City of Vancouver

2023 Inventory of Community and Government Operations Greenhouse Gas Emissions

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Produced by the City of Vancouver Climate Program with Assistance from ICLEI – Local Governments for Sustainability USA

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Executive Summary

The City of Vancouver recognizes that greenhouse gas (GHG) emissions from human activity are catalyzing profound climate change, the consequences of which pose substantial risks to the future health, wellbeing, and prosperity of our community. To respond to this crisis, the Vancouver City Council adopted the Climate Action Framework in December 2022 and set a target year of 2040 for community-wide carbon neutrality.

To monitor progress and adjust strategies to meet the goals set out in the Climate Action Framework, Council directed the City to update its Greenhouse Gas (GHG) Inventory every four years. This report provides estimates of greenhouse gas emissions resulting from activities in City of Vancouver as a whole in 2023 as well as emissions specifically from the City's government operations after one year of work under the Climate Action Framework. The latest update follows previous inventories conducted in 2019 and 2007.[1]

As of 2023, emissions community-wide are down 27% and municipal operations emissions have fallen 54% as measured relative to their respective 2007 baseline inventories (Figure 1).

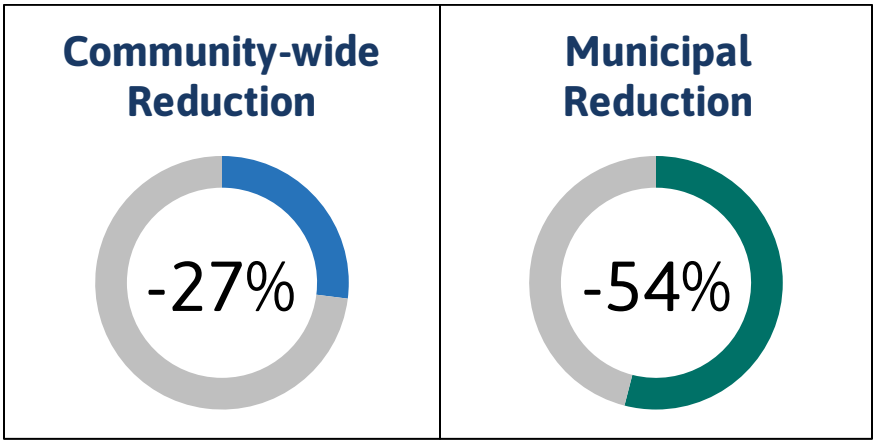

Figure 1: Emissions Reduction from 2007 baseline to 2023

These inventories demonstrate that ambitious goals are critical to motivate the necessary action to stem the worst impacts of climate change. The City has made significant progress on municipal emissions reduction by investing in capital projects and fuel switching in our fleet vehicles, yet more aggressive action is needed to reach our interim targets and set a leading edge pace for climate action in Vancouver.

[1] Over time, available data sources and best practices for greenhouse gas accounting have improved, which can result in changes between inventories. The 2019 and 2023 GHG Inventories were conducted using the same methodology, but the original 2007 GHG Inventory did not measure all of the same emissions sectors or use the same accounting tools and practices. More details on updates to the 2019 inventory for alignment with the 2023 inventory can be found in Appendix B.

In addition to energy efficiency and renewable energy projects to offset overall energy demand by government facilities, forecasts show that transitioning government buildings and vehicles, where appropriate, to electric power sources will put the City in a position to benefit from the rapid decarbonization of the electricity grid mandated by the Clean Energy Transformation Act (CETA). This state policy requires Washington's electric utilities to be GHG neutral by 2030 and 100% carbon-free by 2045, which will drive down emissions in buildings, water and wastewater treatment, street lights, and fleet vehicles that run on electricity.

While cleaner electricity will be a driving force in meeting municipal emissions targets, it is not enough on its own to maintain a downward trajectory for emissions community-wide. Population growth and the return to pre-pandemic travel norms are expected to push transportation sector emissions upward over time without significant interventions to shift behavior.

Many communities in the United States have started to take responsibility for addressing climate change at the local level, and the City of Vancouver has significant and direct influence over community-wide emissions through its policies that determine how land use evolves and changes over time and the standards it sets for building and road development. Reducing fossil fuel use in the community can have many benefits in addition to reducing greenhouse gas emissions. More efficient use of energy decreases utility and transportation costs for residents and businesses. Retrofitting homes and businesses to be more efficient creates local jobs. In addition, when residents save on energy costs, they are more likely to spend at local businesses and add to the local economy. Reducing fossil fuel use improves air quality, and increasing opportunities for walking and bicycling improves residents' health.

These areas are crucial for fostering sustainable community growth, but changing the existing built environment and shifting human behavior are two of the hardest challenges we face in shifting our climate future. As our community grows in its size, economy, and vibrancy, reducing emissions in the Buildings and Transportation sectors will require widespread partnership with private citizens and businesses.

This inventory marks the City's first assessment of the measurable impacts of its early climate action efforts, and these results will inform further refinement and prioritization of the most impactful community actions in the 2026 update to the Climate Action Framework.

Key Findings

Figure 2 shows communitywide emissions by sector, which have declined 27% overall relative to the 2007 baseline inventory. The largest contributors remain On-Road Vehicles (37%) and Buildings & Energy as a sector (37%), followed by Other Emissions (11%), which include process and fugitive emissions from refrigerants, natural gas leakage, and electric power transmission losses. Actions to reduce emissions in all sectors are a key part of the City of Vancouver's Climate Action Framework. However, meeting community-wide carbon-neutrality goals will require widespread private partnership to shift behavior and retrofit existing buildings.

Figure 3 shows local government operations emissions, which have declined 54% relative to the 2007 baseline. Water & Wastewater Treatment accounts for a vast majority (47%) of these emissions. The next largest contributor is Buildings & Facilities (23%), followed by Fleet (11%) and Employee Commute (7%). Paired with the greening of our purchased electricity, there is a strong pathway to realize our municipal climate goals with continued investment in emissions reduction measures. Capital projects already planned over the next biennium and beyond will significantly cut emissions in our largest sectors.

The Inventory Results section of this report provides a detailed profile of emissions sources within Vancouver; information that is key to guiding local reduction efforts.

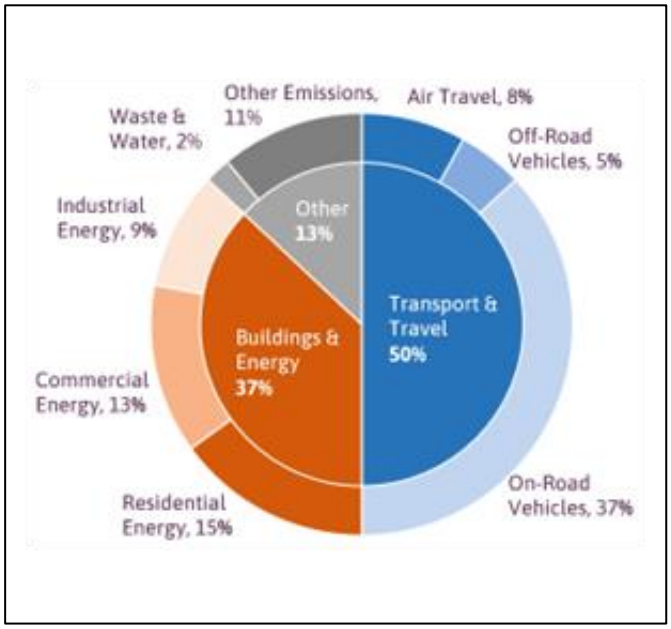

Figure 2: Community-wide Emissions by Sector

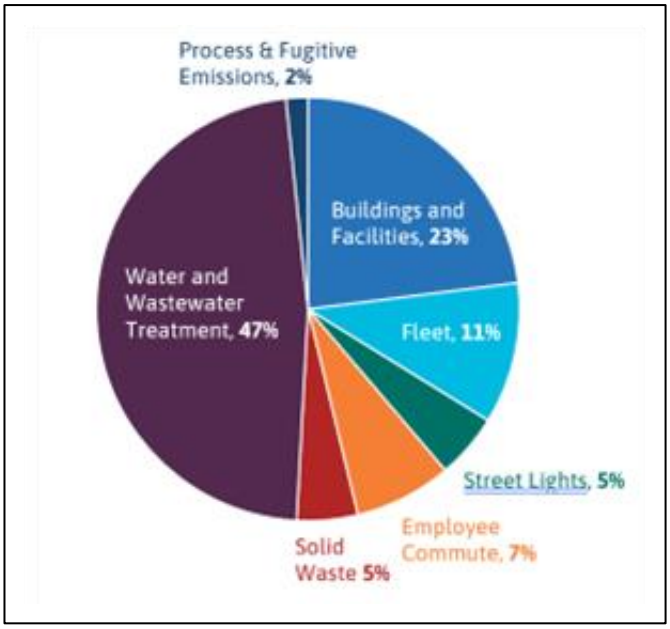

Figure 3: Government Operations Emissions by Sector

Inventory Methodology

Understanding a Greenhouse Gas Emissions Inventory

This report presents emissions from both the Vancouver community as a whole and from operations of the City of Vancouver municipal government. The government operations inventory is mostly a subset of the community inventory, as shown in Figure 4.

Figure 4: Relationship of Community and Government Operations Inventories

Emissions tracking and reporting serves multiple purposes. Climate targets and plans need to be reviewed regularly to bring in the necessary level of ambition to achieve net-zero emissions by 2040. Documentation of emissions sources allows transparency and accountability to the public. And trends observed year-over-year provide direction for large planning processes.

To complete this inventory, City of Vancouver utilized tools and guidelines from ICLEI - Local Governments for Sustainability (ICLEI), which provides authoritative direction for greenhouse gas emissions accounting. Over time, available data sources and best practices for greenhouse gas accounting have evolved, which can result in changes between inventories. The 2007 GHG Inventory, which was the City's first inventory and is used as a baseline for emissions reduction targets, draws on several protocols that were early iterations of what we use today but does not include all of the same sources of emissions that are accounted for in 2019 and 2023.

The 2019 and 2023 inventories use the approach and methods provided by the U.S. Community Protocol for Accounting and Reporting Greenhouse Gas Emissions (Community Protocol) and the Local Government Operations Protocol for Accounting and Reporting Greenhouse Gas Emissions (LGO Protocol), both of which are described below. For 2023, calculations were made using ICLEI's ClearPath software, and Quality Assurance/Quality Control was conducted by ICLEI.

Three greenhouse gases are included in this inventory: carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Many of the charts in this report represent emissions in "carbon dioxide equivalent" (CO_2e) values, calculated using the Global Warming Potentials (GWP) for methane and nitrous oxide from the IPCC 5th Assessment Report.[2]

[2] The Global Warming Potential of Carbon Dioxide (CO_2) is 1, Methane (CH_4) is 28, and Nitrous Oxide (N_2O) is 265. (IPCC, 2014)

Community Emissions Protocol

Version 1.2 of the U.S. Community Protocol for Accounting and Reporting GHG Emissions[3] was released by ICLEI in 2019 and represents a national standard in guidance to help U.S. local governments develop effective community GHG emissions inventories.

The community 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 community as reported by Clark Public Utilities
- 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 community

The community inventory also includes the following activities:

- Wastewater processing and combustion of biosolids
- Air travel within Vancouver and itinerant air traffic by Vancouver residents
- Public transit
- Off-road passenger and freight travel, including marine and rail
- Fugitive emissions from key refrigerants and natural gas leakage
- Electric power transmission losses

Local Government Operations (LGO) Protocol

In 2010, ICLEI, the California Air Resources Board (CARB), and the California Climate Action Registry (CCAR) released Version 1.1 of the LGO Protocol.[4] The LGO Protocol serves as the national standard for quantifying and reporting greenhouse emissions from local government operations.

The following activities are included in the LGO inventory:

- Electricity and natural gas consumption from buildings, facilities, and street lights
- Use of energy in potable water and wastewater treatment and distribution
- Wastewater treatment processes, including combustion of biosolids
- On-road transportation from employee commute and vehicle fleet
- Solid waste generated at government facilities
- Fugitive emissions from key refrigerants and natural gas leakage

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

[4] ICLEI. 2008. Local Government Operations Protocol for Accounting and Reporting Greenhouse Gas Emissions. Retrieved from http://www.icleiusa.org/programs/climate/ghg-protocol/ghg-protocol

Community Emissions Inventory Results

The City of Vancouver aims to reduce community-wide greenhouse gas emissions 80% by 2030 and become carbon neutral by 2040. Since 2019, Vancouver's community-wide greenhouse gas emissions have continued to decline and now amount to a 27% reduction relative to the 2007 baseline inventory.

This change in overall emissions appears to be driven largely by buildings being powered by cleaner electricity sources (i.e. grid decarbonization) and lingering effects of the COVID-19 pandemic on transportation patterns, as well as increased appliance and vehicle efficiency. In other sectors, improved composting is keeping emissions associated with landfilled solid waste down, while fugitive emissions from refrigerants and air conditioning have increased.

The total communitywide emissions for the 2023 inventory are shown in Table 1 and Figure 5.

Table 1: Communitywide Emissions Inventory (2023)

Sector	Fuel or Source	2023 Usage	Usage unit	2023 Emissions ($MTCO_2e$)	% Change from 2019*
Residential Energy	Electricity (Clark Public Utilities)	935,798,884	kWh	132,074	0%
	Natural gas (Northwest Natural)	17,748,236	Therms	94,397	5%
Residential Energy total				**226,471**	**2%**
Commercial Energy	Electricity (Clark Public Utilities)	768,724,075	kWh	108,494	-11%
	Natural gas (Northwest Natural)	14,949,639	Therms	79,512	7%
Commercial Energy total				**188,006**	**-4%**
Industrial Energy	Electricity (Clark Public Utilities)	349,090,417	kWh	49,269	14%
	Natural gas (Northwest Natural)	15,424,459	Therms	81,864	251%
Industrial Energy total				**131,133**	**63%**
On-Road Transportation	Gasoline (passenger vehicles)	978,284,636	VMT	390,148	-15%
	Diesel (passenger and freight)	101,318,961	VMT	145,367	-13%
Transit	Diesel	4542253	VMT	7,325	-8%
	Gasoline	30152	VMT	40	-47%
Aviation	Aviation Gasoline	11,336,811	gal	110,404	-73%*
Off-Road	Diesel	508,807	MMBtu	37,659	4%
	Gasoline	297,668	MMBtu	21,420	15%
	LPG	107,177	MMBtu	6,600	1468%
	CNG	11,178	MMBtu	692	180%
Marine (Freight)	Diesel	53,736	MMBtu	3974	82%
Rail (Freight)	Diesel	21,909	MMBtu	1620	-70%
Transportation total				**725,249**	**-34%**
Solid Waste	Waste Generated	128,152	Tons	23,634	-10%
Solid Waste total				**23,634**	**-10%**
Water & Wastewater	Water Treatment Energy Usage	21,800,000	kWh	3,077	1%
	Wastewater Treatment Energy Usage	17,664,192 3,960	kWh Therms	2,514	9%
	Wastewater Treatment	6,068	million gal/yr	205	6%
	Nitrogen Discharge	1,258	kg N/day	956	18%
	Combustion of Biosolids	21	MT/day	1,866	19%
Water & Wastewater total				**8,618**	**9%**
Process & Fugitive Emissions	Fugitive Emissions from Natural Gas Distribution			8,350	36%
	Process Emissions from Refrigerant Use (HFCs and PFCs)			130,084	22%
Process & Fugitive total				**138,434**	**23%**
Upstream Impacts of Activities	Electric Power Transmission Losses			15,066	-1%
Upstream Impacts total				**15,066**	**-1%**
Total community-wide emissions				**1,456,611**	**-17%**

*Table 1 Note: The percent change from 2019 is based on adjusted 2019 GHG Inventory numbers reported in Appendix B. Also, much of the -73% change reported in Aviation is due to variation in how emissions were calculated in 2019 and 2023. This is the only sector where different methodologies were used between the two inventory years.

Figure 5 shows the distribution of communitywide emissions by sector. On-road vehicles are the largest contributor (37%), followed by residential (15%) and commercial (13%) buildings and fugitive emissions from refrigerants and natural gas distribution (Other Emissions, 11%). Industrial Energy (9%) and Waste & Water (2%) sectors are other areas where the City has influence to help drive down overall community emissions.

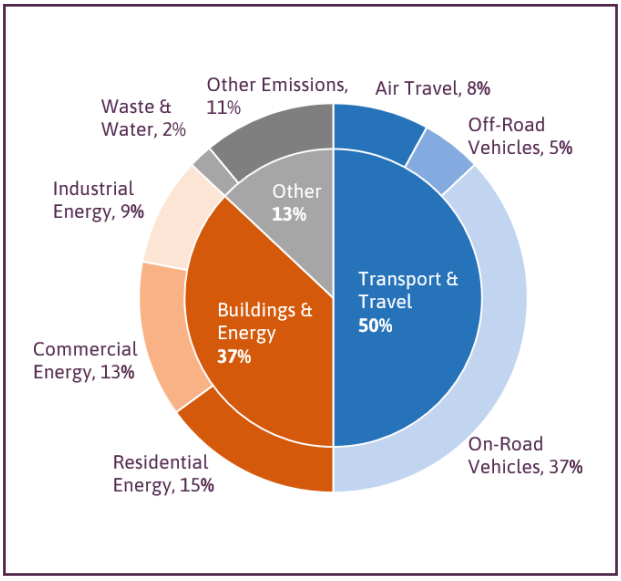

Figure 5: Community-wide Emissions by Sector

Even as population increased from 2019 to 2023, Transportation sector emissions have declined due in large part to lingering effects of the COVID-19 pandemic. Community-wide vehicle miles traveled increased since 2020 but still have not reached pre-pandemic levels. Additionally, a change in methodology for attributing Air Travel from Portland International Airport for Vancouver travelers is contributing to the decline in total Transportation emissions in 2023. These reductions in overall Transportation emissions were significant enough to offset smaller increases in emissions in other sectors.

In Buildings, actual energy use has increased in all three sectors, particularly residential. However, GHG emissions remained steady or went down for electric customers, despite this increasing demand. This is likely a result of increased clean energy in the Clark Public Utilities resource mix. Natural gas usage and related emissions are both increasing in parallel. The industrial sector saw a particularly large increase in natural gas usage by businesses who procure fuels themselves and transport it via NW Natural's system.

Other sectors that saw increased emissions were Water & Wastewater and Process & Fugitive emissions. Water & Wastewater energy use is directly influenced by the amount of water that requires treatment on behalf of the community, which increases along with the population. Water conservation programs are promising for helping to reduce emissions in this sector, and both utilities continue to invest in major capital projects to modernize treatment systems and reduce emissions.

Lastly, Solid Waste saw a decrease in emissions despite an increase in solid waste collected from residences and businesses in Vancouver and sent to the landfill. This is likely due to increased rates of composting. Although this inventory does not account for composting directly, the waste characterization includes much less organic material going to the landfill than in previous years.

Next Steps

Changing the existing built environment and shifting human behavior are two of the hardest challenges we face in shifting our climate future. As our community grows in its size, economy, and vibrancy, reducing emissions in the Buildings and Transportation sectors will require widespread partnership with private citizens and businesses.

However, the City does have significant and direct influence over community-wide emissions through its policies that determine how land use evolves and changes over time and the standards it sets for building and road development. These areas are within the City's immediate control and are crucial for fostering sustainable community growth. By prioritizing emissions-reducing strategies in the upcoming Comprehensive Plan Update and Green Building Strategy, the City has two powerful and immediate opportunities to help mitigate the expected rise in community emissions.

Government Operations Emissions Inventory Results

The City of Vancouver aims to reduce greenhouse gas emissions from local government operations 80% by 2025 and become carbon neutral by 2040.

The City has made steady progress in reducing its greenhouse gas emissions from municipal operations, which total approximately 1% of all emissions community-wide. As of 2023, there has been a 54% reduction in municipal emissions as measured relative to the 2007 baseline inventory. An additional 10,600 $MTCO_2e$ will need to be cut to reach the 80% reduction target.

Government operations emissions for inventory year 2023 are shown in Table 2 and Figure 6.

Table 2: Local Government Operations Inventory (2023)

Sector	Fuel or Source	2023 Usage	Usage unit	2023 Emissions ($MTCO_2e$)	% Change from 2019*
Buildings & Facilities	Electricity	19,520,695	kWh	2,755	-19%
	Natural Gas	299,180	Therms	1,591	17%
Buildings & Facilities total				**4,346**	**-9%**
Street Lights	Electricity	6,632,058	kWh	936	-29%
Street Lights total				**936**	**-29%**
Vehicle Fleet	E-10 Gasoline (on-road)	2,859,713	VMT	1,984	2%
	R99 Diesel (on-road)	785,156	VMT	14	-99%
	Propane Autogas (on-road)	40,055	VMT	31	NA
	E-10 Gasoline (off-road)	1,100	gal	9	-65%
	R99 Diesel (off-road)	11,842	gal	1	-98%
	Propane (off-road)	154	gal	1	-50%
Vehicle Fleet total				**2,040**	**-35%**
Employee Commute	Gasoline	31,84,508	VMT	1213	-35%
	Diesel	329,626	VMT	183	-33%
	Transit	172,422	VMT	10	-55%
Employee Commute total				**1,406**	**-35%**
Solid Waste	Waste Generation	5,315	Tons	877	-6%
Solid Waste total				**877**	**-6%**
Water & Wastewater	Water Treatment Energy Usage	21,800,000	kWh	3,077	1%
	Wastewater Energy – Electricity	17,664,192	kWh	2,493	8%

	Wastewater Energy – Natural Gas	3,960	Therms	21	11%
	Wastewater Energy – Diesel	28,663	gal	295	-5%
	Wastewater Treatment	7,653*	million gal/yr	259	7%
	Nitrogen Discharge	1,258	kg N/day	956	18%
	Combustion of Biosolids	21	MT/day	1,866	19%
Water & Wastewater total				**8,967**	**8%**
Process & Fugitive Emissions	Fugitive Emissions from Natural Gas Distribution			52	16%
	Process Emissions from Refrigerant Use (HFCs)			262	1091%
Process & Fugitive Emissions total				**314**	**369%**
Total government emissions				**18,886**	**-9%**

*Note: The percent change from 2019 is based on the adjusted 2019 GHG Inventory numbers reported in Appendix B.

Figure 6 shows the distribution of emissions among the sectors included in the inventory. Water & Wastewater Treatment (47%) represents the majority of emissions, followed by Buildings & Facilities (23%) and Fleet (11%). Employee Commute (7%), Street Lights (5%), Solid Waste (5%), and Fugitive Emissions (2%) account for a smaller but not insignificant portion of emissions that will also need to be cut to achieve the City's goals.

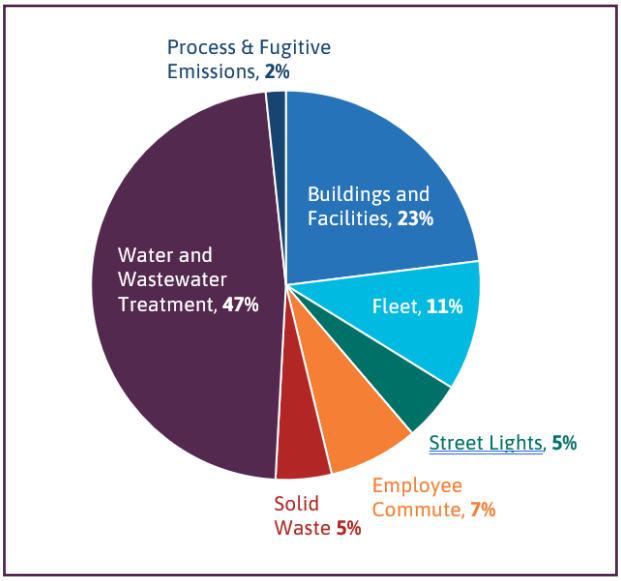

Figure 6: Local Government Operations Emissions by Sector

Between 2019 and 2023, significant progress was achieved through ongoing planning and projects, complemented by high-impact operational changes in 2023 and the influence of

external factors such as cleaner electricity sources. Figure 7 shows the change over time in municipal greenhouse gas emissions by sector.

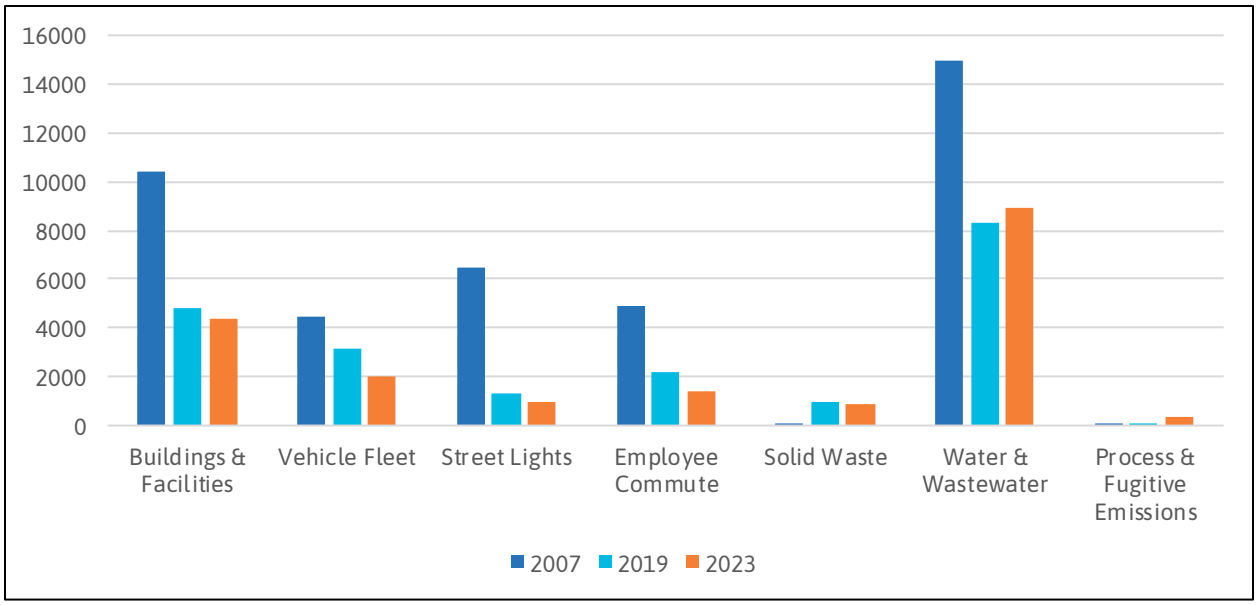

Figure 7: Change in Municipal GHG Emissions by Sector (2007, 2019, and 2023)

Significant factors driving recent changes in municipal emissions include:

- **Fuel Switching:** Fleet Services achieved some of the largest GHG reductions since 2019 through its innovative adoption of renewable fuels. As of 2023, all diesel vehicles and equipment used in City operations have fully transitioned from standard fossil fuel diesel to a 100% renewable, plant-based diesel fuel called R99. This change led to a significant decrease in GHG emissions and other air pollutants from the City's diesel fleet, leaving gasoline vehicles as the primary source of emissions measured in the Fleet sector of the inventory.
- **Energy Efficiency Projects:** Since 2019, Public Works upgraded 18,000 streetlights to more energy efficient LED fixtures and continued our history of regular energy efficiency improvements to our wastewater treatment systems. These projects reduced energy use and associated GHG emissions, while also saving the City more than $700,000 in energy costs annually. Projects are often developed in partnership with Clark Public Utilities and result in additional energy incentives to the City.
- **Telework Policies:** New work-from-home policies implemented during the pandemic, along with Commute Trip Reduction incentive programs, have reduced employee driving trips. Vehicle emissions also continue to trend downward due to federal fuel efficiency standards for new cars.
- **Decarbonization of the Electricity Grid:** Clark Public Utilities (CPU), following Washington's Clean Energy Transformation Act (CETA), is progressing toward its required transition to a carbon-neutral electricity supply by 2030. Cleaner electricity will help

drive down emissions from buildings, streetlights, and water and wastewater treatment over time.

- **Regional Population Growth:** The net increase in Water & Wastewater sector emissions is likely driven by increases in customers served by our municipal-owned utilities, which serve both residents of the City of Vancouver and neighboring unincorporated areas. Increased water demands community-wide will require increased energy usage by utilities to maintain high levels of service, and Water & Wastewater is expected to remain one of the City's largest emissions sectors.
- **Hotter/Colder Weather:** Without further analysis, we are unable to know how much effect to attribute to more frequent, extreme, and prolonged heat and winter storms, but we do expect that these weather events will have upward pressure on buildings-related emissions and fugitive emissions related to air conditioning refrigerants.

Next Steps

The local government operations emissions inventory points to a need for continued investment in infrastructure, staff capacity, and capital projects that have longer planning horizons to accelerate our progress toward interim targets at a leading-edge pace. The City must continue to make progress in every sector, while also prioritizing equipment transitions to electricity sources to ensure municipal operations are on a downward trajectory as the electricity grid is decarbonized.

Conclusion

The 2023 GHG Inventory marks the City's first assessment of the measurable impacts of its early climate action efforts after one year of work under the Climate Action Framework. Significant progress has been made to reduce emissions from municipal operations, and foundational policies are underway to mitigate the expected rise in community emissions.

This inventory shows that buildings as well as communitywide transportation patterns will be particularly important to focus on, which will require widespread partnership with private citizens and businesses, as well as strong policies to prioritize emissions-reducing strategies where the City has significant and direct influence. On the municipal side, reducing energy use wherever possible and transitioning to electric equipment will position the City to take the greatest advantage of the benefits of grid decarbonization.

It is also important to note that the City's greenhouse gas inventory reporting process does not reflect all priorities outlined in the Climate Action Framework nor all actions underway to adapt to and mitigate against climate change in our community and municipal operations. For example, natural systems are key to building and sustaining community and ecosystem resilience locally, but the impact of important programs implemented under the Climate Action Framework like Naturespaces and increased street tree planting by Urban Forestry are not directly represented in the GHG Inventory. As we work toward our emissions-based targets, these critical climate actions should not be overlooked or undervalued due to their absence from emissions accounting systems.

The City of Vancouver will continue to track key energy use and emissions indicators on an on-going basis, and data and methods will be improved over time to provide efficient and purposeful reporting. The next GHG inventory will be completed for the year 2027 to assess progress resulting from actions implemented in the coming years.

Appendix A: Methodology Details

The following tables shows each activity, related data sources, and notes on data gaps.

Energy

This inventory includes electricity and natural gas for the building sectors. Other sources that may be present in the community but are not accounted for include non-utility fuels (e.g. wood or oil heat) and other fuels used in industrial processes.

Table 3: Energy Data Sources

Activity	Data Source	Data Gaps/Assumptions
Communitywide		
Residential, commercial, and industrial electricity consumption	Clark Public Utilities	Electricity usage for customers within the City of Vancouver is reported by sector.
Residential, commercial, and industrial natural gas consumption	Northwest Natural	Weather-normalized natural gas loads for customers within the City of Vancouver are reported by sector. "Transportation" loads are included in the industrial sector.
Local Government Operations		
Electricity consumption	Clark Public Utilities (CPU)	Electricity usage is calculated from consolidated bills for all City accounts provided by CPU. Street Lights electricity is based on one of the largest street lights accounts; other street lights and traffic lights are behind meters connected to building accounts and cannot be separated out from building totals.
Natural gas consumption	Northwest Natural (NWN)	Natural gas loads for all City accounts are provided by NWN.

Table 4: Emissions Factors for Electricity Consumption

Year	CO_2 (lbs/MWh)	CH_4 (lbs/GWh)	N_2O (lbs/GWh)
2022	310.6971	7.71	0.89

Transportation

Table 5: Transportation Data Sources

Activity	Data Source	Data Gaps/Assumptions
Communitywide		
On-road vehicle miles travelled	Google Environmental Insights Explorer (EIE)	Google EIE provides origin and destination data based on cell phone location services. VMT attributed to this inventory includes 50% of inbound, 50% of outbound, and 100% of in-boundary VMT. Inventory does not account for electric vehicle adoption.
Off-road vehicles	US EPA National Emissions Inventory (NEI)	Population is used to scale county-level data from NEI to represent non-road equipment in the City of Vancouver.
Transit ridership	C-TRAN	Total VMT and fuels are reported by C-TRAN and scaled using C-TRAN ridership data on total passenger boardings vs. boardings in Vancouver.
Air travel	City of Portland, Port of Portland	Data provided by City of Portland on estimated actual emissions for flights leaving PDX to their first destination in 2022 is scaled using percent of travelers from Vancouver ZIP codes provided by Port of Portland traveler surveys.
Local Government Operations		
Government vehicle fleet	Fleet Services	Data is tracked and reported using Fleet management software.
Employee commute	WSDOT Commute Trip Reduction (CTR) Employee Commute Survey (City Hall)	City Hall employee commute surveys are used as the basis for commute mode split and scaled to represent the entire employee population. This likely underreports emissions in this sector. As other City facility locations are surveyed, this method will be improved.

For vehicle transportation, it is necessary to apply average miles per gallon and emissions factors for CH4 and N2O to each vehicle type. National default emissions factors are utilized for all vehicle types (see Table 6) except transit vehicle fuel economy where provided by C-TRAN.

Table 6: MPG and Emissions Factors by Vehicle Type

Fuel	Vehicle type	MPG	CH_4 g/mile	N_2O g/mile
Gasoline	Passenger car	25.3	0.0084	0.0069

Gasoline	Light truck	18.2	0.0117	0.0087
Gasoline	Heavy truck	5.383557	0.0719	0.0611
Gasoline	Motorcycle	44	0.0084	0.0069
Diesel	Passenger car	25.3	0.0005	0.0010
Diesel	Light truck	18.2	0.0010	0.0015
Diesel	Heavy truck	6.561615	0.0051	0.0048

Water & Wastewater Treatment

Table 7: Water & Wastewater Data Sources

Activity	Data Source	Data Gaps/Assumptions
Communitywide & Local Government Operations		
Nitrogen Discharge	Wastewater Utility	In the community-wide inventory, wastewater volume of water treated and population served is scaled to City of Vancouver customers, whereas emissions related to treating water for the full service territory are accounted for in the local government inventory. A default multiplier is used for industrial commercia discharge.
Biosolids Combustion	Wastewater Utility	Metric tons and energy content of biosolids is reported by the utility.
Energy used in wastewater treatment facilities	Wastewater Utility	Annual electricity use for treatment processes, natural gas loads for the incinerator, and diesel consumption are reported by the utility.
Energy used in potable water treatment	Water Utility	Annual electricity use for treatment processes is reported by the utility.

Solid Waste

This inventory includes total landfill waste generated by the community and sent to Finley Butte Landfill in Boardman, Ore. The waste mix characterization is based on the Department of Ecology 2020-21 Waste Characterization Study. Composting is not calculated separately for community or government operations, but estimates of organics are included in the waste characterization.

Table 8: Solid Waste Data Sources

Activity	Data Source	Data Gaps/Assumptions

Communitywide		
Landfilled solid waste	Solid Waste Department	Includes residential, commercial, and industrial solid waste collected by Waste Connections.
Local Government Operations		
Landfilled solid waste	Solid Waste Department	Includes waste generated at City of Vancouver government facilities and ash and other special waste from the wastewater treatment facility.

Fugitive Emissions & Upstream Impacts

Table 9: Fugitive Emissions & Upstream Impacts Data Sources

Activity	Data Source	Data Gaps/Assumptions
Communitywide		
Natural gas distribution	ICLEI	National defaults are used for leakage rate and emissions factors for natural gas, which is applied to total therms of natural gas used community-wide.
HFCs & PFCs	US EPA Inventory of U.S. GHG Emissions and Sinks 1990-2022	Estimates were made using national data for HFCs and PFCs and scaling it using population to attribute emissions for the City of Vancouver.
Electric Power Transmission Losses	EPA Emissions & Generation Resource Integrated Database (eGRID)	Western Grid Gross Loss Rate for 2022 is used to estimate transmission losses for communitywide electricity usage.
Local Government Operations		
Natural gas distribution	ICLEI	National defaults are used for leakage rate and emissions factors for natural gas, which is applied to total therms of natural gas used at City facilities.
HFCs	General Services Department	Quantity of HFC-410a refrigerant used in City facilities is tracked by General Services.

Inventory Calculations

The 2023 inventory was calculated following the US Community Protocol and ICLEI's ClearPath software. As discussed in Inventory Methodology, the IPCC 5th Assessment was 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 CO2e emissions.

Appendix B: Adjusted 2019 GHG Inventory

Over time, available data sources and best practices for greenhouse gas accounting can change and improve, which may result in discrepancies between inventories. Some jurisdictions update data from all past inventory years when methodologies change. Others keep past inventory methods intact, recognizing that year-over-year comparisons will not be usable as direct comparisons.

In developing the 2023 GHG Inventory, some updates were made to data inputs, emissions factors, activities included, and to correct for errors. To maintain methodological consistency, improvements made for the 2023 GHG Inventory were also carried over to 2019 data for comparison purposes. The Adjusted 2019 GHG Inventory data used for analysis is presented below in Tables 11 and 12.

These adjustments increased overall emissions reported for 2019 in both the Community-wide and Government Operations inventories by 8% and 28%, respectively, shifting back the trajectory toward our first interim targets, which can be seen in Table 10.

Table 10: Differences between originally reported 2019 emissions and 2019 adjusted

	Originally Reported		2019 Adjusted (Used in 2023 Inventory Report)	
Inventory	**Originally reported total emissions**	**Reduction relative to 2007 baseline**	**Adjusted total emissions**	**Reduction relative to 2007 baseline**
Community-wide Emissions	1,627,037 $MTCO_2e$	-19%	**1,763,768 $MTCO_2e$**	**-12%**
Government Operations Emissions	16,223 $MTCO_2e$	-61%	**20,706 $MTCO_2e$**	**-50%**

In the Community-wide Inventory, increased emissions were primarily driven by the change to a new data source for vehicle miles traveled (VMT) to improve accuracy. Previously, a projected value based on a 2015 model had been used to estimate 2019 VMT, and that method could not be recreated for 2023. Instead, both inventories were updated using origin and destination data based on cell phone location services available through Google Environmental Insights Explorer. This tool provides high-quality data annually for our jurisdiction and will provide a more accurate and consistent data source into the future that is representative of the on-road travel we can influence. This tool is vetted and recommended by ICLEI.

Increases in reported municipal emissions were primarily driven by the addition of wastewater treatment process activities identified as missing by the ICLEI Quality Assurance/Quality Control team. Calculators for process N2O emissions from wastewater treatment and effluent discharge to rivers, as well as combustion of biosolids from the wastewater solids incinerator at the Westside treatment plant, contributed an additional 2,620 $MTCO_2e$ to the adjusted 2019 Municipal Inventory. Smaller increases and decreases in 2019 emissions also resulted from new data inputs for buildings and street lights electricity usage and fleet vehicles. In both cases, reports pulled for the original 2019 inventory were not able to be recreated and new data was pulled for both inventory years to maintain consistency.

Additionally, in the Municipal Inventory, changes were made to how water and wastewater emissions are allocated, which increased the representation of Water & Wastewater Treatment in the inventory results but did not change overall municipal emissions totals (see Figures 8 and 9). Previously, all electricity-related emissions from water and wastewater treatment and distribution were allocated under the Buildings & Facilities sector. Separating these emissions out from other types of government buildings and facilities allows the City to better define and prioritize strategies and resources based on the types of activities driving emissions.

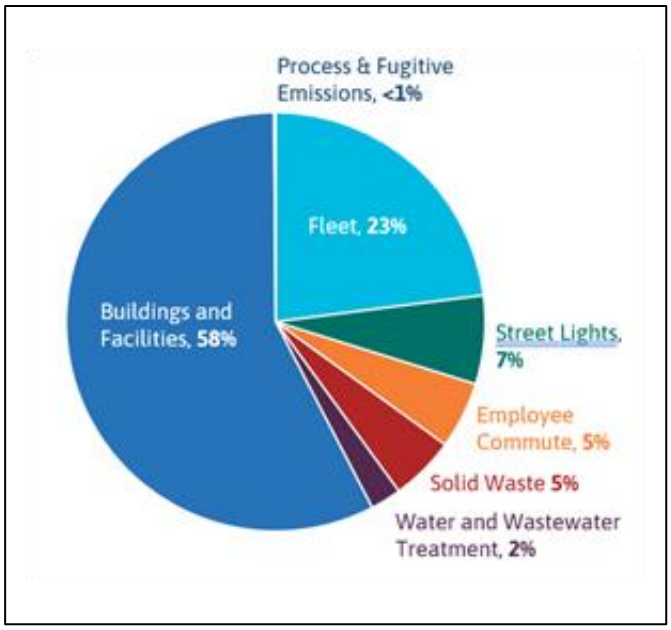

Figure 8: Original 2019 Reported Government Operations Emissions by Sector

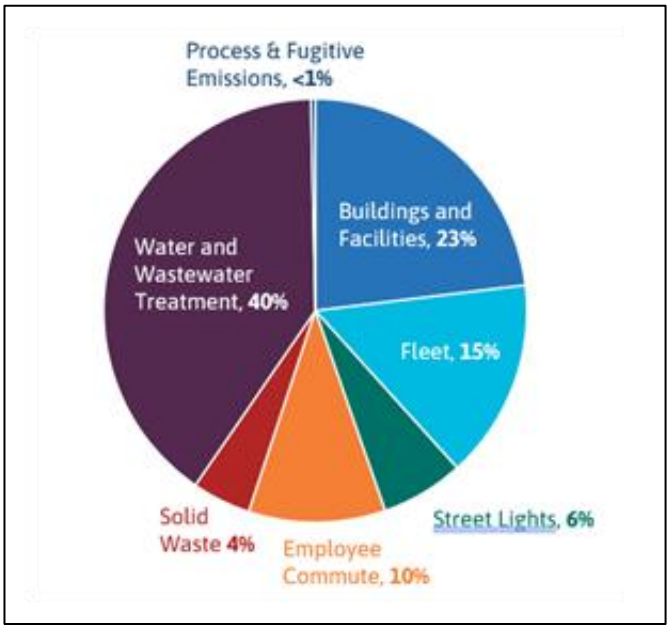

Figure 9: Adjusted 2019 Government Operations Emissions by Sector

As greenhouse gas inventory best practices evolve and data sources improve over time, changes to our methodologies and overall rate of progress-to-goal are expected. As stewards of these data, the City is responsible to maintain the most accurate accounting in order to inform programmatic investments. Both the 2019 and 2023 GHG inventories are based on the best available science for greenhouse gas accounting by local governments, and City Climate Program staff will continue to improve these data and methods in future years to provide efficient and purposeful reporting of emissions for decision making and public transparency.

Table 11: Communitywide Emissions Inventory (2019 Adjusted)

Sector	Fuel or source	2019 Usage	Usage unit	2019 Emissions ($MTCO_2e$)
Residential Energy	Electricity (Clark Public Utilities)	849,728,564	kWh	132,277
	Natural gas (Northwest Natural)	16,939,928	Therms	90,097
Residential Energy total				**222,374**
Commercial Energy	Electricity (Clark Public Utilities)	780,129,152	kWh	121,442
	Natural gas (Northwest Natural)	13,974,309	Therms	74,325
Commercial Energy total				**195,767**
Industrial Energy	Electricity (Clark Public Utilities)	367,445,960	kWh	57,200
	Natural gas (Northwest Natural)	4,399,622	Therms	23,351
Industrial Energy total				**80,551**
On-Road Transportation	Gasoline (passenger vehicles)	1,110,039,495	VMT	461,178
	Diesel (passenger and freight)	113,818,824	VMT	167,554
Transit	Diesel	4,655,032	VMT	7,926
	Gasoline	60,030	VMT	75
Aviation	Aviation Gasoline			403,489
Off-Road	Diesel			36,210
	Gasoline			18,546
	LPG			421
	CNG			247
Marine (Freight)	Diesel	72,620	MMBtu	2,189
Rail (Freight)	Diesel	29,608	MMBtu	5,371
Transportation total				**1,103,206**
Solid Waste	Waste Generated	116,943	Tons	26,373
Solid Waste total				**26,373**
Water and Wastewater	Water Treatment Energy Usage	19,614,585	kWh	3,053
	Wastewater Treatment Energy Usage	14,763,395 3,590	kWh Therms	2,317
	Wastewater Treatment	5,427	million gal/yr	193
	Nitrogen Discharge	1,063	kg N/day	808
	Combustion of Biosolids	18	MT/day	1,570
Water and Wastewater total				**7,941**
Process & Fugitive Emissions	Fugitive Emissions from Natural Gas Distribution			6,127
	Process Emissions from Refrigerant Use (HFCs and PFCs)			106,248
Process & Fugitive total				**112,375**
Upstream Impacts of Activities	Electric Power Transmission Losses			15,181
Upstream Impacts total				**15,181**
Total community-wide emissions in 2019				**1,763,768**

Table 12: Local Government Operations Inventory (2019 Adjusted)

Sector	Fuel or source	2019 Usage	Usage unit	2019 Emissions ($MTCO_2e$)
Buildings & Facilities	Electricity	21,928,099	kWh	3,414
	Natural Gas	256,492	Therms	1,364
Buildings & Facilities total				**4,778**
Street Lights	Electricity	8,433,374	kWh	1,313
Street Lights total				**1,313**
Vehicle Fleet	Gasoline (on-road)	2,828,043	VMT	1,938
	Diesel (on-road)	117,811	gal	1,143
	Gasoline (off-road)	2,990	gal	26
	Diesel (off-road)	4,260	gal	44
	Propane (off-road)	320	gal	2
Vehicle Fleet total				**3,153**
Employee Commute	Gasoline	4,713,795	VMT	1,870
	Diesel	473,508	VMT	274
	Transit	384,679	VMT	22
Employee Commute total				**2,166**
Solid Waste	Waste Generation	4,445	Tons	930
Solid Waste total				**930**
Water & Wastewater	Water Treatment Energy Usage	19,614,585	kWh	3,053
	Wastewater Energy – Electricity	14,763,395	kWh	2,298
	Wastewater Energy – Natural Gas	3,590	Therms	19
	Wastewater Energy – Diesel	30,037	gal	309
	Wastewater Treatment	5,427	million gal/yr	242
	Nitrogen Discharge	1,063	kg N/day	808
	Combustion of Biosolids	18	MT/day	1,570
Water & Wastewater total				**8,299**
Process & Fugitive Emissions	Fugitive Emissions from Natural Gas Distribution			45
	Process Emissions from Refrigerant Use (HFCs)			22
Process & Fugitive Emissions total				**67**
Total government emissions in 2019				**20,706**

Table 13 provides a list of updates that were made to the 2019 GHG Inventory during the development of the 2023 GHG Inventory to align methodologies.

Table 13: Updates to the 2019 GHG Inventory

Sector	Data/Methods Updated
Community-wide Inventory	
Transportation	New data inputs: VMT data updated to accurately compare to 2023. Corrections: Scaling factor for marine and rail emissions updated for accuracy; corrected local attribution of emissions from Pearson Field Airport.
Solid Waste	Corrections: Landfill characteristics updated for location in Eastern Oregon.
Upstream Impacts	Corrections: Formula to calculate electric power transmission losses updated for accuracy.
Municipal Operations Inventory	
Buildings & Facilities; Street Lights	New data inputs: Electricity usage data updated to parallel reports pulled in 2023.
Vehicle Fleet	New data inputs: Data for on-road gasoline and on-road diesel vehicles updated to parallel reports pulled in 2023. Correction: Percent biofuel in fuel blends updated for accuracy.
Solid Waste	Updated methodology: An improved calculator in ClearPath was used to account for landfill characteristics and align with 2023.
Water & Wastewater	Updated methodology: Added three missing calculators for wastewater treatment emissions, effluent discharge, and combustion of biosolids.
Process & Fugitive Emissions	Updated methodology: Added missing calculator for fugitive emissions from natural gas distribution attributed to natural gas usage by municipal operations.
Electricity Grid Emissions Factors	Correction: Emissions factors for grid electricity were updated for accuracy. This change impacts multiple sectors across both inventories.