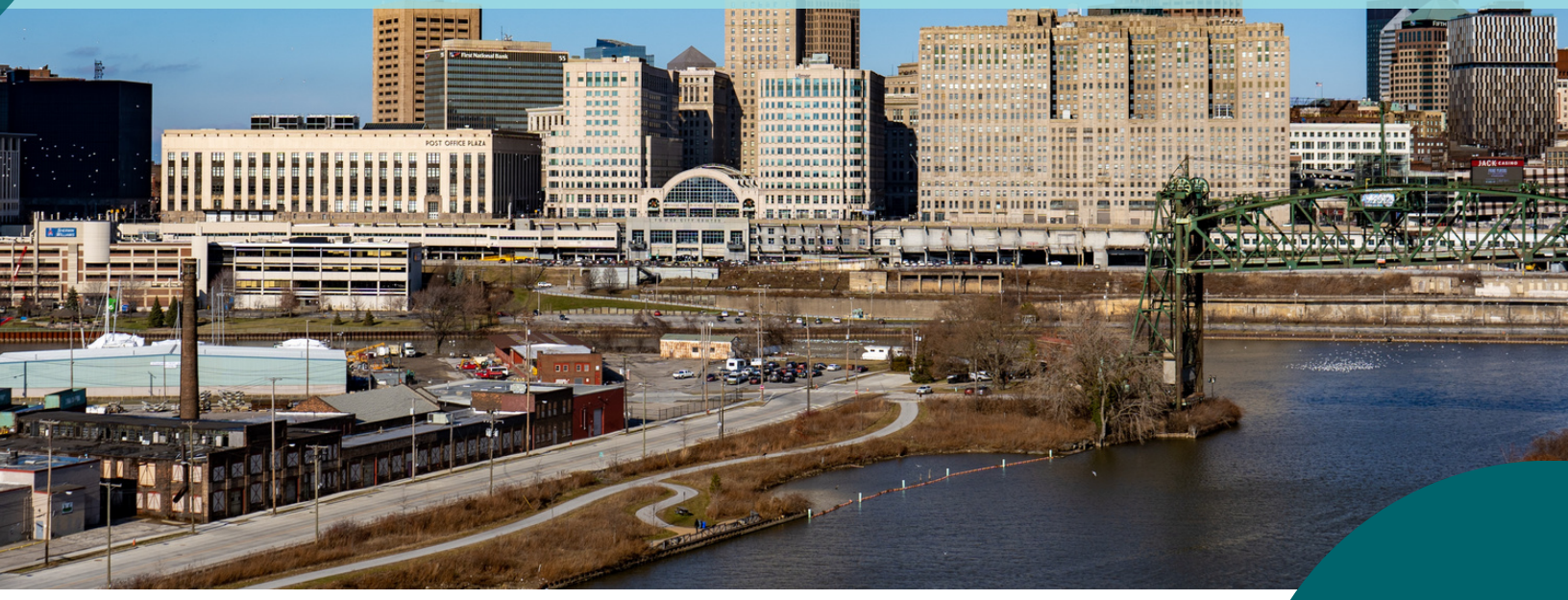
NORTHEAST OHIO AREAWIDE COORDINATING AGENCY

Regional Greenhouse Gas Emissions Inventory: 2018 Baseline



NORTHEAST OHIO AREAWIDE COORDINATING AGENCY
Lake
Geauga
Cuyahoga
Lorain
Medina
NOACA: Planning For Greater Cleveland

ICLEI
Local Governments for Sustainability
USA

Table of Contents

Tables and Figures

List of Tables

List of Figures

Key Findings

The Northeast Ohio Areawide Coordinating Agency Regional Greenhouse Gas Emissions Inventory: 2018 Baseline identifies baseline emissions levels and sources and activities generating emissions in the five counties (Cuyahoga County, Geauga County, Lake County, Lorain County, and Medina County) of the NOACA region. The total emissions by sector for the NOACA regional greenhouse gas inventory baseline report are shown in Figure 1. The largest contributor is Residential Energy with 26% of emissions. The next largest contributors are Transportation (25%), Commercial Energy (19%), and Industrial Energy (19%). Actions to reduce emissions in all of these sectors will likely need to be a key part of a climate action plan. Solid Waste, Water & Wastewater, and Process & Fugitive Emissions (unintentional emissions that occur through leakage) were responsible for the remaining (less than 11%) emissions. Agriculture, Forestry & Other Land Use (AFOLU) sequesters approximately 3% of emissions.

The Inventory Results section of this report provides a detailed profile of emissions sources within the NOACA region; information that is key to guiding local reduction efforts. These data will also provide a baseline against which NOACA will be able to compare future performance and demonstrate progress in reducing emissions.

EMISSIONS AT A GLANCE

1 **Residential Energy** 26%

2 **Transportation** 25%

3 **Industrial Energy** 19%

4 **Commercial Energy** 19%

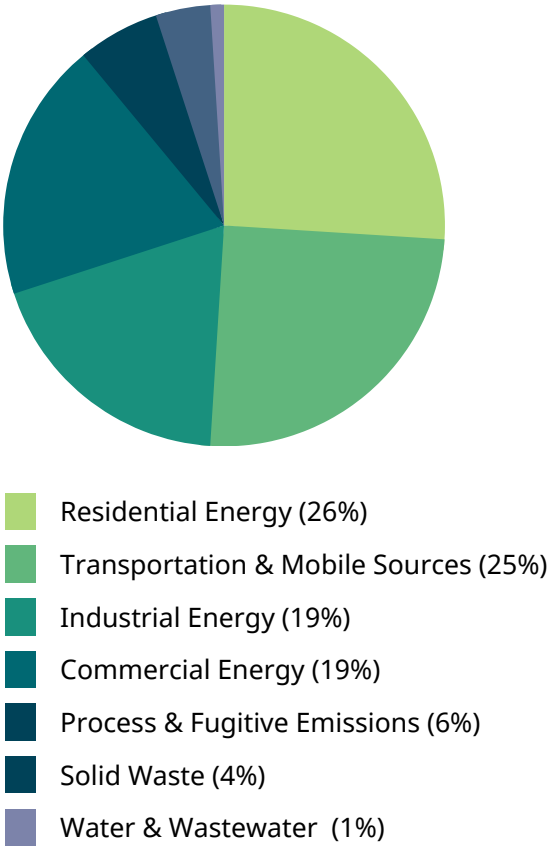


Figure 1: 2018 Total Regional Emissions by Sector

Inventory Methodology

Understanding a Greenhouse Gas Emissions Inventory

The first step toward achieving tangible greenhouse gas (GHG) emission reductions requires identifying baseline emissions levels and sources and activities generating emissions in the community/region. This inventory uses the approach and methods provided by the U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions (Community Protocol) which is described below.

Three greenhouse gases are included in this inventory: carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O). Many of the charts in this report represent emissions in "carbon dioxide equivalent" (CO2e) values, calculated using the Global Warming Potentials (GWP) for methane and nitrous oxide from the IPCC 5th Assessment Report.

Table 1: Global Warming Potential Values (IPCC, 2014)

Greenhouse Gas	Global Warming Potential
Carbon Dioxide (CO2)	1
Methane (CH4)	28
Nitrous Oxide (N2O)	265

Regional Emissions Protocol

ICLEI released Version 1.2 of the U.S. Community Protocol for Accounting and Reporting GHG Emissions [1] in 2019, and represents a national standard in guidance to help U.S. local governments develop effective community GHG emissions inventories. It establishes reporting best practices for all community GHG emissions inventories, provides detailed accounting guidance for quantifying GHG emissions associated with a range of emission sources and community activities, and provides a number of optional reporting frameworks to help local governments customize their community GHG emissions inventory reports based on their local goals and capacities.

[1] ICLEI. 2012. US Community Protocol for Accounting and Reporting Greenhouse Gas Emissions. Retrieved from http://www.icleiusa.org/tools/ghg-protocol/community-protocol

The regional inventory in this report includes emissions from the five Basic Emissions Generating Activities required by the Community Protocol. These activities are:

- Use of electricity by the region
- Use of fuel in residential and commercial stationary combustion equipment
- On-road passenger and freight motor vehicle travel
- Use of energy in potable water and wastewater treatment and distribution
- Generation of solid waste by the region

The regional inventory also includes the following activities to make it a Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) Basic-compliant inventory:

- Wastewater treatment processes
- Rail, marine and off-road transportation
- Forest and trees
- Industrial processes
- Scope 3 air travel

Data is collected from a variety of entities in the region, including electric, gas, water and wastewater utilities. Methodology and data source details are provided in the appendix to this report.

Quantifying Greenhouse Gas Emissions

Sources and Activities

Communities contribute to greenhouse gas emissions in many ways. Two central categorizations of emissions are used in the community inventory: 1) GHG emissions that are produced by "sources" located within the community boundary, and 2) GHG emissions produced as a consequence of community "activities."

Table 2: Source vs. Activity for Greenhouse Gas Emissions (GHG)

Source	Activity
Any physical process inside the jurisdictional boundary that releases GHG emissions into the atmosphere	The use of energy, materials, and/or services by members of the community that result in the creation of GHG emissions.

Local governments can develop and promote a deeper understanding of GHG emissions associated with their communities by reporting on both GHG emissions sources and activities. The GPC applies a division of community emissions into Scopes 1, 2 and 3, rather than sources and activities. The source category is generally equivalent to Scope 1, while activities comprise Scope 2 and Scope 3.

Base Year

The inventory process requires the selection of a base year with which to compare current emissions. NOACA's regional GHG emissions inventory utilizes 2018 as its baseline year because it is the most recent year for which the necessary data are available.

Quantification Methods

GHG emissions can be quantified in two ways:

- Measurement-based methodologies refer to the direct measurement of GHG emissions (from a monitoring system) emitted from a flue of a power plant, wastewater treatment plant, landfill, or industrial facility.
- Calculation-based methodologies calculate emissions using activity data and emission factors. To calculate emissions accordingly, the basic equation below is used:

Activity Data x Emission Factor = Emissions

Most emissions sources in this inventory are quantified using calculation-based methodologies. Activity data refer to the relevant measurement of energy use or other GHG-generating processes such as fuel consumption by fuel type, metered annual electricity consumption, and annual vehicle miles traveled. Please see the appendices for a detailed listing of the activity data used in composing this inventory.

Known emission factors are used to convert energy usage or other activity data into associated quantities of emissions. Emissions factors are usually expressed in terms of emissions per unit of activity data (e.g. lbs CO2/kWh of electricity). For this inventory, calculations were made using ICLEI's ClearPath Climate Planner, an online software platform for completing GHG inventories, forecasts, climate action plans, and monitoring at the community-wide or government operations scales.

2018 Total Regional Emissions Inventory Results

The total regional emissions for the 2018 inventory are shown in Table 3 and Figure 2.

Table 3: 2018 Total Regional Emissions Inventory

Sector	Fuel or Source	2018 Usage*	Usage Unit*	2018 Emissions (MTCO2e)*
Residential Energy	Electricity	7,554,518,825	kWh	3,490,047
	Natural Gas	105,120,498	MMBtu	5,590,991
	Propane	1,170,862	MMBtu	72,662
	Fuel Oil	710,678	MMBtu	52,915
	Residential Energy Total			**9,206,615**
Commercial Energy	Electricity	7,820,324,931	kWh	4,059,675
	Natural Gas	52,657,203	MMBtu	2,800,652
	Commercial Energy Total			**6,860,327**
Industrial Energy	Electricity	7,544,525,035	kWh	3,948,447
	Natural Gas	13,890,114	MMBtu	715,151
	Non-Utility Fuels			2,331,815
	Industrial Energy Total			**6,995,413**
Transportation & Mobile Sources	Gasoline	15,539,152,438	VMT	6,303,888
	Diesel	1,167,907,440	VMT	2,018,766
	Aviation			422,056
	Rail Transportation			6,522
	Public Transit			37,750
	Water Transportation			249,241
	Off-Road			106,369
	Transportation & Mobile Sources Total			**9,144,592**
Solid Waste	Waste Generation	2,450,730	Tons	1,422,575
	Composting	304,938	Tons	21,232
	Combustion of Solid Waste	890	Tons	308
	Solid Waste Total			**1,444,115**

*Table Notes- MTCO2e: Metric Tons of Carbon Dioxide equivalent; kWh: kilowatt-hours; MMBtu: Metric Million British thermal unit; VMT: Vehicle Miles Traveled; Blank cells are a result of variability in the format of available data by sector and fuel or source type.

Table 3: 2018 Total Regional Emissions Inventory (continued)

Sector	Fuel or Source	2018 Usage*	Usage Unit*	2018 Emissions (MTCO2e)*
Water & Wastewater	Septic Systems			89,524
	Combustion of Digester Gas			19
	Combustion of Biosolids and Sludges			12,480
	N2O Emissions			14,049
	Water & Wastewater Total			**116,072**
Process & Fugitive Emissions	Natural Gas Distribution	169,904,636	MMBtu	319,054
	Gas and Oil Wells			587,892
	Other Process and Fugitive			1,148,564
	Process & Fugitive Emissions Total			**2,055,510**
	Total Gross Emissions			**35,822,644**
Forests & Trees	Removals from Forests			-866,533
	Removals from Trees Outside of Forests			-302,838
	Forest & Trees Emissions Total			**-1,169,371**
	Total Emissions with Sequestration			**34,653,273**

*Table Notes- MTCO2e: Metric Tons of Carbon Dioxide equivalent; kWh: kilowatt-hours; MMBtu: Metric Million British thermal unit; VMT: Vehicle Miles Traveled; Blank cells are a result of variability in the format of available data by sector and fuel or source type.

Figure 2 shows the distribution of regional emissions by sector. Residential Energy is the largest contributor, followed by Transportation and then by Commercial Energy.

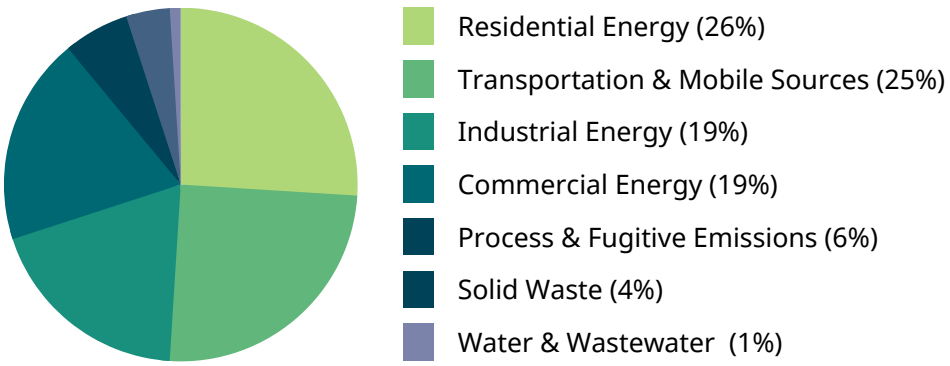


Figure 2: 2018 Total Regional Emissions by Sector (same as Figure 1)

2018 Cuyahoga County Emissions Inventory Results

The Cuyahoga County emissions for the 2018 inventory are shown in Table 4 and Figure 3.

Table 4: 2018 Cuyahoga County Emissions Inventory

Sector	Fuel or Source	2018 Usage*	Usage Unit*	2018 Emissions (MTCO2e)*
Residential Energy	Electricity	4,220,828,789	kWh	1,839,880
	Natural Gas	65,899,151	MMBtu	3,504,945
	Propane	497,744	MMBtu	30,889
	Fuel Oil	84,972	MMBtu	6,327
	Residential Energy Total			**5,382,041**
Commercial Energy	Electricity	5,224,248,774	kWh	2,781,715
	Natural Gas	33,380,881	MMBtu	1,775,412
	Commercial Energy Total			**4,557,127**
Industrial Energy	Electricity	5,566,716,131	kWh	2,964,066
	Natural Gas	4,376,990	MMBtu	232,307
	Non-Utility Fuels			2,242,573
	Industrial Energy Total			**5,438,946**
Transportation & Mobile Source	Gasoline	8,763,716,875	VMT	3,534,879
	Diesel	658,621,243	VMT	1,137,775
	Aviation			422,044
	Rail Transportation			6,335
	Public Transit			37,750
	Water Transportation			202,686
	Off-Road			59,275
	Transportation & Mobile Sources Total			**5,400,744**
Solid Waste	Waste Generation	1,509,312	Tons	876,110
	Composting	185,105	Tons	12,888
	Combustion of Solid Waste		Tons	
	Solid Waste Total			**888,998**

*Table Notes- MTCO2e: Metric Tons of Carbon Dioxide equivalent; kWh: kilowatt-hours; MMBtu: Metric Million British thermal unit; VMT: Vehicle Miles Traveled; Blank cells are a result of variability in the format of available data by sector and fuel or source type.

Table 4: 2018 Cuyahoga County Emissions Inventory (continued)

Sector	Fuel or Source	2018 Usage*	Usage Unit*	2018 Emissions (MTCO2e)*
Water & Wastewater	Septic Systems	242,078		29,412
	Combustion of Digester Gas	83,600	Service Population	8
	Combustion of Biosolids and Sludges			12,480
	N2O Emissions			11,945
	Water & Wastewater Total			**53,845**
Process & Fugitive Emissions	Natural Gas Distribution	102,309,483	MMBtu	196,978
	Gas and Oil Wells			143,385
	Other Process and Fugitive			918,180
	Process & Fugitive Emissions Total			**1,258,543**
	Total Gross Emissions			**22,980,245**
Forests & Trees	Removals from Forests			-112,866
	Removals from Trees Outside of Forests			-120,900
	Forests & Trees Emissions Total			**-233,766**
	Total Emissions with Sequestration			**22,746,479**

*Table Notes- MTCO2e: Metric Tons of Carbon Dioxide equivalent; kWh: kilowatt-hours; MMBtu: Metric Million British thermal unit; VMT: Vehicle Miles Traveled; Blank cells are a result of variability in the format of available data by sector and fuel or source type.

Figure 3 shows the distribution of Cuyahoga County's emissions by sector. Transportation is the largest contributor, followed by Residential & Commercial Energy.

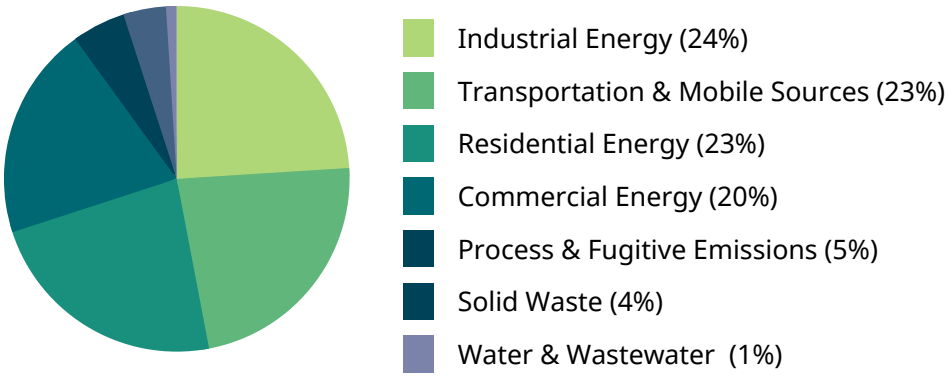


Figure 3: 2018 Cuyahoga County Emissions by Sector

2018 Geauga County Emissions Inventory Results

The Geauga County emissions for the 2018 inventory are shown in Table 5 and Figure 4.

Table 5: 2018 Geauga County Emissions Inventory

Sector	Fuel or Source	2018 Usage*	Usage Unit*	2018 Emissions (MTCO2e)*
Residential Energy	Electricity	480,096,397	kWh	207,535
	Natural Gas	2,614,308	MMBtu	139,046
	Propane	315,188	MMBtu	5,664
	Fuel Oil	91,272	MMBtu	23,468
	Residential Energy Total			**375,713**
Commercial Energy	Electricity	335,961,964	kWh	145,228
	Natural Gas	982,126	MMBtu	52,236
	Commercial Energy Total			**197,464**
Industrial Energy	Electricity	244,082,189	kWh	105,511
	Natural Gas	56,127	MMBtu	2,978
	Non-Utility Fuels			
	Industrial Energy Total			**108,489**
Transportation & Mobile Sources	Gasoline	783,783,448	VMT	317,712
	Diesel	58,994,453	VMT	98,384
	Aviation			
	Rail Transportation			
	Public Transit			
	Water Transportation			
	Off-Road			6,484
	Transportation & Mobile Sources Total			**422,580**
Solid Waste	Waste Generation	73,078	Tons	42,420
	Composting	37,702	Tons	2,625
	Combustion of Solid Waste		Tons	
	Solid Waste Total			**45,045**

*Table Notes- MTCO2e: Metric Tons of Carbon Dioxide equivalent; kWh: kilowatt-hours; MMBtu: Metric Million British thermal unit; VMT: Vehicle Miles Traveled; Blank cells are a result of variability in the format of available data by sector and fuel or source type.

Table 5: 2018 Geauga County Emissions Inventory (continued)

Sector	Fuel or Source	2018 Usage*	Usage Unit*	2018 Emissions (MTCO2e)*
Water & Wastewater	Septic Syste,s	93,859	Service Population	11,404
	Combustion of Digester Gas			
	Combustion of Biosolids and Sludges			
	N2O Emissions			30
	Water & Wastewater Total			**11,434**
Process & Fugitive Emissions	Natural Gas Distribution	3,652,561	Service Population	7,368
	Gas and Oil Wells			134,546
	Other Process and Fugitive			
	Process & Fugitive Emissions Total			**141,914**
	Total Gross Emissions			**1,302,639**
Forests & Trees	Removals from Forests			-296,193
	Removals from Trees Outside of Forests			-64,825
	Forests & Trees Emissions Total			**-361,018**
	Total Emissions with Sequestration			**941,621**

*Table Notes- MTCO2e: Metric Tons of Carbon Dioxide equivalent; kWh: kilowatt-hours; MMBtu: Metric Million British thermal unit; VMT: Vehicle Miles Traveled; Blank cells are a result of variability in the format of available data by sector and fuel or source type.

Figure 4 shows the distribution of Geauga County's emissions by sector. Transportation is the largest contributor, followed by Residential & Commercial Energy.

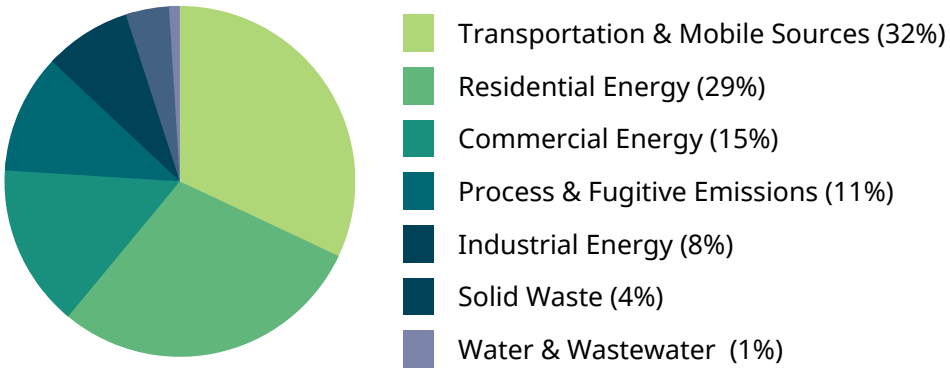


Figure 4: 2018 Geauga County Emissions by Sector

2018 Lake County Emissions Inventory Results

The Lake County emissions for the 2018 inventory are shown in Table 6 and Figure 5.

Table 6: 2018 Lake County Emissions Inventory

Sector	Fuel or Source	2018 Usage*	Usage Unit*	2018 Emissions (MTCO2e)*
Residential Energy	Electricity	906,150,299	kWh	506,729
	Natural Gas	8,162,926	MMBtu	434,157
	Propane	85,581	MMBtu	5,311
	Fuel Oil	102,668	MMBtu	7,644
	Residential Energy Total			**953,842**
Commercial Energy	Electricity	967,757,939	kWh	539,165
	Natural Gas	3,271,702	MMBtu	174,010
	Commercial Energy Total			**713,175**
Industrial Energy	Electricity	577,753,228	kWh	319,314
	Natural Gas	299,575	MMBtu	15,900
	Non-Utility Fuels			84,850
	Industrial Energy Total			**420,064**
Transportation & Mobile Sources	Gasoline	1,775,729,312	VMT	727,972
	Diesel	133,451,715	VMT	231,624
	Aviation			6
	Rail Transportation			
	Public Transit			
	Water Transportation			33,795
	Off-Road			14,002
	Transportation & Mobile Sources Total			**1,007,399**
Solid Waste	Waste Generation	238,705	Tons	138,561
	Composting	38,372	Tons	2,672
	Combustion of Solid Waste		Tons	
	Solid Waste Total			**141,233**

**Table Notes- MTCO2e: Metric Tons of Carbon Dioxide equivalent; kWh: kilowatt-hours; MMBtu: Metric Million British thermal unit; VMT: Vehicle Miles Traveled; Blank cells are a result of variability in the format of available data by sector and fuel or source type.

Table 6: 2018 Lake County Emissions Inventory (continued)

Sector	Fuel or Source	2018 Usage*	Usage Unit*	2018 Emissions (MTCO2e)*
Water & Wastewater	Septic Systems	119,913	Service Population	14,569
	Combustion of Digester Gas	55,567	Service Population	3
	Combustion of Biosolids and Sludges			
	N2O Emissions			826
Water & Wastewater Total				**15,398**
Process & Fugitive Emissions	Natural Gas Distribution	11,734,203	Service Population	23,671
	Gas and Oil Wells			65,436
	Other Process and Fugitive			230,384
Process & Fugitive Emissions Total				**319,491**
Total Gross Emissions				**3,570,602**
Forests & Trees	Removals from Forests			-98,228
	Removals from Trees Outside of Forests			-67,224
Forests & Trees Emissions Total				**-165,452**
Total Emissions with Sequestration				**3,405,150**

*Table Notes- MTCO2e: Metric Tons of Carbon Dioxide equivalent; kWh: kilowatt-hours; MMBtu: Metric Million British thermal unit; VMT: Vehicle Miles Traveled; Blank cells are a result of variability in the format of available data by sector and fuel or source type.

Figure 5 shows the distribution of Geauga County's emissions by sector. Transportation is the largest contributor, followed by Residential & Commercial Energy.

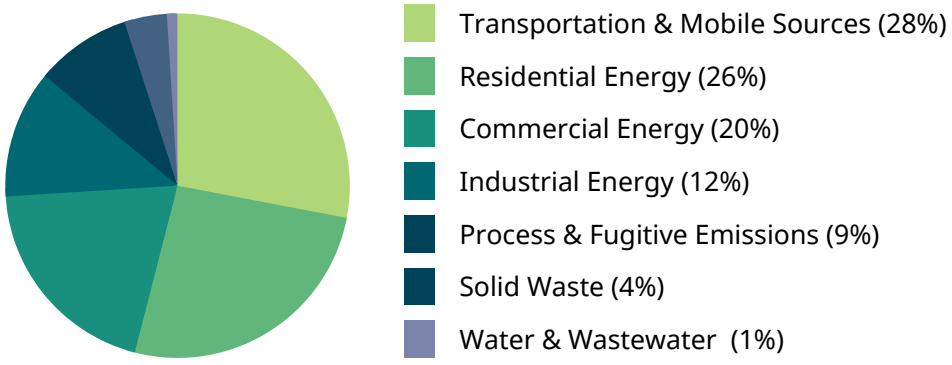


Figure 5: 2018 Lake County Emissions by Sector

2018 Lorain County Emissions Inventory Results

The Lorain County emissions for the 2018 inventory are shown in Table 7 and Figure 6.

Table 7: 2018 Lorain County Emissions Inventory

Sector	Fuel or Source	2018 Usage*	Usage Unit*	2018 Emissions (MTCO2e)*
Residential Energy	Electricity	1,173,965,126	kWh	566,728
	Natural Gas	18,917,550	MMBtu	1,006,158
	Propane	275,145	MMBtu	17,075
	Fuel Oil	74,104	MMBtu	5,518
	Residential Energy Total			**1,595,479**
Commercial Energy	Electricity	855,797,279	kWh	391,673
	Natural Gas	9,706,744	MMBtu	516,268
	Commercial Energy Total			**907,941**
Industrial Energy	Electricity	704,467,502	kWh	313,334
	Natural Gas	7,009,932	MMBtu	372,049
	Non-Utility Fuels			4,393
	Industrial Energy Total			**689,776**
Transportation & Mobile Sources	Gasoline	2,367,586,799	VMT	973,673
	Diesel	177,931,690	VMT	309,532
	Aviation			6
	Rail Transportation			187
	Public Transit			
	Water Transportation			12,760
	Off-Road			17,242
	Transportation & Mobile Sources Total			**1,313,400**
Solid Waste	Waste Generation	409,699	Tons	237,818
	Composting	33,902	Tons	2,361
	Combustion of Solid Waste	890	Tons	308
	Solid Waste Total			**240,487**

*Table Notes- MTCO2e: Metric Tons of Carbon Dioxide equivalent; kWh: kilowatt-hours; MMBtu: Metric Million British thermal unit; VMT: Vehicle Miles Traveled; Blank cells are a result of variability in the format of available data by sector and fuel or source type.

Table 7: 2018 Lorain County Emissions Inventory (continued)

Sector	Fuel or Source	2018 Usage*	Usage Unit*	2018 Emissions (MTCO2e)*
Water & Wastewater	Septic Systems	171,461	Service Population	20,832
	Combustion of Digester Gas	113,844	Service Population	7
	Combustion of Biosolids and Sludges			
	N2O Emissions			1,141
Water & Wastewater Total				**21,980**
Process & Fugitive Emissions	Natural Gas Distribution	35,634,226	Service Population	61,824
	Gas and Oil Wells			62,566
	Other Process and Fugitive			
Process & Fugitive Emissions Total				**124,390**
Total Gross Emissions				**4,893,452**
Forests & Trees	Removals from Forests			-177,161
	Removals from Trees Outside of Forests			-29,712
Forests & Trees Emissions Total				**-206,873**
Total Emissions with Sequestration				**4,686,579**

*Table Notes- MTCO2e: Metric Tons of Carbon Dioxide equivalent; kWh: kilowatt-hours; MMBtu: Metric Million British thermal unit; VMT: Vehicle Miles Traveled; Blank cells are a result of variability in the format of available data by sector and fuel or source type.

Figure 6 shows the distribution of Lorain County's emissions by sector. Transportation is the largest contributor, followed by Residential & Commercial Energy.

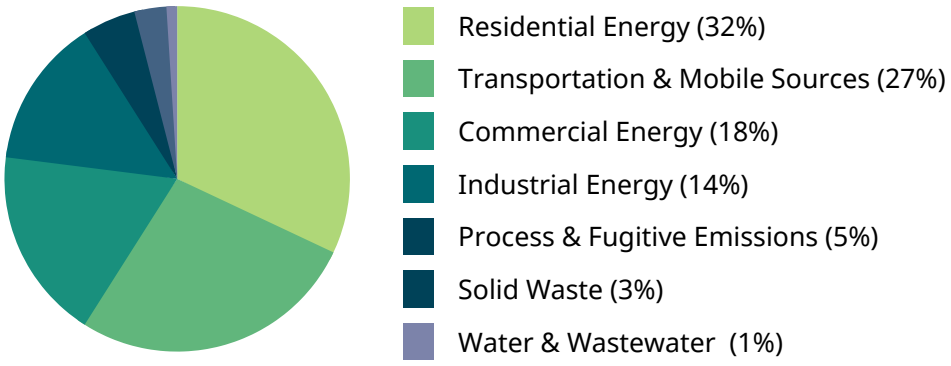


Figure 6: 2018 Lorain County Emissions by Sector

2018 Medina County Emissions Inventory Results

The Medina County emissions for the 2018 inventory are shown in Table 8 and Figure 7.

Table 8: 2018 Medina County Emissions Inventory

Sector	Fuel or Source	2018 Usage*	Usage Unit*	2018 Emissions (MTCO2e)*
Residential Energy	Electricity	773,478,214	kWh	369,176
	Natural Gas	9,526,565	MMBtu	506,685
	Propane	221,121	MMBtu	13,723
	Fuel Oil	133,746	MMBtu	9,958
	Residential Energy Total			**899,541**
Commercial Energy	Electricity	436,558,975	kWh	201,894
	Natural Gas	5,315,750	MMBtu	282,726
	Commercial Energy Total			**484,620**
Industrial Energy	Electricity	451,505,985	kWh	246,221
	Natural Gas	1,731,849	MMBtu	91,917
	Non-Utility Fuels			
	Industrial Energy Total			**338,138**
Transportation & Mobile Sources	Gasoline	1,848,336,004	VMT	749,651
	Diesel	138,908,339	VMT	241,452
	Aviation			
	Rail Transportation			
	Public Transit			
	Water Transportation			
	Off-Road			9,366
	Transportation & Mobile Sources Total			**1,000,469**
Solid Waste	Waste Generation	219,936	Tons	127,666
	Composting	9,857	Tons	686
	Combustion of Solid Waste		Tons	
	Solid Waste Total			**128,352**

*Table Notes- MTCO2e: Metric Tons of Carbon Dioxide equivalent; kWh: kilowatt-hours; MMBtu: Metric Million British thermal unit; VMT: Vehicle Miles Traveled; Blank cells are a result of variability in the format of available data by sector and fuel or source type.

Table 8: 2018 Medina County Emissions Inventory (continued)

Sector	Fuel or Source	2018 Usage*	Usage Unit*	2018 Emissions (MTCO2e)*
Water & Wastewater	Water Supply Energy			
	Wastewater Energy	25,000	Service Population	94
	Fugitive Emissions	109,535	Service Population	13,308
	Combustion of Digester Gas			
	Combustion of Biosolids and Sludges			
	N2O Emissions			107
	Water & Wastewater Total			**13,415**
Process & Fugitive Emissions	Natural Gas Distribution	16,574,163	Service Population	29,214
	Gas and Oil Wells			181,958
	Other Process and Fugitive			
	Process & Fugitive Emissions Total			**211,172**
	Total Gross Emissions			**3,075,708**
Forests & Trees	Removals from Forests			-182,085
	Removals from Trees Outside of Forests			-20,177
	Forests & Trees Emissions Total			**-202,262**
	Total Emissions with Sequestration			**2,873,446**

*Table Notes- MTCO2e: Metric Tons of Carbon Dioxide equivalent; kWh: kilowatt-hours; MMBtu: Metric Million British thermal unit; VMT: Vehicle Miles Traveled; Blank cells are a result of variability in the format of available data by sector and fuel or source type.

Figure 7 shows the distribution of Medina County's emissions by sector. Transportation is the largest contributor, followed by Residential & Commercial Energy.

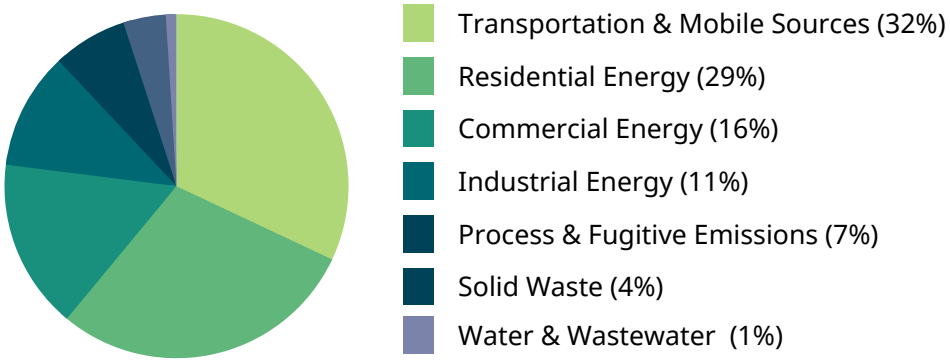


Figure 7: 2018 Medina County Emissions by Sector

Next Steps

The inventory should be used to focus and prioritize actions to reduce emissions. Based on the inventory results, the following areas have the greatest potential for emissions reduction and will be fully explored:

- On-road transportation
  - Vehicle electrification- Transition from internal combustion engine vehicles (passenger, transit fleets, municipal fleets, trucks, freight, etc.) to electric-powered
  - Land use/infrastructure planning- Improving infrastructure to incentivize public transit usage, walking, and biking
  - Work with communities to expand public transportation options
- Regional electricity use
  - Increase distributed generation and local energy resources (solar PV/thermal, wind, hydro, fuel cell, battery storage)
  - Promote energy efficiency programs and incentives
- Regional stationary fuels use
  - Electrify building heating- Convert gas-powered heating appliances (e.g. water heaters) to electric powered
  - Increase the share of renewable and decarbonized fuel sources
- Solid Waste
  - Improve recycling and composting programs to reduce organic waste content in waste streams

Completion of another GHG inventory in two to five years is recommended to assess progress resulting from any implemented actions.

Appendix: Methodology Details

Energy

Table 9: Energy Data Sources with Estimation Applied

Activity	Data Source	Data Gaps/Assumptions
Region-wide		
Residential Electricity	Firelands Electric Cooperative	Estimated by dividing total usage for utility equally to each county that it operates in.
Residential, Commercial, and Industrial Energy Natural Gas Consumption	Columbia Gas of Ohio	Includes agricultural data.
	Northern Industrial Energy Development	Estimated by dividing total usage for utility equally to each county that it operates in.
	Northeast Ohio Natural Gas	Estimated by dividing total usage for utility equally to each county that it operates in.
	Knox Energy Cooperative	Estimated by dividing total usage for utility equally to each county that it operates in.

Table 10: Emissions Factors for Electricity Consumption

Year	CO2 (lbs./MWh)	CH4 (lbs./GWh)	N2O (lbs./GWh)	Data Gaps/Assumptions
Cleveland Public Power / 2018	1,036	0.117	0.017	From Cuyahoga County's 2018 GHGI.
First Energy / 2018	953	0.117	0.017	From Cuyahoga County's 2018 GHGI.
City of Painesville / 2018	3,833.58	0.0000438	0.0000372	From Painesville Municipal Electric.

Transportation

For vehicle transportation, emissions were calculated by NOACA using the U.S. EPA's MOVES model.

Wastewater

Table 11: Wastewater Data Sources with Estimation Applied

Activity	Data Source	Data Gaps/Assumptions
Region-wide		
Wastewater Energy	City of Elyria	Information only; usage most likely included in the commercial/industrial energy usage.
Wastewater Energy	Northeast Ohio Regional Sewer District	Information only; usage most likely included in the commercial/industrial energy usage.
Combustion of Digester Gas	Lake County	Based on number of sewer accounts.
N2O from Effluent Discharge	Lake County	Based on number of sewer accounts and estimated emissions for small utilities in which no data was received.
N2O from Effluent Discharge	Cuyahoga County	Estimated emissions for small utilities in which no data was received.
N2O from Effluent Discharge	Medina County	Estimated emissions for small utilities in which no data was received.
N2O from Effluent Discharge	Lorain County	Estimated emissions for small utilities in which no data was received.
N2O from Effluent Discharge	Geauga County	Estimated emissions for small utilities in which no data was received.
N2O from Effluent Discharge	Lake County	Estimated emissions for small utilities in which no data was received.

Table 11: Wastewater Data Sources with Estimation Applied (continued)

Activity	Data Source	Data Gaps/Assumptions
Region-wide		
Process N2O Emissions	Cuyahoga County	Estimated emissions for small utilities in which no data was received.
Process N2O Emissions	Medina County	Estimated emissions for small utilities in which no data was received.
Process N2O Emissions	Lorain County	Estimated emissions for small utilities in which no data was received.
Process N2O Emissions	Geauga County	Estimated emissions for small utilities in which no data was received.

Inventory Calculations

The 2018 inventory was calculated following the US Community Protocol and ICLEI's ClearPath software. As discussed in Inventory Methods used for global warming potential (GWP) values to convert methane and nitrous oxide to CO2 equivalent units. ClearPath's inventory calculators allow for input of the sector activity (i.e. kWh or VMT) and emission factor to calculate the final carbon dioxide equivalent (CO2e) emissions.