City of Milwaukee

2018 Inventory of Community Greenhouse Gas Emissions

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Executive Summary

The City of Milwaukee 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. Furthermore, Milwaukee has multiple opportunities to benefit by acting quickly to reduce community GHG emissions by leveraging and expanding work in energy efficiency and renewable energy for the built environment. With approximately 76% of emissions associated with residential, commercial, and industrial sector energy use, approaching emissions reductions through both the energy supply (low or no carbon sources) and demand (efficiency) can have a relatively large impact. Milwaukee has begun the climate action planning process, starting with inventorying emissions. Milwaukee County is also developing its own GHG Inventory for 2018 to complement the work of the City of Milwaukee. While the Milwaukee County inventory will include the emissions of the City of Milwaukee, it will provide a much deeper understanding of the regional impacts and opportunities for emissions mitigation. This report provides estimates of greenhouse gas emissions resulting from activities in the City of Milwaukee in 2018. This report, and future Milwaukee County report, in addition to the recently published Preliminary Report from Milwaukee's City-County Task Force on Climate and Economic Equity, are critical first steps in developing a Climate Action Plan for the City of Milwaukee.

Key Findings

Community-Wide Emissions

This community-wide inventory contains a variety of emissions sources and activities. The largest contributor in Milwaukee is Industrial Energy Consumption with 35% of emissions. However, as noted in the methodology section, there is some uncertainty as to the appropriate categorization of Industrial vs. Commercial. When viewed collectively, Commercial and Industrial sectors account for more than 45% of Milwaukee emissions. The next largest contributor is Residential Energy consumption with 30% of emissions. An important note is that while emissions nationwide have seen Transportation claim the top source of emissions, at the local level, and especially in large metropolitan cities, the built environment continues to be the major source of emissions. Actions to reduce emissions in both the Commercial and Residential sectors will be a key part of a climate action plan. Actions to reduce emissions can focus on the supply of energy, electricity and natural gas and/or the demand for energy, energy efficiency. Transportation emissions are often best addressed from a regional level with local input, recognizing the complexities of regional travel patterns along with city-specific strategies that may promote alternative modes of transportation and/or low carbon transportation options, including infrastructure improvements.

Table 1 Comparison of Similar Community-wide Emissions as disclosed to CDP

City	Year	Emissions (mt-CO_2e)				Population	Per Capita Emissions (mt-CO_2e)/person
		Scope 1	Scope 2	Scope 3	Total		
Milwaukee	2018	4,414,266	3,167,129	142,044	7,723,439	592,025	13
Minneapolis	2018	2,756,800	1,402,603	140,461	4,299,864	422,331	10
Detroit	2012	5,520,240	4,809,082	300,451	10,629,773	673,104	16
Indianapolis	2016	1,382,323	14,630,253		16,012,576	872,680	18
Columbus	2018	5,434,813	5,088,528	1,027,277	11,550,618	892,533	13

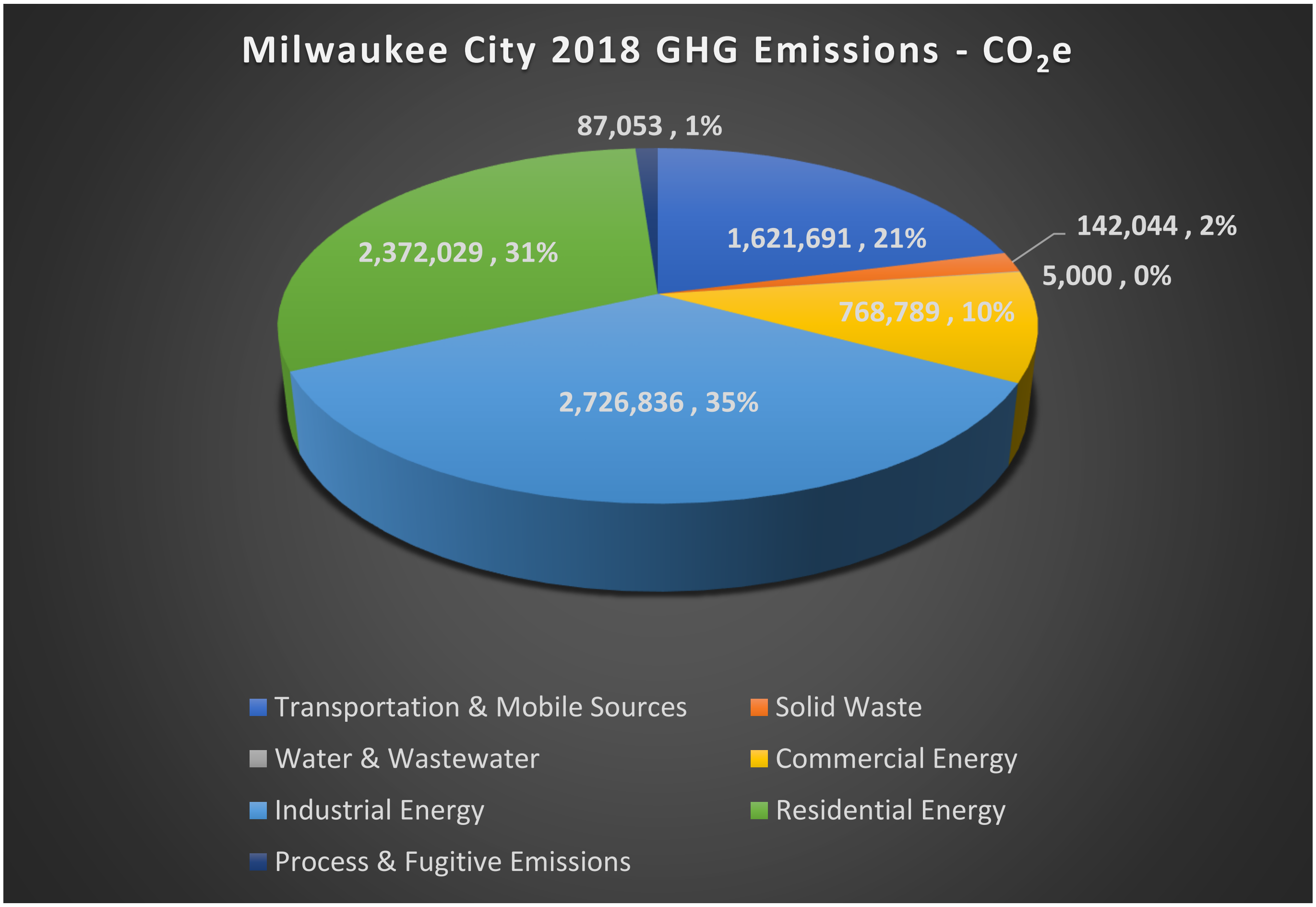

Figure 1 Milwaukee 2018 Community-wide GHG Emissions

Next Steps

Community-wide greenhouse gas emissions inventories are the first step in developing a cohesive and emissions reduction program for Cities. The inventory provides the basis or baseline from which future emissions can be forecasted based on a Business as Usual approach. Setting a target both for mid-term and long-term establishes the City's level of commitment – with Milwaukee already committing to meet or exceed the Paris Agreement reductions relative to their emissions. The development of a Climate Action Plan is informed by calculating potential emissions reductions according to sector, prioritizing those sectors with the largest emissions. An example of this type of planning, called a wedge analysis is included in Figure 3. The final steps include the implementation and monitoring of those identified actions. Pursuing these actions will help attain the joint City-County goal of a 45% reduction of county-wide GHG emissions by 2030 and carbon neutrality by 2050.

Figure 2 ICLEI Emissions Mitigation Milestones

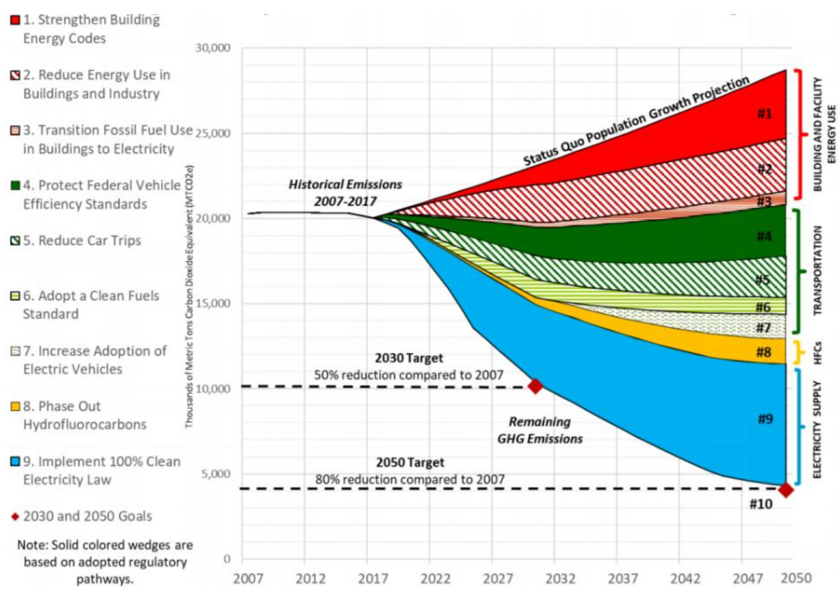

Figure 3 Example of Emissions Reduction Wedge Analysis. Taken from King County, WA

Climate Change Background

Naturally occurring gases dispersed in the atmosphere determine the Earth's climate by trapping solar radiation. This phenomenon is known as the greenhouse effect. Overwhelming evidence shows that human activities are increasing the concentration of greenhouse gases and changing the global climate. The most significant contributor is the burning of fossil fuels for transportation, electricity generation and other purposes, which introduces large amounts of carbon dioxide and other greenhouse gases into the atmosphere. Collectively, these gases intensify the natural greenhouse effect, causing global average surface and lower atmospheric temperatures to rise.

Milwaukee could be impacted by heavy precipitation and flooding, impacts to the Great Lakes, and Air Pollution and Human Health impacts associated with climate change[1]. Current and expected impacts to Milwaukee related to climate change are explained below.

Many communities in the United States have taken responsibility for addressing climate change at the local level. 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, money not spent on energy is more likely to be spent 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.

Regional and Local Impacts

According to the Wisconsin Initiative on Climate Change Impacts Milwaukee and the rest of Wisconsin will see a continued warming trend, increasing considerably in the coming decades. By mid-century statewide annual average temperatures are likely to warm by 6-7 degrees Fahrenheit. The greatest temperature increases will be seen in winter months, impacting runoff and seasonal patterns. Precipitation patterns may become increasingly less predictable, with heavier rains leading to secondary impacts in both natural and built environments. As a community on the shores of Lake Michigan, Milwaukee could also see reduced ice cover from warmer winters, higher fluctuations in lake levels that affects coastlines,

[1] What Climate Change Means for Wisconsin, US EPA 430-F-16-051, August 2016 https://19january2017snapshot.epa.gov/sites/production/files/2016-09/documents/climate-change-wi.pdf

and more turbulent waters from increasing wind strength. These can create additional secondary impacts to shoreline environments, including parks and infrastructure.

Evidence of Human-Caused Climate Change

There is overwhelming scientific consensus that the global climate is changing, and that human actions, primarily the burning of fossil fuels, are the main cause of those changes. The Intergovernmental Panel on Climate Change (IPCC) is the scientific body charged with bringing together the work of thousands of climate scientists. The IPCC's Fourth Assessment Report states that "warming of the climate system is unequivocal."[2] Furthermore, the report finds that "most of the observed increase in global average temperatures since the mid-20th century is *very likely* due to the observed increase in anthropogenic GHG concentrations."

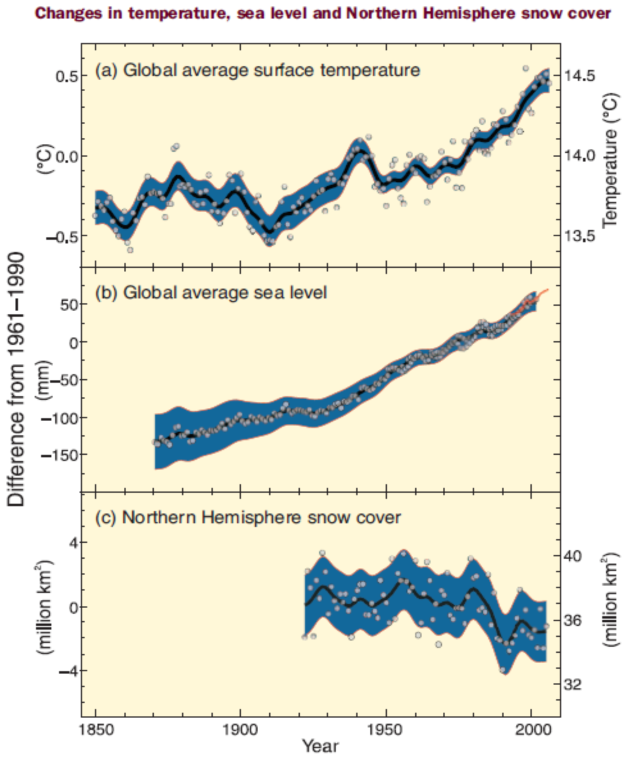

Figure 4 Observed changes in global temperature, sea level and snow cover

The last five years ranked the top five hottest years to date.[3] Globally, the 19 years from 2000-2019 are among the 19 hottest on record.[4] 1976 was the last year with a below average global temperature.[4] The steady uptick in average temperatures is significant and expected to continue if action is not taken to greatly reduce greenhouse gas emissions.

ICLEI Climate Mitigation Program

ICLEI–Local Governments for Sustainability is the leading global network of local and regional governments committed to sustainable urban development. ICLEI supports local governments to deliver

[2] IPCC, 2007: Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K and Reisinger, A. (eds.)]. IPCC, Geneva, Switzerland, 104 pp.
[3] NCEI, 2020: "More Near-Record Warm Years Are Likely On Horizon". February 14, 2020. https://www.ncei.noaa.gov/news/projected-ranks
[4] NASA, 2020: "Global Temperature". Last Modified September 14, 2020. https://climate.nasa.gov/vital-signs/global-temperature/

community-driven sustainability policy and local action for low-emission, nature-based, equitable, resilient and circular development.

In response to the problem of climate change, many communities in the United States are taking responsibility for addressing emissions at the local level. Since many of the major sources of greenhouse gas emissions are directly or indirectly controlled through local policies, local governments have a strong role to play in reducing greenhouse gas emissions within their boundaries. Through proactive measures around land use patterns, transportation demand management, energy efficiency, green building, waste diversion, and more, local governments can dramatically reduce emissions in their communities. In addition, local governments are primarily responsible for the provision of emergency services and the mitigation of natural disaster impacts.

Figure 5 ICLEI Climate Mitigation Milestones

ICLEI provides a framework and methodology for local governments to identify and reduce greenhouse gas emissions, organized along Five Milestones, also shown in Figure 5:

1. Conduct an inventory and forecast of local greenhouse gas emissions;
2. Establish a greenhouse gas emissions reduction target;
3. Develop a climate action plan for achieving the emissions reduction target;
4. Implement the climate action plan; and,
5. Monitor and report on progress.

The framework builds on ICLEI's 20 years of experience as the leader in local emissions management. Over 1000 communities nationwide have benefited from ICLEI's well-managed approach to building more sustainable, climate-friendly communities.

This report represents completion of Milwaukee's Community-wide GHG inventory, the initial step of ICLEI's Climate Mitigation Milestone One, and provides a foundation for future work to reduce greenhouse gas emissions in Milwaukee. Milestone Two, Establishing a Target, has also been completed.

Sustainability & Climate Change Mitigation Activities in Milwaukee

Milwaukee has already implemented programs that have or will lead to ancillary benefits in the form of energy conservation and greenhouse gas mitigation. Figure 6 provides an overview of activities Milwaukee has taken. More details can be found on [Milwaukee's Climate Action]() website.

Figure 6 Timeline of Milwaukee Emissions Reduction Activities

Inventory Methodology

Understanding a Greenhouse Gas Emissions Inventory

The first step toward achieving tangible greenhouse gas emissions reductions requires identifying baseline emissions levels and sources and activities generating emissions in the community. This report presents emissions from the Milwaukee community as a whole. Milwaukee also tracks energy consumption at the government operations level, notably in building energy and transportation fuel. Government operations emissions are typically a much smaller subset of the community inventory; for example, data on commercial energy use by the community includes energy consumed by municipal buildings, and community vehicle-miles-traveled estimates include miles driven by municipal fleet vehicles.

As local governments have continued to join the climate protection movement, the need for a standardized approach to quantify GHG emissions has proven essential. This inventory uses the approach and methods provided by the Community Greenhouse Gas Emissions Protocol (Community Protocol)[5].

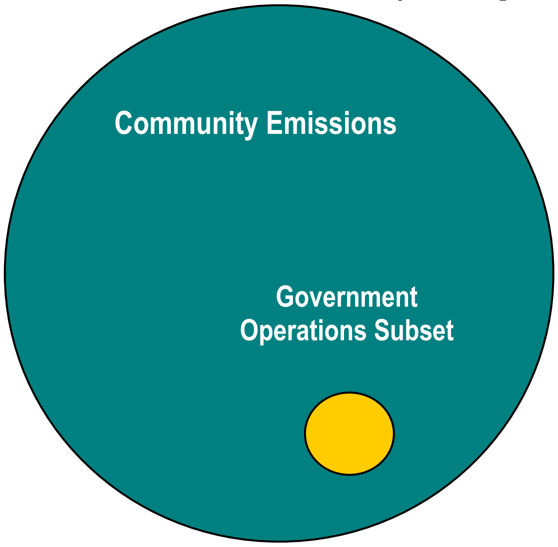

Figure 7 Relationship of Community and Government Operations Inventories

Community Emissions Protocol

The Community Protocol was initially released by ICLEI in October 2012 and has been updated to reflect changes in GHG inventory reporting. It represents a new national standard in guidance to help U.S. local governments develop effective community GHG emissions inventories. It establishes reporting requirements for all community GHG emissions inventories, provides detailed accounting guidance for quantifying GHG emissions associated with a range of emission sources and community activities, and provides a number of optional reporting frameworks to help local governments customize their community GHG emissions inventory reports based on their local goals and capacities.

Quantifying Greenhouse Gas Emissions

Sources and Activities

Communities contribute to greenhouse gas emissions in many ways. Two central categorizations of emissions are used in the community inventory: 1) GHG emissions that are produced by "sources" located

[5] http://www.icleiusa.org/tools/ghg-protocol/community-protocol

within the community boundary, and 2) GHG emissions produced as a consequence of community "activities".

Table 2 Definition of GHG Sources & Activities

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

By reporting on both GHG emissions sources and activities, local governments can develop and promote a deeper understanding of GHG emissions associated with their communities. A purely source-based emissions inventory could be summed to estimate total emissions released within the community's jurisdictional boundary. In contrast, a purely activity-based emissions inventory could provide perspective on the efficiency of the community, even when the associated emissions occur outside the jurisdictional boundary.

GHG Emission Scope

GHG Emissions are also categorized by Scope for reporting purposes. This allows for the collection of activity data without double counting when reporting. Scope 1 emissions are emissions occurring within the boundary of the community, such as combustion of natural gas for heating or gasoline for vehicles. Scope 2 emissions are emissions that occur outside the boundary but are demanded by activity within the boundary, such as electricity generation. Scope 3 emissions occur outside a boundary but relate to in-boundary activities. These include in-boundary generated solid waste or wastewater that is exported to another boundary or cross-boundary transportation.

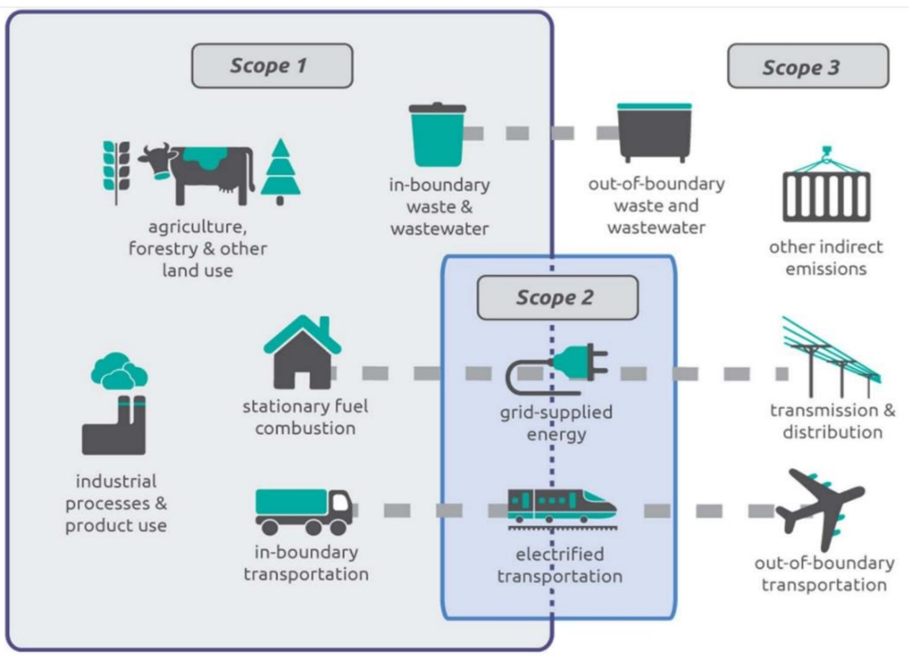

Figure 8 GHG Emissions Scopes

While this inventory does not account for consumption-based scope 3 emissions, it is worth noting that consumption-based emissions have significant global impacts. A large majority of goods and services Milwaukeeans consume are produced outside the city boundary. In all life-cycle phases, from raw material extraction to manufacturing to disposal, the majority of goods directly or indirectly produce GHGs.

Base Year

The inventory process requires the selection of a base year with which to compare future emissions as well as establishing compliance with Milwaukee's commitment to the Global Covenant of Mayors for Climate and Energy. Prior to 2018, Milwaukee was unable to obtain utility data limited solely to Milwaukee– relying instead on estimates of energy consumption based on regional or national averages. As this 2018 inventory represents the first inventory with high quality activity and emissions factor data, Milwaukee has chosen 2018 as its baseline year.

Quantification Methods

Greenhouse gas emissions can be quantified in two ways:

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

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

Known emissions factors are used to convert energy usage or other activity data into associated quantities of emissions. Emissions factors are usually expressed in terms of emissions per unit of activity data (e.g. lbs. CO_2/kWh of electricity). Where needed all emissions and/or emissions factors have been converted to metric units to maintain consistency with reporting requirements.

Community Emissions Inventory Results

Following the Community Protocol, this inventory report organizes emissions in several frames. Each frame includes a particular set of emissions sources and activities, and each helps to tell the story about community emissions. This report looks at Milwaukee's community emissions through three frames:

- Sector and Fuel Type
- Scope
- Global Covenant of Mayors, Common Reporting Framework

Community Profile

To put emissions inventory data in context, it is helpful to have some basic information about community such as population and number of households. This information is provided in Table 3.

Table 3 Milwaukee Community Indicators

Estimated 2018 Population[6]	**591,375**
Estimated 2018 Housing Units[7]	**257,506**
2018 City Budget	**$1,500,000**

Sector and Fuel Type

This frame provides the most detail in terms of GHG emissions. Understanding the share of emissions from residential or commercial built environment as well as whether the emissions are from electricity use or natural gas combustion for heat provides a strong foundation for program and/or policy implementation. It also can help highlight a set of emission sources and activities that Milwaukee has the greatest opportunity to address. This frame includes all the five Basic Emissions Generating Activities required by the community protocol.

[6] Census.gov City And Town Population Totals: 2010-2019,
[7] 2014-2018 American Community Survey 5-Year Estimates

Table 4 Milwaukee 2018 GHG Emissions by Sector and Fuel Type

Sector	Fuel or Source	Usage	Usage units	Emissions CO_2e
Residential Energy	Electricity	1,901,089,585	kWh	1,126,002
Residential Energy	Natural Gas	227,992,102	Therms	1,212,610
Residential Energy	Propane	284,698	MMBtu	17,668
Residential Energy	Distillate Fuel Oil No. 2	211,514	MMBtu	15,749
		Residential Energy Total		**2,372,029**
Commercial Energy	Electricity	474,514,225	kWh	281,051
Commercial Energy	Natural Gas	91,696,527	Therms	487,702
Commercial Energy	Landfill Gas	335,891	MMBtu	36
		Commercial Energy Total		**768,789**
Industrial Energy	Electricity	2,971,630,877	kWh	1,760,076
Industrial Energy	Natural Gas	182,069,641	Therms	966,326
Industrial Energy	Distillate Fuel Oil No. 2	42,381	Gallons	434
		Industrial Energy Total		**2,726,836**
Transportation & Mobile Sources	Diesel	3119503400	VMT	457,767
Transportation & Mobile Sources	Gasoline	3119503400	VMT	1,163,923
		Transportation & Mobile Sources Total[8]		**1,621,691**
Solid Waste	Waste Sent to Landfill	436,781	Tons	142,044
		Solid Waste Total		**142,044**
Water & Wastewater	Wastewater Energy			93,033[9]
Water & Wastewater	Process Emissions			5,000
		Water & Wastewater Total		**98,033**
Process & Fugitive Emissions	Other			87,053
		Process & Fugitive Emissions Total		**87,053**

Table 5 Milwaukee GHG Emissions of In-Boundary Energy Generation

Industrial Energy - Valley WEPCO[10]	**Natural Gas**	**6,534,259**	**MMBtu**	**346,802**

[8] Currently Transportation Emissions **do not** include Aviation or Waterborne Emissions. The City of Milwaukee is preparing to work with Milwaukee County to appropriately determine emissions and allocation.
[9] Emissions resulting from energy consumption in the Water & Wastewater sector are not counted towards total emissions as it was assumed that these would be captured in the Stationary Energy sectors.
[10] Electricity Generation emissions should not be added to Inventory total as those are captured in the Emissions Factor for Electricity Sources. This is reported separately under the Energy Generation Sector.

Scope

Scopes are used in the context of reporting on GHG emissions associated with individual organizational entities (e.g., the operations of a business or local government). In that context, the scopes framework can be used to categorize community emissions as direct (scope 1) emissions (e.g., smoke stacks or tailpipes that release emissions within an organizational boundary), indirect energy-related (scope 2) emissions (e.g., the use of purchased or acquired electricity, heating, cooling, or steam regardless of where the energy is generated), and other indirect (scope 3) emissions not covered in scope 2 (e.g., upstream and downstream emissions from the extraction and production of purchased materials and fuels).

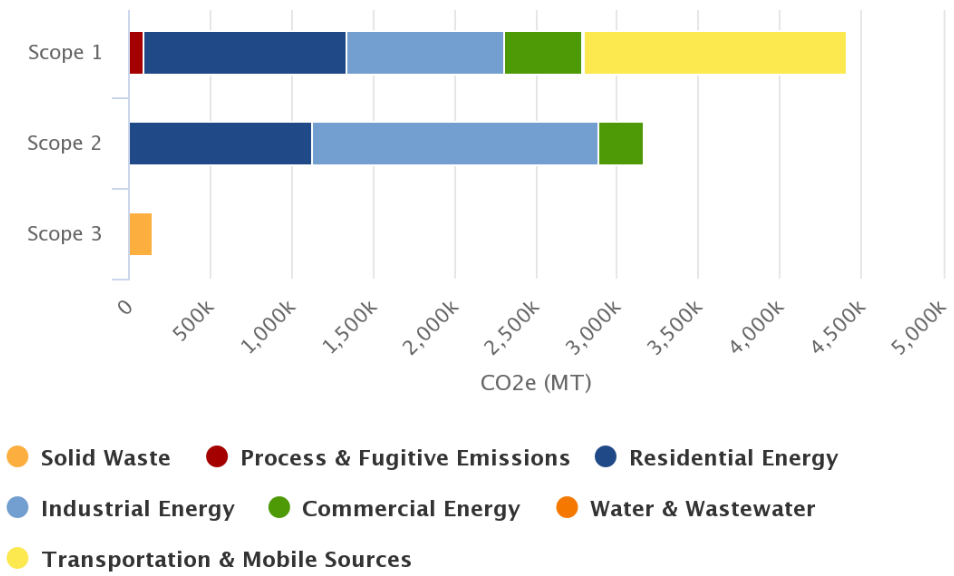

Figure 9 Milwaukee 2018 GHG Emissions by Scope

Global Covenant of Mayors Common Reporting Framework

Milwaukee formally committed to the Global Covenant of Mayors[11] in November of 2015. As part of that commitment, Milwaukee has developed this GHG inventory and will report to GCoM during the 2020 reporting cycle. This reporting is required to be done using the Common Reporting Framework (CRF) The CRF was developed to streamline measurement and reporting procedures, and ensure robust

[11] The Global Covenant of Mayors for Climate & Energy formally brought together the European Union's Covenant of Mayors and the Compact of Mayors – the world's two primary initiatives of cities and local governments – to advance city-level transition to a low emission and climate resilient economy, and to demonstrate the global impact of local action. Milwaukee originally committed under the Compact of Mayors

climate action planning, implementation and monitoring through a set of new global recommendations developed in consultation with partners, cities and local governments around the world, providing flexibility to meet specific local or regional circumstances. Cities globally are now able to report data in a standardized fashion and showcase achievements while unambiguously tracking progress – thus advocating for better multilevel governance of climate and energy issues and for improved technical and financial support. The GCoM CRF was formally endorsed by the GCoM Board in September 2018 and is in effect in starting on January 2019.

Methodology Details

Community Inventory Data

Built Environment Energy

Electricity and natural gas usage data for the built environment were obtained from WE Energies and Wisconsin Public Service in response to a data request submitted by the City of Milwaukee for the residential, commercial, and industrial sectors. Electricity emissions factors were also provided by WE Energies while the CH_4 and N_2O factors were obtained from eGRID[12]. These factors are shown in Table 3.

Table 5 Electricity Emissions Factors & Energy Consumption for 2018

	CO2 (lbs./MWh)	CH4 (lbs./GWh)	N2O (lbs./GWh)
Emissions factor	1,298	129	18

WE Energies also provided a description of their classification of energy consumption, which is primarily based on the rate, or tariff for service. WE Energies provided the following detail of consumption:

Residential: Gas and Electric

- Single family homes/garages for home
- Apartment units
- Common meter for residential apartment 4 or less

Small Commercial: Gas and Electric

- Common meter for residential service > 4 units
- Electric non demand electric meters commercial (CG1 or CG6)
- All Commercial gas (except Transportation)

Industrial

- Electric Demand (CG2 and CG3)
- Electric Primary
- Gas Transportation

12 https://www.epa.gov/energy/egrid-summary-tables

Table 6 Milwaukee's 2018 Built Environment Energy Consumption. Provided by WE Energies.

Milwaukee Community Energy Use in 2018		
Sector	Usage (kwh)	Usage (therms)
Residential	1,901,089,585	227,992,102
Commercial	474,514,225	91,696,527
Industrial	2,971,630,877	182,069,641

Based on this description, it is very likely that a number of "Commercial" premises and/or accounts were put into the "Industrial" Sector due to their rate classification under the Demand classification. WE Energies describes Demand as "the rate at which you consume electricity – or the amount needed to power your business at any given point in time. Demand charges are based on the highest level of electricity supplied at one time during the billing period and at the time of day it's needed by your business." Many commercial properties like large office buildings, businesses that may have high spikes of demand during short periods of time (prompting a utility to shift their rate structure to a Demand rate), and others are put on a demand rate even though their business is not "Industrial" in nature. While this categorization may not provide a clear picture of commercial vs industrial energy consumption, it is a step in the right direction for planning strategies. Continued partnership with WE Energies may allow for a further disaggregation or re-allotment of consumption among the two sectors.

Built Environment – Alternative Analysis

In most US metropolitan cities, commercial buildings tend to have a higher percentage of the electricity load compared to industrial, while industrial having a higher percentage of natural gas consumption compared to commercial. This tends to be the result of Industrial buildings needing more "process" energy to manufacture or produce goods. Commercial buildings often need a relatively higher amount of electricity to provide energy for lights, elevators, air movement, and office equipment. Given these very general assumptions, it is possible to estimate the total sq footage of commercial space based on Milwaukee's Assessor Database. Using the classifications of "mercantile" "special mercantile" and "exempt" it was estimated that approximately 152,514,000 ft^2 true commercial office space exists in

Milwaukee. Using the Commercial Buildings Energy Consumption Survey average of 14.5 kWh/ft^2, Milwaukee's commercial electricity consumption is likely 5 times higher than currently estimated while Industrial would be 2.5 times less. The impact of this alternative analysis is provided in Table 7 and this would fall in line with a typical metropolitan city. Worth noting is that WE Energies took the meaningful and important step of providing data to Milwaukee. Utilities are designed to bill customers based on consumption habits and not building classification. Therefore, a continued dialogue with WE Energies is very likely to produce more informed results for use in updating this and future inventories.

Table 7 Comparison of "Billed" usage and estimated usage.

Milwaukee Community Energy Use in 2018		Estimated using Assessor and CBECS average
Sector	Usage (kWh)	Estimate kWh
Residential	1,901,089,585	1,901,089,585
Commercial	474,514,225	2,225,962,760
Industrial	2,971,630,877	1,220,182,342

Electricity Generation

WE Energies Valley Power Plant (VPP) was constructed in Milwaukee in 1968 to generate electricity for the grid and to supply steam for more than 300 district energy customers in downtown Milwaukee. Today, the plant continues to produce electricity and steam along with providing voltage support for the downtown area. At this cogeneration plant electricity is generated by burning natural gas in a furnace to create heat. In a boiler, the heat converts water into steam, which drives a turbine that drives a generator to make electricity. Cogeneration occurs when a portion of the steam used to generate electricity is extracted from the turbine and distributed to Milwaukee downtown customers and businesses for thermal heating, and other purposes[13].

As the energy generated at VPP is supplied to the grid, the resulting emissions will have already been captured as the indirect or Scope 2 emissions from consumption of grid-supplied energy, under the Stationary Energy sector of Milwaukee and any other communities that share the same grid. As such, scope 1 emissions reported in the Energy Generation sector will not be included in the emissions total of the local government in order to avoid double counting.

[13] WE Energies https://www.we-energies.com/home/projects/vapp.htm accessed 08/19/2020

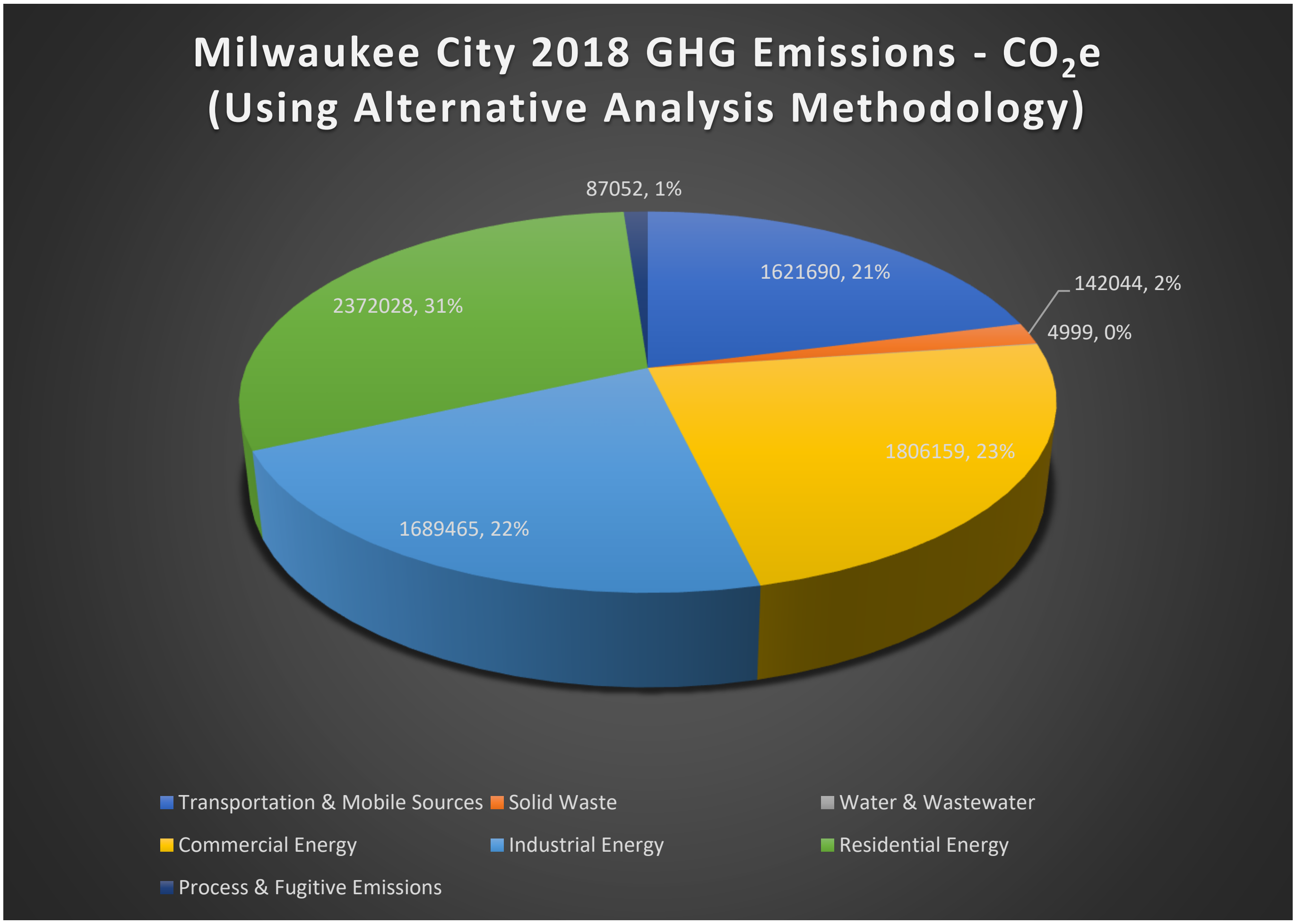

Figure 10 Milwaukee City 2018 GHG Emissions using an alternative analysis of Commercial vs Industrial electricity consumption

Transportation

On Road Passenger and Commercial Transportation

Total annual vehicle miles traveled (VMT) for City of Milwaukee was provided by the Southeastern Wisconsin Regional Planning Commission (SEWRPC). SEWRPC provides daily Vehicle Miles Travelled (VMT) for a) Trips that both begin and end within the Milwaukee Boundary (in boundary), b) Trips that either begin or end within Milwaukee (origin-destination)[14], and c) Trips that neither end nor begin within Milwaukee (pass through trips). The daily VMT was then multiplied by 338 to get annual VMT for each trip type. 338 is a commonly used multiplier to get from daily to annual as it represents a roughly 25% reduction in daily VMT for weekend trips.

[14] When reporting transportation emissions, it is required that origin destination VMT be divided in half with one half counted as Scope 1 or in boundary and the other half as Scope 3 out of boundary. For this report, emissions are combined to provide information on the demand center nature of Milwaukee, either as a destination for trips originating outside of the boundary or as an origin for trips.

To calculate emissions, the VMT needs to be allocated to different vehicle and fuel types. This was done using additional data from SEWRPC adjusting national inputs to match vehicle class counts more closely within Milwaukee County VMT by vehicle type and fuel. This data was used to calculate the percent of VMT for each vehicle type and fuel, which are shown in Table 5. These percentages were applied to the total Milwaukee VMT above.

Table 8 Milwaukee VMT by Fuel and Vehicle Type

Fuel	% of VMT	
Gasoline	90.7	
Diesel	9.3	
Vehicle type	**% of Gasoline VMT**	**% of Diesel VMT**
Passenger car	58.6	0.3
Light truck	31.4	1.3
Heavy truck	0	8.4
Motorcycle	0	0

Next it is necessary to apply average miles per gallon and emissions factors for CH_4 and N_2O to each vehicle type. The factors used are shown in Table 7.

Table 9 MPG and Emissions Factors by Vehicle Type[15]

Fuel	Vehicle type	MPG	CH_4 g/mile	N_2O g/mile
Gasoline	Passenger car	24.21	0.0186	0.0093
Gasoline	Light truck	17.52	0.0201	0.017
Gasoline	Heavy truck	5.36	0.086	0.066
Gasoline	Motorcycle	24.21	0.0186	0.009
Diesel	Passenger car	24.21	0.0005	0.001
Diesel	Light truck	17.52	0.001	0.0015
Diesel	Heavy truck	6.22	0.0051	0.0048

Additional Analysis for Transportation Sector[16]

The most common data sources currently used for local GHG inventory transportation data are agent-based models and road-count extrapolations. Larger regional planning agencies in the United States run agent-based models for the purpose of planning future transportation infrastructure needs as is the case with the Southeastern Wisconsin Regional Planning Commission. The Vehicle Miles Traveled (VMT) outputs from these models have been adapted in many

[15] These are standard defaults provided by ICLEI USA for many GHG inventories, and are derived from the following sources: Table 2.8 Motor Vehicle Mileage Fuel Consumption and Fuel Economy 1949-2010, https://www.eia.gov/totalenergy/data/annual/showtext.php?t=ptb0208; Freight Existing Trucks Fuel Efficiency Heavy Motor Gasoline Reference AEO2015, https://www.eia.gov/opendata/qb.php?category=1373322&sdid=AEO.2015.REF2015.EFI_NA_FGHT_RADS_MGS_NA_NA_MPG.A; Freight Existing Trucks Fuel Efficiency Heavy Diesel Phase 2 AEO2016, https://www.eia.gov/opendata/qb.php?sdid=AEO.2016.PHASEII.EFI_NA_FGHT_RADS_DSL_NA_NA_MPG.A; Table 4-23M: Average Fuel Efficiency of U.S. Light Duty Vehicles, Bureau of Transportation Statistics (2018).

[16] *Technical Review of Google Environmental Insights Explorer Data for Local Greenhouse Gas Inventories*, ICLEI USA, 2019

cases for use in local GHG inventories. The models have the ability to identify VMT from [modeled] trips that begin or end in a jurisdiction, making the data particularly useful for connecting land-use patterns to VMT and emissions.

In 2019 Google's Environmental Insights Explorer Team (EIE) announced a new and complementary set of data for communities looking to better understand their major sources of emissions. Google uses proprietary data to model actual transportation activity. There are a number of advantages to EIE data for policy development. The first is that, in common with agent-based models, but unlike other transportation data sources, EIE captures the impact of trips that begin or end within the jurisdiction, showing the contribution of local land uses to regional transportation flows. The ability to show flows between adjacent cities can further boost the value of EIE data for policy development at a scale larger than just the City of Milwaukee. The second advantage while not directly related to the inventory, presents the ability to show transit, bicycle, and walking trips and can be used as baseline data for climate action planning. While the current GHG analysis does not include EIE data, it is an important source to better understand transportation activity within the city of Milwaukee.

Transportation data in EIE is from a source of continuous observation, which has unique benefits beyond those provided by other sources of data. Many other potential applications can occur with data provided at shorter intervals that would be highly valuable to city planners. Through direct observation, the impact of acute events, anomalous years of transportation activity, and policy could be inferred, none of which is currently possible. While some of these advantages are being developed by the EIE team, there are data for immediate consideration by the Task Force. An example is shown in Figure 11.

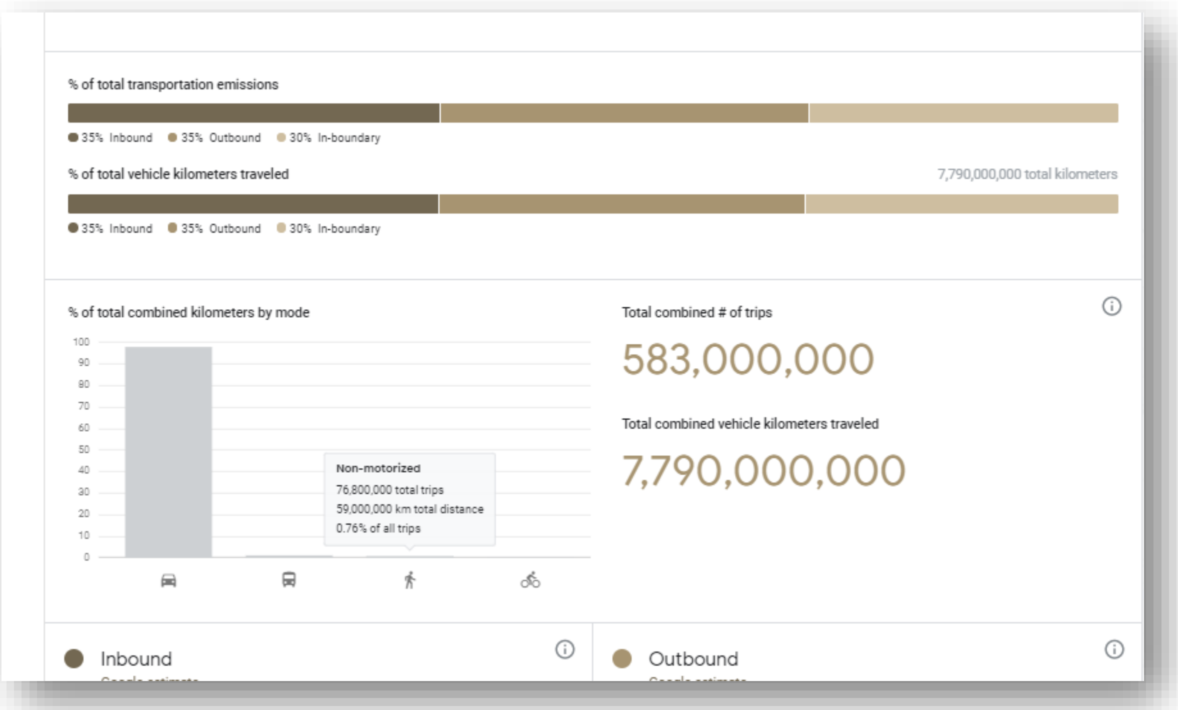

Figure 11 Example of Google EIE data for the City of Milwaukee

Wastewater

Wastewater treatment can create a unique set of process, stationary, and fugitive greenhouse gas emissions. Nitrous Oxide (N_2O) is an intermediary product of both conventional treatment and specialized biologically mediated processes to remove excess nitrogen in wastewater. A fraction of the nitrogen discharged into natural waters may undergo similar processes and also produce N2O. Treatment facilities often produce methane (CH_4) when utilizing anaerobic digestion. During collection and treatment, wastewater may be unintentionally or deliberately managed under anaerobic conditions, potentially releasing some uncaptured or uncombusted CH4 into the environment. Facilities often flare captured gasses or combust them for energy generation.

Jones Island Water Reclamation Facility, the sole treatment facility for Milwaukee wastewater, produces both N_20 process emissions and emissions from Nitrogen-load discharge to waterbodies. Jones Island also consumes on-site energy, however, this energy is not included in the waste sector as it was assumed that this would be captured in the WE Energies consumption report. The facility does not utilize anaerobic or aerobic digestion.

Potable Water

Energy use for the water utility was unavailable, and considered included elsewhere, specifically in the WE Energies consumption report.

Solid Waste

Data on residential solid waste generated and sent to landfill from Milwaukee was provided by Public Works – Sanitation, while landfill gas combustion, composition and destruction efficiency was provided by Waste Management.

Non-residential waste was not available, so this inventory utilized job numbers from the Wisconsin Department of Workforce development[17] to make assumptions about the amount of waste generated in workplaces. EPA estimates that each person produced 4.51 pounds of trash per day, with about 64% going to a landfill, while the other 36% is either recycled or composted, resulting in approximately 2.89 lbs per person per day. This value was multiplied by the number of jobs in Milwaukee County, 488,376 and annualized by multiplying by 365, resulting in 257,261 tons of non-residential waste. Due to the high number of assumptions, limited city-wide data, and use of national averages applied to County level jobs data that don't differentiate between household and business waste, these data are not considered high quality, but serve to inform the general scope of the solid waste sector.

[17] https://jobcenterofwisconsin.com/wisconomy/wits_info/downloads/CP/milwaukee_profile.pdf

To calculate emissions from landfilled waste, data is needed on the percentage of different material types, such as paper, food waste, leaves and branches. This is referred to as a waste characterization. A specific waste characterization study of Milwaukee was not available, thus the 2009 Wisconsin State-Wide Waste Characterization Study prepared for the WI Dept. of Natural Resources, Final Report June 30th 2010 was utilized[18]. The inventory utilized Multi-family waste composition (Figure 3-7) as it was most representative of the Milwaukee area. The waste composition is shown in Table 9.

Table 10 Comparison of Waste Characterization and ClearPath Categories and the percent of waste

WI Study Classification	ClearPath Classification Material	% of Waste
Newspaper	Newspaper	1.4
High-grade Office Paper, Mixed Paper, Recyclable, Compostable Paper, Other Paper	Office Paper	7.2
Uncoated OCC, Coated OCC, Boxboard	Corrugated Cardboard	4.6
Magazines/Catalogs	Magazines/3rd Class Mail	1.6
Food Scraps, Diapers, Animal Waste/Kitty Litter, Other Organic (Did not include Bottom Fines/Dirt)	Food Scraps	15.8
Split Yard Materials <6" evenly among Grass & Leaves	Grass	1.7
	Leaves	1.7
Branches	Branches	0.6
Lumber	Lumber	1.2

Fugitive Emissions

Fugitive emissions from natural gas distribution were calculated from the ClearPath calculator, following a default 0.3% leakage rate[19]. The total natural gas usage from the residential and commercial sectors was used as the input.

Inventory Calculations

The 2018 inventory was calculated following the US Community Protocol and ICLEI's ClearPath software. The 5th IPCC Climate Assessment was used for global warming potential (GWP) values to convert methane and nitrous oxide to CO_2 equivalent units. ClearPath's inventory calculators allow for input of the sector activity (i.e. kWh or VMT) and emissions factor to calculate the final CO2e emissions.

[18] https://dnr.wi.gov/topic/Recycling/documents/WI_WCS_Final_Report_June-30-2010.pdf
[19] EDF User Guide for Natural Gas Leakage Rate Modeling Tool. https://www.edf.org/sites/default/files/US-Natural-Gas-Leakage-Model-User-Guide.pdf