Photo courtesy of City of Naperville

NAPERVILLE GREENHOUSE GAS INVENTORY

MARCH 2025

This page intentionally left blank

EXECUTIVE SUMMARY

This greenhouse gas (GHG) inventory covers emissions for incorporated Naperville, Illinois, with analyses completed for both the community and government operations. The City of Naperville has previously completed GHG inventories in 2009, 2013, and 2019. This report intends to build off this work with updated information, and care has been taken to ensure alignment with past inventories.

To complete this analysis, data related to emissions sources was collected from the City of Naperville, Nicor, Chicago Metropolitan Agency for Planning (CMAP), and Groot. When data was unavailable, additional information from public resources was collected to make estimates. Information on emissions sources was paired with emissions factors to calculate emissions.

Potential strategies for consideration have been included, though a robust climate action planning process would better inform these strategies. The City can look to the Greenest Region Compact for a framework for such activities. Additionally, the City of Naperville can seek alignment with Naperville's Sustainability Work Plan and consider the resources provided via Sustainable Naperville 2036. Continued efforts in this space can advance Naperville's sustainability goals and position them as a leader in an increasingly environmentally conscious region.

Results

Part of the analysis included using multiple emissions factors to understand the emissions related to electricity. Emissions factors for electricity are dependent on what fuel is used to generate electricity. If the electricity mix for a provider uses more emissions-producing fuel sources like coal, the emissions factor is higher. As such, this inventory looked at three emissions factors for electricity – the U.S. EPA Emissions & Generation Resource Integrated Database (eGRID) emission factors for the RCF West (RCFW) region, a calculated emissions factor for the Illinois Municipal Electric Agency (IMEA), and an emissions factor for generation by PJM, the regional transmission organization and independent system operator for northeastern Illinois. None of the three emissions factors is necessarily "right" – they each provide different information and a richer illustration of emissions when considered together. However, this also inhibits being able to claim one absolute number summarizing emissions.

Results Using eGRID RCFW Emissions Factor

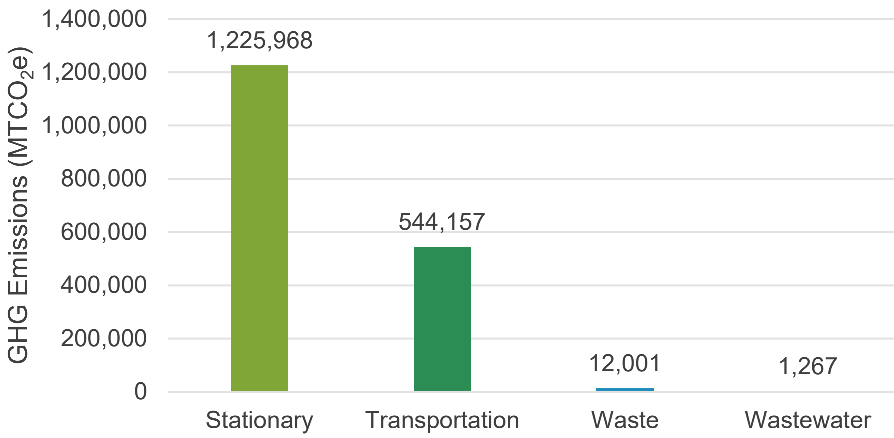
Using the eGRID RCFW emissions factor, total community GHG emissions for 2022 were 1,783,393 MTCO_2e,[1] equivalent to the annual fuel usage of 415,986 gasoline-powered passenger vehicles (U.S. Environmental Protection Agency, 2023c). Most emissions came from stationary sources. Remaining emissions came from transportation, waste, and wastewater (Figure 1). Emissions have stayed relatively constant since 2017, but saw a reduction of 19

---

[1] MTCO_2e represents "metric tonnes of carbon dioxide equivalent," the commonly used measurement for inventorying GHGs. Carbon dioxide equivalent captures carbon dioxide emissions, as well as those from methane (CH_4) and nitrous oxide (N_2O) which are also produced. Carbon dioxide equivalent factors in the higher global warming potentials for CH_4 and N_2O relative to carbon dioxide.

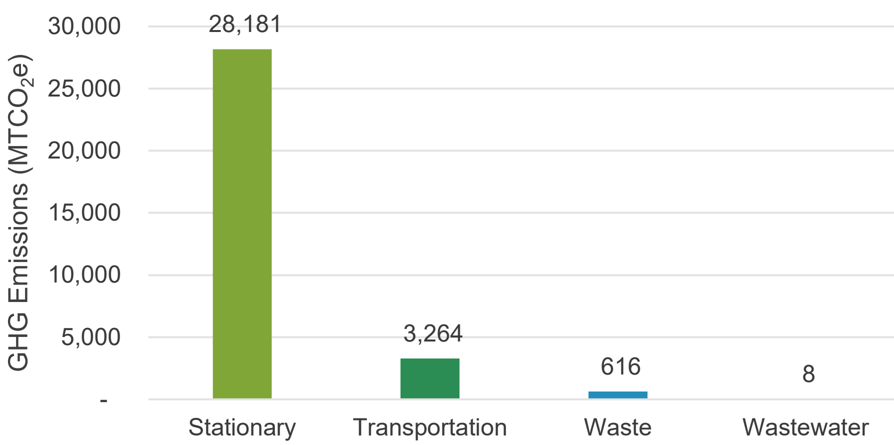
percent since 2005, the first year data is available.

Figure 1: Community Emissions Summary by Sector Using eGRID RCFW, Naperville, IL (2022)



Of the total community GHG emissions, 32,069 $MTCO_2e$ came from City of Naperville's government operations related to stationary sources, fleet vehicles, waste, and wastewater. Similar to community-wide emissions, stationary emissions was the largest component, followed by transportation (Figure 2). Emissions for stationary sources and fleet vehicles have increased by 9.2 percent since 2013 but decreased by 16.1 percent since 2005.

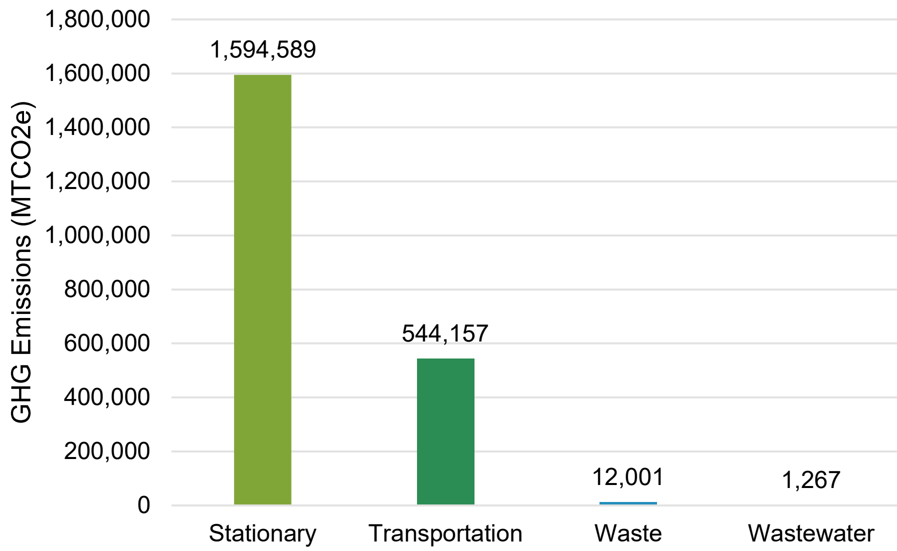
Figure 2: Government Operations Emissions Summary by Sector Using eGRID RCFW, City of Naperville, IL (2022)



Results using IMEA Emissions Factor

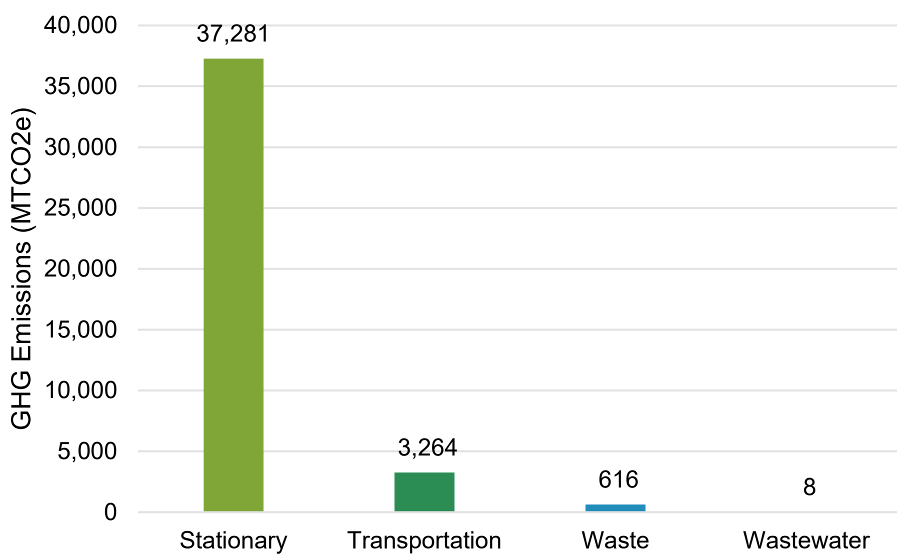
Using the IMEA emissions factor, total GHG emissions are the highest of the three analyses at 2,152,014 $MTCO_2e$, the equivalent of 501,969 gasoline powered passenger vehicles for one year or charging over 173 billion cell phones (U.S. Environmental Protection Agency, 2023c). The difference comes from the much higher emissions factor used for electricity – emissions from all other sources do not change.

Figure 3: Community Emissions Summary by Sector Using IMEA, Naperville, IL (2022)



In this analysis, 41,169 $MTCO_2e$ came from City of Naperville's government operations related to stationary sources, fleet vehicles, waste, and wastewater. Stationary emissions was the largest component, with over ten times the emissions from the next highest source, transportation (Figure 4).

Figure 4: Government Operations Emissions Summary by Sector using IMEA, City of Naperville, IL (2022)

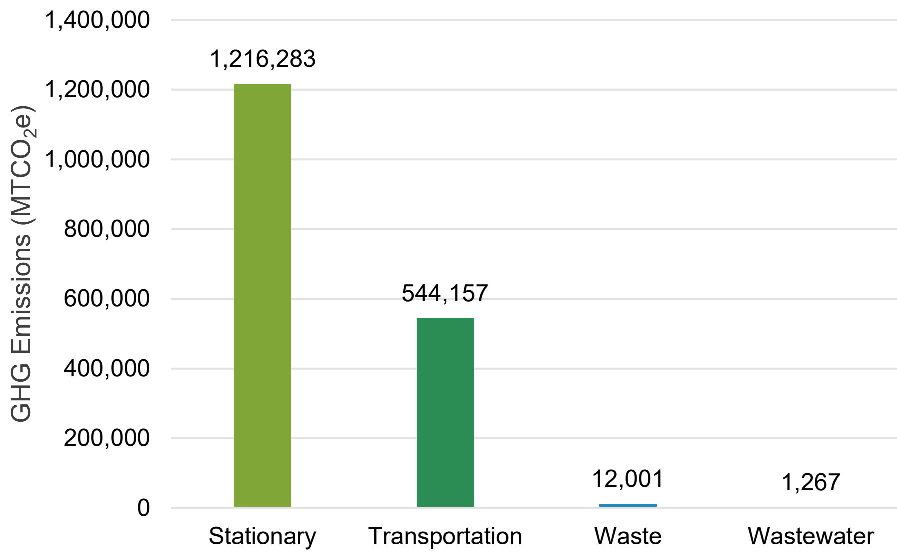


delta institute

Results Using PJM Emissions Factor

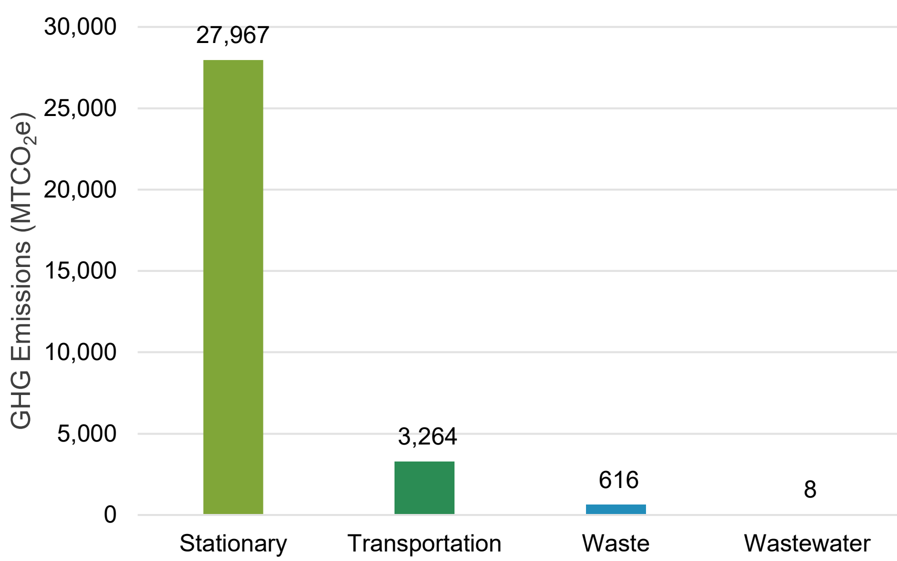
The third and final analysis used an emissions factor for PJM and found total emissions to be 1,773,708 $MTCO_2e$, with the majority from stationary emissions (Figure 5). Total emissions are equivalent to driving 404,397 gasoline powered vehicles for one year or charging over 140 billion cell phones (U.S. Environmental Protection Agency, 2023c).

Figure 5: Community Emissions Summary by Sector Using PJM, Naperville, IL (2022)



In this analysis, government emissions totaled 31,855, with stationary emissions and transportation emissions the largest contributors.

Figure 6: Government Operations Emissions Summary by Sector Using PJM, City of Naperville, IL (2022)



About Delta Institute

Delta Institute collaborates with communities to solve complex environmental challenges throughout the Midwest. Delta exists because environmental, economic, and climate issues hit communities—urban and rural—through disinvestment, systemic inequity, and policy decisions. We collaborate at the community level to solve our home region's new and legacy issues, by focusing on the self-defined goals and needs of our partners.

Delta Institute improves the living conditions of more than five million Midwesterners by transitioning one million acres to more resilient, conservation-focused practices, and by improving water quality and reducing flooding by capturing 100 million stormwater gallons. By 2025 we will achieve these goals through our agriculture, climate, water, and community development projects.

This is what a more resilient, equitable, and innovative Midwest looks like. Visit us online at www.delta-institute.org.

Acknowledgements

The Naperville Greenhouse Gas Inventory report was prepared by Delta Institute for the City of Naperville. The project team would like to recognize the support and contributions made by several stakeholders who collaborated as part of this process, including:

- Brian Groth: Electric Utility Director
- Ben Mjolsness: Sustainability Manager
- Ryan Rey: Communications Specialist
- Tracy Rulo: Fleet Services Manager
- Phil Watson: Business Analyst
- Amy Wrigley: Technical Specialist

This document and the tools provided aim to be action oriented and to provide the most current, correct, and clear information possible, but some information may have changed since publication. We encourage practitioners to reach out to us at delta@delta-institute.org with questions, corrections, or to discuss implementation challenges.

TABLE OF CONTENTS

INTRODUCTION

A GHG inventory aggregates emissions from multiple sources over a set period. Doing so allows municipalities to understand current emission levels. When repeated over time, results can identify trends and measure the impact of policy changes. For municipalities, analysis calculates total emissions for the community, as well as separately breaking out emissions related to municipal operations. These analyses may differ in data availability and scale, and results can be used in different ways, especially given the different levels of control a municipality has over emissions. The following document summarizes emissions for the City of Naperville for 2022.

In completing a GHG inventory, boundaries are set to determine what is and is not included in the inventory. This inventory was done in alignment with the Global Protocol for Community-Scale Greenhouse Gas Inventories BASIC framework. Multiple sectors for both community and government activities were considered in the analysis including:

- Stationary energy – any fuel or electricity consumed for residential, commercial, industrial, or institutional purposes within the geographic boundary;
- In-boundary transportation – any travel activity occurring within the geographic boundary; and
- Waste – disposal of any waste produced within the city (GHG Protocol, 2013).

Analyses can also be broken down by scopes, which define emissions from where they are produced. This report prioritizes breaking down emissions by sector over scope as sectors are generally more familiar to most audiences. There are three scopes used when considering GHG emissions:

- Scope 1 – emissions from sources within a geographic boundary, typically related to fuel usage like natural gas, gasoline, and diesel;
- Scope 2 – emissions produced in the generation of electricity produced elsewhere but consumed within the geographic boundary; and
- Scope 3 – emissions produced outside of the geographic boundary due to activities within the boundary. As Scope 3 emissions can be extensive and difficult to track, the BASIC framework limits Scope 3 analysis to solid waste and wastewater generated within a city (GHG Protocol, 2013).

Most emissions calculations combine consumption data with appropriate emissions factors, a multiplier used to convert consumption to GHG emissions. For many sources, these emissions factors are relatively stable. All else being equal, a gallon of gasoline consumed in different states will likely produce the same emissions. A gallon of gas consumed today and ten years into the future will likely have the same emissions, barring significant changes in measurement. As such, the emissions factor would not change in these scenarios.

Measuring emissions from electricity poses a unique challenge as the emissions factor can vary far more widely. If the energy mix of a region relies more on fuel sources that produce fewer GHG emissions like wind and solar, the emissions factor will be lower than a region that relies more on fuel sources like coal that produce more GHG emissions. Emissions factors can also change over time as shifts in energy use within a region occur. To complete this analysis, three different emissions factors were considered:

- The U.S. EPA Emissions & Generation Resource Integrated Database (eGRID) emission factors for the RCF West (RCFW) region, in alignment with previous Naperville GHG inventories;
- A calculated emissions factor for the Illinois Municipal Electric Agency (IMEA), Naperville's current electricity provider; and
- An emissions factor for generation by PJM, the regional transmission organization and independent system operator for northeastern Illinois.

These emissions factors can vary greatly, as shown in Figure 7. IMEA directly purchases power from certain energy providers, purchasing directly from parts of the RCFW grid and its neighbors that produce more GHG due to higher fossil fuel usage. In 2022, IMEA's energy mix was 82 percent coal, compared to 31 percent coal for RCFW (U.S. Environmental Protection Agency, 2023a).

Figure 7: Emissions Factors

eGRID – RCFW (lbs CO_2e/MWh)	IMEA (lbs CO_2e/MWh)	PJM (lbs CO_2e/MWh)
1052.65	1702.64	1037.23

For both community and government emissions, information is first presented in its most aggregate form before breaking down results more granularly. When including electricity related emissions, three scenarios are presented using each emissions factor reviewed. When necessary, multiple emissions results are noted to show how emissions vary using different electricity emissions factors. None of the three emissions factors is necessarily "right" – they each provide different information and a richer illustration of emissions when considered together.

Where possible, trends and changes over time have been identified, though data gaps sometimes prevented more complete analyses. These analyses only use eGRID emission factors to maintain consistency with previous inventories.

Detailed methodology follows in Appendix A and can be used to inform future inventorying work. The methodology for how the IMEA and PJM emissions factors were calculated is available in Appendix B and Appendix C respectively.

Photo courtesy of City of Naperville

COMMUNITY LEVEL EMISSIONS

To understand GHG emissions for a municipality, analysis is taken to calculate emissions at the community level, related to the activities of residents, visitors, commercial operations, and institutions. The following is a summary of this analysis.

Emissions Summary

Using the eGRID RCFW emissions factor, total GHG emissions for Naperville in 2022 were 1,783,393 MTCO_2e. This is equivalent to driving 415,986 gasoline powered passenger vehicles for one year or charging over 144 billion cell phones (U.S. Environmental Protection Agency, 2023c). Per capita emissions are 11.9 MTCO_2e.

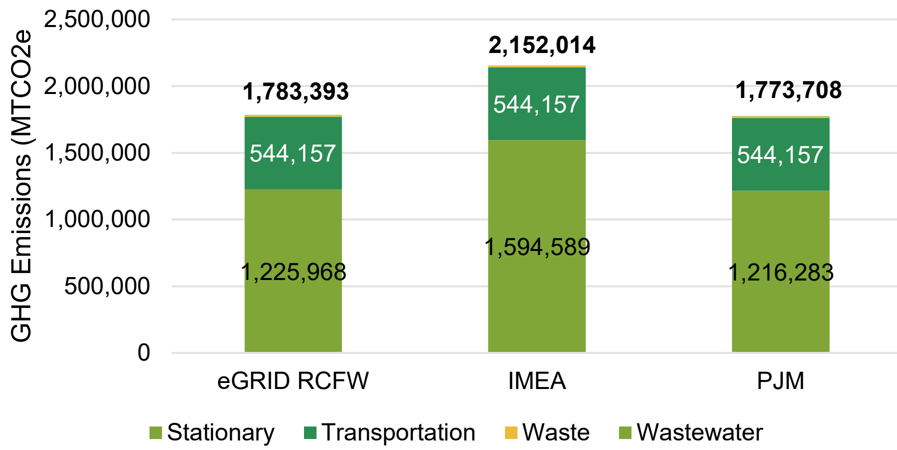
Comparatively, when using the IMEA emissions factor, total GHG emissions are higher at 2,152,014 MTCO_2e, the equivalent of 501,969 gasoline powered passenger vehicles for one year or charging over 173 billion cell phones (U.S. Environmental Protection Agency, 2023c). Using this emissions factor, per capita emissions are 14.3 MTCO_2e. Using the PJM emissions factor, total GHG emissions are 1,733,708 MTCO_2e with per capita emissions of 11.8 MTCO_2e. Total emissions are equivalent to driving 404,397 gasoline powered vehicles for one year or charging over 140 billion cell phones (U.S. Environmental Protection Agency, 2023c).

Across all analyses, the largest source of emissions was from stationary uses, followed by transportation and waste. Note that the absolute numbers for transportation, waste, and wastewater do not change across analyses, though their proportion of the total emissions do. A complete breakdown of emissions by source is available in Figure 8 and Figure 9.

Figure 8: Community Emissions Summary by Sector, Naperville, IL (2022)

Sector	eGRID RCFW		IMEA		PJM	
	GHG Emissions (MTCO_2e)	%	GHG Emissions (MTCO_2e)	%	GHG Emissions (MTCO_2e)	%
Stationary	1,225,968	68.74%	1,594,589	74.10%	1,216,283	68.57%
Transportation	544,157	30.51%	544,157	25.29%	544,157	30.68%
Waste	12,001	0.67%	12,001	0.56%	12,001	0.68%
Wastewater	1,267	0.07%	1,267	0.06%	1,267	0.07%
Total	1,783,393	100%	2,152,014	100%	1,773,708	100%

Figure 9: Community Emissions Summary by Sector, Naperville, IL (2022)

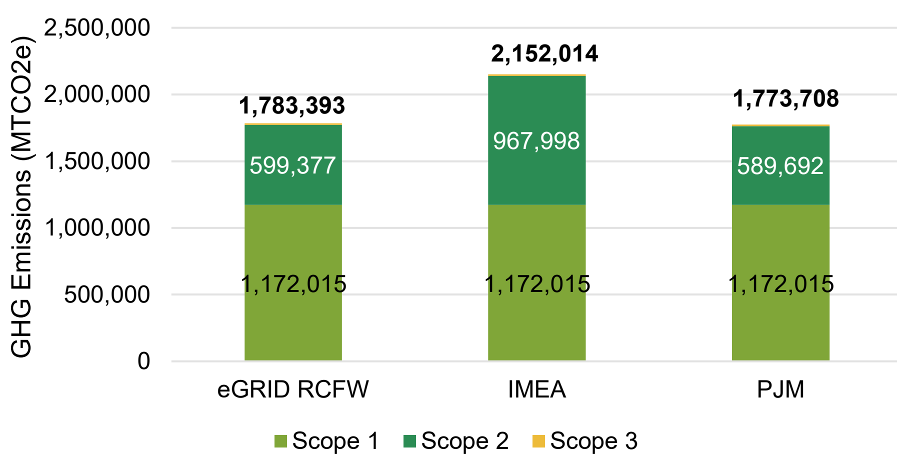


When broken down by scope, Scope 1 emissions from natural gas usage, transportation, and wastewater management made up the largest component of total emissions, A breakdown of emissions by scope is shown in Figure 10 and Figure 11.

Figure 10: Community Emissions Summary by Scope, Naperville, IL (2022)

Scope	eGRID RCFW		IMEA		PJM	
	GHG Emissions ($MTCO_2e$)	%	GHG Emissions ($MTCO_2e$)	%	GHG Emissions ($MTCO_2e$)	%
Scope 1	1,172,015	65.72%	1,172,015	54.46%	1,172,015	66.08%
Scope 2	599,377	33.61%	967,998	44.98%	589,692	33.25%
Scope 3	12,001	0.67%	12,001	0.56%	12,001	0.68%
Total	1,783,393	100%	2,152,014	100%	1,773,708	100%

Figure 11: Community Emissions Summary by Scope, Naperville, IL (2022)



Community Emissions Trends

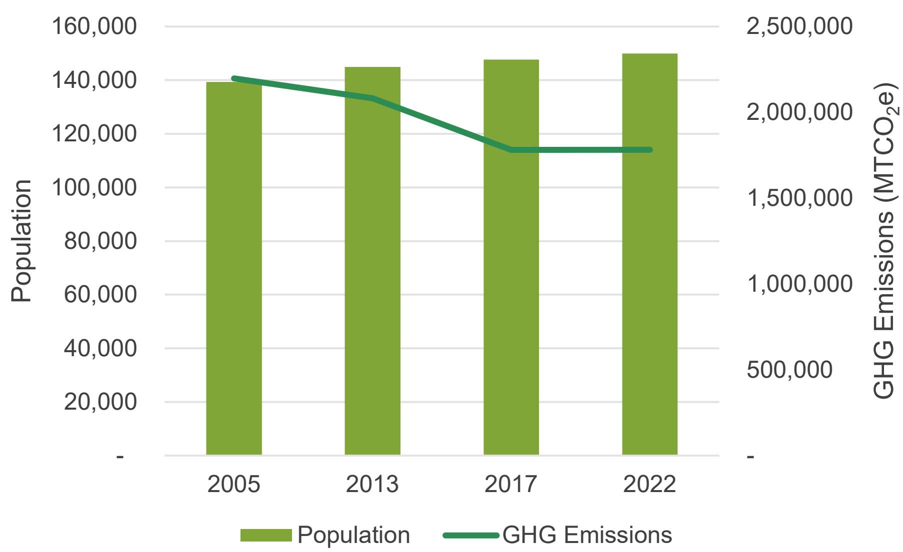
Having previous inventories of GHG emissions can make emissions trackable over time, though analyses may not often match perfectly with one another as methodologies change, new information becomes available, and scopes are adjusted to include different emissions sources. Across the four GHG inventories that have been conducted for Naperville, the following sources of GHG emissions have been tracked as far back as 2005:

- Stationary Natural Gas
- Stationary Electricity
- On-Road Transportation
- Curbside Collection Waste[2]

This section addresses the aggregate trends for these four categories only to avoid making unfair comparisons. Discrepancies between this section and others is the product of having to limit the analysis to these four categories. All analysis uses the eGRID RCFW emissions factor for electricity to maintain consistency across years.

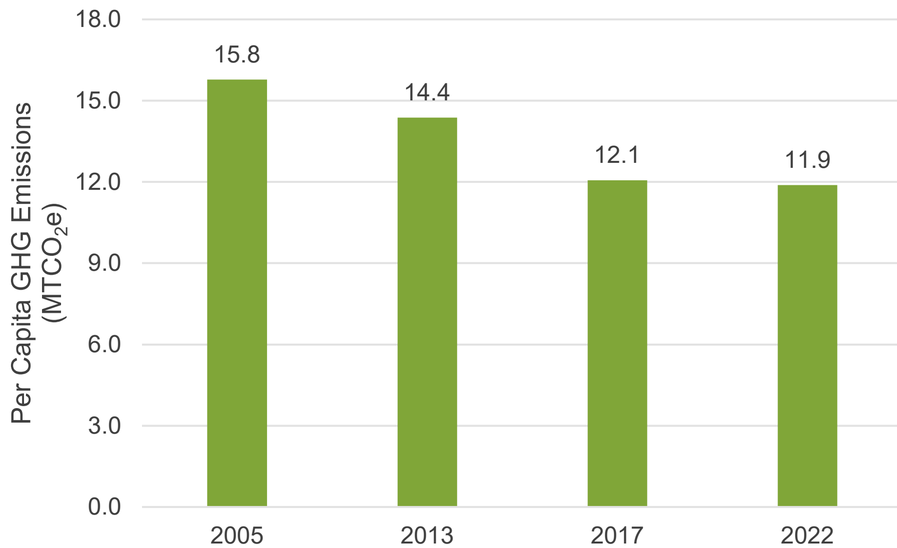
Total annual emissions for Naperville have declined 415,984 MTCO_2e since 2005, a 19 percent reduction. This is the equivalent to the emissions of 92,569 gasoline powered passenger vehicles in one year (U.S. Environmental Protection Agency, 2023c). This has occurred during a period of growth for Naperville – between 2005 and 2022, the population has grown 8 percent with over 10,000 additional residents. Decreasing emissions paired with growing population has resulted in falling per capita emissions. In 2005, per capita emissions were 15.8 MTCO_2e compared to 11.9 MTCO_2e for 2022. Emissions and population trends are shown in Figure 12, while per capita emissions are shown in Figure 13.

Figure 12: Population and Community GHG Emissions, Naperville, IL (2005-2022)



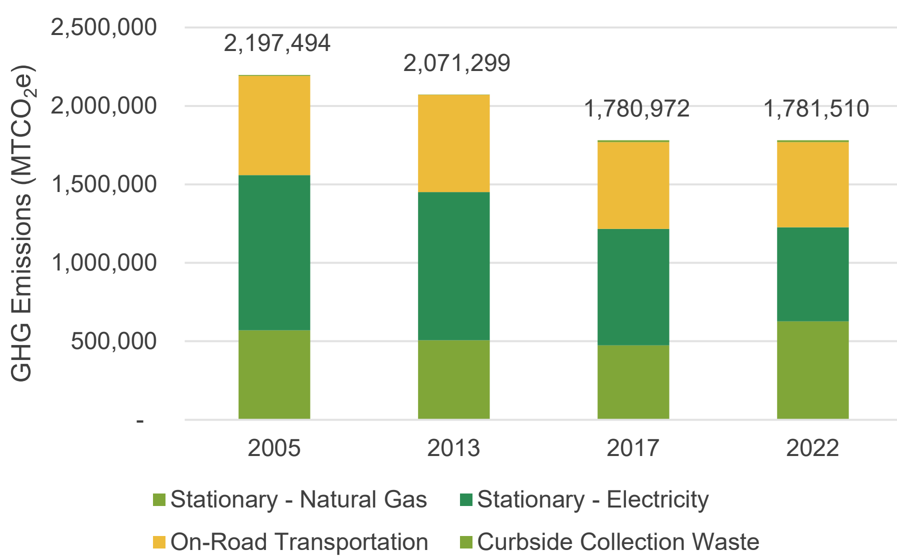
[2] Waste emissions information was not available as part of the most recent GHG inventory. Emissions for 2017 have been estimated.

Figure 13: Community Emissions Summary Per Capita, Naperville, IL (2005-2022)



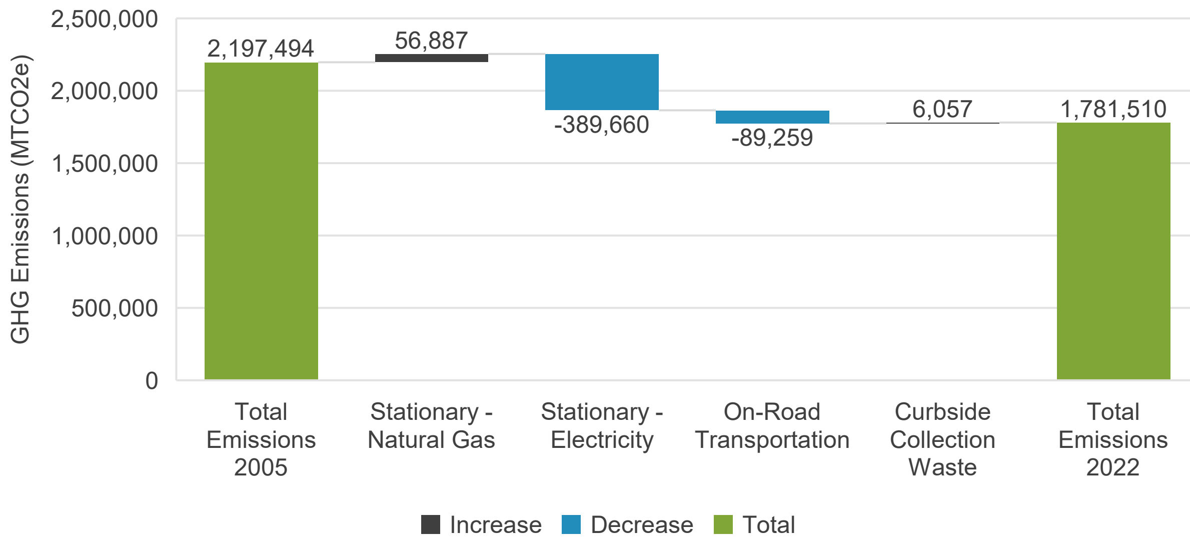
Stationary emissions from electricity and natural gas usage have consistently been the largest component of Naperville's emissions, as seen in Figure 14. Emissions reductions have come from electricity and on-road transportation, though emissions from natural gas usage and waste have increased since 2005. Emissions reductions, increases, and how they relate to overall changes from 2005 to 2022 are shown in Figure 15.

Figure 14: Community Emissions Summary by Sector, Naperville, IL (2005-2022)



delta institute

Figure 15: GHG Emissions Changes by Sector, Naperville, IL (2005-2022)



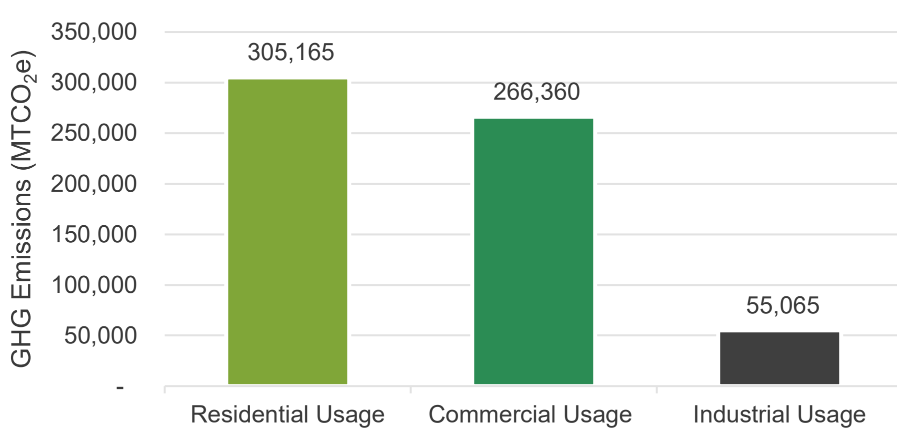
Stationary Emissions

Stationary emissions – coming from the powering of residential, commercial, institutional, and industrial buildings – comprise the largest component of Naperville's GHG emissions. Emissions come from both the use of natural gas and electricity. Information was provided by Nicor and the City for natural gas and electricity respectively.

Natural Gas

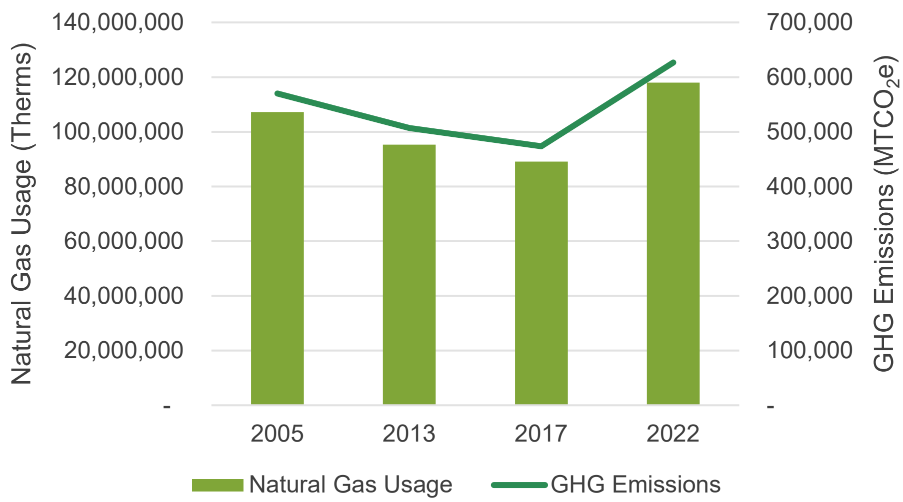
117,969,916 therms of natural gas were used in Naperville in 2022, producing 626,591 $MTCO_2e$ of GHG emissions. The largest source of emissions came from residential usage with 305,165 $MTCO_2e$ of emissions (48.70 percent). Commercial usage and industrial usage had 266,360 $MTCO_2e$ (42.51 percent) and 55,065 $MTCO_2e$ (8.79 percent) respectively. A breakdown of these usage types and their associated emissions is shown in Figure 16.

Figure 16: Community Natural Gas GHG Emissions by Source, Naperville, IL (2022)



Natural gas usage has increased 32.43 percent since 2017, and GHG emissions have also increased by 32.33 percent. Increased natural gas consumption is in keeping with national trends in natural gas usage (U.S. Energy Information Administration, 2023). Natural gas usage and GHG emissions trends are shown in Figure 17.

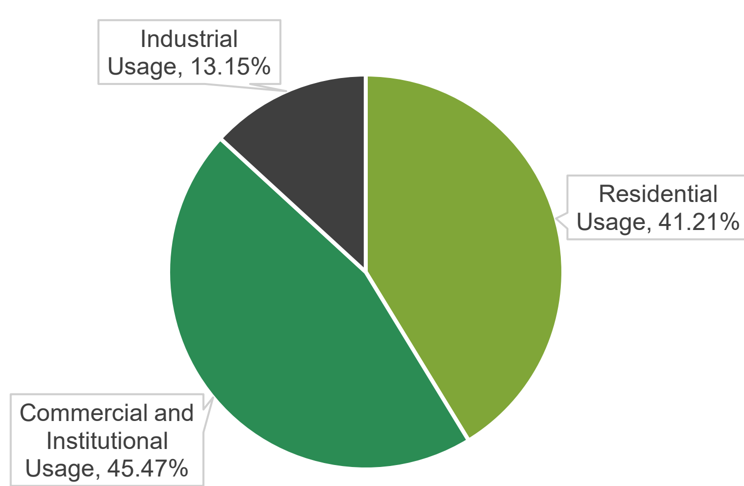
Figure 17: Community Natural Gas Usage and Related GHG Emissions, Naperville, IL (2005-2022)



Electricity

In 2022, total electricity usage was 1,255,483,584 kWh. The largest source of electricity-related emissions was from commercial and institutional usage (45.47 percent), followed by residential usage (41.21 percent) and industrial usage (13.15 percent), as shown in Figure 18. This breakdown is tied directly to electricity usage and does not change with different emissions factors.

Figure 18: Community Electricity Related GHG Emissions Proportions by Source, Naperville, IL (2022)

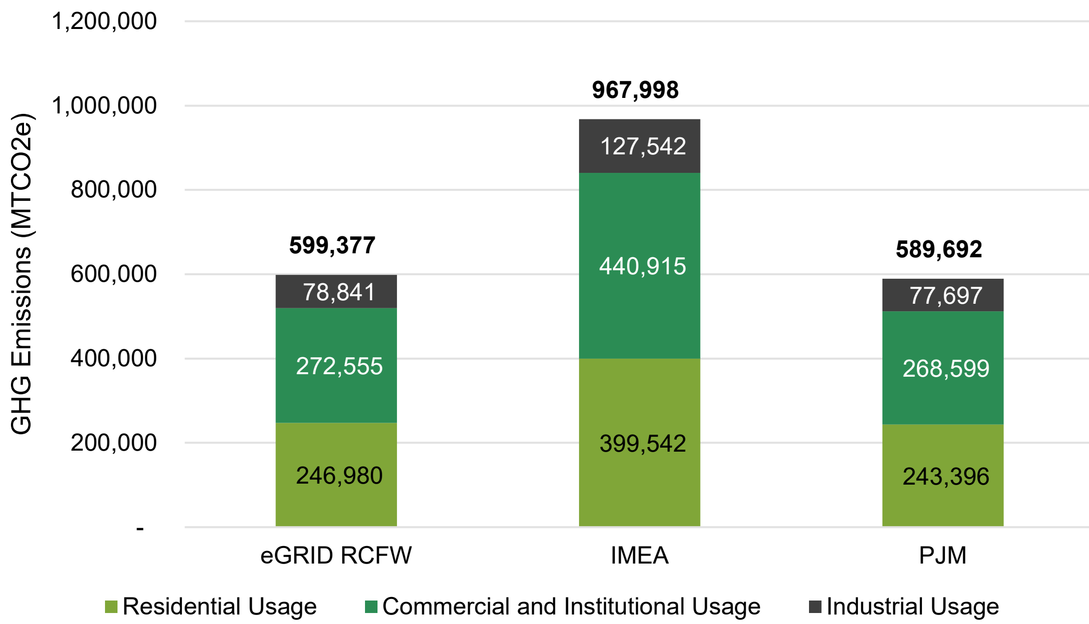


Breakdowns of community emissions by source using different emissions factors is shown tabulated and graphically in Figure 19 and Figure 20.

Figure 19: Community Electricity Related GHG Emissions by Source with Multiple Emissions Factors, Naperville, IL (2022)

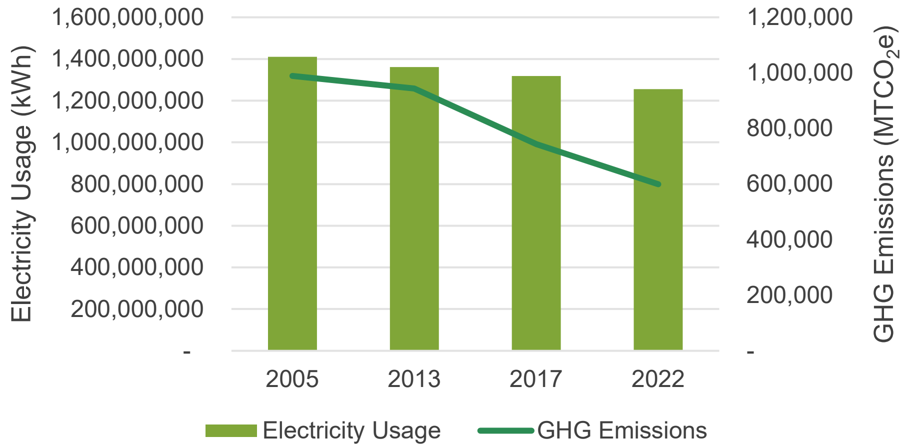
	eGRID RCFW ($MTCO_2e$)	IMEA ($MTCO_2e$)	IPJM ($MTCO_2e$)
Residential Usage	246,980	399,542	243,396
Commercial and Institutional Usage	272,555	440,915	268,599
Industrial Usage	78,841	127,542	77,697
Total	599,377	967,998	589,692

Figure 20: Community Electricity Related GHG Emissions by Source with Multiple Emissions Factors, Naperville, IL (2022)



Using the eGRID RCFW emissions factor, since 2017, electricity usage has decreased 6.02 percent. The related GHG emissions have decreased by 19.36 percent. Emissions can decrease more rapidly than electricity usage composition of energy sources that power electricity grids. If energy generation shifts towards sources that produce fewer GHG emissions like wind and solar, emissions related to electricity usage can decrease without changes in usage or decrease faster than usage. Electricity usage and its associated GHG emissions are shown in Figure 21.

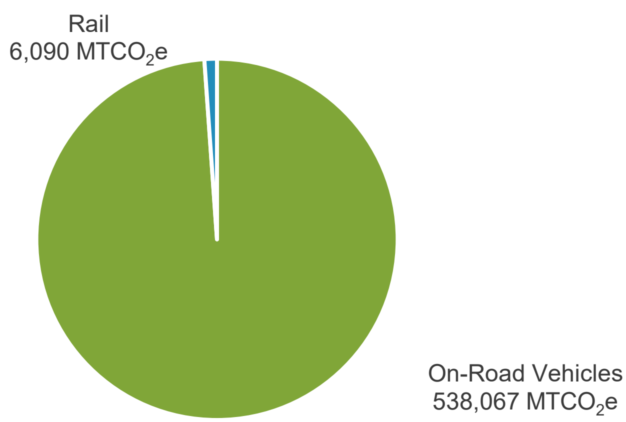
Figure 21: Community Electricity Usage and Related GHG Emissions, Naperville, IL (2005-2022)



Transportation Emissions

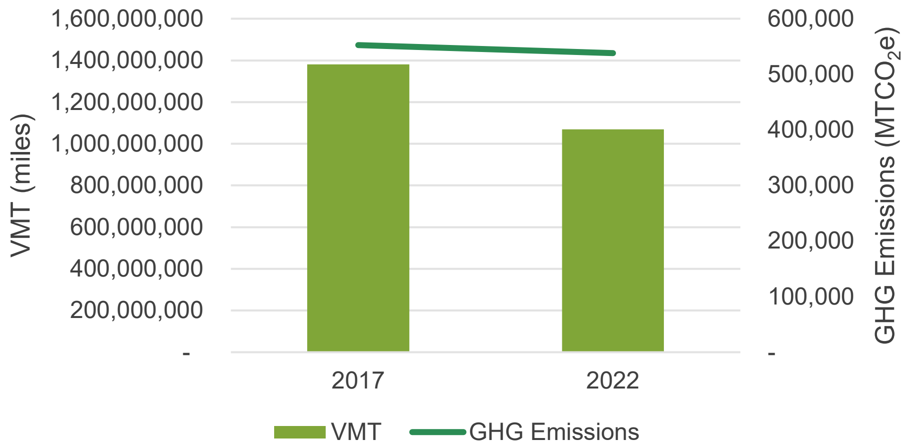
In 2022, 544,157 $MTCO_2e$ of emissions were produced from transportation activities within Naperville. 538,067 $MTCO_2e$ or 98.88 percent of these emissions came from on-road vehicles, including automobiles, motorcycles, trucks, and transit buses. On-road vehicle emissions were calculated using vehicle miles traveled (VMT) from CMAP combined with information on vehicle fuel efficiency, number of vehicles, and number of electric vehicles. The other 6,089 $MTCO_2e$ of emissions came from rail travel from Metra, Amtrak, and freight. Emissions were estimated based on publicly available information on rail activities. Transportation emissions are shown in Figure 22.

Figure 22: Community Transportation Emissions by Source, Naperville, IL (2022)



Emissions for on-road vehicles (excluding rails) have decreased since 2017 by 1.51 percent, while vehicle miles travelled (VMT), a key component of understanding transportation related GHG emissions, decreased 22.62 percent (Figure 23). The differences in changes between VMT and GHG emissions stem from changes in the emissions factors used between inventories. As more granular information concerning vehicle compositions, vehicle mileage per gallon, and fuel consumption becomes available, emissions factors can continue to be refined.

Figure 23: Community VMT and Related GHG Emissions, Naperville, IL (2017-2022)



Waste Emissions

In 2022, the community generated a total of 49,905 tons of solid waste through curbside collections, government operations, white goods, and yard waste. The emissions from solid waste generated within the City of Naperville amounted to 12,001 MT, a 1.33 percent drop in emissions since 2013 (when waste related emissions were last calculated). Emissions related to curbside collections dropped 6.83 percent. Data was provided by the City of Naperville and Groot Industries.

An additional 13,876.97 tons of materials like newspaper, mixed paper, metals, glass, and plastics, were recycled. Through these recycling efforts, 37,686.2 $MTCO_2e$ were avoided.

Note that these emissions only include materials collected from residences and government operations – data from private collectors, which would cover commercial, industrial, and other institutional waste, was not included in this analysis due to lack of available data.

Wastewater Emissions

Emissions related to the treatment of wastewater generated in the City of Naperville account for 1,267 $MTCO_2e$. Emissions for wastewater have not been tracked in previous GHG inventories. Data was provided by the City of Naperville.

Emissions Reduction Strategies

Municipal governments can disseminate information and encourage their residents to pursue activities that reduce GHG emissions. The success of these strategies may vary based on public opinion, and municipal governments have far less control over GHG emissions from the community. The following are seven strategies that the City of Naperville could consider when looking to reduce community GHG emissions.

Stationary Strategies

Strategy 1: Encourage residents to take advantage of Naperville's sustainability incentives and rebates.

The City of Naperville offers a number of programs to help residents improve energy efficiency and use renewable energy in their homes. Rebate programs can cover a portion of the cost for green technology like for smart thermostats or solar installation, while the Renewable Energy Program supports renewable energy projects within the community.

Strategy 2: Encourage residents to consider of Nicor Gas energy efficiency programs.

The Nicor Gas Energy Efficiency Program offers assessments, rebates, and educational opportunities for residential customers. Weatherization and improvements to residential HVAC can improve energy efficiency, reducing energy demand and costs.

Strategy 3: Electrify buildings where feasible.

As the electricity grid continues to shift towards renewable energy generation, electrification of residential and commercial spaces can become lower emitting than those using natural gas for things like heating, cooking, and drying clothes.

Strategy 4: Develop an energy benchmarking ordinance that requires commercial properties to report energy usage.

An energy benchmarking ordinance can require commercial properties to report their energy use, with information used to understand trends in energy consumption. Data can be used to acknowledge facilities that are performing well and flag those who may need additional support in adopting energy efficiency measures.

Strategy 5: Require private waste haulers operating in the city to report on waste collection.

Requiring private waste haulers to report on waste collection provides additional information on a significant waste stream. Collection over multiple years can be used to determine waste management trends and the impact of waste management policies.

Strategy 6: Encourage residents to participate in curbside composting.

The City of Naperville currently offers curbside composting as part of their yard waste collection service. Residents who request a cart and pay an annual fee can have food scraps collected alongside yard waste. Composting food scraps allows materials to break down aerobically, rather than anaerobically digested as they do in landfills. When food scraps are anaerobically digested, they produce methane, a GHG more potent than carbon dioxide.

Mobile Strategies

Strategy 1: Encourage residents to consider electric vehicles.

Providing residents with resources on electric vehicles and charging stations can encourage them to consider electric vehicles when making vehicle purchases. Incentives like priority parking can further encourage electric vehicle use.

Strategy 2: Encourage fleet electrification for commercial and industrial operations.

Adopting electric vehicles in commercial and industrial operations could reduce emissions as the electricity grid shifts towards renewable energy sources. Commercial and industrial operations can consider moving to electric vehicles as vehicles reach the end of their usable life and must be replaced.

Strategy 3: Encourage residents to take advantage of Naperville's electric vehicle charging station rebates.

The City of Naperville offers a rebate program to offset some of the cost of Level 2 or 3 charging stations and is available for both residential and nonresidential use.

Photo courtesy of City of Naperville

GOVERNMENT OPERATIONS EMISSIONS

In addition to the community emissions inventory, an analysis was completed isolating the activities of the City of Naperville municipal government. Emissions included here are a subset of those included in the previous section to recognize Naperville's government operations as a component of the overall community.

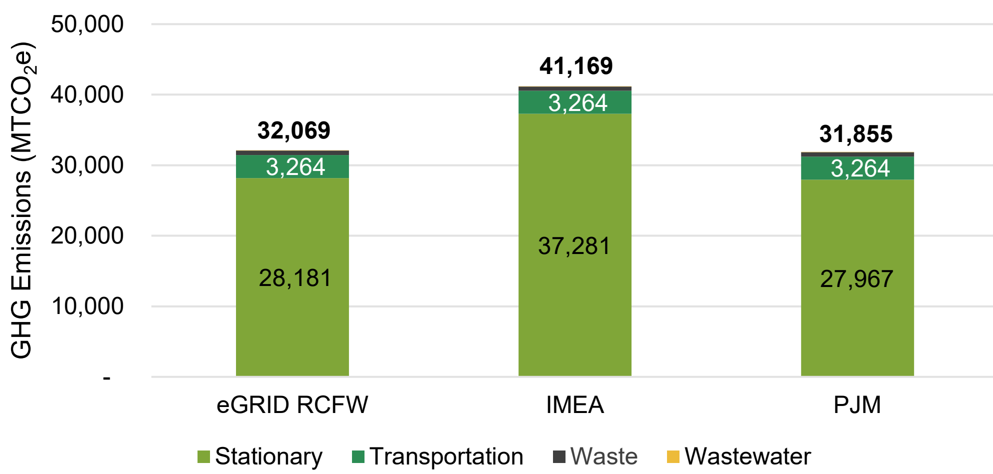
Emissions Summary

Total emissions for the City of Naperville vary depending on the electricity emissions factor used, but stationary emissions consistently make up the largest component of these emissions. A breakdown of emissions by sector using different emissions factors for electricity is shown in Figure 24 and Figure 25.

Figure 24: Government Operations Emissions Summary by Sector, City of Naperville, IL (2022)

Sector	eGRID RCFW		IMEA		PJM	
	GHG Emissions ($MTCO_2e$)	%	GHG Emissions ($MTCO_2e$)	%	GHG Emissions ($MTCO_2e$)	%
Stationary	28,181	87.88%	37,281	90.56%	27,967	87.79%
Transportation	3,264	10.18%	3,264	7.93%	3,264	10.25%
Waste	616	1.92%	616	1.50%	616	1.93%
Wastewater	8	0.02%	8	0.02%	8	0.03%
Total	32,069	100%	41,169	100%	30,450	100%

Figure 25: Government Operations Emissions Summary by Sector, City of Naperville, IL (2022)



delta institute

Government Emissions Trends

Similar to community level emissions, evaluating trends over time can be limited by what is available. Data for government-related stationary and fleet emissions were available for 2005, 2013, and 2022. Stationary emissions for the 2019 analysis were not available and excluded here. Discrepancies between this section and others is the product of having to limit the analysis to stationary and fleet emissions for these three years.

Using the eGRID RCFW emissions factor for electricity, government emissions have decreased 6,035 $MTCO_2e$, or 16 percent, since 2005. Stationary emissions make up the largest component, but have also seen the greatest reductions, decreasing 5,519 $MTCO_2e$ during this time. Breakdowns of emissions by sector and emissions reductions compared to overall emissions are shown in Figures 26 and 27 respectively.

Figure 26: Government Emissions Summary by Sector, Naperville, IL (2005-2022)

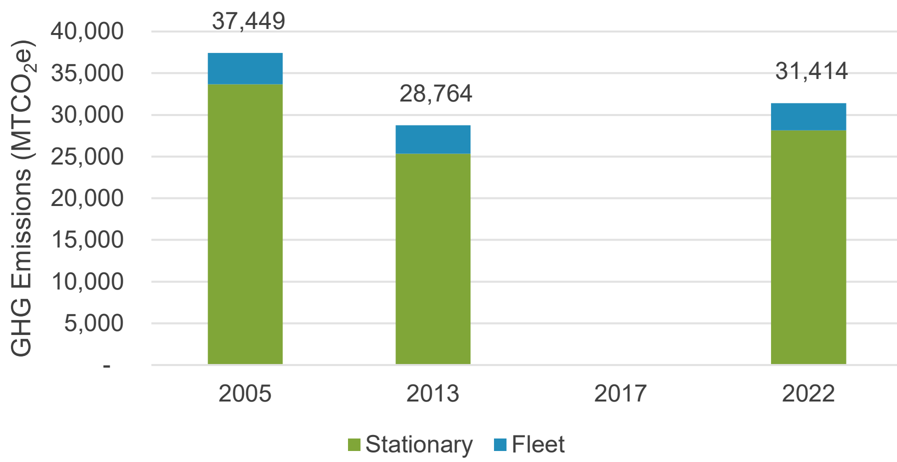
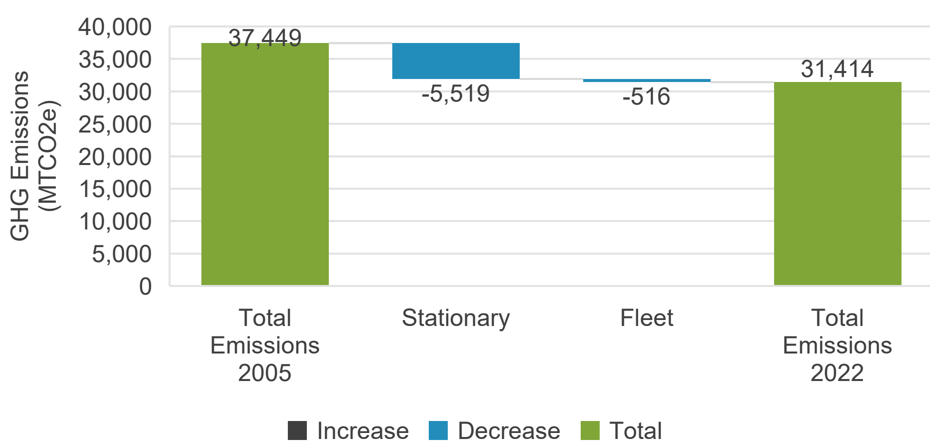


Figure 27: GHG Emissions Changes by Sector, Naperville, IL (2005-2022)



delta institute

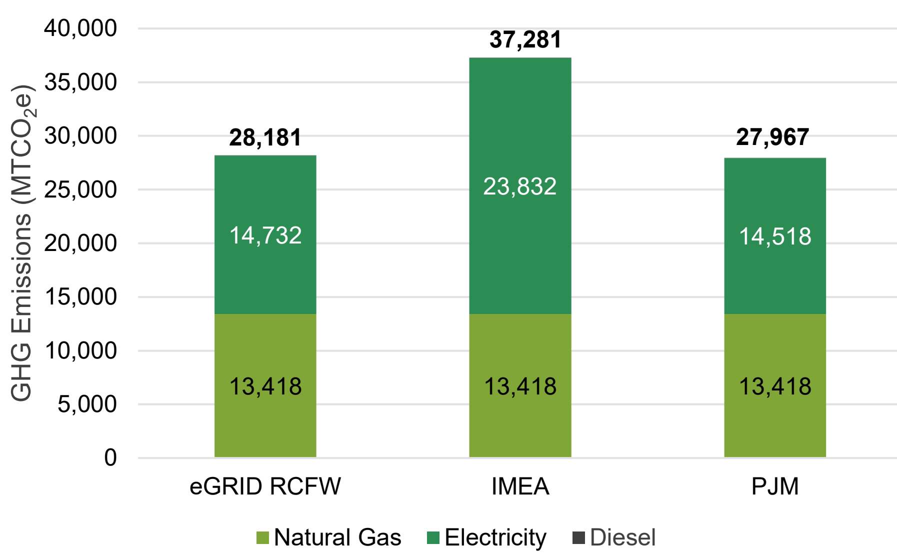
Stationary Emissions

Stationary emissions included 13,418 $MTCO_2e$ from natural gas usage and 31 $MTCO_2e$ from diesel usage. Emissions from electricity vary depending on the emissions factor used – using the eGRID RCFW and PJM emissions factors, emissions are similar to natural gas usage, but electricity emissions are significantly higher when using the IMEA emissions factor. Natural gas usage was provided by Nicor, with electricity and diesel information from the City of Naperville. Emissions by source are shown in Figure 28 and Figure 29.

Figure 28: Government Operations Stationary Emissions by Source with Multiple Emissions Factors, City of Naperville, IL (2022)

	eGRID RCFW ($MTCO_2e$)	IMEA ($MTCO_2e$)	PJM ($MTCO_2e$)
Natural Gas	13,418	13,418	13,418
Electricity	14,732	23,832	14,518
Diesel	31	31	31
Total	28,181	37,281	27,967

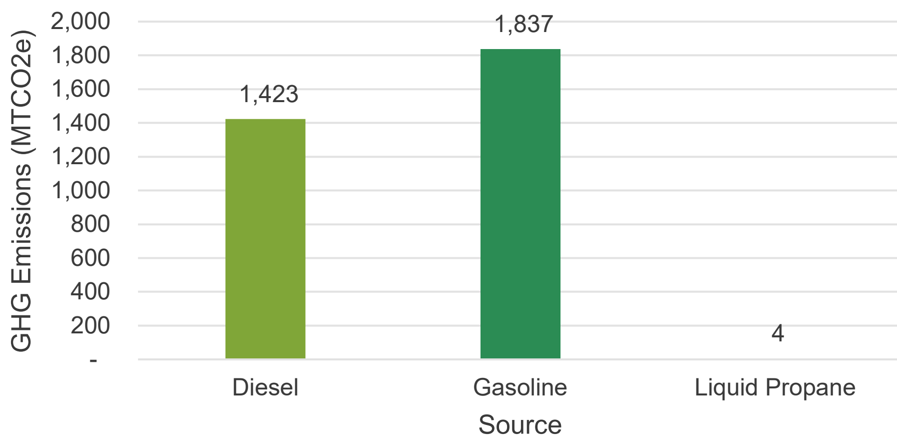
Figure 29: Government Operations Stationary Emissions by Source with Multiple Emissions Factors, City of Naperville, IL (2022)



Transportation Emissions

The City fleet produced 3,264 $MTCO_2e$ in 2022. The city's fleet uses both diesel and gasoline for its vehicles. Diesel usage accounted for 43.59 percent of transportation emissions at 1,423 $MTCO_2e$, while gasoline accounted for 56.28 percent of transportation emissions at 1,837 $MTCO_2e$. 4 $MTCO_2e$ of emissions came from liquid propane, 0.12 percent of transportation emissions. Fleet information was provided by the City of Naperville. Emissions by source are shown in Figure 30.

Figure 30: Government Operations Transportation Emissions by Source, City of Naperville, IL (2022)



Waste Emissions

In 2022, the City of Naperville facilities produced 1,991 tons of solid waste. Emissions from solid waste totaled 616 $MTCO_2e$. An additional 87 tons of materials were recycled, preventing an additional 248 $MTCO_2e$ of GHG emissions from being produced. Waste information was provided by the City of Naperville and Groot.

Wastewater Emissions

Emissions related to the treatment of wastewater generated in the City of Naperville account for 8 $MTCO_2e$ based on full-time staff for 2022. Wastewater information was provided by the City of Naperville,

Emission Reduction Strategies

Different strategies can be employed to reduce greenhouse gases for a municipal government. Strategies vary in their ease of implementation and the magnitude of impact they have on emissions. Once implemented, tracking the GHG emissions associated with a sector over time and identifying trends can inform the effectiveness of a strategy. The following are eight strategies that the City of Naperville could consider, should they align with City and community priorities.

Stationary Emissions Strategies

Strategy 1: Set up EnergyStar Portfolio Manager for City properties.

Portfolio Manager is a free platform provided by EnergyStar where users can track utility usage for properties. Usage information for natural gas, electricity, water consumption, and waste is used to calculate GHG emissions, as well as energy use intensity (EUI) for each building. EUI incorporates building type and square footage and can be useful in understanding building efficiency, particularly which facilities may benefit most from energy efficiency interventions.

Manually entering information for facilities, especially with multiple facilities, can be cumbersome. There are multiple ways to streamline this, like batch uploading data and using application program interfaces (APIs) to connect to utility databases.

Strategy 2: Consider energy efficiency programs through Nicor Gas.

The Nicor Gas Energy Efficiency Program offers assessments, rebates, and educational opportunities for municipalities. As energy efficiency goals for utilities continue to increase, Nicor rebates and program options will continue to improve.

Strategy 3: Consider electrification within facilities.

Electrification reduces greenhouse gas emissions as the grid continues to use more renewable energy and replace fossil fuels as a primary fuel source. Within facilities, natural gas is typically used for heating and cooking.

Strategy 4: Increase waste diversion from landfills.

Continuing to provide information and opportunities for employees to recycle can prevent recyclable materials from going to landfills and help minimize contamination from materials incorrectly placed in recycling bins. Adding composting opportunities for food scraps allows them to be digested aerobically, producing fewer harmful GHGs.

Mobile Emissions Strategies

Strategy 1: Consider electrification for City fleet vehicles and maintenance equipment.

As fleet vehicles and maintenance equipment that run on fossil fuels reach the end of their useful life, Naperville can study whether it is worthwhile to replace them with electric counterparts, both from a financial and environmental standpoint. Electric vehicle technology has improved over the past few years, improving vehicle range and charging requirements. As the electric vehicle industry has expanded, there are an increasing number of choices in vehicle brands and types that the City can consider.

Strategy 2: Identify potential gaps in electric vehicle charging infrastructure.

Naperville currently has 63 electric vehicle charging stations within 15 kilometers. As electric vehicles are becoming increasingly popular, the City can identify where charging stations are located to identify if there are significant gaps in charging station coverage.

GHG Tracking Strategies

Strategy 1: Expand GHG inventory to include additional sources of emissions.

The BASIC framework covers stationary, transportation, waste, and wastewater emissions for a municipality. An expanded GHG inventory, like the BASIC+ framework, considers additional emission sources like the use of certain products and travel outside of the municipality's geographic boundary. Adding these sources of emissions can provide a fuller picture of emissions but are typically difficult to track.

Strategy 2: Establish goals for GHG emissions reductions.

GHG inventorying can be paired with goal setting around GHG emissions, so that the City has explicit targets it is working towards while adopting GHG reduction strategies. Having GHG emissions goals can determine if strategies employed are insufficient or overly aggressive.

Photo courtesy of City of Naperville

REFERENCES

Amtrak. (n.d.). *Amtrak routes and destinations*. National Railroad Passenger Corporation. https://www.amtrak.com/routes.html

Bureau of Transportation Statistics. (2023). *Amtrak fuel consumption and travel.* [Data set]. U.S. Department of Transportation. https://www.bts.gov/content/amtrak-fuel-consumption-and-travel-1

CDM Smith. (2009). *Greenhouse Gas Emissions Inventory & Best Practices for Emissions Reductions*. City of Naperville. https://www.naperville.il.us/globalassets/media/sustainability/2009-greenhouse-gas-inventory.pdf

Chicago Metropolitan Agency for Planning. (2023). *Naperville VMT 2022.* [Data set].

City of Naperville. (2014). *Greenhouse gas emissions report for 2005-2013*. City of Naperville. https://www.naperville.il.us/globalassets/media/sustainability/2013-greenhouse-gas-inventory.pdf

City of Naperville. (2023a). *City operations electric usage 2022.* [Data set].

City of Naperville. (2023b). *Citywide electricity usage 2022.* [Data set].

City of Naperville. (2023c). *Refuse and recycling monthly collection data.* [Data set].

City of Naperville. (2023d). *2022 city facility dumpsters.* [Data set].

City of Naperville. (2023e). *2022 HHW data report.* [Data set].

City of Naperville. (2023f). *2022 fuel transportation summary.* [Data set].

City of Naperville. (2023g). *2022 generator off-road diesel deliveries.* [Data set].

City of Naperville. (2023h). *2022 Groot recycling city facilities.* [Data set].

City of Naperville. (2023i). *Wastewater consumption 2022.* [Data set].

Clean Energy Naperville. (2023). *Naperville/IMEA Sources of Electricity*. Clean Energy Naperville. https://cleanenergynaperville.org/did-you-know/naperville-imea-sources-of-electricity/

Federal Transit Administration. (2023). *Fuel and energy by agency.* [Data set]. U.S. Department of Transportation. https://www.transit.dot.gov/ntd/data-product/2022-fuel-and-energy

Grantham Research Institute on Climate Change and the Environment. (2022). *What is the role of nuclear in the energy mix and in reducing greenhouse gas emissions?* London School of Economics and Political Science. https://www.lse.ac.uk/granthaminstitute/explainers/role-nuclear-power-energy-mix-reducing-greenhouse-gas-emissions/

Greenhouse Gas Protocol. (2013). *Global protocol for community-scale greenhouse gas inventories*. World Resource Institute. https://ghgprotocol.org/sites/default/files/standards/GPC_Full_MASTER_RW_v7.pdf

Illinois Municipal Electric Agency. (2022). *2022 Annual Report.* Illinois Municipal Electric Agency. https://www.imea.org/Documents/IMEA%20Annual%20Reports/2022AnnualReport.pdf

Illinois Municipal Electric Agency. (2023). *2023 Annual Report.* Illinois Municipal Electric Agency. https://www.imea.org/Documents/IMEA%20Annual%20Reports/2023AnnualReport.pdf

Illinois Secretary of State. (2023). *Illinois electric vehicle counts December 15, 2022.* [Data set]. Illinois Secretary of State. https://www.ilsos.gov/departments/vehicles/statistics/electric/2022/electric121522.pdf

Monitoring Analytics. (2023). *State of the Market Report for PJM Volume 2: Detailed Analysis*. Monitoring Analytics. https://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2022/2022-som-pjm-vol2.pdf

Nicor Gas. (2023). *Natural gas consumption data 2022.* [Data set].

North Central College Environmental Studies Department. (2019). *Greenhouse gas inventory*. North Central College.

Office of Highway Policy Information. (2023). *Annual vehicle distance traveled in miles and related data – 2021*. [Data set] U.S. Department of Transportation. https://www.fhwa.dot.gov/policyinformation/statistics/2021/vm1.cfm

PJM. (2023). *2018-2022 CO_2, SO_2, and NO_x Emissions Rates.* PJM. https://www.pjm.com/-/media/library/reports-notices/special-reports/2023/2022-emissions-report.ashx

Regional Transportation Authority Mapping and Statistics. (2023). *Metra monthly ridership by line*. [Data set]. Regional Transportation Authority Mapping and Statistics. https://rtams.org/media/datasets/metra-ridership

Trendler, J. (2021). *Sustainable Naperville 2036.* Naperville Environment and Sustainability Task Force. https://www.sustainnaperville.org/2036

U.S. Census Bureau. (2023). *American community survey 1-year estimates table DP04: selected housing characteristics – Naperville, IL.* [Data set]. U.S. Census Bureau. https://data.census.gov/table/ACSDP1Y2022.DP04?q=vehicles&g=160XX00US1751622

U.S. Energy Information Administration. (2023). *State Electricity Profile.* [Data set]. U.S. Energy Information Administration. https://www.eia.gov/tools/faqs/faq.php?id=74&t=11

U.S. Energy Information Administration. (2023). *U.S. natural gas consumption set nine monthly records and an annual record in 2022*. U.S. Energy Information Administration. https://www.eia.gov/todayinenergy/detail.php?id=55800#

U.S. Environmental Protection Agency. (2023a). *Emissions & Generation Resource Integrated Database.* U.S. Environmental Protection Agency. https://www.epa.gov/egrid

U.S. Environmental Protection Agency. (2023b). *GHG emission factors hub.* U.S. Environmental Protection Agency. https://www.epa.gov/climateleadership/ghg-emission-factors-hub

U.S. Environmental Protection Agency. (2023c). *Greenhouse gas equivalencies calculator*. U.S. Environmental Protection Agency. https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator#results

U.S. Environmental Protection Agency. (2010). *Local government GHG protocol.* U.S. Environmental Protection Agency. https://www.epa.gov/egrid

APPENDIX A: METHODOLOGY

Community Level Emissions

Stationary Emissions

Natural Gas

For natural gas, consumption information was provided by Nicor. Consumption was multiplied by the emissions factors as defined by EPA's GHG Emission Factors Hub.

Electricity

Electricity data for Naperville was provided by the City of Naperville. Usage was multiplied by three different emissions factors – the regional emissions factors provided by EPA's Emissions & Generation Resource Integrated Database (eGRID), a calculated emissions factor for the Illinois Municipal Electric Agency, and a calculated emissions factor for PJM generation.

Transportation

Vehicle emissions were calculated using VMT data from the Chicago Metropolitan Agency for Planning (CMAP) multiplied against estimated annual average miles per gallon (MPG) consumption. Average MPG is calculated using US Department of Transportation Federal Highway Administration's Annual Vehicle Distance Traveled in Miles and Related Data and car ownership from the U.S. Census Bureau. The share of electric vehicles in Naperville was determined using the Illinois Secretary of State's Electric Vehicle Counts.

Metra emissions were calculated using the Federal Transit Administration's (FTA) data on fuel and energy for the Metra. A proportion of Metra's diesel consumption within Naperville was estimated using the ridership data for the Burlington North Santa Fe (BNSF) compared to total Metra ridership and the length of the BNSF within Naperville compared to the entire length of the line. Diesel consumption was multiplied by the emissions factors as defined by EPA's GHG Emission Factors Hub.

Daily Amtrak and freight trains through Naperville were estimated to determine annual VMT for the two rail services. VMT was converted to diesel consumption using Bureau of Transportation Statistics' Amtrack Fuel Consumption and Travel data, and diesel consumption was multiplied by the emissions factors as defined by EPA's GHG Emission Factors Hub.

Waste

Waste data on recycling and reuse for curbside collection was provided by the City of Naperville and Groot Industries. The generated tons of solid waste and recyclables were entered into the EPA's Waste Reduction Model (WARM) to produce a summary report on GHG emissions analysis.

Wastewater

Wastewater treatment data was provided by the City of Naperville. Emissions were calculated using the U.S. EPA Local Government Operations Protocol.

Government Operations Emissions

Stationary Emissions

Natural Gas

Natural gas usage information was provided by Nicor. Consumption was multiplied by the emissions factors as defined by U.S. EPA’s GHG Emission Factors Hub.

Electricity

Electricity usage for City operations was provided by the City of Naperville. Usage was multiplied by three different emissions factors – the regional emissions factors provided by EPA’s Emissions & Generation Resource Integrated Database (eGRID), a calculated emissions factor for the Illinois Municipal Electric Agency, and a calculated emissions factor for PJM generation.

Transportation

Gasoline, diesel, and liquid propane consumption for the City fleet was provided by the City of Naperville. Consumption data was multiplied by the emissions factors as defined by EPA’s GHG Emission Factors Hub.

Waste

Waste data including recycling and reuse for the city’s facilities were provided by the City of Naperville along with additional recycling data from Groot Industries. The data primarily includes container type, size, and frequency of service collection. All data were converted to tons of solid waste, with an assumed 70 percent fill rate for all containers in the facilities. The generated tons of solid waste and recyclables were entered into the EPA's Waste Reduction Model (WARM) to produce a summary report on GHG emissions analysis.

Wastewater

Wastewater treatment data was provided by the City of Naperville. Emissions were calculated using the U.S. EPA Local Government Operations Protocol.

APPENDIX B: IMEA EMISSIONS FACTOR CALCULATION

As part of the NEST Sustainable Naperville 2036 report, an emissions factor of 1991.67 lbs CO_2e/MWh was calculated for IMEA, based on IMEA's energy mix and the associated emissions factors for each element of the energy mix. It used the most recently available data, which at the time was from 2018 (Trendler, 2021). The following is a summary of how that analysis was replicated using updated data to calculate the IMEA emissions factor used in this report. The final emissions factor calculated was 1,705.328 lbs CO_2e/MWh, a 14.38 percent decrease from 2022, indicating a shift towards less polluting energy sources.

Step 1: Determine IMEA's Energy Mix.

The breakdown of IMEA's energy mix is shown in Figure B1. IMEA's fiscal year ends in April each year, and in calendar year 2022, its energy mix changed significantly at this time. Remaining calculations used weights to capture this change.

Figure B1: IMEA Energy Mix, 2022 (Clean Energy Naperville, 2023)

IMEA Energy Mix	January to April 2022	May to December 2022
Coal (Ownership): Prairie State and Trimble County	77%	78%
Coal (Purchased): Vistra	11%	1%
Renewables	11%	11%
Short Term Purchases	1%	10%
Total	100%	100%

Step 2: Determine Emission Factors for Prairie State and Trimble County.

In 2022, Prairie State had an emissions factor of 2073.512 lbs CO_2e/MWh and Trimble State had an emissions factor of 1,848.873 lbs CO_2e/MWh (U.S. Environmental Protection Agency, 2023a). 240 MW of electricity or 61.07% of IMEA's owned coal came from Prairie State and 153 MW came from Trimble County or 38.93% (Illinois Municipal Electric Agency, 2022; Illinois Municipal Electric Agency, 2023). These values were used as weights to calculate a total emissions factor for IMEA's owned coal energy.

$$Owned\ Coal\ Emissions\ Factor = 2{,}073.512\frac{lbs\ CO_2e}{MWh} \times 0.6107 + 1{,}848.873\frac{lbs\ CO_2e}{MWh} \times 0.3893 = 1{,}986.057\frac{lbs\ CO_2e}{MWh}$$

Step 3: Determine Emissions Factors for Purchased Coal via Vistra

In addition to owned coal, IMEA purchases coal-produced energy from Vistra. In 2022, Vistra had four active facilities (Figure B2). These emissions factors were averaged (weighed equally(for an emissions factor of 2,244.116 lbs CO_2e/MWh.

Figure B2: Vistra Coal Plants, 2022 (U.S. Environmental Protection Agency, 2023a)

Coal Plant	Emissions Factor (lbs CO_2e/MWh)
Baldwin	2,241.018
Edwards	2,156.302
Newton	2,211.595
Joppa	2,367.549

Step 4: Determine Emissions Factors for Renewables

Following the convention used in the NEST Sustainable Naperville 2036 report, 0 lbs CO_2e/MWh was used as the emissions factor for renewables.

Step 5: Determine Emissions Factors for Short Term Purchases

Short term purchased used the published average annual emissions factor for PJM of 898.45 lbs CO_2e/MWh (PJM, 2023).

Step 6: Weigh Emissions by Energy Mix

Emissions factors for January to April 2022 and May to December 2022 were calculated by weighing the emissions factor for each component of the energy mix and summing them.

$$January - April\ Emissions\ Factor = 1{,}986.057\frac{lbs\ CO_2e}{MWh} \times 0.77 + 2{,}244{,}116\frac{lbs\ CO_2e}{MWh} \times 0.11 + 0\frac{lbs\ CO_2e}{MWh} \times 0.11 + 898.45\frac{lbs\ CO_2e}{MWh} \times 0.01 = 1{,}785.485\frac{lbs\ CO_2e}{MWh}$$

$$May - December\ Emissions\ Factor = 1{,}986.057\frac{lbs\ CO_2e}{MWh} \times 0.78 + 2{,}244{,}116\frac{lbs\ CO_2e}{MWh} \times 0.01 + 0\frac{lbs\ CO_2e}{MWh} \times 0.11 + 898.45\frac{lbs\ CO_2e}{MWh} \times 0.1 = 1{,}665.250\frac{lbs\ CO_2e}{MWh}$$

Step 7: Weight Emissions by Fiscal Year

Emissions factors calculated in Step 6 were weighed by the portion of the calendar year they represented.

$$Total\ Emissions\ Factor = \frac{1}{3} \times 1{,}785.485\frac{lbs\ CO_2e}{MWh} + \frac{2}{3} \times 1{,}661.411\frac{lbs\ CO_2e}{MWh} = 1{,}702.641\frac{lbs\ CO_2e}{MWh}$$

APPENDIX C: PJM GENERATION EMISSIONS FACTOR CALCULATION

The following is a summary of how an emissions factor was calculated for generation by PJM. Methods were informed by work previously conducted as part of the NEST Sustainable Naperville 2036 report that calculated an emissions factor for IMEA. The final emissions factor calculated was 1,037.23 lbs CO_2e/MWh.

Step 1: Determine PJM's Energy Mix.

The breakdown of PJM's energy mix is shown in Figure C1

Figure C1: IMEA Energy Mix, 2022 (Monitoring Analytics, 2023)

PJM Energy Mix	Percent of Energy Mix
Coal	20.0%
Nuclear	32.3%
Gas	40.0%
Hydroelectric	1.9%
Wind	3.7%
Waste	0.5%
Oil	0.3%
Solar	1.1%
Biofuel	0.2%

Step 2: Determine Emission Factors for Energy Sources

Emissions factors for each energy source were determined using the U.S. Energy Information Agency State Energy Profiles, the U.S. Environmental Protection Agency Emissions Factors for Greenhouse Gas Inventories dataset, and information from the London School of Economics concerning emissions related to nuclear energy generation. Renewables (hydroelectric, wind, and solar) were set to an emissions factor of 0 lbs CO_2e/MWh, following the convention used in the NEST Sustainable Naperville 2036 report. Emissions factors are shown in Figure C2.

Figure C1: IMEA Energy Mix, 2022 (Monitoring Analytics, 2023)

PJM Energy Mix	Emissions Factor (lbs CO2e/MWh)
Coal	2678.601
Nuclear	110.231

Gas	1124.689
Hydroelectric	0
Wind	0
Waste	810.674
Oil	3450.479
Solar	0
Biofuel	810.674

Step 3: Weigh Emissions by Energy Mix

The final emissions factors for 2022 was calculated by weighing the emissions factor for each component of the energy mix and summing them.

$$\begin{aligned} Emissions\ Factor &= 2{,}678.601\frac{lbs\ CO_2e}{MWh} \times 0.20 + 110.231\frac{lbs\ CO_2e}{MWh} \times 0.323 \\ &+ 1{,}124.689\frac{lbs\ CO_2e}{MWh} \times 0.40 + 810.674\frac{lbs\ CO_2e}{MWh} \times 0.005 \\ &+ 3{,}450.479\frac{lbs\ CO_2e}{MWh} \times 0.003 + 810.674\frac{lbs\ CO_2e}{MWh} \times 0.002 = 1{,}037.226\frac{lbs\ CO_2e}{MWh} \end{aligned}$$