volatile, surging by as much as 40% in some communities.[85] Meanwhile, up to 40% of the entire food supply is lost or wasted in the United States, which contributes to negative environmental, economic, and social outcomes.[86]

**Potential benefits and disbenefits of greenhouse gas emission reduction measures to LIDACs:*[87]***

Potential benefits of waste prevention, reduction, and recycling include community empowerment and engagement in climate solutions, reduced fossil fuel use, improved soil health, reduced nitrogen runoff, improved water quality, reduced landfill expansion and avoidance of the health and environmental harms from landfill leachates contaminating groundwater, decreased waste collection fees through

[84] Cannon, "Examining Rural Environmental Injustice: An Analysis of Ruralness, Class, Race, and Gender On the Presence of Landfills Across the United States."
[85] Healthy Foods, Healthy Lives Institute, University of Minnesota, "Food Security Dashboard."
[86] Chen, "Examining Contributors and Solutions to Prevent and Manage Food Waste in Households with Low Incomes and the Emergency Food System within the U.S."
[87] Benefits identified through workplans and discussions with MDA and MDH staff

participation in the food scrap collections, and economic opportunities, including building a circular economy, construction job opportunities, and revenue for operators and municipalities.

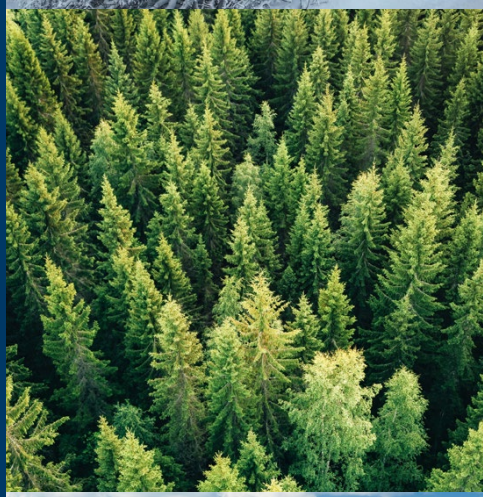
Community empowerment and engagement in climate solutions: Reducing food waste presents an opportunity to address food security and healthy food access in LIDACs. Improved food security and healthy food access are predictors of a wide range of health outcomes.

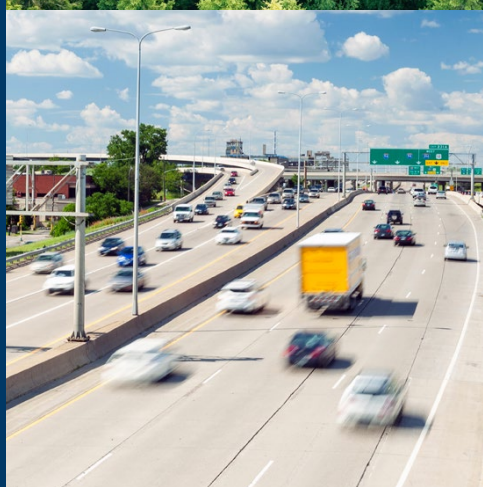
# Appendix A – Minnesota greenhouse gas emissions 2005-2020

REPORT TO THE LEGISLATURE
JANUARY 2023

# Greenhouse gas emissions in Minnesota 2005-2020

Biennial report to the Legislature tracking the state's contribution to emissions contributing to climate change.





MINNESOTA

Pollution Control Agency
Department of Commerce

Summary

# Progress and opportunities to address climate change

A summary of Minnesota's greenhouse gas emissions

## Minnesota is on track to meet greenhouse gas reduction goals for the first time.

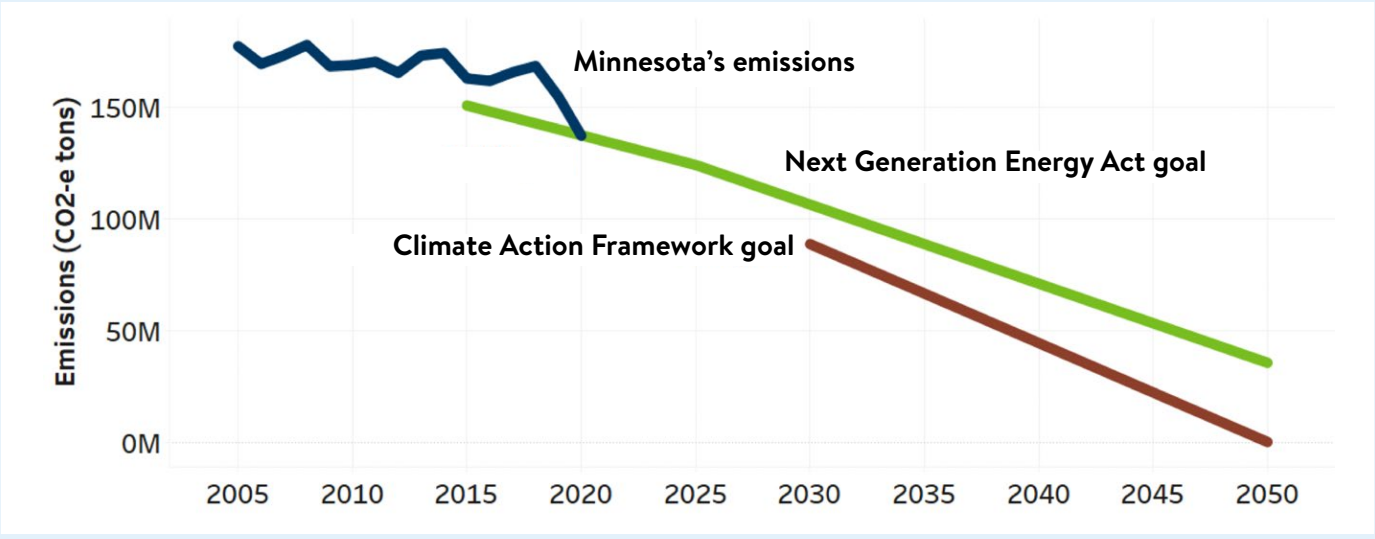
Efforts from individuals, businesses, and local governments as well as the COVID pandemic resulted in a sharp decline greenhouse gas (GHG) emissions in Minnesota. Minnesota's GHG emissions declined 23% between 2005 and 2020. If current trends continue, the state is on track to meet our goal of reducing emissions 30% by 2025. That goal was established in the bipartisan Next Generation Energy Act in 2007.

In 2022, Governor Tim Walz and Lt. Governor Peggy Flanagan rolled out Minnesota's Climate Action Framework that updates Minnesota's climate goals to reduce emissions 50% by 2030 and achieve net-zero emissions by 2050.

**Decline in GHGs across all industry sectors 2005-2020**

**23%**

### GHG emissions 2005–2020 and goals from the Next Generation Energy Act and Climate Action Framework




MINNESOTA

## **GHG emissions by sector** 2005-2020

**Transportation**

↓ 18%

Largest sources:

- Light-duty trucks
- heavy-duty trucks

**Transportation remains largest source of GHG emissions in Minnesota.** Transportation accounts for approximately 25% of the state's GHG emissions. While GHG emissions in the transportation sector have fallen 18% since 2005, most of that decrease is attributed to the reduction in aviation and vehicle usage during the pandemic.

**Agriculture, forestry and land use**

↓ 0.5%

Largest sources:

- Crop agriculture
- Animal agriculture

**Forests continue to offset agriculture emissions through carbon sequestration.** This is important because the overall agriculture, forestry, and land use sector has become the second largest source of emissions as electrical generation emissions have declined. Emissions from manure and fertilizer use have increased since 2005.

**Electrical generation**

↓ 54%

Largest sources:

- Natural gas
- Coal

**Electricity generation is a Minnesota success story.** Since 2005, emissions from the electricity generation sector have declined by 54%. The significant decrease is mainly a result of producing electricity from renewable sources like wind and solar instead of coal.

**Residential**

↑ 14%

Largest sources:

- Oil
- Natural gas

**Industrial**

↑ 14%

Largest sources:

- Oil
- Natural gas

**Emissions from homes and industrial facilities continue to rise.** Emissions from Minnesota's homes and industrial facilities have risen 14%, due to the continued use of oil and natural gas to heat and operate.

## Our path forward: Minnesota's Climate Action Framework


The Minnesota's Climate Action Framework sets a vision for how our state will address and prepare for climate change. It identifies near-term actions we must take to achieve our long-term vision of a carbon-neutral, resilient, and equitable future for Minnesota.

**The Framework is organized around six climate action goals** with specific steps and progress measures to guide and evaluate our work.

**Clean transportation**

**Climate-smart natural and working lands**

**Resilient communities**

**Clean energy and efficient buildings**

**Healthy lives and communities**

**Clean economy**

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MINNESOTA

## Legislative charge

*Minn. Stat. § 216H.02 Greenhouse gas emissions control.*

*Subd. 1. Greenhouse gas emissions-reduction goal. It is the goal of the state to reduce statewide greenhouse gas emissions across all sectors producing those emissions to a level at least 15% below 2005 levels by 2015, to a level at least 30% below 2005 levels by 2025, and to a level at least 80% below 2005 levels by 2050. The levels shall be reviewed based on the climate change action plan study.*

*Minn. Stat. § 216H.07 Emissions-reduction attainment; policy development process.*

*Subd. 3. Biennial report. (a) By January 15 of each odd-numbered year, the commissioners of commerce and the Pollution Control Agency shall jointly report to the chairs and ranking minority members of the legislative committees with primary policy jurisdiction over energy and environmental issues the most recent and best available evidence identifying the level of reductions already achieved and the level necessary to achieve the reductions timetable in section 216H.02. (b) The report must be in easily understood nontechnical terms.*


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This report is available in alternative formats upon request, and online at www.pca.state.mn.us.

# Contents

# Introduction

Climate change is here and now. Damaging storms and floods have increased in frequency, and our winters are warming fast, reducing lake ice coverage across the state by 10 to 14 days over the past 50 years. Beloved Northwoods trees like spruce, aspen, and birch are expected to leave Minnesota over the next 80 years if we continue to change our climate.

More information about climate trends and the impacts of climate change is available from the Department of Natural Resources www.dnr.state.mn.us/climate

These changes are caused by human activities that release greenhouse gases (GHGs). This emissions inventory summarizes what we know about GHG emissions in Minnesota, including the major sources and trends over time. Tracking GHG emissions and identifying their sources are two important ways that state government can help Minnesotans understand our changing climate and respond accordingly.

To guide our response to climate change, the State of Minnesota has developed a Climate Action Framework mn.gov/framework. The Framework identifies immediate, near-term actions to reduce climate pollution and prepare Minnesota communities for the impacts of climate change. It also sets new goals for Minnesota to reduce GHG emissions by 50% by 2030 and achieve net-zero emissions by 2050. Analyzing Minnesota's emissions through this inventory allows us to track progress on the framework goals and focus actions for maximum impact to address climate change.

This inventory documents Minnesota's GHG emissions from 2005 through 2020 and shows the impact of actions taken by individuals, organizations, and governments across Minnesota. The COVID-19 pandemic changed how Minnesotans lived and worked in 2020, further reducing emissions, but emissions were trending downward, even before the lifestyle shifts caused by the pandemic. Future years' data will show whether these are sustained trends or if some emissions bounced back when COVID-19 restrictions were eased. While there is much work ahead of Minnesota to meet our climate goals, this inventory demonstrates that collaborative action works.

# Evaluating greenhouse gas emissions

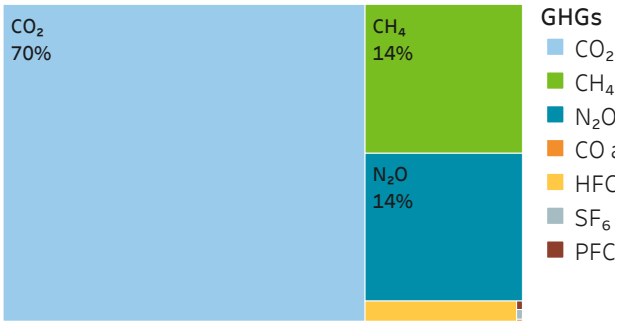
GHGs are gases that warm the atmosphere and surface of the planet. Human activity increases the amount of GHGs in the atmosphere, leading to changes in Earth's climate. The primary GHGs are carbon dioxide ($CO_2$), nitrous oxide ($N_2O$), methane ($CH_4$), sulfur hexafluoride ($SF_6$), and two types of compounds called hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs).

GHGs come from a variety of sources:

- Fossil fuel combustion is responsible for most carbon dioxide emissions in Minnesota and the United States. The majority of fossil fuels used today generate electricity and fuel vehicles.
- Animal agriculture is responsible for most methane emissions in Minnesota, and the anaerobic decomposition of organic material also emits methane.
- Agricultural nutrient management practices, including fertilizer application and subsequent mineralization, cause over 50% of nitrous oxide emissions.
- Most hydrofluorocarbon emissions are from refrigerants, such as air conditioners in vehicles and buildings.
- Perfluorocarbons and sulfur hexafluoride account for a small portion of GHG emissions and are emitted from technical applications like semiconductor manufacturing and electricity transmission.

Carbon dioxide is the most abundant GHG and has the most significant effect on our climate. In Minnesota, $CO_2$ emissions account for most GHG emissions, followed by methane and nitrous oxide. Other GHGs are emitted in smaller amounts but can trap heat more effectively than carbon dioxide, and some stay in our atmosphere for a very long time.

**Net 2020 GHG emissions in Minnesota by gas, in $CO_2$-equivalent tons (includes carbon storage)**




Global warming potential (GWP) is a relative measure of how much heat a GHG traps in the atmosphere. To compare different emissions and pollutants, we use the effect of carbon dioxide on our climate as a standard reference. In this report, emissions are reported as carbon dioxide-equivalent ($CO_2$-e) tons, meaning emissions are stated in relative terms that reflect their impact on global temperatures.

**Primary GHGs, their 100-yr global warming potentials, and their persistence in Earth's atmosphere**

| Greenhouse gas | Global warming potential | Persistence in Earth's atmosphere |
|---|---|---|
| Carbon dioxide ($CO_2$) | 1 | Variable, up to thousands of years |
| Nitrous oxide ($N_2O$) | 298 | 114 years |
| Methane ($CH_4$) | 25 | 12 years |
| Sulfur hexafluoride ($SF_6$) | 22,800 | 3,200 years |
| Hydrofluorocarbons (HFCs) | Up to 14,800 | Up to 270 years |
| Perfluorocarbons (PFCs) | Up to 12,200 | 2,600 to 50,000 years |

Source: IPCC Fourth Assessment Report, Working Group 1 Chapter 2

# Tracking Minnesota's emission reduction progress

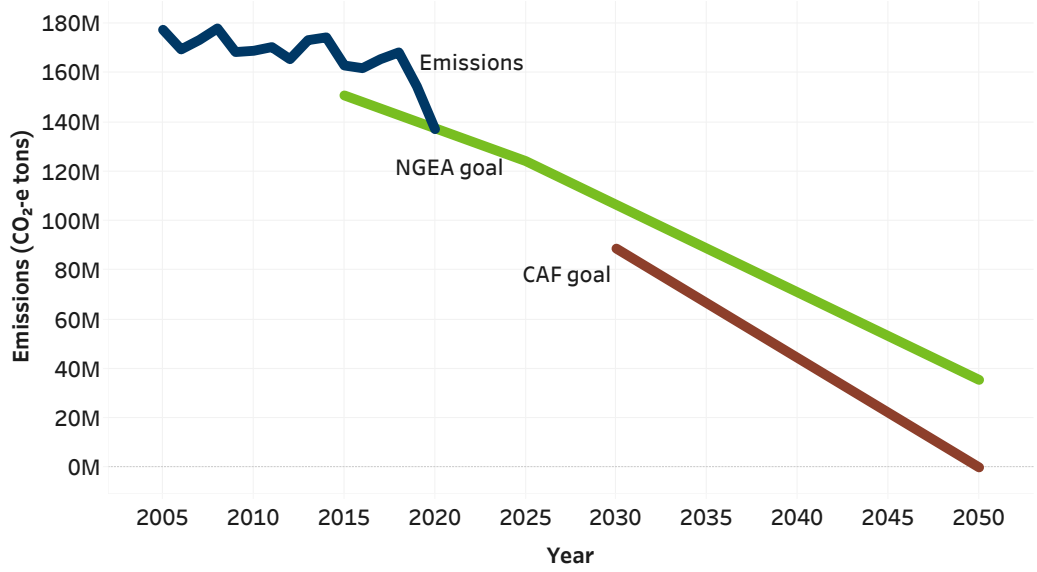
In 2007, the Minnesota Legislature passed the Next Generation Energy Act (NGEA), setting goals to reduce our GHG emissions in the state compared to our emissions in 2005.[1] The NGEA goals – based on the best science at the time – are to reduce emissions by 15% by 2015, 30% by 2025, and 80% by 2050. Today, science tells us that we must go farther, faster. To address this reality, Minnesota's Climate Action Framework includes additional goals to reduce GHG emissions by 50% by 2030 and achieve net-zero emissions by 2050.

Minnesota did not reach the NGEA goal of reducing emissions by 15% by 2015, but between 2005 and 2020, Minnesota's GHG emissions fell by 23%, putting us on track to meet future goals if we maintain current trends. Changes in electricity generation have resulted in significant emission reductions from the power generation sector and are the most significant contributor to statewide emission reductions.

The year 2020 was unusual as individuals, organizations, and governments took action to reduce the impacts of the COVID-19 pandemic. These actions caused disruptions across all parts of the economy and thus impacted Minnesota's GHG emissions in unique ways. Due to the unusual nature of 2020, this report is cautious in interpreting trends with a 2020 endpoint. All economic sectors had declining emissions between 2019-2020. While the pandemic certainly impacted those results, emissions across many sectors were already declining between 2018-2019. The declines between 2018-2019 may indicate longer-term trends, but it is too soon to tell. Future years' data will show whether these are lasting trends.

Recent emission reductions show that collaborative action can get us on track to achieve our Next Generation Energy Act goals and reach net-zero emissions by 2050. However, much work is ahead to achieve these ambitious but necessary goals.

**Minnesota's GHG emissions 2005-2020 and goals from the Next Generation Energy Act and Climate Action Framework**




[1] Data revisions and changes in methodology can cause the baseline to change, but continuity is provided when making relative year-to-year emissions comparisons.

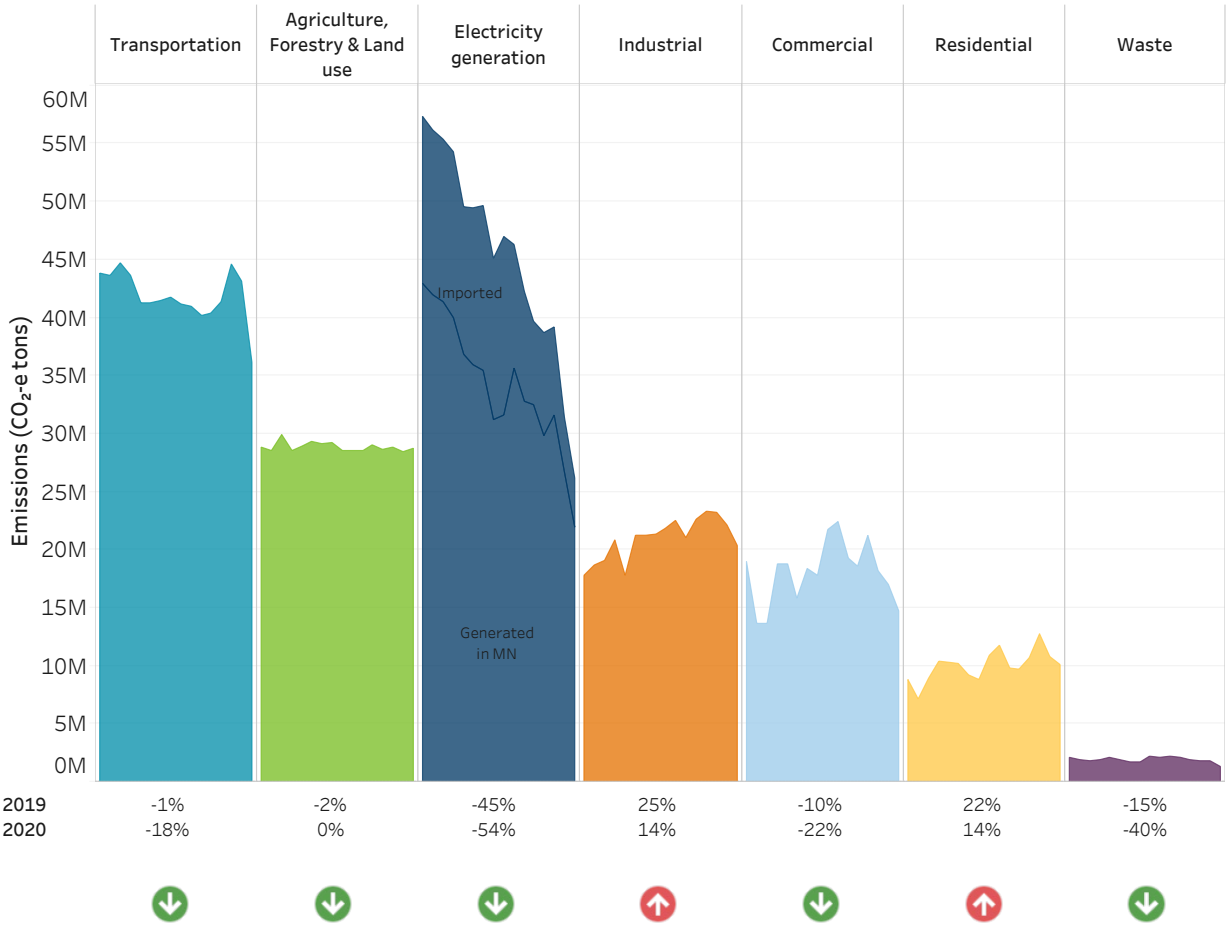
# Greenhouse gas emissions across sectors

This section outlines changes to GHG emissions across seven economic sectors in Minnesota: transportation, electricity generation, agriculture and forestry, industrial, residential, commercial, and waste.

Interactive GHG emission dashboards are available at https://www.pca.state.mn.us

### Minnesota's GHG emissions across economic sectors, 2005-2020, ranked by net emissions.

The dark line in the column for the electricity generation sector represents the division between emissions from electricity generated in Minnesota (below the line) and emissions from imported electricity (above the line). The percent change from 2005 is shown beneath the charts for 2019 and 2020, with an arrow indicating the 2020 change compared to 2005.



# Transportation

Minnesota's largest source of GHG emissions is the transportation sector, accounting for about one-quarter of the state's total emissions. GHG emissions from transportation have decreased by about 18% since 2005. A significant decrease in aviation and vehicle miles traveled during the COVID-19 pandemic played a prominent role in the emissions reduction in 2020.

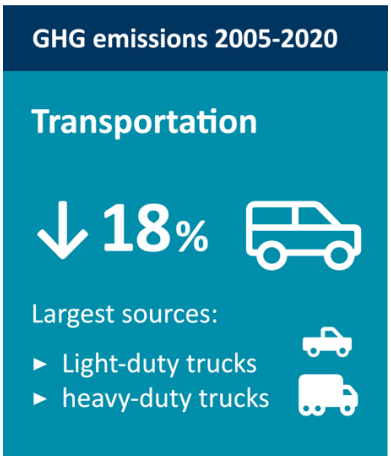
Methods to measure vehicle miles traveled and types of vehicles on our roads have changed over time. This means that we understand current transportation activity much better than we did in the past, and it also means that there is more uncertainty in estimates for past years. However, our emissions trend is similar to other published estimates, such as the U.S. Environmental Protection Agency (EPA) state inventory.

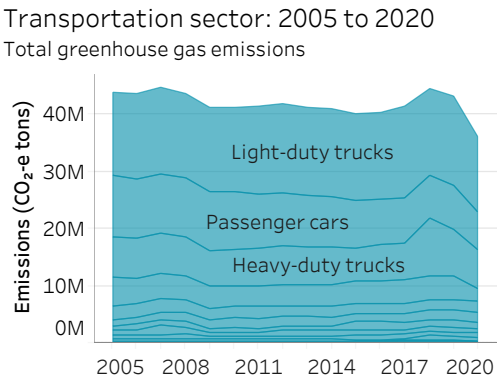
Emissions sources in the transportation sector include:

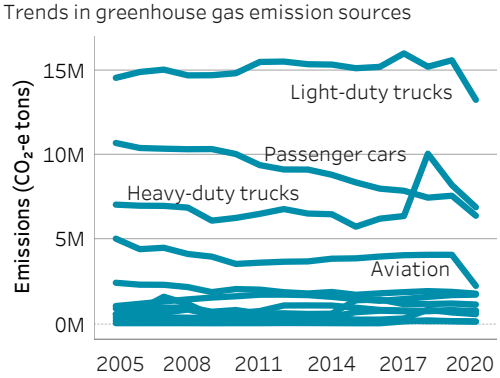
- on-road vehicles
- airplanes and other aviation equipment
- trains
- vehicle air conditioning units
- natural gas transmission pipelines

Our personal choices have a significant impact on emissions, especially when it comes to how we move around. Within the transportation sector, passenger vehicles, light-duty trucks (including SUVs), and medium- to heavy-duty trucks produce more than 70% of emissions.

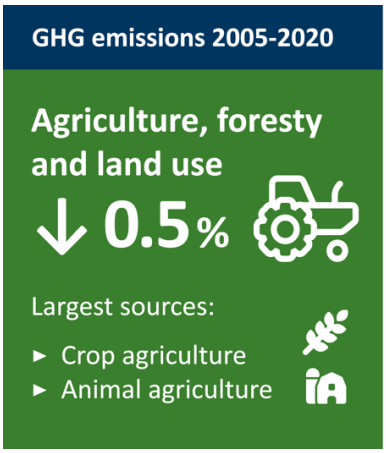
Stronger vehicle emissions standards at the federal level have lowered vehicle GHG emissions generally. However, the long-term consumer trend of choosing larger vehicles and the general trend of more miles driven (except during the pandemic) prevent more significant emissions reductions in this sector. Continued investment in cleaner vehicles and transportation options, including transit, biking, walking, and rolling, is critical to continuing the trend of emission reductions in this sector.



# Agriculture, forestry, and land use

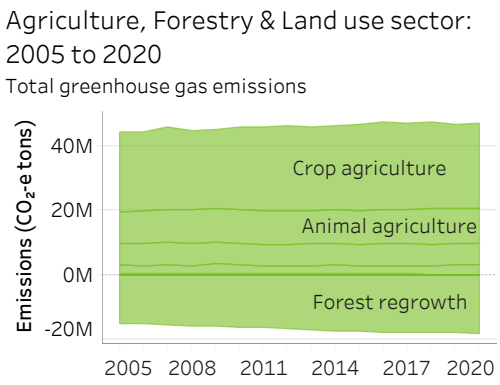


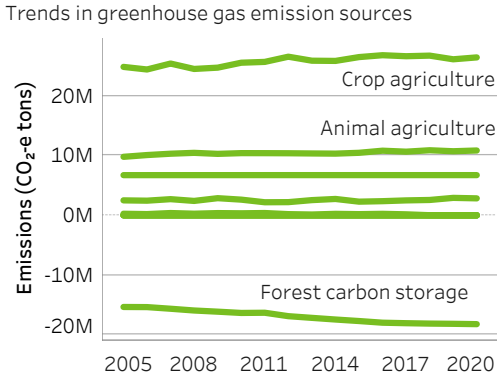

This sector groups together activities on natural and working landscapes. Some of these activities, like growing forests and grasslands, absorb and store carbon, offsetting the total amount of GHG emissions within this sector from growing crops and raising animals. Compared to the 2005 baseline, net emissions, considering both the sources and sinks of carbon, are flat, but both gross emissions and carbon sequestration have increased.

Emissions sources in the agriculture and land use sector include:

- livestock
- animal feedlots
- manure
- fertilizer
- crop cultivation practices
- anaerobic decomposition of material in lakes, rivers, and streams
- related fuel combustion of off-road implements, like tractors and combines

Agricultural practices in Minnesota are responsible for most nitrous oxide and methane emissions, two GHGs with higher GWP than carbon dioxide.




Nitrous oxide emissions from crop agriculture increased by approximately 9% from 2005 to 2020. The largest source of nitrous oxide emissions in Minnesota is nutrient management, which includes fertilizer use, mineralization, and runoff. The increase from 2005 to 2020 was due to increases in emissions from a variety of agricultural sources, including nutrient application, crop residues, and runoff. Animal agriculture also produces nitrous oxide from manure.

Animal agriculture is Minnesota's largest source of methane emissions, specifically from manure management and cattle digestion. Methane emissions from animal agriculture increased by 10% between 2005 and 2020. Lakes, rivers, and reservoirs are other significant sources of methane emissions. Plant material and fertilizers that enhance plant growth and productivity collect in waterbodies, and $CH_4$ is emitted during the anaerobic decomposition of organic matter. The $CH_4$ emissions from these biological systems are counted in the GHG inventory because methane, though short-lived, causes warming in our atmosphere before oxidizing into $CO_2$ and re-entering the carbon cycle.

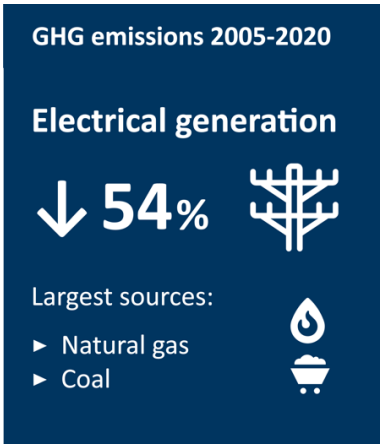
Carbon sequestration in forest regrowth is a significant offset in this sector, as forests can act as carbon sinks or storage. Carbon is sequestered in our forests as they grow. Estimation methods for sequestered forest carbon have changed since the last inventory to reflect the current best practices and are described in the appendix to this report. The updated method to estimate sequestered forest carbon has also been applied to prior years to ensure consistency over the years of the inventory.

Policy, economic factors, and voluntary actions have begun to drive down emissions from the electricity generation and transportation sectors, while emissions from agriculture have remained relatively steady since 2005. The reductions in other sectors have left the agriculture, forestry, and land use sector as Minnesota's second-largest emitter of GHGs, and also our largest sink of GHGs. This sector also is one of the biggest opportunities for achieving emission reductions and carbon sequestration, as many practices that land managers use to improve water quality and soil health also reduce emissions and sequester carbon. More investment is needed in this sector to support emission reductions and increase carbon sequestration and storage. Minnesota's Climate Action Framework identifies specific priorities for this sector to reduce emissions, store carbon, and improve our ability to understand the emissions from the sector.

## Electricity generation

Electricity generation is the third largest source of GHG emissions in Minnesota. Burning fossil fuels, especially coal, to generate electricity for Minnesotans, whether produced in-state or out-of-state, is the primary source of GHG emissions from this sector. Other small sources include:

- methane from coal storage
- the breakdown of organic matter in the sediments found in hydroelectric reservoirs
- carbon dioxide from flue-gas desulfurization
- sulfur hexafluoride from electricity transmission and distribution



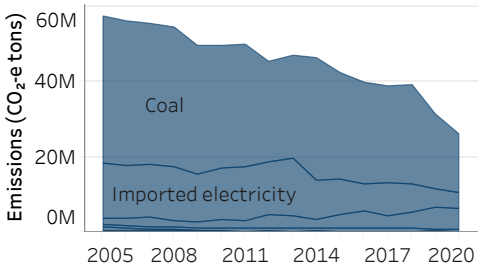

Since 2005, emissions from the electricity generation sector have declined by 54%. The significant decrease is mainly a result of the transition away from coal toward renewable energy to generate electricity. Previously, Minnesota's electricity generation sector was the largest source of GHG emissions. This sector has achieved the most emission reductions since 2005.

As required by the Next Generation Energy Act, this report measures total GHG emissions from electricity generation, including emissions from electricity generated at facilities within the state (in-state generation) and electricity used here in Minnesota that is generated outside of our state borders (imported). Emissions from in-state generation fell nearly 50% from 2005 to 2020, reflecting efforts by Minnesota's electric utilities to create a cleaner, lower-carbon electrical grid.

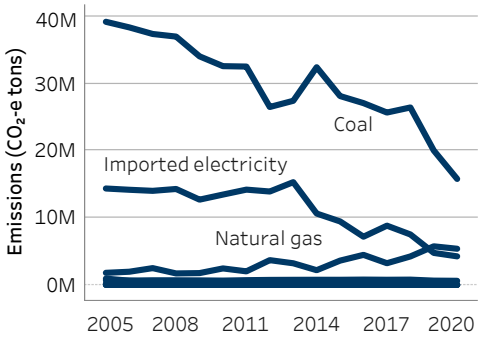
Emissions per kilowatt-hour from electricity imported from the regional electrical grid are higher than in-state generation because some neighboring states haven't reduced their emissions as much as Minnesota. The amount of electricity imported into Minnesota continues to decrease as in-state generation increases, reducing the amount of estimated imported electricity and associated GHG emissions.

Electricity generation sector: 2005 to 2020

Total greenhouse gas emissions

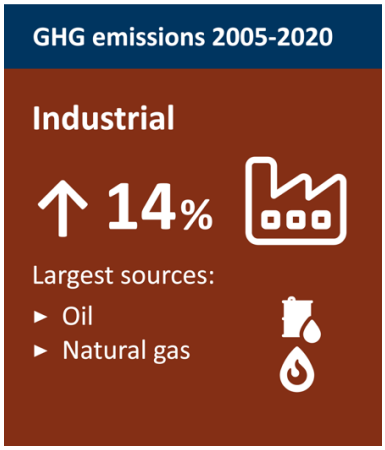



Trends in greenhouse gas emission sources



Continued emission reductions in the electricity generation sector are planned with future closures of coal plants. Achieving emission reductions in this sector is also important to help other sectors, such as transportation, residential, commercial, and industrial, reduce emissions through electrification. Continued focus on thoughtful planning for this transition to support reliability along with emission reductions is vital to achieving economy-wide GHG emission reduction goals.

## Industrial




The industrial sector includes direct emissions from industrial facilities, processes, and fuel combustion. While this sector has increased emissions by 14% overall since 2005, in recent years, it has begun to experience emission reductions.

Emissions sources in the industrial sector include:

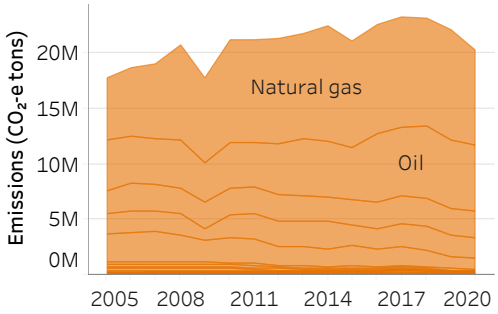
- fossil-fuel combustion
- taconite processing
- petroleum refining
- magnesium casting
- lead recycling
- peat mining
- industrial wastewater treatment
- solvent use
- manufacturing of steel, glass, insulating foam, and semiconductors

Although recent emissions are declining, emissions from the industrial sector increased by about 2.5 million tons from 2005 to 2020. Within the industrial sector, coal use has continued to decline steadily, and natural gas use has increased since 2005 but has declined from a peak in 2014.

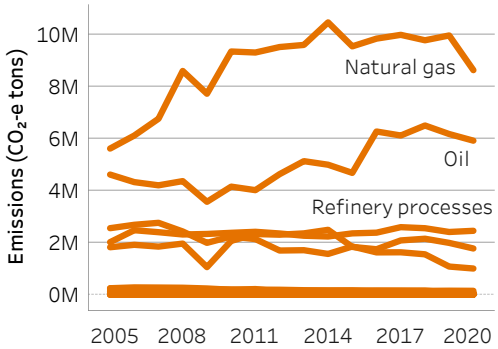
GHG emissions from this sector have declined since a peak in 2018, but more is needed to achieve the reductions needed to meet the Next Generation Energy Act goals. The pandemic likely forced changes that reduced emissions in 2020; however, some of the changes that caused emissions to fall may persist.

The Climate Action Framework includes a focus on transforming Minnesota's economy through innovation. With federal funding and assistance, industrial businesses can be national leaders in changing operations and using greener fuels to reduce GHG emissions.

Industrial sector: 2005 to 2020
Total greenhouse gas emissions




Trends in greenhouse gas emission sources



# Residential

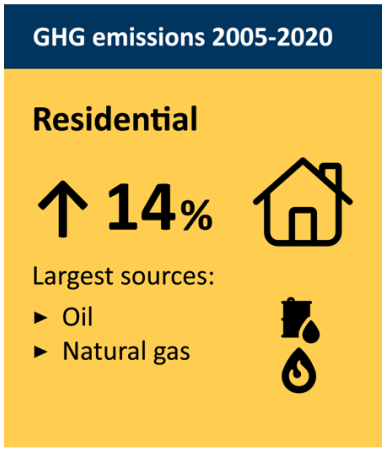
The residential sector includes products used in homes, direct combustion of fuel for heating and appliances, and carbon stored in structural materials. Relative to 2005, net emissions from the residential sector rose by 14%, but in recent years, it has begun to experience some emission reductions.

Emissions sources in the residential sector include:

- fossil-fuel combustion for heating and in-home appliances, such as furnaces that run on natural gas
- home-product use
- food additives
- refrigerant leakage from air conditioners and refrigerators
- fertilizer use

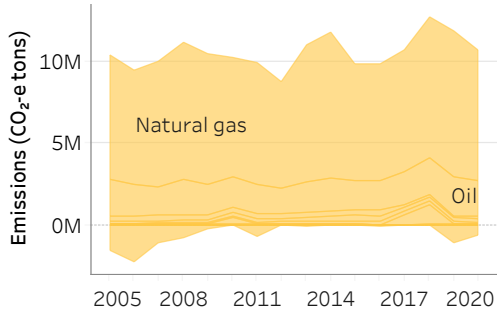
The residential sector does not include emissions from electricity use in residences – these emissions are captured in the electricity generation sector. Also, this category contains carbon stored in wood construction materials. Over the lifetime of a house, carbon is sequestered, effectively removed from the atmosphere and carbon cycle, which offsets some emissions.

The largest residential emissions source is natural gas used for home heating and appliances. Weather influences the need for heating, but switching to technologies like solar furnaces, geothermal heat pumps, electric appliances, and high-efficiency furnaces to reduce emissions from homes. The Climate Action Framework includes initiatives to renovate older buildings, replace natural gas home appliances with electric models, and improve the insulation in housing.

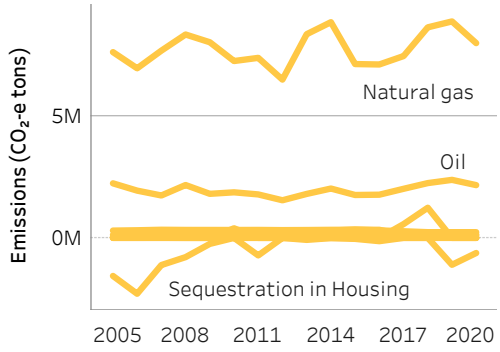



Residential sector: 2005 to 2020

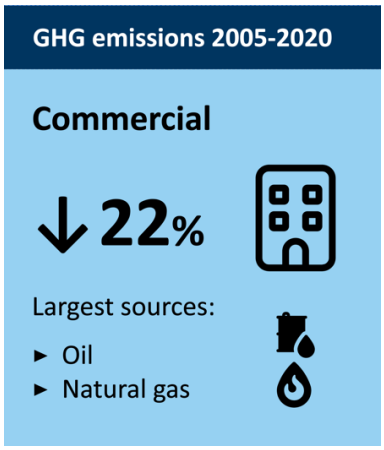
Total greenhouse gas emissions




Trends in greenhouse gas emission sources



# Commercial




The commercial sector includes activities, products, and combustion in buildings that house businesses, governments, and institutional sources, such as schools, corrections facilities, or state hospitals. Relative to 2005, emissions from the commercial sector were 22% below the 2005 baseline.

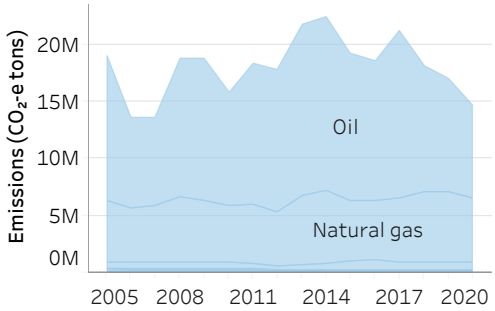
Emissions sources in this sector include:

- fossil-fuel combustion
- solvent use
- air conditioning
- medical $N_2O$ emissions

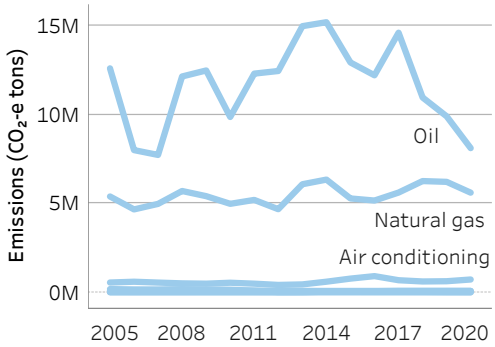
The decrease in emissions from the commercial sector was driven, at least in part, by the declining use of oil and natural gas, which peaked in 2014. Emissions from air conditioning and refrigeration chemical leakage increased. Continued investments in energy efficiency, electrification, and building efficiency, will help commercial and institutional sources reduce their fossil fuel use and energy consumption. The scheduled phase down of high global warming potential HFC refrigerants will also reduce GHG emissions.

Commercial sector: 2005 to 2020

Total greenhouse gas emissions




Trends in greenhouse gas emission sources



# Waste

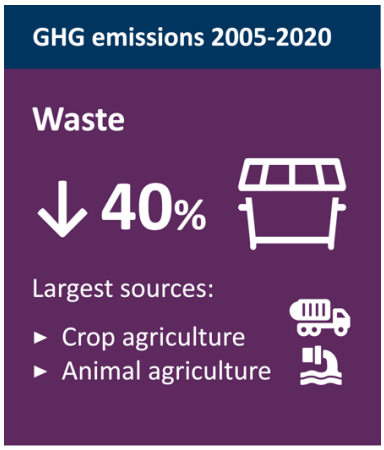
The waste sector produces about 1% of GHG emissions annually in Minnesota. Compared to the 2005 baseline, GHG emissions from the waste sector have decreased by about 40%.

Emissions sources in the waste sector include:

- energy use in waste processing
- incinerator fuels
- waste incineration
- methane from landfill gas and wastewater treatment

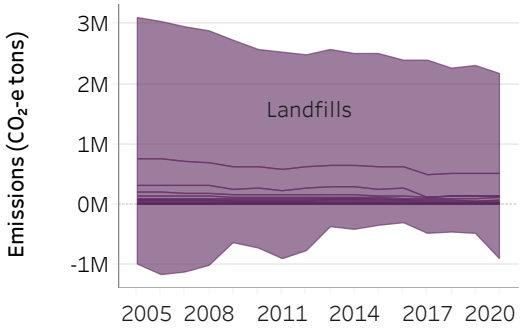
Carbon is stored or sequestered from the atmosphere as wood waste in demolition and construction landfills, which offsets other waste emissions. Today, less wood waste is landfilled than it was in the past, so carbon sequestration in landfills has declined, leading to a lower emissions offset.

Gradually decreasing methane emissions from landfills are driving the overall GHG reduction trend in this sector. Declining methane emissions are due to a combination of factors, partly the aging of waste in open landfills – older waste emits less methane as the organic fraction decomposes and becomes more stable. Also, gas capture technologies used at landfills reduce emissions of methane, either combusting it in a flare or using it to produce usable energy. As the administrator of the state's closed landfill program, the Minnesota Pollution Control Agency (MPCA) is working to address methane emissions from these facilities.

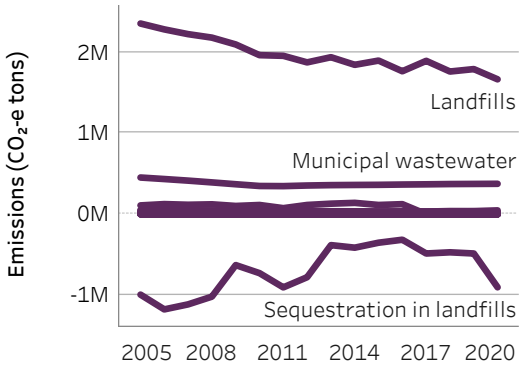



Waste sector: 2005 to 2020

Total greenhouse gas emissions



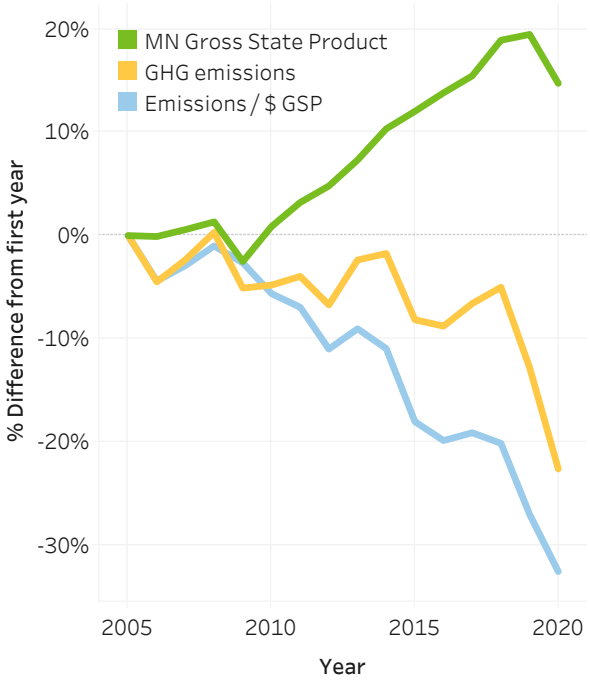

Trends in greenhouse gas emission sources



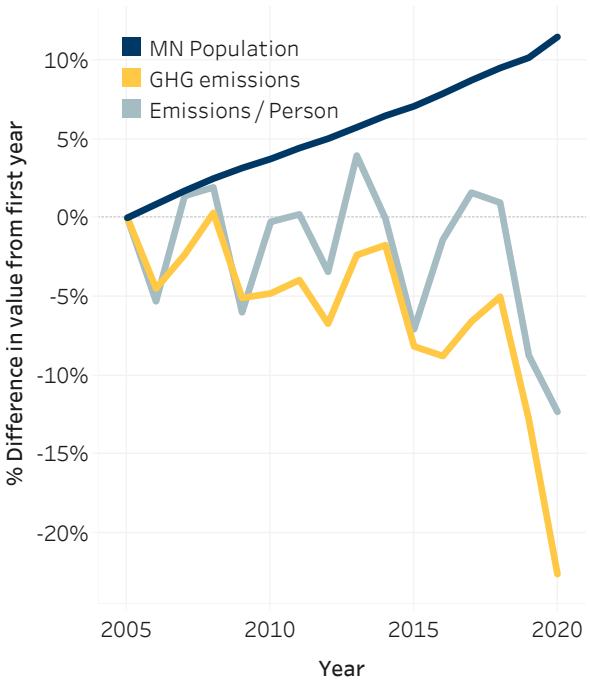
# Greenhouse gas emissions and our economy

Measuring the amount of GHG emissions compared to other economic indicators is one way to understand how GHG emissions relate to the state's economy. Trends show that Minnesota has begun disconnecting economic growth from GHG emissions. Minnesota's gross state product has grown since 2005, while GHG emissions have generally decreased, demonstrating that the state economy can grow without necessarily increasing GHG emissions. Similarly, Minnesota's generally decreasing GHG emissions show that population growth can occur while reducing GHG emissions. Though the population in Minnesota is increasing, there is a net decrease in emissions per person. The Climate Action Framework includes initiatives that will help Minnesota continue to grow with a clean economy.

**Minnesota's GHG emissions per dollar gross state product (GSP), 2005-2020.**




**Minnesota's GHG emissions per capita, 2005-2020.**



## Our Path Forward: Minnesota's Climate Action Framework

In September of 2022, Minnesota's Climate Action Framework was released. The Framework, developed with input from 3,000+ Minnesotans, sets a vision for how the state will address and prepare for climate change. It identifies near-term actions we must take to achieve the long-term vision of **a carbon-neutral, resilient, and equitable future for Minnesota**.

The Framework is organized around six climate action goals with specific steps and progress measures to guide and evaluate our work.

- **Clean transportation**
  Transportation represents the greatest opportunity to reduce climate pollution. The Framework's goal is to connect and serve all people through a safe, equitable, and sustainable transportation system.
- **Climate-smart natural and working lands**
  Minnesota can manage natural and working lands to address climate change by absorbing and storing carbon, reducing emissions, and sustaining local economies.
- **Resilient communities**
  Communities experience the impacts of climate change differently, and solutions must be tailored to local needs. The state can prepare communities with the resources they need to plan and build a more resilient future for themselves.
- **Clean energy and efficient buildings**
  Minnesotans can benefit from investments in clean energy and energy efficiency that will create jobs, lower energy costs, and contribute to a more stable climate.
- **Healthy lives and communities**
  Changes in Minnesota's climate threaten the health of every community, but not everyone experiences these impacts equally. The Framework's goal is to protect the health and well-being of all Minnesotans in the face of climate change.
- **Clean economy**
  Transitioning to a cleaner economy must include solutions that benefit everyone. Minnesota will build an economy that addresses climate change and equitably provides family-sustaining job opportunities.

The Framework will guide the state of Minnesota's priorities for addressing climate change in the coming years. Actions identified in the document will be developed into new policies, programs, and grants to reduce our greenhouse gas emissions.

Learn more about our next steps to tackle climate change and how you fit into this work by visiting **mn.gov/framework**.

## Climate policy leadership

Ongoing state-led efforts will support GHG emission reductions in the coming years. These actions aim to accelerate our downward emissions trends to achieve our long-term goals of reducing GHGs 50% by 2030 and net zero emissions by 2050. The state is an important leader in this work, but must collaborate with businesses, other levels of government, nonprofit organizations, and individuals to achieve the Framework's goals. This section highlights a few key areas of state leadership.

## Decarbonizing electricity

Minnesota's work on clean energy shows that GHG emissions can be reduced cost-effectively while meeting the energy needs of a growing economy. The electricity generation sector's steep reductions in GHG emissions in Minnesota have resulted from policies to reduce demand for electricity and shift generation to cleaner energy sources. These policies have worked with market forces that make many renewable resources more cost-effective than coal facilities.

In Minnesota and surrounding states, utilities continue to close coal plants and replace that power generation with a mix of renewables supported by natural gas. Several electricity generating facilities, especially those powered by coal, have either recently retired or are planned to be retired soon.

The Infrastructure Investment and Jobs Act and Inflation Reduction Act are two recent federal laws that will direct significant funding towards actions to reduce GHG emissions. Minnesota state agencies will use the Climate Action Framework to guide direction and prioritizing of these funds, with focuses on equitable access to funding, quality jobs, healthy communities and environment, and GHG emission reductions. This investment will support substantial progress towards achieving our climate change goals.

### Utility-owned coal-fired electricity generating units in Minnesota (as of December 2022)

| Facility | Size (MW) | Status |
|---|---|---|
| **Hibbing Public Utilities Commission** | | |
| Hibbing 3 | 10 | Standby/backup: available for service but not normally used |
| Hibbing 5 | 20 | Standby/backup: available for service but not normally used |
| Hibbing 6 | 6 | Standby/backup: available for service but not normally used |
| **Minnesota Power** | | |
| Boswell unit 3 | 365 | Operating: Cease coal-fired operations by year-end 2029 |
| Boswell unit 4 | 558 | Operating: Proposed to cease coal-fired operations by 2035 |
| Taconite Harbor Energy Center unit 1 | 75 | Retired |
| Taconite Harbor Energy Center unit 2 | 75 | Retired |
| **Otter Tail Power Company** | | |
| Hoot Lake 2 | 54 | Retired |
| Hoot Lake 3 | 75 | Retired |
| **Xcel Energy** | | |
| Sherburne County 1 | 680 | Operating: full retirement by 2026 |
| Sherburne County 2 | 682 | Operating: full retirement by 2023 |
| Sherburne County 3 | 876 | Operating: full retirement by 2030 |
| Allen S King | 511 | Operating: full retirement by 2028 |

Future emissions reductions in Minnesota's power sector depend on resources entering the regional market as utilities retire aging power plants and bring new sources of electricity into service. Current utility plans show a transition to an energy mix that is over 75% carbon-free by 2034.[2] However, transmission capacity limits could slow the region's long-term growth of wind and solar energy development. The Minnesota Department of Commerce and the Minnesota Public Utilities Commission (PUC) continue to advocate for the state's interest in regional and federal forums to improve long-range regional transmission planning for a reliable and affordable transition to a decarbonized economy.

## Supporting clean buildings and industry

### Natural Gas Innovation Act (NGIA)

Passed in 2021 with strong bipartisan support, the Natural Gas Innovation Act (NGIA) creates a regulatory pathway to help Minnesota's natural gas utilities invest in innovative clean-energy resources and technologies. These resources could include electrification, renewable natural gas, biogas, green hydrogen, energy efficiency, carbon capture, district heating systems, or other resources. These resources offer the potential to reduce emissions, diversify Minnesota's energy supply, improve waste management, and support job creation and economic development throughout the state. The PUC has approved the framework to assess resource carbon intensity and cost-effectiveness within NGIA. Utilities are currently developing 5-year plans to be filed in 2023 for review and approval by the PUC. If done right, the NGIA can decrease GHG emissions from sectors that have been the hardest to decarbonize.

### Energy Conservation & Optimization Act (ECO)

The 2021 Energy Conservation & Optimization Act (ECO) modernizes the Conservation Improvement Program (CIP) framework by allowing utilities to optimize energy use and delivery with load management and efficient fuel-switching programs. Fuel-switching measures must reduce energy usage and GHG emissions, be cost-effective, and improve the utility system load factor, compared to the displaced fuel source. ECO also raises the energy savings goals for the state's electric investor-owned utilities (IOUs), more than doubles the low-income spending requirement for all IOUs, provides greater planning flexibility for municipal and cooperative utilities, and includes activities to improve energy efficiency for public schools. Since the passage of ECO, the Minnesota Department of Commerce has focused on working with Minnesota stakeholders to develop the guidance and methodologies utilities need to deliver innovative and cost-effective CIP programs. Implementation of ECO-related programs will start in 2023.

### Minnesota Efficient Technology Accelerator (META)

The Minnesota Efficient Technology Accelerator (META), working under the umbrella of the Conservation Improvement Program, supports programs that accelerate deployment and reduce the cost of emerging innovative technologies. META activities may include strategic initiatives with technology manufacturers to improve the efficiency and performance of products, as well as with equipment installers and other key actors in the technology supply chain. Benefits of activities expected from META include cost-effective energy savings for Minnesota utilities, lower bills for utility customers, enhanced employment opportunities in Minnesota, and avoidance of greenhouse gas emissions. The Center for Energy and Environment will begin implementing an approved 5-year META plan in 2023.

[2] Based on Xcel, Minnesota Power, OtterTail Power, and Great River Energy resource plans and announced retirements as of October 2022.

## Advancing transportation options

### National Electric Vehicle Infrastructure Program

The federal National Electric Vehicle Infrastructure (NEVI) program funds states to build electric vehicle charging infrastructure along highway corridors. The NEVI program provides $68 million to Minnesota and requires a $17 million match. The Minnesota Electric Vehicle Infrastructure Plan describes how Minnesota will spend the first year of NEVI Program funds. Minnesota's plan identifies potential exits along the I-35 and I-94 Alternative Fuels Corridors for fast charger installation. The Minnesota Department of Transportation (MnDOT) will conduct site feasibility analyses and manage a competitive site selection process in 2023 to install fast chargers at 16 sites. Minnesotans can expect to see the first round of fast chargers installed with NEVI funds by the end of 2024.

### VW Settlement Grants

The Volkswagen Corporation (VW) violated air pollution standards for its diesel cars and sport utility vehicles. As part of the national legal settlement, Minnesota received $47 million to spend on projects to replace older, more polluting diesel vehicles and install electric vehicle charging infrastructure. The MPCA has invested $5 million from the VW Settlement fund in EV charging. Grants have funded 60 stations statewide, bringing the total miles of EV charging corridors to 3,600 miles. All stations from the first two phases of funding will be installed by early 2024. Between 2024 and 2027, there will be $1.76 million available for additional EV charging grants.

### Active Transportation Program

MnDOT's Active Transportation Program envisions a state where all people can access safe and convenient active transportation where they live, work, and play. This year, thirteen cities and counties are receiving help with plans for walking and biking, and two communities are receiving assistance with quick-build or demonstration projects. Successful applicants in the Active Transportation Program receive support from a qualified consultant team. Each plan creates a road map for improvements through grants or community-led initiatives. Quick-build or demonstration projects assist communities in creating a concept and implementing a short-term change to a street in the community. Projects will begin being installed in 2023.

## Climate-smart natural and working lands

### Innovative technology to create renewable fuel

Deploying innovative technologies and increasing the adoption of climate-smart practices in Minnesota's agricultural sector holds tremendous opportunity for reducing GHG emissions, increasing carbon sequestration, and offsetting fossil fuel usage. Minnesota farmers are already using technologies like anaerobic digestion to treat livestock manure and other agricultural wastes. Anaerobic digestion reduces methane emissions from manure and creates renewable biogas that can be used on-site and lowers electricity and fossil fuel natural gas usage. Minnesota currently has three industrial-scale anaerobic digesters that remove impurities from biogas and convert it to renewable natural gas that is injected into natural gas pipelines for distribution for off-farm users. There is significant potential for expanding anaerobic digestion in Minnesota through implementing the Natural Gas Innovation Act, funding from the Minnesota Department of Agriculture's (MDA) Methane Digester Loan Program and Advanced Biofuel Incentive Program, payments through Low Carbon Fuel Standards, and federal funding available through the Inflation Reduction Act.

### Soil health, water quality and carbon markets

Soil health activities mitigate climate change in several ways. Enhanced nitrogen and manure management can reduce both nitrous oxide and methane. Continuous living cover can store carbon in

the soil and decrease nitrogen fertilizer use. Investments comprehensively incentivize soil health practices that address climate resilience and adaptation on the farm, within Minnesota agri-businesses, and in broader agricultural market activities. On-farm activities include grant and loan funding to implement soil health activities. Agri-business funding assists with developing and enhancing markets for continuous living cover, encourages broader markets for climate-smart goods and services, and assists farmers as they consider carbon markets.

The Minnesota Agricultural Water Quality Certification Program (MAWQCP) promotes and quantifies the climate benefits of water quality and soil health practices that MAWQCP-certified farms implement. MAWQCP further accelerates the adoption of climate-smart practices through the program's Climate Smart Farm endorsement, which includes climate incentive payments to facilitate farmers' voluntary entry into carbon markets or public programs. MDA anticipates continuing and expanding programs that build climate-smart activities, including MAWQCP, Agriculture Best Management Practices loans, soil health grants, continuous living cover grants, Forever Green Initiative grants, groundwater nitrate research, technical assistance, and financial assistance.

### State investment to increase seedling production at the State Forest Nursery

In 2021, the state legislature appropriated $2.5 million to the Minnesota Department of Natural Resources (DNR) to increase seedling production at the State Forest Nursery. The DNR put these funds to work by purchasing additional equipment and boosting procurement of seeds and cones. Increasing seedling production will accelerate sustainable forestry strategies that generate multiple benefits, including carbon sequestration. For example, high-quality seedlings are essential for replanting forests after harvest on public and private lands each year – a practice that promotes carbon sequestration in working forests. More seedlings are needed to increase forestlands – planting trees on formerly forested open lands – which also increases forest carbon sequestration. However, this one-time investment is only a start. Additional funding for procuring greater quantities of seeds, updating aging buildings and facilities, and developing a trained workforce is critical to sustained increases in seedling production.

## Waste

### Prevention of wasted food and food rescue

The MPCA received $1 million to award grants to organizations working to prevent food from going to waste or rescue food for donation. These funds are focused on prevention and rescue, and they cannot be used for waste management efforts (e.g., composting) to maximize the impact on GHG reduction. Reducing food waste both reduces emissions from Minnesota's waste sector and also emissions from the production and transportation of food, whether those emissions occur in Minnesota or outside of the state. To date, the MPCA has executed grant agreements for two rounds of grants, awarding eight projects. These grant funds support projects that reduce GHG emissions and increase food security for Minnesotans.

### Solid Waste Management Act

Recycling in Minnesota has significant benefits in reducing greenhouse gas emissions. Making a product from recycled material generally uses up to 90% less energy than virgin material. The MPCA supports recycling in several ways. Numerous recycling grants pass money through to local government programs and private companies. The Recycling Education Committee helps haulers, counties, and cities get information to residents about the right way to recycle and decrease contamination. Dedicated staff work on developing new recycling markets so that recyclable materials maintain a fair price in the marketplace. In 2020, Minnesotans recycled 1.8 million tons of paper, plastic, aluminum, steel, and glass.

# Conclusion

Minnesota's work to reduce climate pollution is paying off. The state has successfully reduced emissions approximately 23% since 2005 and we are closer than ever to meeting our Next Generation Energy Act goal of reducing emissions 30% by 2025. Individuals, organizations, and governments across Minnesota are taking steps to reduce climate pollution. This inventory shows these actions are working. During the pandemic, emissions declined across all sectors of the state's economy. However, emissions from key sectors like transportation, industry, and power generation were already trending downward in 2018 and 2019.

There is still significant work ahead to meet Minnesota's long-term goals. Minnesota's Climate Action Framework sets new GHG reduction goals for the state, based on the best available science. This includes reducing GHG emissions by 50% by 2030 and achieving net-zero emissions by 2050. To meet these goals, the state has put forward a roadmap of actions that will reduce greenhouse gas pollution in the form of Minnesota's Climate Action Framework. Visit mn.gov/framework for more information.

# Appendix: Methodology

## Greenhouse gas emission inventory

The GHG inventory reports progress toward statutory goals and provides information with high confidence and transparency. The long record of emissions and high level of data disaggregation using the best available data and methods based on EPA and Intergovernmental Panel on Climate Change (IPCC) recommendations helps ensure that the inventory is complete, consistent, transparent, accurate, and relevant.

Minnesota's state-level emission reduction goals are expressed as percentage reductions from estimated emissions in a historical baseline year (2005). Like most GHG inventories, the Minnesota GHG inventory has undergone substantial revisions since it was first built. It is in a state of continuous revisions as methods and data improve, and new emission sources are incorporated. These changes are applied to all inventory years to ensure consistency, including the 2005 baseline year. Developing a consistent time series of emissions estimates is essential to measure progress.

Not all emissions are included in statewide emission totals. Only those sources which can be included in the baseline year are evaluated. While ideally, all sources of GHG emissions from Minnesota would be inventoried and tracked, in practice, the inventory includes only those sources for which there exists a well-developed scientific understanding of the physical and biological processes involved in the production and emission of GHGs. Protocols or methods must exist, and data must be available to support estimation.

Only emissions that occur within the geographical borders of the state are estimated, with two exceptions. Our estimate includes net electricity imports to meet Minnesota's electricity demand, which exceeds in-state electricity production. Emissions from the combustion of aviation fuel purchased in Minnesota but not necessarily combusted within Minnesota air space are also included.

GHG inventory protocols require accounting for photosynthetically-removed carbon dioxide stored in biomass in forests, landfills, and structures. Long-term storage of wood-carbon in residential structures and demolition and construction landfills is included in statewide GHG emission totals as sequestration because the materials will remain as carbon stores for a long time. Forest carbon fluxes are included from forest land that remains forest land and land converted to forest land following the EPA state methodology report (2022). Other land use and land use change emissions and sequestration are not yet included in the inventory but may be incorporated in the future.

Emissions are estimated from 1970 to 2020, though presented here in an abbreviated timeline. With a few exceptions, the methods used to develop these estimates are derived from the following sources:

- U.S. Environmental Protection Agency (2022) Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2020.
- U.S. Environmental Protection Agency (2022) Methodology Report: Inventory of U.S. Greenhouse Gas Emissions and Sinks by State: 1990-2020.
- Intergovernmental Panel on Climate Change (2006) IPCC Guidelines for National Greenhouse Gas Inventories. Vol. 1-4.
- Intergovernmental Panel on Climate Change (2019) 2019 Refinement to the 2006 IPCC Guidelines on National Greenhouse Gas Inventories.
- Radian Corporation (1996) Methane emissions from the natural gas industry. Vol. 1-15. Prepared for the U.S. Environmental Protection Agency and the Gas Research Institute.

- California Air Resources Board, et al. (2010) Local government operations protocol for the quantification and reporting of greenhouse gas emissions inventories, version 1.1.
- The Climate Registry (2008) General reporting protocol, version 1.1.
- Minnesota Pollution Control Agency (2012) Greenhouse gas emissions in Minnesota: 1970-2008.

## Changes in methods and data sources

The methods used to develop the emission estimates are generally consistent from year to year, and changes made since the last report are discussed here.

Data collection methods implemented by MnDOT improved our understanding of vehicle miles traveled and the breakdown of miles traveled by vehicle types, but it is only available for recent years. Comparisons to 2005 details are less accurate, but the trend in emissions is reflected in other inventories and still useful for tracking overall progress.

Since the last report, significant changes have been made to estimate forest carbon sequestration. The DNR recommended using forest carbon data produced by the U.S. Department of Agriculture Forest Inventory and Analysis and published in the Environmental Protection Agency Inventory of U.S. Greenhouse Gas Emissions and Sinks by State: 1990-2020.

## Uncertainty of estimates and opportunities for improvements

It is difficult to calculate the precise amounts of GHG emissions; however, getting a reasonable estimate is still helpful in understanding the general scope of emissions.

Several methods and data sources are used to estimate emissions from each activity within a sector to get a comprehensive view. Some of the methods for generating the estimates are very detailed and are the result of site-specific measurements for both activity and emissions, while others are based on the use of a model with only general data to characterize the source of emissions.

The accuracy of data for different economic sectors can vary:

- Economic sectors that use fossil fuel combustion, such as electricity generation and heating, have low uncertainty, especially when aggregated to state totals because the activity is regulated and tracked.
- Emissions from on-road transportation are estimated using the MOVES model, which depends on vehicle population data and vehicle miles traveled.
- Methane generated from municipal solid waste in landfills is modeled. There is some uncertainty from data inputs and the model's underlying equations and assumptions.
- Emissions and sequestration from agriculture, forestry, and land use have a higher degree of uncertainty due to the multitude of factors influencing biological processes and the difficulty of obtaining accurate, relevant detailed information.

Within the scope of natural and working lands, there has been significant scientific development and growth in data collection because our lands offer ways to manage emissions and store carbon. As we implement new policies and change practices, it can be challenging to reflect those actions in the inventory calculations. As a result of the Climate Action Framework, teams of specialists, including state agency staff, academics and representatives from the agricultural sector, have begun to focus on this issue in Minnesota, and we plan to incorporate their recommendations into the state GHG inventory where possible. An example is to include any offsetting or reduction in emissions achieved through climate-smart practices such as cover crop, continuous living cover establishment, and nitrogen fertilizer management. While the extent of such practices is difficult to assess, an estimate of $CO_2$-equivalent reductions due to conservation practices funded through state cost-share and grants in 2022 indicated reductions of over 450,000 tons $CO_2$-e per year.

# Appendix B – Comparison of the 2020 Minnesota and EPA state inventory estimates

A requirement of the CPRG program is to produce an inventory of state greenhouse gas emissions. States may use independently produced inventory data if compared to the state data in the EPA's *Inventory of US Greenhouse Gas Emissions and Sinks by State*[88] or use the EPA's State Inventory Tool. Since the MPCA produces an inventory of greenhouse gas emissions regularly, a comparison of estimates follows.

The EPA inventory used the IPCC AR5 global warming potentials and metric tons, and the MPCA 2020 inventory used short tons and the IPCC AR4 global warming potentials, so the MPCA inventory units and conversions had to be adjusted to be comparable. Therefore, the emission estimates for comparison here differ from the legislative report in Appendix A, but they are dimensionally equivalent.

Our definitions of sectors and data are often why the MPCA emissions estimates differ from EPA state estimates. The following discussion covers the similarities and differences between the two inventory systems. When the difference between estimates is greater than 10%, we tried to understand and explain the reasons for significant differences.

## Transportation

The MPCA inventory estimates 32.7 MMT $CO_2e$ from the transportation sector. This is a 17%, or 5.5 MMT $CO_2e$, difference from the EPA inventory estimate of 27.2 MMT $CO_2e$.

EPA breaks the transportation sector inventory into four subsections:

- $CO_2$ from fossil fuel combustion
- Substitution of ozone-depleting substances
- Mobile combustion
- Non-energy use of fuels

It is difficult to compare the subsections between the two reports without further breakdowns of the sources included in each. However, the *Inventory of U.S. Greenhouse Gas Emissions and Sinks by State*[89] and the *Methodology Report: Inventory of U.S. Greenhouse Gas Emissions and Sinks by State: 1990-2021*[90] indicate there may be some appropriate adjustments for direct comparison.

- Emissions due to natural gas transmission and distribution are included in the transportation sector of the MPCA inventory (1.15 MMT $CO_2e$). The EPA inventory includes this as part of the natural gas systems in the industrial sector.
- Non-highway emissions in the transportation sector of the EPA inventory include aviation, rail, and marine sources. The MPCA inventory non-highway category also includes military and other off-highway source estimates. A direct comparison of these categories is not possible with the

[88] EPA. https://www.epa.gov/ghgemissions/methodology-report-inventory-us-greenhouse-gas-emissions-and-sinks-state-1990-2021
[89] EPA. https://www.epa.gov/ghgemissions/state-ghg-emissions-and-removals
[90] EPA. https://www.epa.gov/ghgemissions/methodology-report-inventory-us-greenhouse-gas-emissions-and-sinks-state-1990-2021

information available. In the national inventory, the EPA estimates military aircraft and naval fuels for international bunker fuels, but these are not included in the national total. The MPCA estimates for military and other emissions are derived from the U.S. Energy Information Administration (2020) Fuel Oil and Kerosene Sales at the state level for distillate and residential fuel oil. Removing these estimates from the MPCA total is appropriate for comparison purposes.

- Finally, the methodology of the two inventories is different. EPA estimates fuel consumption nationally and then allocates fuel consumption to the states based on the percentage of fuel use by state from the U.S. Department of Transportation's Federal Highway Administration Highway (FHWA) statistics data (tables MF-225 and MF-226). MPCA uses Motor Vehicle Emission Simulator (MOVES) to estimate greenhouse gas emissions for the transportation sector. Though both inventories use FHWA data and MOVES, EPA determines national estimates and uses FHWA data to allocate emissions to the states, while MPCA derives statewide estimates based on vehicle miles traveled, reported to FHWA from the Minnesota Department of Transportation.

## Forestry

Using EPA's state-level datasets to estimate the net flux of $CO_2e$ from forests could yield different estimates, depending on which of EPA's tree-related land use, land use change, and forestry (LULUCF) categories are included.

- Forest land remaining forest land represents -12.64 MMT $CO_2e$
- Land converted to forest land represents -3.39 MMT $CO_2e$
- Settlements remaining settlements: tree biomass represents -0.866 MMT $CO_2e$

In the most recent version of Minnesota's statewide inventory, we considered only forest land remaining forest land and land converted to forest land for a total flux of -16.03 MMT $CO_2e$ (-17.67 million short tons $CO_2e$). If tree biomass from land in settlement remaining in settlement were included, the total would be 16.9 MMT $CO_2e$ (18.63 million short tons $CO_2e$).

There are no contemporaneous estimates for Minnesota's statewide carbon flux from forestry that differ from the EPA methodology. In previous versions of Minnesota's greenhouse gas inventory, an in-house method was used but has since been replaced by the EPA's more accurate and comprehensive methodology and results. The federal default values are empirically derived and should yield the most accurate assessment of forest land available for Minnesota. It should be noted that the EPA data published in 2022 was used for our most recent statewide greenhouse gas inventory. As discussed above, carbon fluxes for forests were less negative (revised upward) in the 2023 version. Our most recent statewide inventory reported -18.24 million short tons of $CO_2e$, as opposed to -17.64 million short tons of $CO_2e$, but using different versions of EPA data explains these differences.

One limitation of the EPA method is the lack of accounting for carbon associated with trees outside of some land use types, such as in agricultural settings (orchards, tree-intercropping, silvopasture, windbreaks, and shelterbreaks) and riparian zones.

Minnesota's current greenhouse gas inventory does not incorporate land-use estimates beyond forests, histosols in agricultural use, and inland waters, so it does not account for trees outside of the forest remaining forest and land converted to forest land use types. As mentioned previously, the EPA estimates carbon associated with trees in settlements. Minnesota's inventory could incorporate these settlement trees, but doing so without full implementation of other carbon fluxes associated with

settlement areas (and all land use and land use change categories) would skew Minnesota's accounting to overcount sequestration relative to emissions fluxes.

Finally, the EPA estimates carbon stored in harvested wood products at a national scale but not at the level of individual states. Our current greenhouse gas inventory estimates carbon storage in wood products used in housing and in construction and demolition landfills, but ignores other wood-based products and disposal of any such products in municipal solid waste landfills. We look forward to a centralized method for state-level downscaled data from the EPA in future iterations, which would replace our currently incomplete assessment of carbon stored in harvested wood products.

Minnesota's greenhouse gas inventory is organized differently than the EPA's regarding LULUCF. Instead of grouping greenhouse gas fluxes into LULUCF and agriculture sectors, Minnesota has historically grouped the accounting for natural and working lands (NWL) into a single agriculture, forestry, and land use sector. In 2020, Minnesota's NWL category represented a net flux of 22.97 MMT $CO_2e$. Combining EPA's LULUCF (-10.2 MMT $CO_2e$) and agriculture (26.7 MMT $CO_2e$) sectors for Minnesota results in a total of 16.5 MMT $CO_2e$, approximately 7.5 MMT $CO_2e$ less than Minnesota's estimate. That said, there are still components of Minnesota's NWL category that are land use and land use change related and comparable to EPA's LULUCF sector. We detail those relevant components here.

Cultivated histosols (10 MMT $CO_2e$) corresponds incompletely to multiple EPA categories: croplands remaining croplands, land converted to croplands, grasslands remaining grasslands, and land converted to grasslands. These EPA categories total 5.46 MMT $CO_2e$. Minnesota's cultivated histosols category also partially overlaps with EPA's $N_2O$ from agricultural soil management in the agriculture sector but only represents a small $N_2O$ flux compared to other $N_2O$-related categories in Minnesota's inventory. Minnesota's cultivated histosol data comes from the DAYCENT model. Minnesota's inventory currently does not estimate carbon fluxes due to agriculture on mineral soils, while the EPA's shows agriculture on mineral soils to generally be a carbon sink due to things like increased adoption of conservation tillage and CRP enrollment, and likely explains at least some of the difference between Minnesota's and EPA's estimates for these sectors.

Rivers and streams (1.93 MMT $CO_2e$) and Reservoirs and lakes (1.15 MMT $CO_2e$) correspond incompletely to EPA's wetlands remaining wetlands and lands converted to wetlands sector (totaling 0.106 MMT $CO_2e$). Both inventories are missing fluxes from intact peatlands. Minnesota's inventory includes fluxes from lakes, which the EPA does not.

Prescribed burning and wildfire (0.03 MMT $CO_2e$) are included in Minnesota's inventory but are not explicitly included in EPA's inventory. Instead, EPA implicitly includes the effects of burning on various stores of carbon in grasslands and forests via measurements taken as part of the Natural Resources Inventory (NRI) and Forest Inventory Analysis (FIA). Ultimately, Minnesota's values in these categories are so small as to be unimportant.

Minnesota also estimates emissions caused by N mineralization and N fixation (total 4.18 MMT $CO_2e$). Both terms, however, sum the estimates from crop agriculture, grazing lands, and non-agricultural lands, so it is difficult to disentangle these from EPA's $N_2O$ from agricultural soil management category, which is a much more comprehensive accounting of $N_2O$, but only within agricultural land use. EPA's $N_2O$ from agricultural soil management source has other correlates in Minnesota's NWL category of our inventory.

Minnesota lacks estimates that correspond to EPA's settlements remaining settlements and land converted to settlements land use categories, which are a net source of 0.625 MMT $CO_2e$, per the EPA.

# Agriculture

Minnesota combines agricultural and land use, land use change, and forestry (LULUCF) fluxes into a single natural and working lands category (NWL). Minnesota's agricultural components of NWL are cultivated histosols (10.0 MMT $CO_2e$), crop residues (2.27 MMT $CO_2e$), manure soil application (0.54 MMT $CO_2e$), fertilizer (3.43 MMT $CO_2e$), N mineralization (4.01 MMT $CO_2e$), N fixation (0.17 MMT $CO_2e$), N deposition (0.90 MMT $CO_2e$), N runoff (2.52 MMT $CO_2e$), feedlots (1.32 MMT $CO_2e$), manure management (2.78 MMT $CO_2e$), ruminants (5.21 MMT $CO_2e$), petroleum-based fuel consumption (2.58 MMT $CO_2e$), urea application (0.57 MMT $CO_2e$), wild rice cultivation (0.09 MMT $CO_2e$), field liming (0.01 MMT $CO_2e$), and agricultural burning of residues (0.03 MMT $CO_2e$). Minnesota also has methods to calculate coal, natural gas, and other fossil fuels, totaling less than 0.01 MMT $CO_2e$ in 2020. Summing all of these equals 36.43 MMT $CO_2e$, which is 9.73 MMT $CO_2e$ greater (36%) than EPA's Agriculture sector total for 2020 (26.7 MMT $CO_2e$).

Most agriculture-related components of Minnesota's NWL category map directly onto EPA's Agriculture sector components. However, Minnesota's cultivated histosols line item combines elements of EPA's LULUCF: Cropland and Grasslands categories and the Agriculture: $N_2O$ from Agricultural Soil Management category and is more difficult to compare directly.

We expect Minnesota's total to be greater because of the inclusion of LULUCF-related emissions embedded in the cultivated histosols category, but it is difficult to disentangle the magnitude. EPA estimates emissions of croplands remaining croplands, lands converted to croplands, grasslands remaining grasslands, and lands converted to grasslands at 2.54, 1.62, 1.78, and -0.41 MMT $CO_2e$, respectively, for a total of 5.53 MMT $CO_2e$. Subtracting these values from Minnesota's agriculture total leaves Minnesota with an estimate that is 4.2 MMT $CO_2e$ greater than EPA's for 2020.

In its most recent form, Minnesota's greenhouse gas inventory does not include any estimates of soil carbon changes occurring in mineral soils. EPA uses a Tier 3 method (DAYCENT model) to estimate this flux and found that mineral soils sequestered an estimated 32.9 MMT $CO_2e$ at the national level in 2020.

Although the itemization between organic and mineral soils is not available from the EPA at the state level, if Minnesota were to include mineral soil carbon fluxes, the net emissions from the agriculture sector would likely be in closer agreement, though it is difficult to say exactly how close they would be without gathering DAYCENT results for Minnesota.

Several agricultural line items in Minnesota's inventory map onto EPA line items in a one-to-one fashion. Of those, all line items are within 10% of EPA's estimates, or their difference is less than 0.1 MMT $CO_2e$. Minnesota uses several categories to represent $N_2O$ from agricultural soil management (mineralization, fixation, deposition, runoff, manure soil application, fertilizer, and a small piece of cultivated histosols). Minnesota also has line items for manure management ($CH_4$) and Feedlots ($N_2O$), whereas EPA estimates both gasses under the manure management line item. Finally, Minnesota estimates emissions from coal, oil, natural gas, and other fossil fuels, while EPA estimates emissions from $CO_2$ from fossil fuel combustion, mobile combustion, and stationary combustion. In all three of these sets of groupings, the totals for Minnesota and EPA are within 10% of each other.

# Industrial

The MPCA inventory estimates 18.41 MMT $CO_2e$ from the industrial sector in 2020. This is 37% less than the 29.17 MMT $CO_2e$ estimated in the EPA inventory for 2020.

The EPA inventory breaks the industrial sector down into the following sources categories (sources with no number for the Minnesota level inventory have been excluded from this list):

- $CO_2$ from Fossil Fuel Combustion
- Natural Gas Systems
- Non-Energy Use of Fuels
- Petroleum Systems
- Iron and Steel Production
- Substitution of Ozone Depleting Substances
- Wastewater Treatment
- Urea Consumption for Non-Agricultural Purposes
- Mobile Combustion
- Carbon Dioxide Consumption
- Electronics Industry
- $N_2O$ from Product Uses
- Stationary Combustion
- Other Process Uses of Carbonates
- Glass Production
- Magnesium Production and Processing
- Lead Production
- Landfills (Industrial)
- Carbide Production and Consumption

The MPCA inventory breaks the industrial sector down into the following source categories:

- Energy, by fuel type
- Coal storage
- Oil refining
- Peat mining/use
- Industrial wastewater treatment
- Taconite induration
- Refinery processes
- Steel production
- Glass manufacturing
- Secondary lead production
- Paraffinic wax consumption
- Industrial solvent release
- Other industrial volatile organic compounds (VOC) and Toxic Release Inventory (TRI) releases
- Other industrial processes
- Industrial refrigeration
- Solvent use
- Semiconductor manufacture
- Magnesium casting

In addition, the MPCA waste sector contains emissions from industrial landfills. The EPA inventory includes these emissions in the industrial sector. These emissions have been counted in the industrial sector for this comparison.

As seen above, the breakdown in the specific sources for each sector is quite different between the two inventories. This makes comparing the two difficult and reduces the validity of any comparisons between them.

The most significant difference between the two appears in the iron and steel production source in the EPA inventory. The closest matching sources in the MPCA inventory are the steel production and taconite induration sources. Based on Greenhouse Gas Reporting Program (GHGRP) data, the EPA estimates emissions from iron and steel production to be 14.02 MMT $CO_2e$ in 2020, which is over 75% of the total emissions in the industrial sector in the MPCA inventory. The MPCA inventory taconite induration and steel production sources, based on production data and criteria air emissions reporting, are estimated to have emitted 1.62 MMT $CO_2e$. The MPCA inventory estimates for taconite production emissions are calculated based on data in production reports made to the Minnesota Department of Revenue. We have high confidence in the underlying data and emissions estimates from various induration methods.

Without knowing the source of the underlying numbers for the EPA inventory, we are not able to determine the source of this difference in estimates. We are not able to locate the complete data the EPA used to estimate the 14.02 MMT $CO_2e$ of emissions from the iron and steel production source. Using the Minnesota 2020 data in the Facility Level Information on Greenhouse Gases Tool, the total sum of all facilities in the iron and steel production sector is only 2.5 MMT $CO_2e$. [91] This is closer to the MPCA inventory estimate of 1.62 MMT $CO_2e$, which only includes process emissions. Fuel combustion emissions are reported at industrial sector level totals and can be traced to individual facilities, but are not organized this way in regular reporting.

Another source of difference between the estimated emissions is in the accounting of emissions from natural gas systems. In the EPA inventory, these emissions are included in the industrial sector. In the MPCA inventory, any emissions related to natural gas transportation are included in the transportation sector. This accounts for 1.38 MMT $CO_2e$.

Additionally, it is possible the MPCA inventory estimate is low due to a lack of data for industrial processes using HFCs, PFCs, and $SF_6$. The total emissions from industrial processes might be as much as 0.9 MMT $CO_2e$ below actual levels.

## Commercial and waste

The MPCA inventory estimated 14.67 MMT $CO_2e$ from the commercial and waste sectors in 2020. This is 60% more than the 8.76 MMT $CO_2e$ estimated in the EPA inventory for 2020.

The EPA inventory structure includes landfill and wastewater emission sources in the commercial sector, whereas the MPCA inventory structure separates waste activity emissions into its own economic sector. The MPCA commercial and waste sectors were combined for comparison.

The EPA inventory breaks the commercial sector down into the following source categories:

- $CO_2$ from Fossil Fuel Combustion
- Landfills (Municipal)
- Substitution of Ozone-Depleting Substances
- Wastewater Treatment
- Composting
- Stationary Combustion
- Anaerobic Digestion at Biogas Facilities

The MPCA inventory breaks the commercial sector down into the following source categories:

- Energy, by fuel types
- Medical uses
- Limestone use
- Solvent uses
- Air conditioning and space cooling

[91] FLIGHT, stored at https://ghgdata.epa.gov/ghgp/main.do

The MPCA inventory breaks the waste sector down into the following source categories:

- Sludge incineration
- Natural gas
- Distillate fuel oil
- Landfill Operations
- Yard Waste Reprocessing
- MRF
- RDF Processing
- LFG Combustion/Flaring
- Rural Open Burning
- Medical Waste Incineration
- Municipal Wastewater
- Yard waste composting
- Biosolids Land Application
- MMSW Landfills
- Industrial Landfills
- Sequestration in demolition/construction landfills

The industrial landfills source in the MPCA inventory waste sector is compared as part of the Industrial sector to align with the EPA inventory industrial sector.

As seen above, the breakdown in the specific sources for each sector is quite different between the two inventories. This makes comparing the two difficult and reduces the validity of any comparisons.

The most significant difference between the two sectors is the difference in $CO_2e$ emitted from fossil fuel combustion. This correlates to the $CO_2$ from fossil fuel combustion, stationary combustion, and fossil fuel combustion: other greenhouse gases in the EPA inventory. The EPA estimates 6.55 MMT $CO_2e$ in 2020 from these sources, while the MPCA inventory estimates 12.48 MMT $CO_2e$.

The majority of the emissions from the 12.48 MMT $CO_2e$ fossil fuel combustion for the MPCA inventory are from $CO_2$ from the combustion of petroleum-based fuel (7.33 MMT $CO_2e$) and natural gas (5.09 MMT $CO_2e$). The MPCA inventory obtains consumption estimates for these fuels from the Department of Energy, Energy Information Administration through the Natural Gas Annual and the State Energy Data System (SEDS), and we are confident in the data and results produced.

According to the methodology report for the EPA inventory, the EPA uses similar sources for data, including SEDS and the Monthly Energy Review from the EIA. However, without the underlying calculations, it is difficult to determine where the differences in consumption estimates, emissions calculations, or emissions allocation occur.

## Electricity generation

The MPCA inventory estimates 23.74 MMT $CO_2e$ from the electricity generation sector in 2020. This is 14% higher than the EPA inventory estimate of 20.34 MMT $CO_2e$. However, the EPA inventory does not include imported electricity necessary to meet Minnesota's demand that exceeds in-state electricity generation. Removing imported electricity from the MPCA inventory results in an estimated 19.87 MMT $CO_2e$ for 2020, which is 2% less than the EPA's estimate. No additional explanation is necessary since this difference is less than 10%.

## Residential

The MPCA inventory estimates 9.12 MMT $CO_2e$ from the residential sector in 2020. This is 8% less than the 9.84 MMT $CO_2e$ estimated in the EPA inventory for 2020. No additional explanation is necessary since this difference is less than 10%.

# Appendix C – Greenhouse gas estimation methods for PCAP measures

The Energy Policy Simulator[92] scenario created for the Minnesota Climate Action Framework[93] is the baseline for activities across the state. That scenario contains enacted policies such as the 2040 clean energy goal and renewable energy standards. That scenario was modified as described below for our priority activities for the PCAP greenhouse gas analysis.

The MPCA used policy levers provided by the Energy Policy Simulator tool. Sometimes we had to use policies to *represent* categories of activities even if the policy itself is not proposed in Minnesota's PCAP or Climate Action Framework. This methods document describes those translations.

Other tools supplemented the Energy Policy Simulator analysis. All estimates within the Climate Smart Natural and Working Lands category were derived from peer-reviewed literature, Minnesota-specific market data, and resources published by the US government (e.g., EPA, USDA, USFS). Scenarios such as adoption rates of new technologies were determined by expert opinion.

## 1. Clean transportation

The Electric Vehicle Sales Standard policy was used to represent the accelerated transition to zero-emission vehicles in Measure 1.1. The policy is parameterized with the assumption that 75% of passenger vehicles, light-duty commercial vehicles, buses, and heavy- and medium-duty trucks sold in 2050 are electric, and 5% of rail and marine cargo vessel sales are electric. The implementation schedule is based on the Statewide Multimodal Transportation Plan,[94] and the impact on vehicle sales is shown in Table 6. The use of this simulator policy does not mean that Minnesota will further pursue an electric vehicle sales standard beyond the adoption of its current Clean Cars Minnesota standards.

**Table 6: Electric vehicle sales standard parameters and implementation schedule**

| Parameter | 2025 | 2030 | 2035 | 2040 | 2050 |
|---|---|---|---|---|---|
| % of progress toward implementation of sales standard | 30% | 50% | 65% | 80% | 100% |
| % of total on-road vehicle sales that are electric vehicles | 22.5% | 37.5% | 48.8% | 60% | 75% |
| % of total rail and marine cargo vessel sales are electric | 1.5% | 2.5% | 3.25% | 4% | 5% |

A low-carbon fuel standard policy was used to represent a transition in Measure 1.1 and Measure 1.2 to low-carbon fuels and the adoption of lower-carbon vehicles and equipment that reduce the overall carbon emissions from transportation 15% by 2050. The implementation schedule is a 7.5% emission reduction achieved by 2030 and a 15% emission reduction achieved in 2050. The use of this simulator policy does not indicate that Minnesota will pursue a fuel standard, and was used only to the extent that the simulator was able to represent the impact of a transition toward lower-carbon intensity fuels by choice.

[92] Energy Innovation and RMI. 2003. Energy Policy Simulator v.3.4.3. https://energypolicy.solutions/simulator/minnesota/en
[93] Minn. Climate Action Framework. 2022. https://climate.state.mn.us/minnesotas-climate-action-framework
[94] Minn. Department of Transportation. 2022. Statewide Multimodal Transportation Plan https://minnesotago.org/final-plans/smtp-final-plan-2022

Mode shifting represents the decrease in vehicle miles traveled per capita in Measure 1.2. The implementation schedule necessary to align the model with the Statewide Multimodal Transportation Plan goals is shown in Table 7.

**Table 7: Mode shifting implementation schedule to meet goals**

| Parameter | 2025 | 2030 | 2035 | 2040 | 2050 |
|---|---|---|---|---|---|
| % of progress toward 2050 goal to achieve interim goals | 20% | 40% | 55% | 70% | 100% |
| % decrease in vehicle miles traveled | 4% | 8% | 11% | 14% | 20% |

Other transportation sector policies set in the baseline model are:

- A rebate for electric passenger vehicles at 1% of the vehicle purchase price from 2024-2040
- A fuel economy standard aligned with current proposed rates

# 2. Climate-smart natural and working lands

Peatlands: Approximately 279,000 acres of Minnesota peatlands on public lands and 395,000 acres on private lands have been impacted by past efforts to drain the land for agricultural and other purposes; many of these drained peatlands have since been "abandoned" and transferred to local or state ownership. We assumed that 100,000 acres could be reestablished at a rate of 25,000 acres every five years, starting in 2027 and finishing in 2042. In each of those cohorts, 10,000 acres would be converted from partially drained peatlands, 7,500 acres from crop agriculture, and 7,500 from pasture. Emission factors were derived from peer-reviewed meta-analyses.[95]

Grassland corridors: Minnesota Department of Transportation manages over 175,000 acres of roadside. Counties and townships manage at least 400,000 acres of roadside. We assumed that 200,000 acres of roadside could be converted from low diversity plantings to high diversity grassland habitats. We assumed that 25,000 acres of waterways could be upgraded from low diversity plantings to high diversity grassland habitat. Finally, Minnesota has 1.7 million acres of urban area according to the National Resources Inventory. We assumed that 2% of this total area (34,000 acres) could be converted from lawns to high diversity grasslands in five cohorts, starting in 2027 and finishing in 2045. Emission factors were all derived from peer-reviewed meta-analyses.[96]

Forests: Minnesota currently has about 17 million acres of forest, many of which are well managed. We assumed that optimal management of all current forest acreage may increase sequestration rates by 2% for the state compared to 2021 rates, as determined by the EPA.[97] Minnesota's urban and community forests sequester a net of 203.5 tons annually.[98] We assumed that additional planting and management could result in a 10% increase in sequestration starting in 2026. We did not estimate greenhouse gas reductions stemming from reduced heating and cooling expenses as a result of additional urban trees. Finally, according to the EPA greenhouse gas inventory, Minnesota lands converted to forest sequesters 3.4 MMT $CO_2e$ per year. We assumed that aggressive establishment of windbreaks, living snow fences, and shelterbreaks starting in 2026 could result in similar land use related changes and carbon sequestration, even though these new stands may not meet the EPA's definition of forest land due to

[95] (Ciborowski 2022 and citations therein)
[96] (Ciborowski, 2022; Yang et al., 2019)
[97] (EPA, 2023).
[98] Nowak et al., 2013

their small areas or linear shapes. We assumed 10% of existing flux due to lands converted to forest could be replicated in these tree plantings.

Agricultural practices: We considered seven agricultural practices aimed at sequestering carbon and improving soil health. All emission factors were derived from meta-analyses and other peer reviewed literature.[99] Regarding agroforestry, we assumed that 100,000 acres of Minnesota's current 21.8 million acres of cropland could be established starting in 2026. Regarding optimized prescribed grazing, we assumed that 200,000 of Minnesota's existing >1,000,000 acres of pasture could be implemented starting in 2026. Regarding silvopasture, we assumed that 100,000 of Minnesota's existing >1,000,000 acres of pasture could be implemented starting in 2026. Regarding winter cover crops, no-till practice, reduced tillage practices, and perennial cropping, we assumed each practice could be applied to 1,000,000 acres, either separately or on shared acreage.

Nutrient management: Regarding split nitrogen applications and nitrification inhibitors, we assumed both practices could be applied to 2,000,000 acres, either separately or on shared acreage. Emission factors were derived from peer reviewed publications.[100]

Feed additives: We assumed that feed additives could reduce methane emissions from enteric fermentation by 50% for 20% of the ruminants in the state. The EPA estimates that enteric fermentation generated 4.83 MMT of $CO_2e$ in Minnesota during 2020, so feed additives could reduce total emissions by 0.483 MMT $CO_2e$ per year. These additives are not yet market ready, so we assumed full adoption of this scenario beginning in 2029. The change in emissions was based on a review by Palangi and Lackner (2022).

Manure and food waste storage utilization: Minnesota is home to large populations of swine, dairy, beef, and poultry, which together produce about 100 million tons of manure per year. Minnesota also has large organic waste streams related to food and beverage industries and wastewater treatment facilities. Estimating emissions reductions due to anaerobic digestion, composting, lagoon covers, flaring, manure drying, and other manure and organic waste management activities is especially difficult because outcomes vary by livestock species, feedstocks, scale, and many site-specific considerations. Regarding anaerobic digestors, based on publicly available data on anaerobic digesters in Minnesota and Wisconsin,[101] we assumed that 20 medium-sized, on-farm or regional anaerobic digesters could be operational by 2028. On average, each digester would offset 20,000 metric tons of $CO_2e$ annually.

Regarding industrial composting, we assumed that half of organic materials currently sent to landfills (210 of 420 metric tons) in Minnesota could be diverted to compost.[102] We used EPA's Waste Reduction Model (WARM) model to determine the greenhouse gas impacts of this change. Regarding manure, we assumed that 10% of the current manure in the state could be diverted to compost, which reduces methane emissions by about 50%, with significant variability based on season and management, as well as varied impacts on $N_2O$ emissions.[103] Manure separation benefits are included in the calculation of manure composting; we did not calculate additional potential benefits of waste separation in isolation to avoid double counting of emissions reductions. We assumed that both food and manure composting could be fully operational by 2027.

[99] (Ciborowski 2022 and citations therein)
[100] (Ciborowski 2022 and citations therein)
[101] USDA, AgSTAR https://www.epa.gov/agstar/livestock-anaerobic-digester-database
[102] MPCA 2019/2020 Food Waste Generation And Composition Study Analysis, available at https://www.pca.state.mn.us/sites/default/files/w-sw1-67.pdf and MPCA SCORE Report, available at https://www.pca.state.mn.us/air-water-land-climate/understanding-solid-waste
[103] (Peterson et al., 2013)

Regarding manure storage covers, we assumed that an additional 10% of the state's existing manure could be switched from uncovered lagoons to covered lagoons. Covers include a diverse set of materials and practices, with varied impacts on methane production, so we conservatively assume that covers can reduce methane production by 15%.[104]

Biochar: We assumed that at a rate of 15,000 tons per acre, 50,000 acres of croplands could be augmented with biochar in cohorts of 10,000 acres every three years, starting in 2026 and ending in 2038. Emission factors were derived from meta-analyses and other peer-reviewed literature.[105]

Anaerobic digesters for industrial food processing waste: We assumed that the average anaerobic digester can process 11,440 tons of waste and that 0.75 metric tons of $CO_2e$ is avoided for every ton of food waste anaerobically digested.[106,107] We assumed one industrial food processing facility would have an anaerobic digester operating beginning in 2028 and two more would be operational in 2030.

## 3. Clean energy and efficient buildings

For Measures 3.1 and 3.2, the same model settings were applied for residential (urban and rural) and commercial buildings. However, residential and commercial buildings were modeled separately in the Energy Policy Simulator to isolate the greenhouse gas reductions from policies targeting different building types. The results from running these building categories separately are very similar, but not equal to, modeling the complete set of policies together.

A building energy efficiency standard on new components for new and existing buildings represents actions under Measure 3.1 and Measure 3.2. The model was set with a 10% reduction in energy use in 2030 and a 25% reduction in energy use in 2050 for all commercial and residential buildings and all components, including heating, cooling and ventilation, envelope, lighting, appliances, and other elements.

Building component electrification represents actions under Measure 3.1 and Measure 3.2. The model was set to increase the share of newly-sold electric appliances and heating systems to 85% by 2050.

Weatherization and retrofitting of existing buildings was set to improve 20% of currently existing residential and commercial buildings by 2050, which will address about half of the current buildings predicted to survive to 2050, representing actions under Measure 3.1 and Measure 3.2.

## 4. Clean economy

The transition to cleaner energy in the industrial sector in Measure 4.1 is modeled with 40% of fuel shifted to electricity in all industry categories by 2050.

Waste heat recovery in Measure 4.1 is modeled where 15% of the total state potential is achieved in 2030[108] and 50% of the total state potential is achieved by 2050.

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[104] (Veltman et al., 2018)
[105] (Ciborowski 2022).
[106] EPA. 2021. Anaerobic Digestion Facilities Processing Food Waste on the United States 2019. https://www.epa.gov/system/files/documents/2023-04/Anaerobic_Digestion_Facilities_Processing_Food_Waste_in_the_United_States_2019_20230404_508.pdf
[107] ReFED Insights Engine https://insights.refed.org/
[108] Minn. Climate Action Framework. 2022. https://climate.state.mn.us/minnesotas-climate-action-framework

Increasing energy efficiency in all industrial categories in Measure 4.1 is modeled with a 10% reduction in energy use in 2030[109] and a 20% reduction in energy use in 2050. The potential of efficiency improvements from system design is modeled as accomplishing 50% of system design changes by 2050. To describe replacing inefficient, older industrial facilities with new technologies, facilities are retired early in the model, with 5% retiring by 2030 and 20% retiring by 2050.

Measure 4.1 includes many options to reduce the use of high global warming potential (HGWP) fluorinated refrigerant gases, also known as F-gases. F-gas substitution is modeled on an implementation schedule where 50% of F-gases are replaced with less-harmful gases by 2030, and 100% are substituted by 2050. F-gas recovery and destruction are modeled on an implementation schedule where 50% of F-gases are recovered by 2030, and 100% are recovered by 2050. F-gas maintenance and repairs to reduce leaks is modeled with an implementation schedule of 50% of leaks addressed by 2030 and 100% of leaks addressed by 2050.

The potential impact of developing clean fuel stocks in Measure 4.2 is modeled within multiple policies. Hydrogen production for off-site use is shifted to 100% electrolysis production by 2050.[110] The EPS tool does not have the capability to designate new fuel production. Increasing the demand response capacity of the grid integrates more clean electricity and is modeled at 80% of the potential achieved by 2050. Increasing the grid transmission capacity by 20% by 2050 is also modeled. The increases in efficiency and reductions in energy use in other areas could be accomplished by the types of alternative fuels described.

Methane capture and destruction from the waste and wastewater treatment sectors is modeled for Measure 4.2 as achieving 50% of the state potential by 2050.

Measure 4.3 was modeled using waste prevention solutions from the ReFED[111] tool for Minnesota. Emissions impacts modeled in ReFED are from implementing manufacturing byproduct utilization, manufacturing line optimization, food service temperature monitoring, food service waste tracking, consumer education campaigns, package design, trayless packaging, centralized composting, conversion for livestock feed, and all food rescue opportunities.

[109] Minn. Climate Action Framework. 2022. https://climate.state.mn.us/minnesotas-climate-action-framework
[110] This policy does not impact on-site production and consumption.
[111] ReFED Insights Engine https://insights.refed.org/

# Appendix D – LIDAC census tracts in Minnesota

The following table lists the census tracts that qualify as LIDACs based on the Climate Justice Economic Screening Tool, which includes tracts that qualify as LIDACs using the CEJST Categories of Burden as well as the additional areas that qualify based on being above the 90th percentile for one or more EJScreen Supplemental Indices. All Tribal areas are considered LIDACs, as well. Because EJScreen uses census block groups (not census tracts) and because Tribal boundaries don't align with census tract boundaries, some tracts on the list are partly, but not fully, comprised of LIDAC areas.

**Table 8: Minnesota census tracts that qualify as LIDACs (based on census tract classifications in the 2010 Census)**

| Census tract 2010 ID | County |
|---|---|
| 27001770100 | Aitkin County |
| 27001770300 | Aitkin County |
| 27001770400 | Aitkin County |
| 27003050807 | Anoka County |
| 27003050901 | Anoka County |
| 27003051304 | Anoka County |
| 27003051501 | Anoka County |
| 27005450100 | Becker County |
| 27005450500 | Becker County |
| 27005940000 | Becker County |
| 27007450500 | Beltrami County |
| 27007450702 | Beltrami County |
| 27007940001 | Beltrami County |
| 27007940002 | Beltrami County |
| 27011950300 | Big Stone County |
| 27013171202 | Blue Earth County |
| 27017070100 | Carlton County |
| 27017940000 | Carlton County |
| 27021940001 | Cass County |
| 27021940002 | Cass County |
| 27021960100 | Cass County |
| 27021960200 | Cass County |
| 27021960600 | Cass County |
| 27021960700 | Cass County |
| 27027020202 | Clay County |
| 27029000200 | Clearwater County |
| 27029000300 | Clearwater County |
| 27031480100 | Cook County |
| 27033270100 | Cottonwood County |
| 27033270400 | Cottonwood County |
| 27035951000 | Crow Wing County |
| 27035951100 | Crow Wing County |
| 27035951200 | Crow Wing County |
| 27037060105 | Dakota County |
| 27037060711 | Dakota County |
| 27045960500 | Fillmore County |
| 27047180600 | Freeborn County |
| 27047180800 | Freeborn County |
| 27047180900 | Freeborn County |
| 27049080200 | Goodhue County |
| 27051070100 | Grant County |
| 27053000102 | Hennepin County |
| 27053001700 | Hennepin County |
| 27053002200 | Hennepin County |
| 27053002700 | Hennepin County |
| 27053003300 | Hennepin County |
| 27053005901 | Hennepin County |
| 27053005902 | Hennepin County |
| 27053007801 | Hennepin County |
| 27053008200 | Hennepin County |
| 27053008300 | Hennepin County |
| 27053008400 | Hennepin County |
| 27053008500 | Hennepin County |
| 27053009500 | Hennepin County |
| 27053012003 | Hennepin County |
| 27053020200 | Hennepin County |
| 27053020301 | Hennepin County |
| 27053020304 | Hennepin County |
| 27053021502 | Hennepin County |
| 27053024802 | Hennepin County |
| 27053024903 | Hennepin County |
| 27053026809 | Hennepin County |
| 27053026819 | Hennepin County |
| 27053100400 | Hennepin County |
| 27053100700 | Hennepin County |
| 27053100800 | Hennepin County |

| Census tract 2010 ID | County |
|---|---|
| 27053100900 | Hennepin County |
| 27053101300 | Hennepin County |
| 27053101600 | Hennepin County |
| 27053101800 | Hennepin County |
| 27053102000 | Hennepin County |
| 27053102100 | Hennepin County |
| 27053102300 | Hennepin County |
| 27053102500 | Hennepin County |
| 27053102800 | Hennepin County |
| 27053102900 | Hennepin County |
| 27053103400 | Hennepin County |
| 27053104100 | Hennepin County |
| 27053104400 | Hennepin County |
| 27053104800 | Hennepin County |
| 27053104900 | Hennepin County |
| 27053105700 | Hennepin County |
| 27053106000 | Hennepin County |
| 27053106200 | Hennepin County |
| 27053106400 | Hennepin County |
| 27053107000 | Hennepin County |
| 27053107400 | Hennepin County |
| 27053108600 | Hennepin County |
| 27053109400 | Hennepin County |
| 27053110000 | Hennepin County |
| 27053125700 | Hennepin County |
| 27053125800 | Hennepin County |
| 27053125900 | Hennepin County |
| 27053126000 | Hennepin County |
| 27053980000 | Hennepin County |
| 27057070100 | Hubbard County |
| 27057070600 | Hubbard County |
| 27061480100 | Itasca County |
| 27061940000 | Itasca County |
| 27067770900 | Kandiyohi County |
| 27067780500 | Kandiyohi County |
| 27067780800 | Kandiyohi County |
| 27069090100 | Kittson County |
| 27071790300 | Koochiching County |
| 27071790500 | Koochiching County |
| 27077460300 | Lake of the Woods County |
| 27077460400 | Lake of the Woods County |
| 27083360500 | Lyon County |
| 27083360700 | Lyon County |
| 27085950700 | McLeod County |
| 27087940100 | Mahnomen County |
| 27087940300 | Mahnomen County |
| 27091790600 | Martin County |
| 27095970100 | Mille Lacs County |
| 27095970200 | Mille Lacs County |
| 27095970300 | Mille Lacs County |
| 27097780100 | Morrison County |
| 27097780600 | Morrison County |
| 27099000100 | Mower County |
| 27099000300 | Mower County |
| 27099000410 | Mower County |
| 27099000800 | Mower County |
| 27105105400 | Nobles County |
| 27105105500 | Nobles County |
| 27105105600 | Nobles County |
| 27109000100 | Olmsted County |
| 27109000200 | Olmsted County |
| 27109000300 | Olmsted County |
| 27111960300 | Otter Tail County |
| 27111960500 | Otter Tail County |
| 27111960900 | Otter Tail County |
| 27111961300 | Otter Tail County |
| 27115950400 | Pine County |
| 27115950500 | Pine County |
| 27119020200 | Polk County |
| 27119020700 | Polk County |
| 27123030400 | Ramsey County |
| 27123030500 | Ramsey County |
| 27123030601 | Ramsey County |
| 27123030704 | Ramsey County |
| 27123030800 | Ramsey County |
| 27123030900 | Ramsey County |
| 27123031000 | Ramsey County |
| 27123031100 | Ramsey County |
| 27123031300 | Ramsey County |
| 27123031400 | Ramsey County |
| 27123031500 | Ramsey County |
| 27123031600 | Ramsey County |
| 27123031701 | Ramsey County |
| 27123031702 | Ramsey County |

| Census tract 2010 ID | County |
|---|---|
| 27123031801 | Ramsey County |
| 27123031802 | Ramsey County |
| 27123032400 | Ramsey County |
| 27123032500 | Ramsey County |
| 27123032600 | Ramsey County |
| 27123032700 | Ramsey County |
| 27123033000 | Ramsey County |
| 27123033100 | Ramsey County |
| 27123033400 | Ramsey County |
| 27123033500 | Ramsey County |
| 27123033600 | Ramsey County |
| 27123033700 | Ramsey County |
| 27123033900 | Ramsey County |
| 27123034400 | Ramsey County |
| 27123034500 | Ramsey County |
| 27123034601 | Ramsey County |
| 27123034602 | Ramsey County |
| 27123034701 | Ramsey County |
| 27123035900 | Ramsey County |
| 27123036100 | Ramsey County |
| 27123037100 | Ramsey County |
| 27123037403 | Ramsey County |
| 27123037602 | Ramsey County |
| 27123040901 | Ramsey County |
| 27123040902 | Ramsey County |
| 27123042800 | Ramsey County |
| 27127750100 | Redwood County |
| 27127750300 | Redwood County |
| 27131070800 | Rice County |
| 27131070901 | Rice County |
| 27131070902 | Rice County |
| 27135970400 | Roseau County |
| 27137001400 | St. Louis County |
| 27137001600 | St. Louis County |
| 27137001700 | St. Louis County |
| 27137001800 | St. Louis County |
| 27137001900 | St. Louis County |
| 27137003300 | St. Louis County |
| 27137003700 | St. Louis County |
| 27137003800 | St. Louis County |
| 27137011200 | St. Louis County |
| 27137012200 | St. Louis County |
| 27137012400 | St. Louis County |
| 27137013000 | St. Louis County |
| 27137013100 | St. Louis County |
| 27137013800 | St. Louis County |
| 27137015500 | St. Louis County |
| 27137015600 | St. Louis County |
| 27139080302 | Scott County |
| 27139080400 | Scott County |
| 27139080903 | Scott County |
| 27139080905 | Scott County |
| 27145000302 | Stearns County |
| 27145000500 | Stearns County |
| 27145000801 | Stearns County |
| 27145011500 | Stearns County |
| 27147960400 | Steele County |
| 27151960200 | Swift County |
| 27151960400 | Swift County |
| 27153790100 | Todd County |
| 27153790200 | Todd County |
| 27153790300 | Todd County |
| 27153790600 | Todd County |
| 27159480300 | Wadena County |
| 27161790500 | Waseca County |
| 27173970100 | Yellow Medicine County |