NORTH DAKOTA GREENHOUSE GAS INVENTORY

Revised Final Report

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

NORTH DAKOTA GREENHOUSE GAS INVENTORY

EXECUTIVE SUMMARY

The Energy & Environmental Research Center (EERC) at the University of North Dakota (UND) compiled a high-level greenhouse gas (GHG) inventory of the state of North Dakota in support of the North Dakota Department of Environmental Quality (NDDEQ) work on the Climate Pollution Reduction Grant (CPRG) and potential future GHG reduction efforts. Six sectors were identified to structure the inventory based on their importance to the state and emissions impact: Agriculture, Natural, and Working Lands; Oil and Natural Gas; Electric Power Generation; Industry; Commercial and Residential Buildings and Waste; and Transportation. Carbon dioxide (CO_2) was included in the state's inventory as well as methane (CH_4) and nitrous oxide (N_2O) calculated as a CO_2 equivalent. Hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), sulfur hexafluoride (SF_6), and nitrogen trifluoride (NF_3) were included as a relatively small (3%) but potent portion of GHGs in the industrial sector.

The inventory was completed using the U.S. Environmental Protection Agency's (EPA's) State Inventory Tool (SIT) (1). The toolset is broken down into 11 modules that identify sources and sinks within each state. Default data were verified and used for this initial inventory. Deviations from methodology because of a lack of readily available information are discussed. Completed modules provided summary files that were used to compile the inventory based upon the sectors identified.

In 2019, North Dakota's gross GHG emissions were 85.6 million standard tons of CO_2 equivalent ($MMtCO_2e$) and net emissions were 80.8 $MMtCO_2e$. Industry accounted for the largest share at 21% followed by Oil and Natural Gas (20%); Agriculture, Natural, and Working Lands (19%); Electric Power Generation (16%); Commercial and Residential Buildings and Waste (13%); and Transportation (11%).

NORTH DAKOTA GREENHOUSE GAS INVENTORY

INTRODUCTION

The Energy & Environmental Research Center (EERC) at the University of North Dakota (UND) compiled a high-level greenhouse gas (GHG) inventory of the state of North Dakota in support of the North Dakota Department of Environmental Quality (NDDEQ) work on the Climate Pollution Reduction Grant (CPRG) and potential future GHG reduction efforts. The primary objective of this initial effort was to establish a state GHG inventory fulfilling CPRG requirements. The year 2019 was used as a baseline year to forecast and eventually measure the impact of subsequent GHG reduction programs in the states Priority Climate Action Plan (PCAP). 2019 was selected as the baseline year because it was the most recent year with widely available published data that was not significantly affected by the global COVID-19 pandemic. A substantial decrease in emissions was observed in the data between 2019 and 2020, and the years 2022–2023 were not assessed due to the inherent lag between years' end and the publishing of large aggregate datasets.

The EERC identified six sectors to structure the inventory based on their importance to the state and emission impact according to the 2018 data from the U.S. Environmental Protection Agency's (EPA's) Inventory of U.S. Greenhouse Gas Emissions and Sinks by State: 1990–2021 (2). These sectors and their 2018 emission impact are described below:

- Agriculture, Natural, and Working Lands – Agriculture accounted for 22% of the state's 2018 emissions and is nearly ubiquitous across the geographical extent of the state. The land within the state both left within a natural state and used agriculturally acts as sinks for carbon, removing CO_2 from the atmosphere.

- Oil and Natural Gas – The state's oil and gas production accounted for 11.5% of all U.S. production in 2018, and methane's potency as a GHG has put it under scrutiny nationwide.

- Electric Power Generation – The electric power sector generated 32% of North Dakota's 2018 emissions and is responsible for the state's status as a net energy exporter.

- Industry – Industrial sources, including fertilizer production, food processing, and manufacturing, were the largest source of emissions for the state in 2018 at 34%.

- Commercial and Residential Buildings and Waste – While the magnitude of emissions in these sectors are relatively small, commercial and residential buildings represent some end use of power generation, landfills have a large impact on methane emissions, and wastewater treatment is a major source of nitrous oxide emissions. EPA's national GHG data listed emissions associated with residential and commercial at less than 3% of the total emissions by their methodology. Percentages for waste were not independently provided in the summary.

- Transportation – Transportation activities accounted for 8.6% of North Dakota's 2018 emissions.

Three primary GHGs were included in the state's inventory as CO_2 equivalents. These gases are CO_2, CH_4, and N_2O.

GREENHOUSE GAS INVENTORY PROCEDURE AND METHODOLOGY

The preliminary inventory was generated using EPA's SIT. This tool consists of a series of Microsoft Excel workbooks that are frequently updated by EPA. The toolset comprises 11 modules:

- CO_2 from fossil fuel combustion (CO_2FFC)
- CO_2 from electricity consumption (CO_2EC)
- Stationary combustion
- Mobile combustion
- Coal mining
- Natural gas and oil systems
- Industrial processes
- Agriculture
- Land use, land-use change, and forestry (LULUCF)
- Municipal solid waste
- Wastewater

Each module included some level of default data. For the purposes of this inventory, default data include datasets contained within the SIT modules that can be used to populate inputs. Data that were not included within modules but were suggested by a module were also considered to be default data. Default data were given priority and utilized whenever possible while completing these modules given the timeline and scope for this first phase. The default data within each module were checked for accuracy against their external sources. If default data were not available, data from other federal, state, or industry sources were used, or it was confirmed that data were truly missing. Instances where default data were not used will be described with the applicable modules.

As each of the modules were completed, summary files were loaded into the Synthesis Tool of the SIT. The aggregate data from the modules were then sorted into the appropriate sector resulting in the baseline North Dakota state GHG inventory. The sorting process is described by sector:

- Agriculture, Natural, and Working Lands – consists of CO_2, CH_4, and N_2O emissions in the Agriculture module as well as CO_2 emissions and sinks in the LULUCF module.

- Oil and Natural Gas – consists of CO_2 and CH_4 emissions in the Natural Gas and Oil Systems module.

- Electric Power Generation – consists of CO_2 emissions from the Electric Utilities total in the CO_2FFC module, CH_4 and N_2O emissions from the Electric Utilities total in the Stationary Combustion module, and CO_2 emissions from end-use consumption in the CO_2EC module. Electric Power Generation also included emissions (CH_4) from the Coal module since the end use was for power generation.

- Industry – consists of total emissions in the Industrial Processes module, CO_2 emissions from the Industrial total in the CO_2FFC module, CH_4 and N_2O emissions from the Industrial total in the Stationary Combustion module, and total emissions from the Industrial total in the Electricity Consumption module.

- Commercial and Residential Buildings and Waste – consists of CO_2 emissions from the Residential and Commercial totals in the CO_2FFC module, CH_4 and N_2O emissions from the Residential and Commercial totals in the Stationary Combustion module, total emissions from the Residential and Commercial totals in the Electricity Consumption module, CH_4 and N_2O emissions in the Municipal Solid Waste module, and CH_4 and N_2O emissions in the Wastewater module.

- Transportation – consists of CO_2 emissions from the transportation total in the CO_2FFC Module. CH_4 and N_2O emissions from Mobile Combustion module were added to the CO_2 total.

GREENHOUSE GAS INVENTORY RESULTS

Table 1 summarizes the emission totals by sector and provides the module(s) used to contribute to the overall sector total. Gross emissions for 2019 totaled 89.8 million metric tons of CO_2 equivalent ($MMtCO_2e$), and net emissions for 2019, sum of sources and sinks, totaled 85.0 $MMtCO_2e$. Figure 1 shows the percentage breakdown of each sector. Figure 2 shows the compositional breakdown of the GHG warming effect with respect to the gases investigated.

Agriculture, Natural, and Working Lands included CO_2, CH_4, and N_2O emissions associated with agricultural as well as those from LULUCF. Agriculture's largest emissions came from enteric fermentation and manure management associated with livestock. The largest component of LULUCF as a sink of emissions is attributed to agricultural soil carbon flux and grasslands. This important sink of emissions removed 4.8$MMtCO_2e$ from the atmosphere, offsetting North Dakota's GHG emissions. The amount of carbon stored in cropland is a function of the acres of cropland, crop, farming practices, and climate. Differences existed between the EPA state-level estimate, and this estimate attributed to where each inventory counted agriculture transportation and energy emissions.

Emissions from Oil and Natural Gas are primarily CH_4 emissions, where the GHG potential has been converted to $MMtCO_2e$. Additionally, CO_2 emissions from flaring are directly counted. Next to Industry, this sector accounted for the largest share of direct emissions.

Table 1. Emissions by Sector

Sector	Emissions in MMtCO_2e	
Agriculture, Natural, and Working Lands		15.1
Agriculture	19.9	
LULUCF	−4.8	
Oil and Natural Gas		16.8
Equivalent from CH_4	6.5	
Flaring	10.2	
Electric Power Generation		13.7
CO_2FFC Electric Utilities	28.3	
Indirect CO_2 from Electricity Consumption	−14.9	
Stationary CO_2e	0.12	
Coal	0.15	
Industry		18.2
IP	0.78	
CO_2FFC Industrial	10.9	
Stationary CO_2e Industrial	0.04	
Indirect CO_2 from Electricity Consumption Industrial	6.5	
Commercial and Residential Buildings and Waste		11.5
Residential	4.9	
CO_2FFC Residential	1.3	
Stationary CO_2e Residential	0.01	
Indirect CO_2 from Electricity Consumption Residential	3.6	
Commercial	6.1	
CO_2FFC Commercial	1.3	
Stationary CO_2e Commercial	0.01	
Indirect CO_2 from Electricity Consumption Commercial	4.9	
Waste	0.48	
Equivalent from Municipal Solid Waste (MSW)	0.41	
Equivalent from Wastewater	0.07	
Transportation		9.7
CO_2FFC	9.58	
Mobile CO_2E	0.13	
Sequestered CO_2		**−4.8**
Gross GHG Emissions		**89.8**
Net GHG Emissions		**85.0**

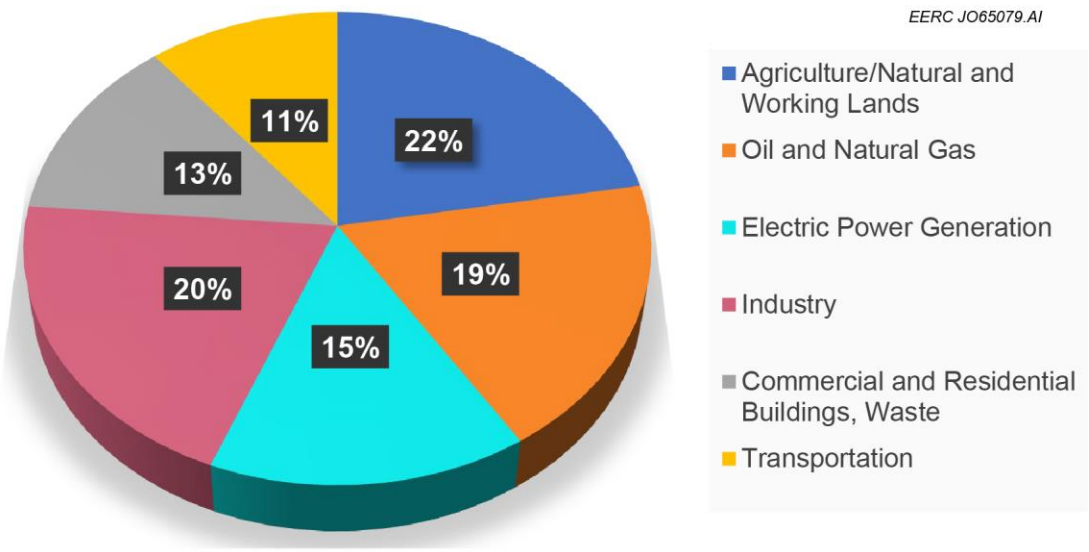

Figure 1. Percentage contribution by sector.

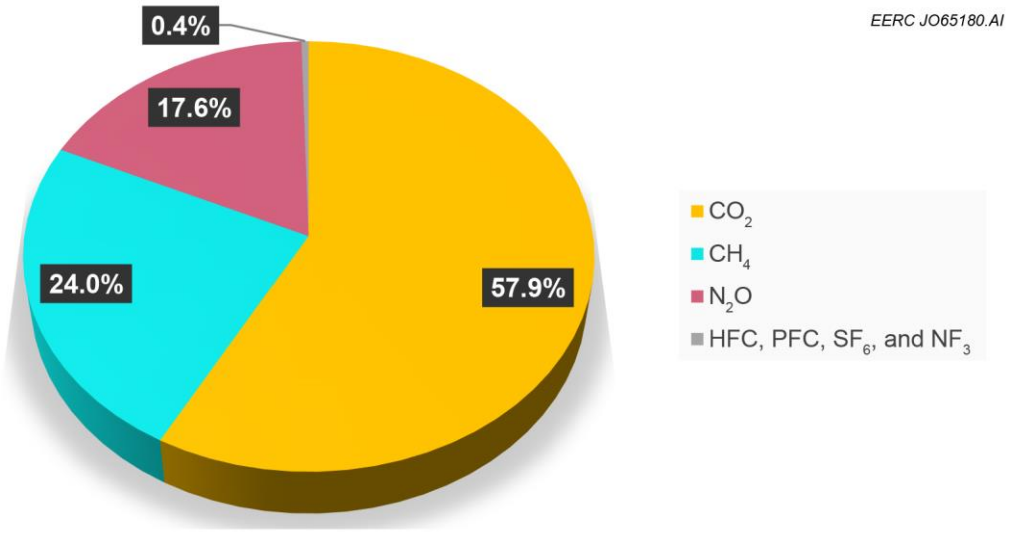

Figure 2. Percentage contribution by gas.

Electric power generation emissions totaled 28.45 $MMtCO_2e$. Figure 3 demonstrates allocation of emissions to their end uses in residential, commercial, and industrial. The 13.53 $MMtCO_2e$ is representative of the emissions associated with electricity exported via the grid to end uses outside of North Dakota. The breakdown of consumption can be seen in Figure 2. Because of the end use of this power occurring outside of the state, it is worth noting the net GHG emissions are 67.24 $MMtCO_2e$, a difference of 17%. Differences existed between EPA and this estimate primarily because of EPA keeping emissions from electrical production together, whereas this inventory breaks them into their sectors.

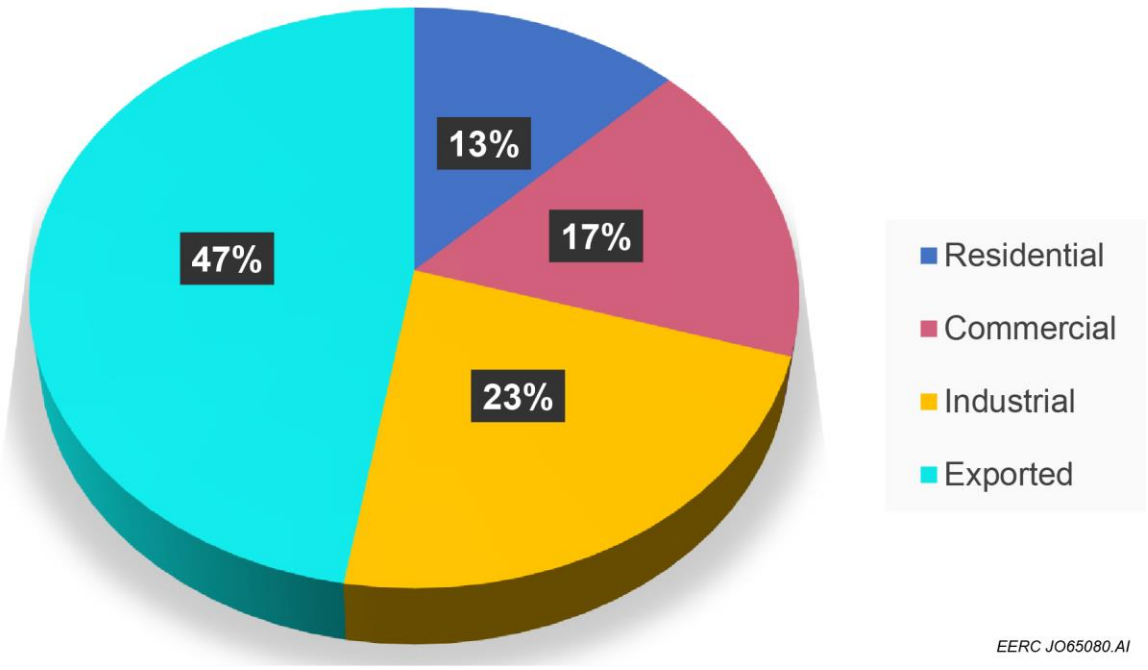

Figure 3. Electric power generation breakdown.

Industry included values for the direct emissions of industrial processes (IP), emissions from combustion of fossil fuels for process heat and building conditioning, indirect emissions of electrical consumption, and CO_2 equivalent emissions from NO_2 and CH_4 associated with the combustion of fossil fuels. This category is the largest contributor to emissions. Differences existed between EPA and this estimate primarily because of EPA combining the Oil and Gas sector with the Industry sector.

Commercial and Residential Buildings and Waste is broken down into three subtotals. This group was kept together as they are largely associated with the population of the state. Waste included a breakdown by equivalent emissions of NO_2 and CH_4 associated with MSW and wastewater treatment. Any carbon sinks such as landfilling of yard waste, trimmings, or food scraps are not counted in the MSW section and were calculated/included in the LULUCF model.

Transportation consisted of 9.71 $MMtCO_2e$ in 2019. The total for transportation was tabulated based upon combustion of fossil fuels and the equivalent emissions for NO_2 and CH_4. Any transportation associated with electrical vehicles would have been counted in the module for Indirect CO_2 from Electricity Consumption. Electrical power for transportation was not included in this section and otherwise included in residential and commercial power consumption.

Differences between EPA state estimates and this estimate can be further understood by the methodology employed. EPA state estimates must sum to the national total and often use top-down methodologies. State estimates utilizing state data and a bottom-up methodology result in differences in the numbers. According to EPA, the organization “recognizes that there will be differences between the EPA’s state-level estimates and some inventory estimates developed

independently by individual state governments. Inventories compiled by states may differ for several reasons and differences do not necessarily mean that one set of estimates is more accurate, or 'correct'" (3).

Data Methodology Deviations

Default data were not necessarily available for the entirety of each module, as previously mentioned. Alternative data sources were used in these instances. Deviations are described below by module. If a module is not included, that module was completed using default data.

- CO_2 from Electricity Consumption – Data from the U.S. Department of Transportation Bureau of Transportation (4) Statistics were used to confirm that North Dakota did not consume electricity for transportation.

- Coal Mining – Data from the U.S. Department of Labor Mine Safety and Health Administration's Mine Data Retrieval (5) System were used to populate the Additional Abandoned Coal Mines list on the CH_4 from Abandoned Coal Mines tab.

- Natural Gas and Oil Systems – Regarding the Natural Gas–Transmission tab, transmission and gathering pipeline mileage was pulled from the U.S. Department of Transportation Pipeline Hazardous Materials Safety Administration (6) (PHMSA) annual reports as suggested by the module. The first concern with this dataset is PHMSA-regulated lines are only a small fraction of the total mileage in the state. Secondly, the mileage reported is often for multiple states with no clear indication which portion belongs to each state. For this initial inventory, the mileage was divided evenly among each state. Data for the number of gas-processing plants were obtained from the North Dakota Pipeline Authority (NDPA) (7). Regarding the oil transportation values on the Petroleum Systems tab, the full export capacity across all options provided by NDPA was assumed. Refining values on the same tab were obtained from Energy Information Administration (EIA) (8) data and assumed to be the maximum daily capacity reported in barrels per calendar day.

- Land Use, Land-Use Change, and Forestry – Data from the National Interagency Fire Center's InFORM Fire Occurrence Data Records (9) were used to determine a real extent of wildfire burns.

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