# City of Dubuque 2022 Community Greenhouse Gas Inventory Report

September 2023

THE CITY OF DUBUQUE
*Masterpiece on the Mississippi*

LOTUS
Engineering & Sustainability

# TABLE OF CONTENTS

# Table of Figures



# Table of Tables



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# EXECUTIVE SUMMARY

The City of Dubuque hired Lotus Engineering and Sustainability (Lotus) to complete a greenhouse gas (GHG) emissions inventory for community-wide emissions in 2022. Dubuque has been measuring community GHG emissions since 2003 and has an emissions reduction goal of 50% from 2003 levels by 2030. The inventory completed by Lotus for 2022 included all of the same sources as in previous years and added several new sources for which data were available. Between 2003 and 2018, the emission sources measured by Dubuque included residential electricity, residential natural gas, commercial and industrial (C&I) electricity, C&I natural gas, gasoline on-road vehicles, diesel on-road vehicles, and landfill gas.

For the 2022 inventory, Lotus added the following sources: residential propane, residential fugitive emissions, residential transmission & distribution (T&D) losses, C&I propane, C&I stationary diesel, C&I T&D losses, on-road electricity, on-road T&D losses, transit, railways, aviation, waterborne, composted waste, wastewater, and refrigerant leakage.

## 2022 GHG Inventory Results

### Total Emissions

**The City of Dubuque's GHG emissions totaled 744,112 mt $CO_2e$ in 2022.** This value includes emissions from all sources listed in the previous section. Dubuque's per capita emissions in 2022 totaled 13 mt $CO_2e$ per person.

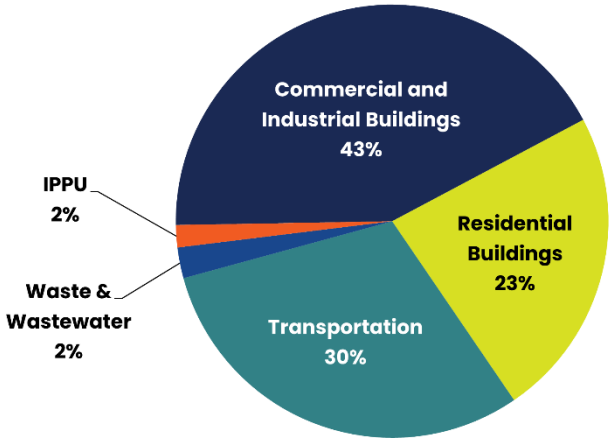


Figure ES 1. 2022 Emissions by sector.

### Emissions by Sector

The three largest sectors, or categories, of emissions in 2022 were C&I building energy usage (43% of total emissions), transportation fuels (30%), and residential building energy usage (23%). The waste and wastewater sector and the industrial processes and product use (IPPU) sector each made up 2% of total emissions. See Figure ES 1. 2022 Emissions by sector.

## Emissions by Source

Breaking down sectors into individual sources, the three largest sources of emissions for Dubuque in 2022 were natural gas usage (32% of total emissions), electricity usage (31%), and on-road fossil fuel vehicles (29%). Solid waste and refrigerant leakage each made up two percent of total emissions, and the remaining sources together comprised less than three percent of total emissions. See Figure ES 2.

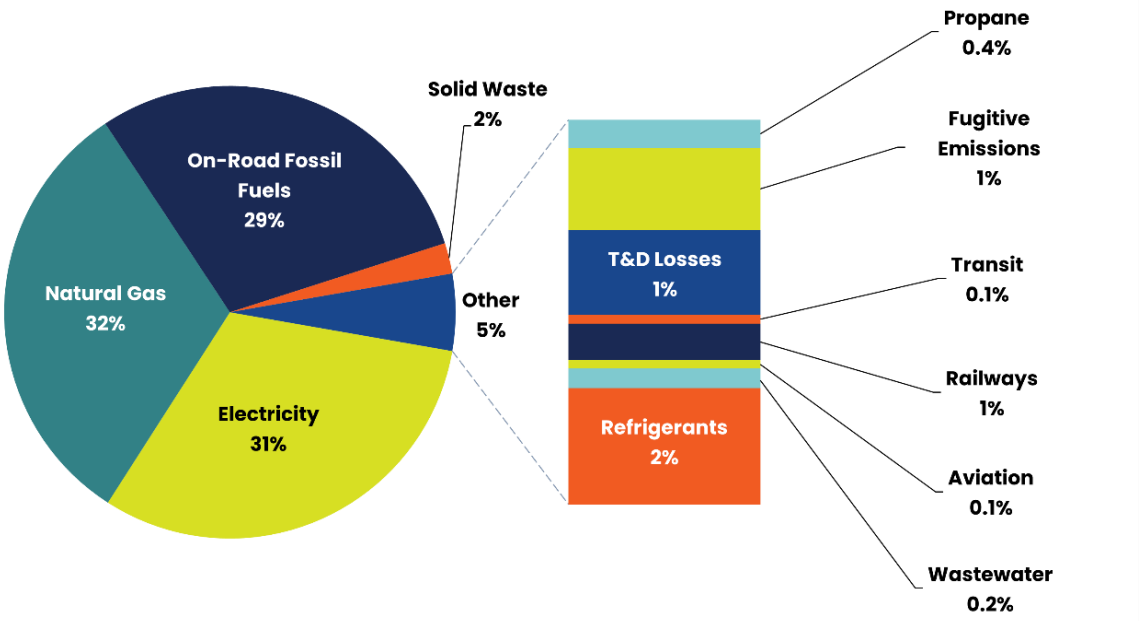


Figure ES 2. 2022 Emissions by source. Sources comprising less than 0.1% of total not included.

# Emissions Over Time

## Total Emissions 2018-2022

Looking at total emissions (including the new sources added by Lotus), Dubuque's emissions decreased nine percent between 2018 and 2022. Excluding the new sources (only looking at comparable sources), Dubuque's emissions decreased 14% between the two years. In other words, despite the addition of several new sources, Dubuque's total emissions still decreased between this inventory and the previous iteration. See Figure ES 3. Total and comparable emissions in 2018 and 2022. One

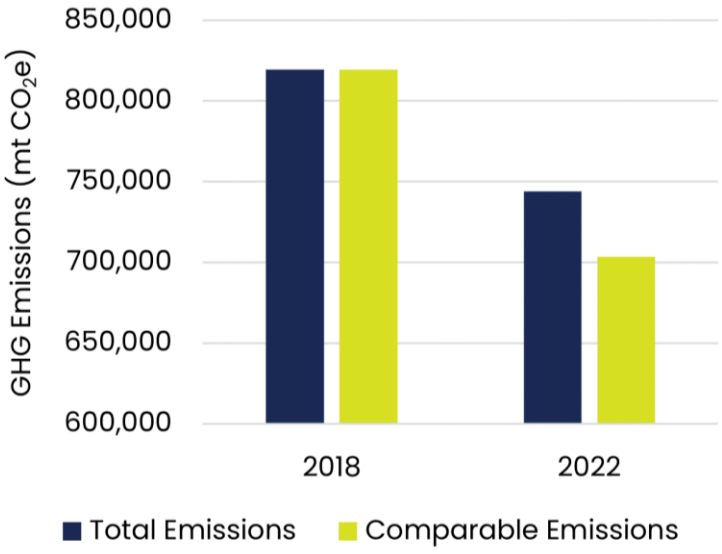


Figure ES 3. Total and comparable emissions in 2018 and 2022.

important change to note is that Dubuque's landfill began collecting methane gas between 2018 and 2022, decreasing the landfill's emissions by 75%.

## Emissions by Source 2018-2022

Focusing on only comparable sources between 2018 and 2022, all emission sources decreased except for on-road gasoline and diesel vehicle emissions. See Figure ES 4. Emissions reductions for electricity can be attributed to reductions in Alliant Energy's electricity emission factor. Between 2018 and 2022, the emission factor for electricity decreased 29%, from 0.538 mt $CO_2$/MWh to 0.382 mt $CO_2$/MWh.

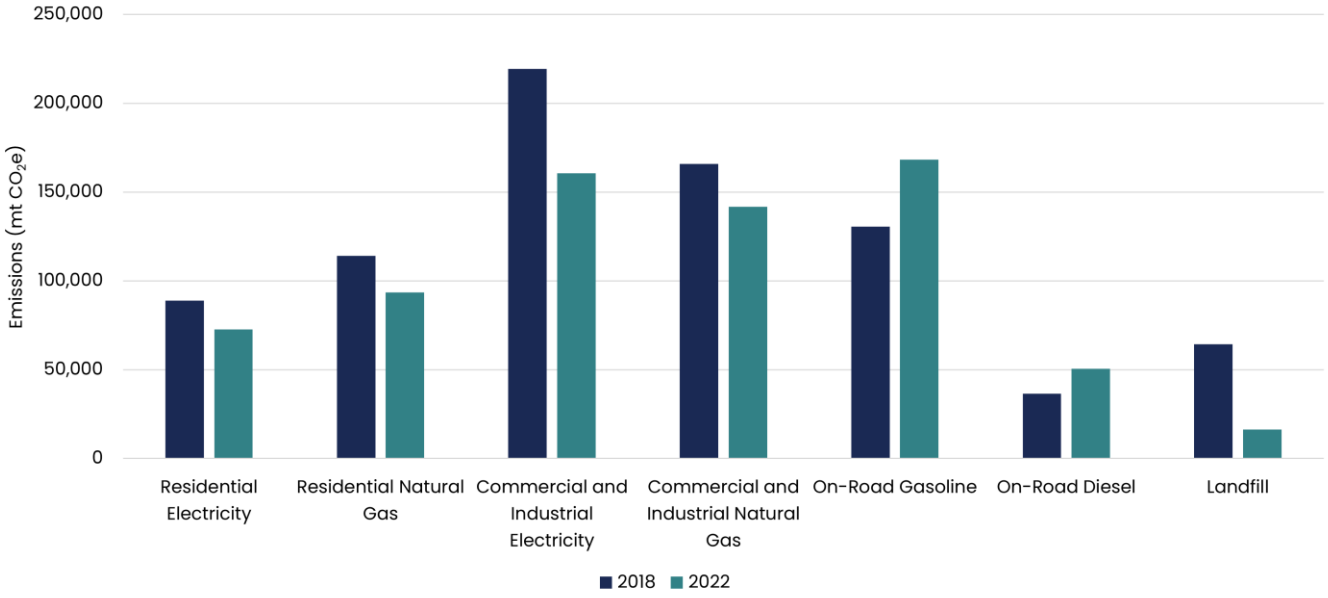


Figure ES 4. Comparable emission sources in 2018 and 2022.

## Total Emissions 2003-2022

Looking at Dubuque's total emissions (including new sources added by Lotus), between the baseline year of 2003 and the most recent inventory year of 2022, Dubuque's emissions decreased by 34%. Excluding the new emission sources added in 2022, Dubuque's emissions decreased by 37% between 2003 and 2022. Dubuque is still on track to meet its current emissions reduction goal, regardless of included emissions sources. See Figure ES 5.

# Science-based Target

Although the City of Dubuque has an existing emissions reduction goal of 50% from 2003 levels by 2050, Lotus used the One Planet City Challenge's (OPCC) approach to calculate a science-based emissions reduction target for Dubuque. This approach uses the US Human Development Index Score (HDI) and population growth projections, as well as the community's

total scope 1 and 2 emissions and population during the baseline year. For Dubuque, the baseline year is 2018. Using the methodology from OPCC, Lotus calculated Dubuque's science-based target to be a 62% emissions reduction from 2018 levels by 2030 and net-zero emissions by 2050.

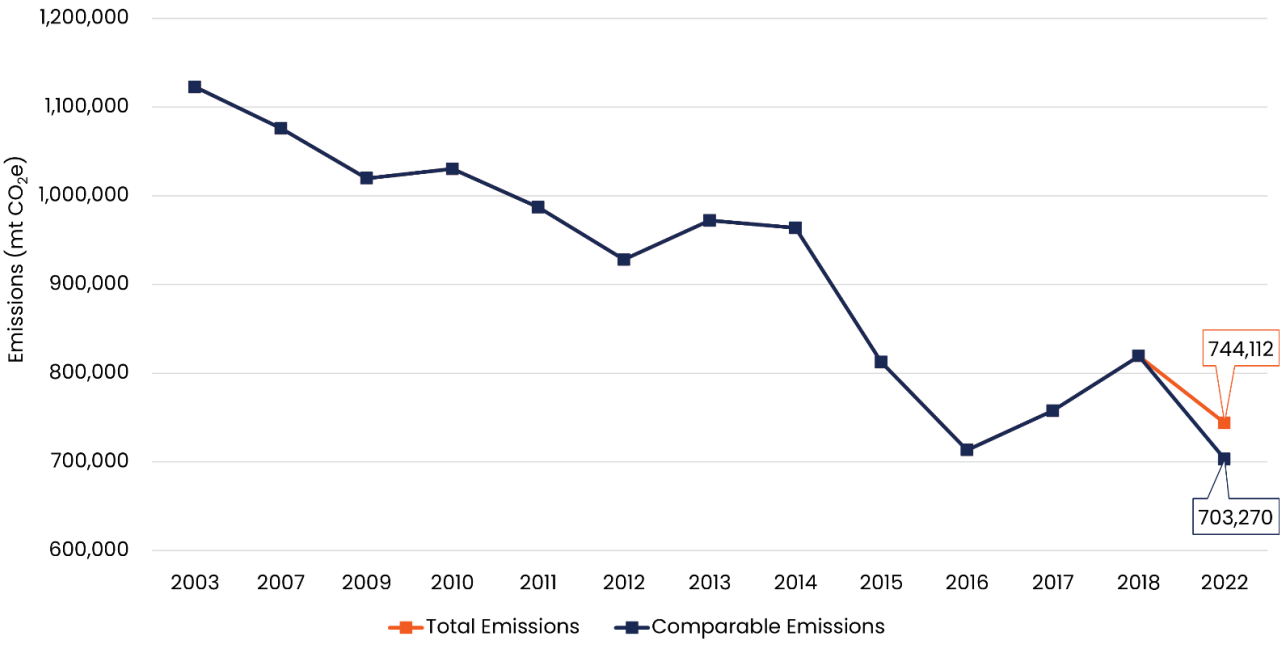


Figure ES 5. Emission trends from 2003 to 2022. Emission sources remain identical from 2003 to 2018. "Total emissions" value in orange reflects the additional emission sources added by Lotus in the 2022 inventory.

## Business-As-Usual (BAU) Model

In addition to the 2022 GHG inventory and science-based target, Lotus created a business-as-usual (BAU) model for Dubuque. A BAU model estimates what emissions will look like in the future without any additional sustainability or emission reduction work. This model projects Dubuque's GHG emissions by source from 2022 to 2050 using different growth rates such as population growth or commercial square footage growth. Some emission sources are held constant if they are not expected to change significantly over time.

Other factors were included in the BAU projections, including projected decreases in Alliant Energy's electricity emission factor, the national projected increase in electric vehicle adoption, and the projected doubling of Dubuque's railway activity in coming years. Dubuque's BAU emissions estimate in 2050 is 457,648 mt $CO_2e$. This is a 38% decrease in emissions from 2022. Between the GHG inventory, science-based target, and BAU model, Dubuque has a robust set of resources on which to base future sustainability work and emission reduction strategies.

# INTRODUCTION

The City of Dubuque has been tracking greenhouse gas (GHG) emissions since 2003 and has an emissions reduction goal of 50% from 2003 levels by 2030. In 2023, the City contracted with Lotus Engineering and Sustainability, LLC (Lotus) to create a community-wide GHG emissions inventory for calendar year 2022. The inventory completed by Lotus for 2022 included the same emissions sources as in previous years and added several new sources. One other notable difference is the use of the latest global warming potentials from the 6th Assessment Report from the International Panel on Climate Change, which were released in late 2021.

Between 2003 and 2018, the emission sources measured by Dubuque included residential electricity, residential natural gas, commercial and industrial (C&I) electricity, C&I natural gas, gasoline on-road vehicles, diesel on-road vehicles, and landfill gas. For the 2022 inventory, Lotus added the following sources: residential propane, residential fugitive emissions, residential transmission & distribution (T&D) losses, C&I propane, C&I stationary diesel, C&I T&D losses, on-road electricity, on-road T&D losses, transit, railways, aviation, waterborne, composted waste, wastewater, and refrigerant leakage. Throughout the report, "total emissions" will refer to all calculated sources of emissions for 2022, including the new sources added by Lotus. "Comparable emissions" will refer to only the sources of emissions that Dubuque has tracked since 2003 and does not include new sources.

This inventory will help the City understand the current state of emissions in Dubuque and learn where to target future action. The inventory results should not be considered an absolute measure of the community's emissions, but rather a tool to track primary emissions sources and evaluate year-to-year trends. Inventories should be completed regularly to track emissions over time and to estimate progress toward sustainability and emissions reduction goals.

To calculate emissions for Dubuque's 2022 inventory, Lotus used the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC).[1] The GPC protocol provides a robust framework for accounting and reporting City-wide GHG emissions. This protocol is the standard used by cities globally to calculate and track emissions from within their community boundary. By completing a GPC-compliant inventory, Dubuque can report emissions to the Carbon Disclosure Project (CDP),[2] which demonstrates the City's commitment to reporting its emissions to a larger audience. The following report reviews the 2022 inventory process, 2022 GHG emissions sources, and trends in emissions.

[1] For more information see: https://ghgprotocol.org/greenhouse-gas-protocol-accounting-reporting-standard-cities.

[2] For more information see: https://www.cdp.net/en/info/about-us.

# DUBUQUE'S 2022 EMISSIONS

**Dubuque's community-wide GHG emissions in 2022 totaled 744,112 mt $CO_2e$. This equates to a nine percent decrease compared to the last inventory year of 2018 and a 34% decrease compared to the baseline year of 2003. The majority of 2022 emissions came from building energy use and on-road transportation fuel use.**

## Emissions Overview

### Emissions by Sector

The three largest emission sectors in 2022 were C&I building energy usage (316,018 mt $CO_2e$ or 43% of total emissions), transportation (224,956 mt $CO_2e$ or 30%), and residential building energy usage (172,693 mt $CO_2e$ or 23%). The waste and wastewater sector and the industrial processes and product use (IPPU) sector each made up two percent of total emissions (18,101 mt $CO_2e$ and 12,344 mt $CO_2e$, respectively). See Figure 1.

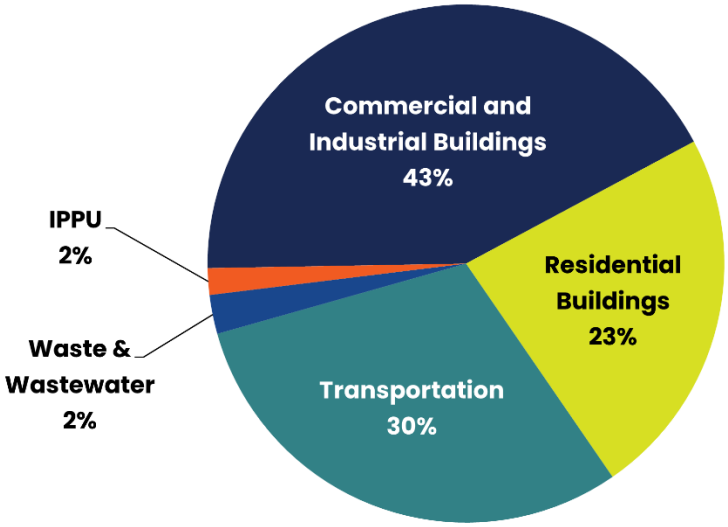


Figure 1. 2022 GHG emissions by sector.

### Emissions by Source

Breaking down sectors into individual sources, the three largest sources of emissions for Dubuque in 2022 were natural gas usage (235,143 mt $CO_2e$ or 32% of total emissions), electricity usage (233,237 mt $CO_2e$ or 31%), and on-road fossil fuel vehicles (218,593 mt $CO_2e$ or 29%). Solid waste and refrigerant leakage in buildings each made up two percent of total emissions (16,297 mt $CO_2e$ and 12,344 mt $CO_2e$, respectively), and the remaining sources together comprised less than three percent of total emissions. See Figure 2.

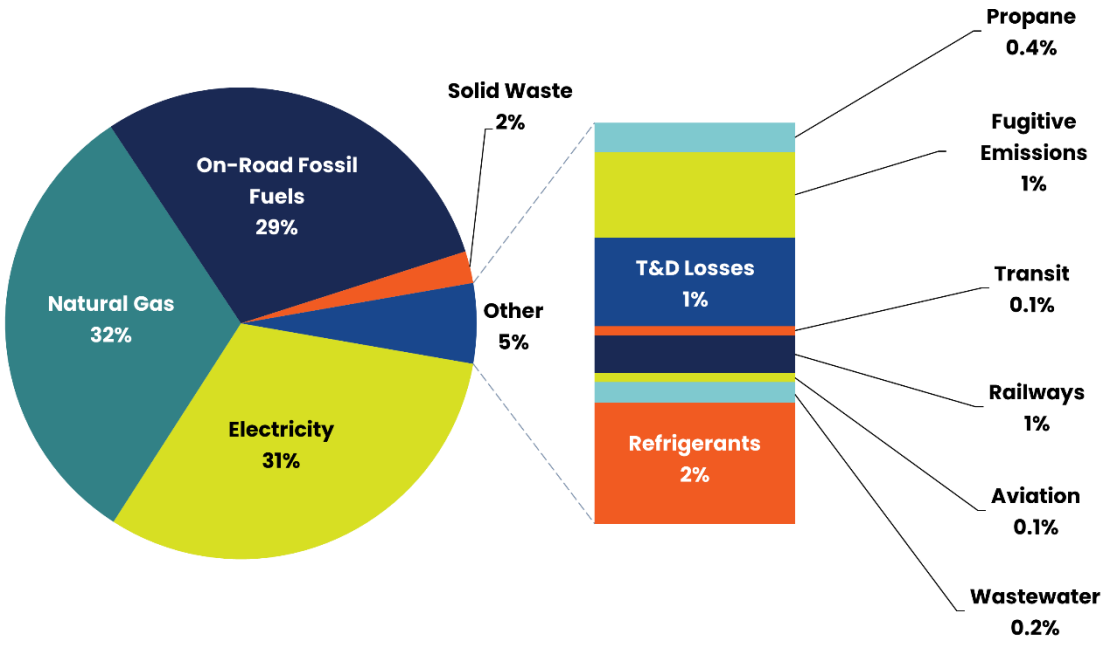


Figure 2. 2022 GHG emissions by source.

## Emissions by Sector and Source

The following figure combines emission sectors and sources. The figure separates residential building energy usage from commercial and industrial (C&I) building energy usage, as well as on-road gasoline vehicles from on-road diesel vehicles. This provides a more detailed analysis of emission sources. See Figure 3. Separating the categories of building energy usage and on-road fossil fuel vehicles, the three largest emission sources for Dubuque in 2022 were on-road gasoline vehicles (168,137 mt $CO_2e$ or 23% of total emissions), C&I electricity usage (166,543 mt $CO_2e$ or 22% of total emissions), and commercial natural gas usage (141,689 mt $CO_2e$ or 19%).

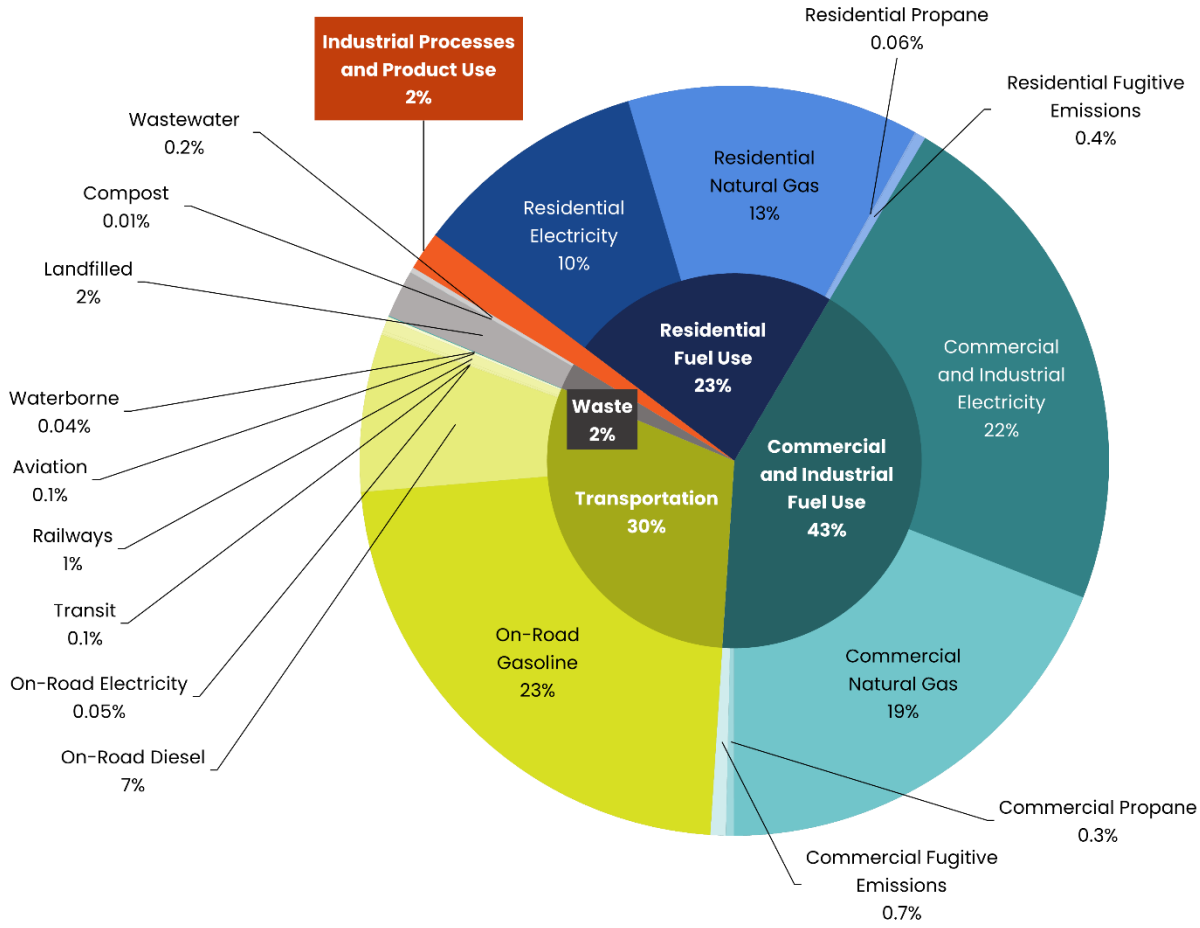


Figure 3. 2022 GHG emissions by sector and source.

The following table lists all emission sectors and sources by total emissions in mt $CO_2e$ and percentage of total emissions. See Table 1. For comparison between 2003, 2018, and 2022 emission sources, see Table 3 in the *Appendix*.

Table 1. 2022 GHG emissions by sector and source (mt $CO_2e$).

| Emission Source | Emissions (mt $CO_2e$) | | Percent of Total |
|---|---|---|---|
| **Residential Fuel Use** | **172,693** | | **23%** |
| Residential Electricity | | 75,330 | 10% |
| Residential Natural Gas | | 93,455 | 13% |
| Residential Propane | | 447 | 0.06% |
| Residential Fugitive Emissions | | 3,461 | 0.5% |
| **Commercial and Industrial Fuel Use** | **316,018** | | **42%** |

| | | | |
|---|---|---|---|
| Commercial and Industrial Electricity | | 166,543 | 22% |
| Commercial Natural Gas | | 141,689 | 19% |
| Commercial Propane | | 2,539 | 0.3% |
| Commercial Fugitive Emissions | | 5,247 | 0.7% |
| **Transportation** | **224,956** | | **30%** |
| On-Road Gasoline | | 168,137 | 23% |
| On-Road Diesel | | 50,456 | 7% |
| On-Road Electricity | | 380 | 0.05% |
| Transit | | 932 | 0.1% |
| Railways | | 3,846 | 0.5% |
| Aviation | | 932 | 0.1% |
| Waterborne | | 273 | 0.04% |
| **Waste** | **18,101** | | **2%** |
| Landfilled | | 16,297 | 2% |
| Compost | | 96 | 0.01% |
| Wastewater | | 1,708 | 0.2% |
| **Industrial Processes and Product Use** | **12,344** | | **2%** |
| Refrigerant Leaks | | 12,344 | 2% |
| **Total** | **744,112** | | **100%** |

**Note that transmission and distribution losses have been combined with electricity use in the residential, commercial, and on-road sectors.*

## Normalized Metrics and Benchmarking

Below are normalized metrics[3] for Dubuque's 2022 GHG emissions, as well as normalized metrics for other cities in the region. See Table 2. These data help situate Dubuque amongst its neighboring cities in terms of emissions. It is important to note that not all cities listed below have updated inventories for 2022, so their most recent inventory data were used. National

[3] Normalized metrics are intensity ratios that can be used in GHG emissions accounting to scale the net generated emissions by business metrics or other financial or community indicators, such as emissions per person or emissions per job.

emission trends in 2020 and 2021 were significantly lower due to the COVID-19 pandemic, so data from these years likely underestimates "normal" conditions.

Table 2. Benchmarking of normalized GHG emissions metrics.

| City | Inventory Year | Population | Total Emissions (mt $CO_2e$) | Emissions per Capita | Emissions per Household | Emissions per Employee |
|---|---|---|---|---|---|---|
| **Dubuque, IA** | 2022 | 58,873 | 744,112 | 13 | 30 | 25 |
| **Iowa City, IA** | 2021 | 74,582 | 787,993 | 11 | 16 | 17 |
| **La Crosse, WI** | 2020 | 51,543 | 667,101 | 13 | 31 | 24 |
| **Rochester, MN** | 2020 | 117,134 | 1,265,047 | 11 | 26 | 19 |
| **Des Moines, IA** | 2019 | 214,200 | 2,622,472 | 12 | 29 | 22 |
| **Cedar Rapids, IA** | 2019 | 133,563 | 5,599,700 | 42 | 97 | 76 |
| **Winona, MN** | 2019 | 26,854 | 270,800 | 10 | 26 | 17 |

**Note: 70% of Cedar Rapids' GHG emissions come from industrial facilities, such as power plants and corn mills.*

## Stationary Energy

**Building energy use, or stationary energy, emissions made up 66% of Dubuque's total emissions in 2022.** Commercial and industrial electricity usage was the largest source of stationary energy emissions (160,689 mt $CO_2e$ or 33% of total stationary energy emissions). This source was followed by commercial natural gas usage (141,689 mt $CO_2e$ or 29%), residential natural gas usage (93,455 mt $CO_2e$ or 19%), and residential electricity usage (72,640 mt $CO_2e$ or 15%). The remaining stationary energy sources made up four percent of total stationary energy emissions. See Figure 4.

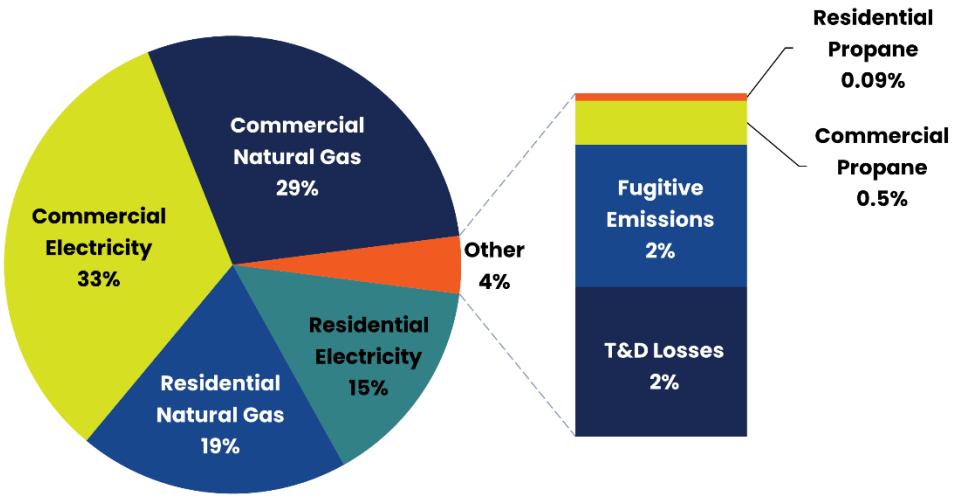


Figure 4. 2022 stationary energy sector breakdown.

Compared to the last inventory year of 2018, both residential electricity and natural gas emissions have decreased by 18%. Commercial electricity emissions have decreased by 27% and commercial natural gas emissions have decreased by 14%. Since the baseline year of 2003, commercial electricity emissions have decreased by 64%, residential electricity emissions have decreased by 61%, commercial natural gas emissions have increased by 13%, and residential natural gas emissions have decreased by 15%.

Emissions from natural gas will decrease if more homes and businesses convert from natural gas furnaces, stoves, and water heaters to electric heat pumps. Much of the decrease in electricity emissions has been possible due to Alliant Energy's work to add renewable energy to the electric grid. Between 2018 and 2022, the emission factor for electricity decreased from 0.538 mt $CO_2$/MWh to 0.382 mt $CO_2$/MWh; this is a 29% decrease from 2018.

## Transportation

**Transportation emissions made up 30% of Dubuque's total emissions in 2022.** The largest source of transportation emissions was on-road gasoline vehicles (168,137 mt $CO_2e$ or 75% of total transportation emissions). This was followed by on-road diesel vehicles (50,456 mt $CO_2e$ or 22%). All other sources of transportation emissions made up two percent of all transportation emissions. See Figure 5.

The only transportation sources comparable to past inventories are on-road gasoline and diesel vehicles. Emissions from gasoline vehicles increased by 29% between 2018 and 2022 and have increased by 25% since 2003. Emissions from diesel vehicles increased by 38% between 2018 and 2022 and have increased by 45% since 2003.

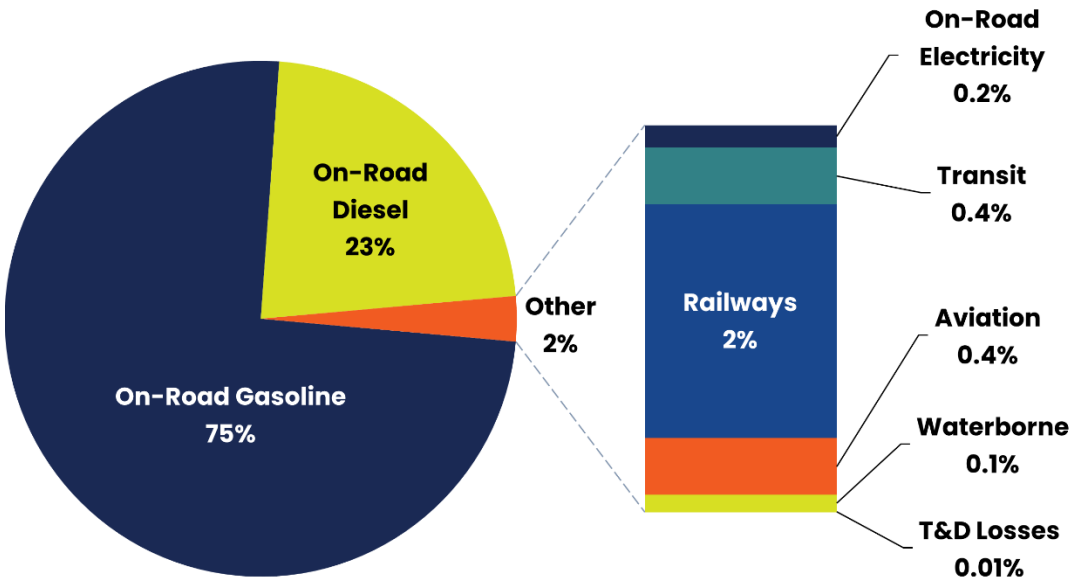


Figure 5. 2022 transportation sector breakdown.

## Waste and Wastewater

**Waste and wastewater emissions made up two percent of Dubuque's total emissions in 2022.** The Dubuque Metropolitan Area landfill falls inside city limits, so all emissions from the landfill are attributable to Dubuque. Emissions from the landfill made up the majority of waste and wastewater emissions (16,297 mt $CO_2e$ or 90%). Wastewater made up nine percent (1,708 mt $CO_2e$) and composted waste made up less than one percent (96 mt $CO_2e$). See Figure 6. Although all landfill emissions are attributable to the city, 64% of landfilled waste is directly attributable to Dubuque residents.

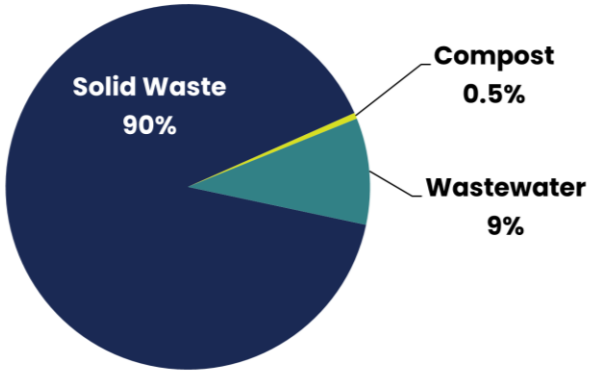


Figure 6. 2022 waste sector breakdown.

Dubuque's past inventories did track emissions from the landfill; however, they did not track emissions from composting or wastewater. Landfill emissions have decreased by 75% since 2018 and 80% since 2003. The landfill recently began capturing landfill gas, significantly reducing emissions.

## Industrial Processes & Product Use (IPPU)

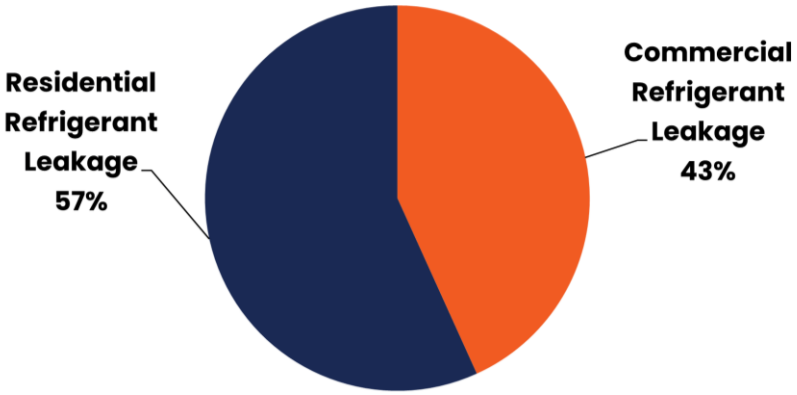


Figure 7. 2022 IPPU sector breakdown.

**IPPU emissions made up two percent of Dubuque's total emissions in 2022.** This was the first year where IPPU emissions have been included. The only source of IPPU emissions calculated for Dubuque was refrigerant leakage from commercial and residential systems. Residential refrigerant leakage made up 57% of total IPPU emissions (7,009 mt $CO_2e$) and commercial refrigerant leakage made up 43% of total IPPU emissions (5,336 mt $CO_2e$). See Figure 7.

# YEAR-OVER-YEAR TRENDS

There are two ways to compare the year-over-year GHG emissions totals for Dubuque: total emissions and comparable emissions. Total emissions include all emission sources for each inventory year. This includes the new sources added by Lotus to the 2022 inventory. Comparable emissions only look at sources that are directly comparable between all inventories. This does not include the new sources added in 2022.

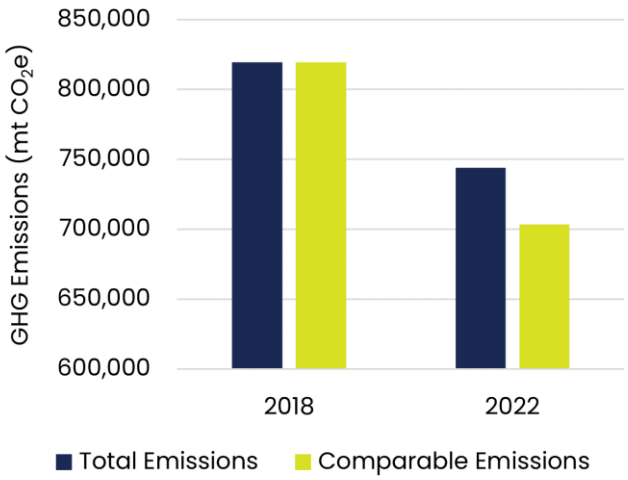


Figure 8. Total and comparable emissions in 2018 and 2022.

Looking at total emissions, Dubuque's emissions decreased nine percent between 2018 and 2022. Excluding the new sources (only looking at comparable sources), Dubuque's emissions decreased 14% between the two years. See Figure 8. In other words, despite the addition of several new sources, Dubuque's total emissions still decreased. Only looking at comparable emission sources between 2018 and 2022, all emission sources decreased except for on-road gasoline and diesel vehicle emissions. See Figure 9.

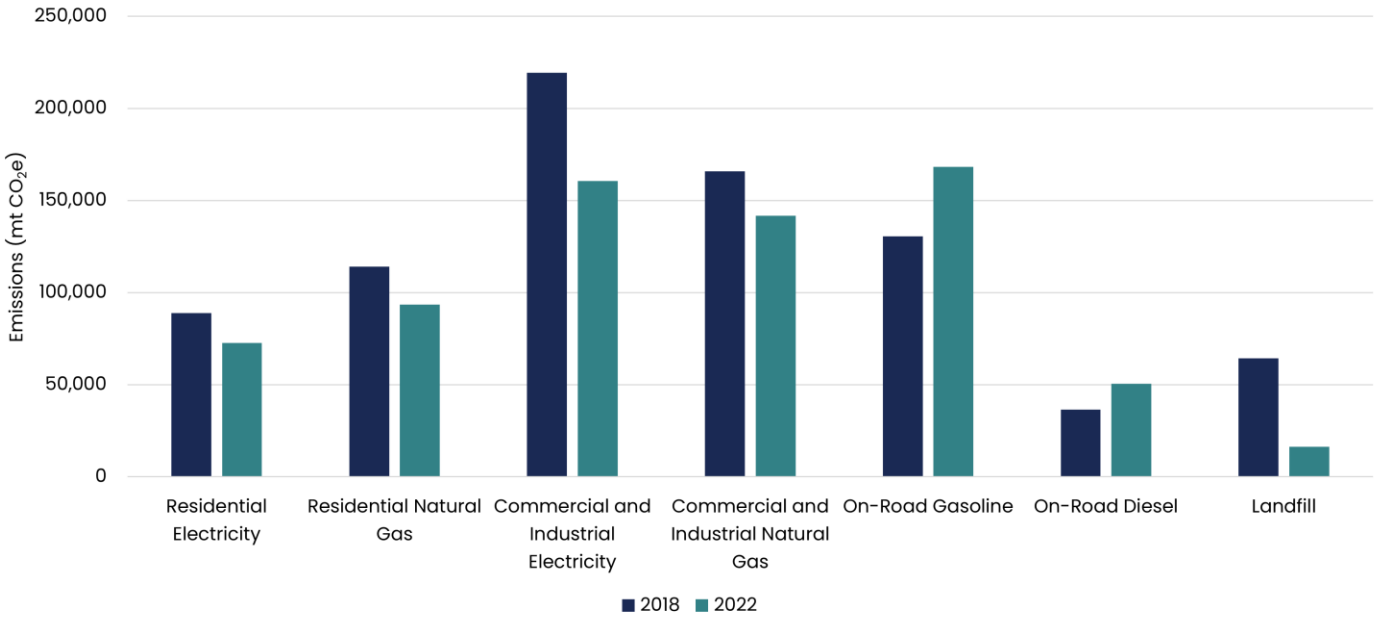


Figure 9. Comparable emission sources in 2018 and 2022.

Dubuque's total emissions have decreased by 34% between the baseline year of 2003 and the most recent inventory year of 2022. Excluding the new emission sources, Dubuque's comparable emissions decreased by 37% between 2003 and 2018. See Figure 10 and Figure 11. Regardless, Dubuque is currently on track to meet the goal of 50% emissions reductions from 2003 levels by 2030.

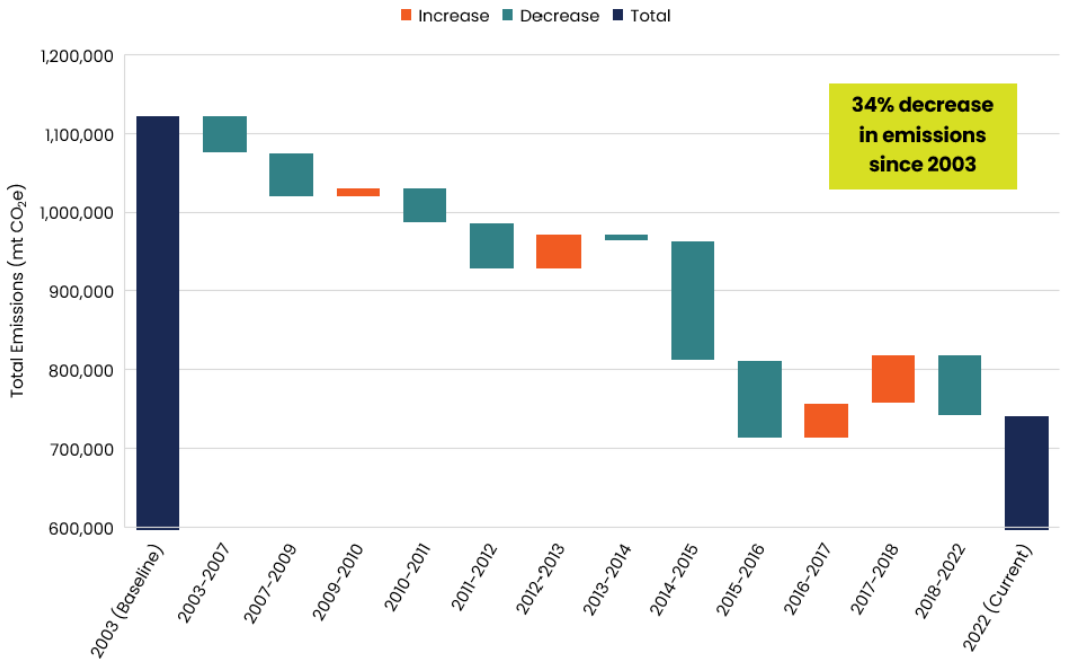


Figure 10. Year-over-year total emissions (increases and decreases).

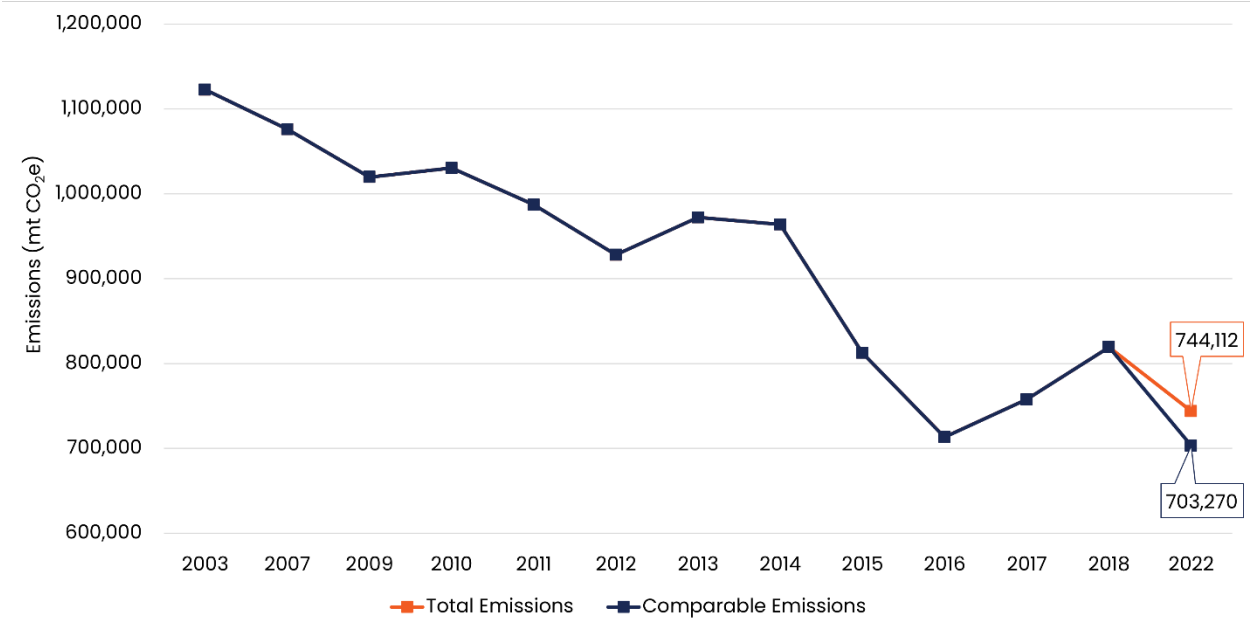


Figure 11. Emission trends from 2003 to 2022. Emission sources remain identical from 2003 to 2018. "Total emissions" value in orange reflects the additional emission sources added by Lotus in the 2022 inventory.

# SCIENCE-BASED TARGET

**Dubuque's Science-Based Target:**

**62%**

reduction from 2018 levels by 2030

As a part of the scope of work, Lotus developed a Science-based Target for the City to consider adopting. Lotus used the One Planet City Challenge's (OPCC)[4] approach to calculate a science-based emissions reduction target for Dubuque. This approach uses several values to calculate the target, including the US Human Development Index Score (HDI), population growth projections, and the community's total scope 1 and 2 emissions and population during the baseline year. Dubuque's baseline year is 2018. Using the methodology from OPCC, Lotus calculated Dubuque's science-based target to be a 62% emissions reduction from 2018 levels by 2030. Dubuque's 2018 emissions totaled 819,408 mt $CO_2e$; a 62% reduction in emissions would mean 2030 emissions equaling approximately 311,000 mt $CO_2e$.

# BUSINESS-AS-USUAL

A business-as-usual emissions projection model was developed to help Dubuque understand what the state of GHG emissions would be like through 2050 without any additional sustainability or emission reduction work. See Figure 12. To project emissions, sources were either held constant (not projected to change measurably over time), projected using the growth rate of commercial square footage, or projected using population growth. Sources were projected in the following manner:

- **Constant:** commercial and residential propane; transit; railways; waterborne activity; aviation.
- **Population Growth:** residential electricity; residential natural gas and fugitive emissions; fossil fuel vehicles; landfilled and composted waste; wastewater; refrigerant leakage.
- **Commercial Square Footage Growth:** commercial electricity; commercial natural gas and fugitive emissions.

Additional factors were considered, including the projected decreases in Alliant Energy's electricity emissions factor and the national projected increase in electric vehicle adoption. Also considered was the projected doubling of railway activity in the city. With all factors considered, emissions in Dubuque in 2050 will total 457,648 mt $CO_2e$ with no additional climate action. Compared to emissions in 2022, this is a reduction of 38%. The largest driver of the emissions reduction is Alliant Energy's renewable energy portfolio goals. Emissions from electricity, T&D losses, fossil fuel vehicles, electric vehicles, see reductions in this model, while

[4] See: https://wwf.panda.org/projects/one_planet_cities/one_planet_city_challenge/.

emissions from natural gas, fugitive emissions, railways, waste, wastewater, and refrigerant leakage see increases. Emission sources that are projected to be constant see no changes in the model. These sources are propane, waterborne activity, transit, and aviation.

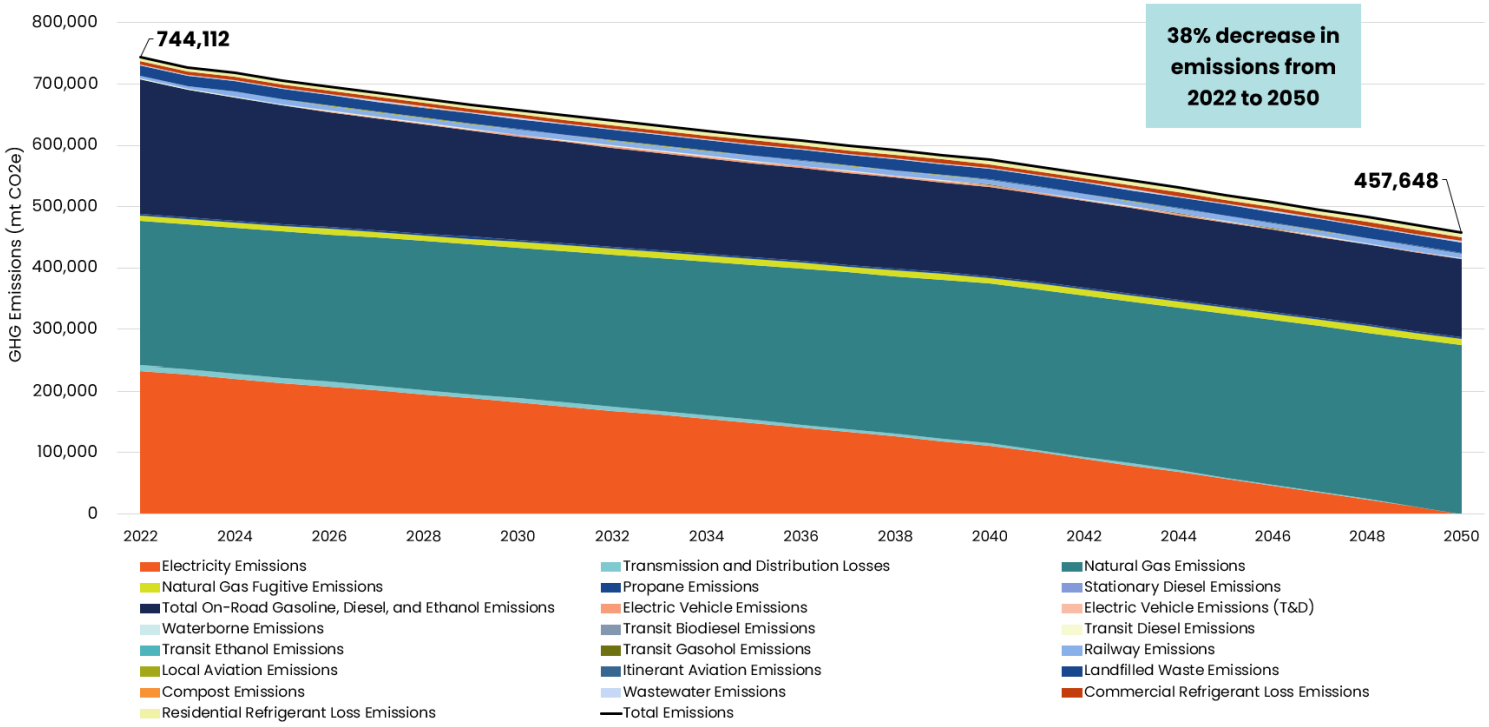


Figure 12. Dubuque's Business-As-Usual model (2022-2050).

# CONCLUSION

Monitoring greenhouse gas emissions is a vital step in working towards a more sustainable community. Dubuque will need to continue tracking emissions over time in order to identify trends and learn the impacts of emission reduction work enacted by the City. This sustainability work will help Dubuque become more resilient to the changing climate and will serve as an example for other communities to begin similar work.

# APPENDIX: DETAILED EMISSIONS OVER TIME

Table 3. 2003, 2018, and 2022 emissions comparison.

| Emission Source | 2003 Emissions (mt $CO_2e$) | 2018 Emissions (mt $CO_2e$) | 2022 Emissions (mt $CO_2e$) |
|---|---|---|---|
| **Residential Fuel Use** | **295,023** | **202,896** | **172,693** |
| Residential Electricity | 184,805 | 88,832 | 72,640 |
| Residential Natural Gas | 110,218 | 114,064 | 93,455 |
| Residential Propane | N/A | N/A | 447 |
| Residential Fugitive Emissions | N/A | N/A | 3,461 |
| Residential T&D Losses | N/A | N/A | 2,690 |
| **Commercial and Industrial Electricity Fuel Use** | **575,374** | **385,074** | **316,018** |
| Commercial and Industrial Electricity | 450,118 | 219,369 | 160,596 |
| Commercial and Industrial Natural Gas | 125,256 | 165,704 | 141,689 |
| Commercial and Industrial Propane | N/A | N/A | 2,539 |
| Commercial and Industrial Stationary Diesel | N/A | N/A | 0 |
| Commercial and Industrial Fugitive Emissions | N/A | N/A | 5,247 |
| Commercial and Industrial T&D Losses | N/A | N/A | 5,946 |
| **Transportation** | **169,881** | **167,132** | **224,956** |
| On-Road Gasoline | 134,980 | 168,137 | 168,137 |
| On-Road Diesel | 34,901 | 36,523 | 50,456 |
| On-Road Electricity | N/A | N/A | 367 |
| On-Road Electricity T&D Losses | N/A | N/A | 14 |
| Transit | N/A | N/A | 932 |
| Railways | N/A | N/A | 3,846 |
| Aviation | N/A | N/A | 932 |
| Waterborne | N/A | N/A | 273 |
| **Waste** | **82,319** | **64,305** | **18,101** |

| | | | |
|---|---|---|---|
| Landfilled | 82,319 | 64,305 | 16,297 |
| Compost | N/A | N/A | 96 |
| Wastewater | N/A | N/A | 1,708 |
| **Industrial Processes and Product Use** | **N/A** | **N/A** | **12,344** |
| Refrigerant Leaks | N/A | N/A | 12,344 |
| **All Emissions Total** | **1,122,597** | **819,408** | **744,112** |
| **Comparable Emissions Total** | **1,122,597** | **819,408** | **703,270** |