



Local Governments
for Sustainability

Madison's 2018 & 2022 Community- Wide & Local Government Operations GHG Inventories

Overview & Results



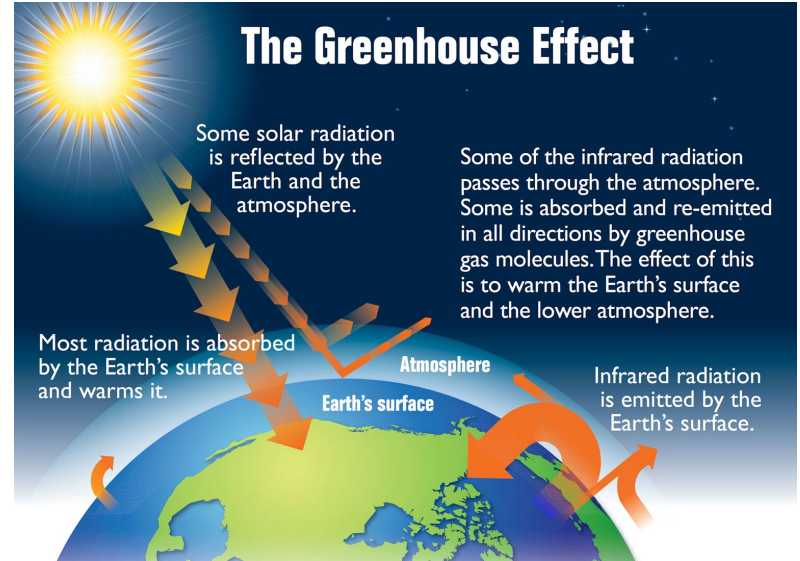
Agenda

1. Greenhouse Gas and Inventory 101
2. Inventory and Forecasting Importance
3. 2018 & 2022 Community-Wide Inventory Results
4. 2018 & 2022 Local Government Operations Inventory Results
5. Science-Based Target
6. BAU Forecast
7. Key Takeaways & Principles



What is a greenhouse gas?

- “GHG” for short
- Gases that act like the glass in a greenhouse, trapping the sun’s heat near the earth’s surface
- GHG emissions from human activities are largely responsible for our changing climate



Primary types of GHGs

GHG	Global Warming Potential (GWP)
Carbon Dioxide (CO₂)	1
Methane (CH₄)	28
Nitrous Oxide (N₂O)	265
Hydrofluorocarbons (HFCs)	116-12,400 (varies based on type)
Perfluorocarbons (PFCs)	6,630-11,100 (varies based on type)
Sulfur Hexafluoride (SF ₆)	23,500

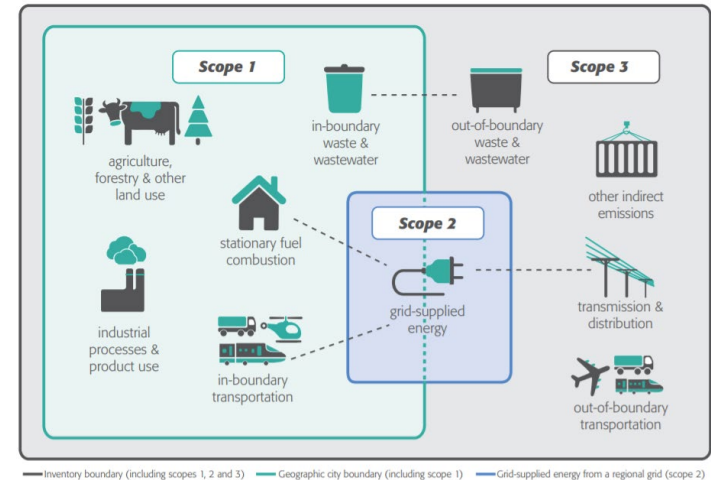
GHG Emissions are typically reported as Carbon Dioxide-Equivalent (CO₂e)

GHG Inventory Scopes

- **Scope 1:** Direct emissions
- **Scope 2:** Indirect emissions from electricity consumption
- **Scope 3:** All other indirect emissions (exported waste, out-of-boundary transportation, etc.)

Information-only / optional items:

- biofuels, ozone depleting substances, carbon offsets, RECs



What is a Community-Wide GHG Inventory?

Although community-wide GHG inventories do not necessarily include all of these activities, these are a majority of the emissions-generating activities that might be included:

- Stationary energy use (e.g. buildings)
 - Electricity
 - Natural Gas
 - Other fuels (propane, kerosene, etc)
- Mobile fuel use (gas and diesel)
 - Vehicles
 - Off-road equipment
- Industrial processes
- Solid waste decomposition/combustion
- Wastewater treatment (such as digester gas combustion or nitrogen discharge)
- Agriculture, Forestry, and Land use
- Fugitive Emissions

What is a Local Government Operations (LGO) GHG Inventory?

Although LGO GHG inventories do not necessarily include all of these activities, these are a majority of the emissions-generating activities that might be included:

- Energy consumption from buildings & facilities and streetlights & traffic signals
 - Electricity
 - Natural Gas
 - Steam
- Government owned/operated landfills
- Energy consumption in the supply of potable water & wastewater treatment
 - Electricity
 - Natural Gas
- On-road transportation from vehicle fleet, transit fleet, and employee commute
 - Gasoline
 - Diesel
- Process & fugitive emissions from natural gas distribution

How are GHG emissions calculated?

- Activity Data x Emissions Factor = Emissions Estimate

Activity Data	Emissions Factor	Emissions
Electricity Consumption (kilowatt hours)	CO ₂ emitted/kWh	CO ₂ emitted
Natural Gas Consumption (therms)	CO ₂ emitted/therm	CO ₂ emitted
Gasoline/Diesel Consumption (gallons)	CO ₂ emitted /gallon	CO ₂ emitted
Solid Waste Generated (tons)	CH ₄ emitted/ton of waste	CH ₄ emitted

Why is a GHG Inventory Important?

- This is a foundational element of your Climate Action Plan
- Your GHG inventory is a baseline that will allow your community to:
 - Forecast business-as-usual emissions
 - Create emissions reduction targets
 - Model potential reduction scenarios
 - Monitor emissions reduction progress
 - Make informed decisions on mitigation
 - Demonstrate accountability and leadership
 - Motivate community action
 - Recognize GHG emissions performance relative to similar communities



ICLEI Five Milestones for Climate Mitigation

Why is a GHG Inventory Important? (Cont)

- Create emissions reduction targets- **Science Based Targets**
 - Measurable, actionable, and time-bound climate targets
 - Aligned with:
 - Earth's limits (1.5°C)
 - The Global need of 50% reduction by 2030/ net zero by 2050
 - Societal sustainability goals
 - A 2030 target that reflects maximum effort toward or beyond a fair share of 50% CO₂ reductions by 2030

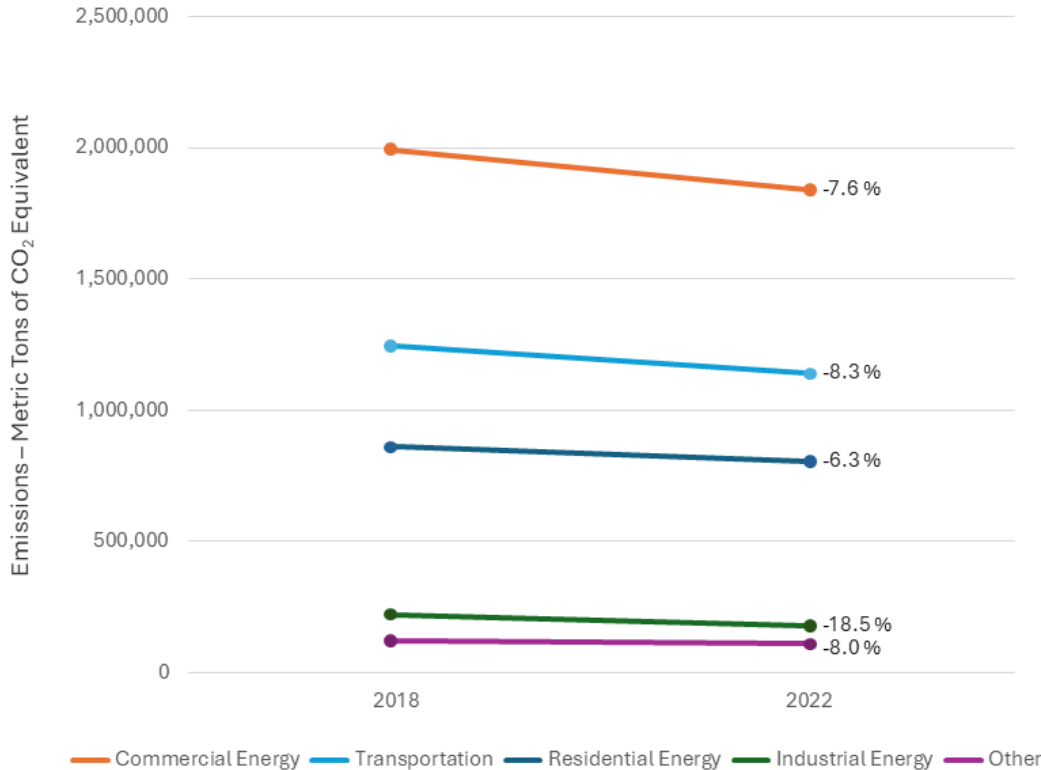
Why is a GHG Forecast Important?

- Another foundational element of your Climate Action Plan
- Projects future emissions based on a Business-as-Usual Scenario
 - BAU= “on the books” expected emissions reductions/growth before reduction strategies put in place
 - Examples: fuel efficiency standards for on-road vehicles, Xcel grid decarbonization, household/population growth
- GHG reduction strategies (e.g., energy efficiency) are then applied to forecasted emissions



Community-Wide Inventories

Figure 1: Community-wide Emissions Trends (2018 to 2022)



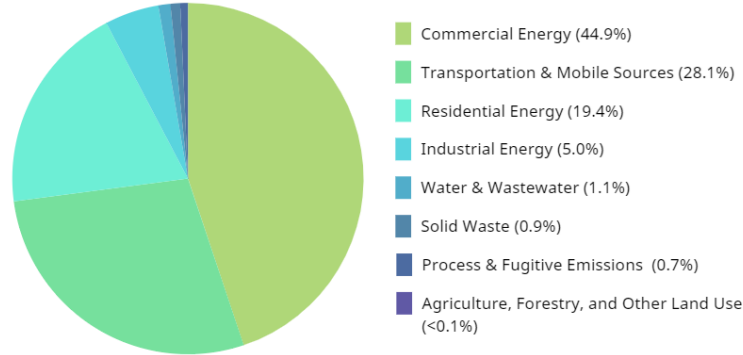
*Other includes Wastewater, Solid Waste, Process & Fugitive Emissions, and Agriculture, Forestry, and Other Land Use

Community-Wide Inventories

EMISSIONS AT A GLANCE 2018

- 1** Commercial Energy
44.9%
- 2** Transportation & Mobile Sources
28.1%
- 3** Residential Energy
19.4%

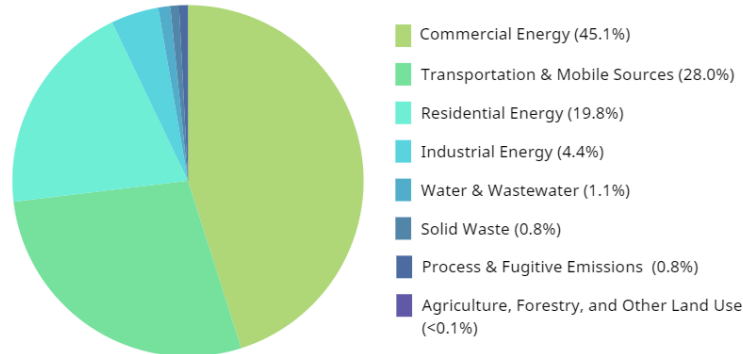
Figure 1: 2018 Community-wide Emissions by Sector



EMISSIONS AT A GLANCE 2022

- 1** Commercial Energy
45.1%
- 2** Transportation & Mobile Sources
28.0%
- 3** Residential Energy
19.8%

Figure 2: 2022 Community-wide Emissions by Sector



Community-Wide Inventories Results



Sector	Fuel or Source	2018 Usage	2022 Usage	Usage Unit	2018 Emissions (MT CO2e)	2022 Emissions (MT CO2e)	% Change (MT CO2e)
Residential Energy	Electricity - MG&E	572,601,784	585,818,271	kWh	426,307	393,263	-7.75%
	Electricity - Alliant	155,322,170	167,678,343	kWh	111,768	88,416	-20.89%
	Natural Gas - MG&E	56,900,296	56,825,703	Therms	302,633	302,236	-0.13%
	Natural Gas - Alliant	90,933	86,515	Therms	484	460	-4.96%
	Distillate Fuel Oil No. 2	77,320	63,467	MMBtu	5,757	4,726	-17.91%
	Propane	181,973	259,769	MMBtu	11,293	16,121	42.75%
	Wood	166,824	46,322	MMBtu	1,662	461	-72.26%
Residential Energy Total					859,904	805,683	-6.31%
Commercial Energy	Electricity - MG&E	1,613,279,463	1,634,207,147	kWh	1,201,099	1,097,053	-8.66%
	Electricity - Alliant	176,883,048	161,944,318	kWh	127,283	85,393	-32.91%
	Natural Gas - MG&E	112,413,044	111,515,384	Therms	597,886	593,111	-0.80%
	Natural Gas - Alliant	279	254	Therms	1	1	-0.00%
	Distillate Fuel Oil No. 2	328,595	346,278	MMBtu	24,466	25,783	5.38%
	Propane	488,451	537,642	MMBtu	30,313	33,365	10.07%
	Wood	444,047	428,291	MMBtu	4,423	4,266	-3.55%

Sector	Fuel or Source	2018 Usage	2022 Usage	Usage Unit	2018 Emissions (MT CO2e)	2022 Emissions (MT CO2e)	% Change (MT CO2e)
Commercial Energy	Coal	44,405		MMBtu	4,266		
Commercial Energy Total					1,989,737	1,838,972	-7.58%
Industrial Energy	Electricity - MG&E	151,265,613	133,393,672	kWh	112,618	89,548	-20.49%
	Electricity - Alliant	103,674,475	95,521,269	kWh	74,603	50,368	-32.49%
	Natural Gas - MG&E	6,034,324	6,471,869	Therms	32,027	34,349	7.25%
	Distillate Fuel Oil No. 1 - Blount Street	420	292	Gallons	4	3	-25.00%
	Distillate Fuel Oil No. 2 - Charter Street	96,675	522,964	Gallons	990	5,357	441.11%
	Distillate Fuel Oil No. 2 - Walnut Street	1,753	429	Gallons	18	4	-77.78%
	Industrial Energy Total					220,260	179,629
Transportation & Mobile Sources	Gasoline - On Road	1,816,215,478	1,634,236,501	VMT	749,736	658,868	-12.12%
	Diesel - On Road	193,761,811	195,255,160	VMT	289,698	281,231	-2.92%
	Gasoline - Offroad	510,015	511,228	VMT	36,133	36,219	0.24%
	Diesel - Offroad	1,677,357	1,681,372	MMBtu	124,064	124,361	0.24%
	CNG - Offroad	21,900	21,953	MMBtu	1,162	1,165	0.26%
	LPG - Offroad	174,693	175,116	MMBtu	10,741	10,767	0.24%
	Gasoline - Union Cab	108,833	65,238	Gallons	964	577	-40.15%

Community-Wide Inventories Results (Continued)

Sector	Fuel or Source	2018 Usage	2022 Usage	Usage Unit	2018 Emissions (MT CO2e)	2022 Emissions (MT CO2e)	% Change (MT CO2e)
Transportation & Mobile Sources	Diesel - Metro Transit	1,227,847	989,509	Gallons	12,539	10,105	-19.41%
	Diesel - Canadian Pacific	230	230	MMBtu	17	17	0.00%
	Diesel - Wisconsin & Southern	15,299	15,299	MMBtu	1,141	1,141	0.00%
	Jet Kerosene - Dane County Regional Airport	1,600,000	1,600,000	Gallons	15,652	15,652	0.00%
	Aviation Gasoline - Dane County Regional Airport	225,001	80,000	Gallons	1,876	667	-64.45%
Transportation & Mobile Sources Total					1,243,723	1,140,770	-8.28%
Solid Waste	Methane - Demetral Landfill (Closed)	7	7	Pounds	0.00000085960	0.00000085960	0.00%
	Methane - Sycamore Landfill (Closed)	0.0003	0.0003	Pounds	0.0000038612	0.0000038612	0.00%
	Methane - Olin Landfill (Closed)	0.0001	0.0001	Pounds	0.0000016856	0.0000016856	0.00%
	Methane - Mineral Point Landfill (Closed)	0.00008	0.00008	Pounds	0.000001036	0.000001036	0.00%
	Methane - Greentree Landfill (Closed)	0.0003	0.0003	Pounds	0.0000035084	0.0000035084	0.00%

Sector	Fuel or Source	2018 Usage	2022 Usage	Usage Unit	2018 Emissions (MT CO2e)	2022 Emissions (MT CO2e)	% Change (MT CO2e)
Solid Waste	Combustion of Landfill Gas - Rodefild Landfill	813,669,278	324,489,031	Cubic Feet / Year	109	12	-88.99%
	In-jurisdiction Landfills - Rodefild Landfill	1,240	1,084	Metric Tons CH4	34,717	30,353	-12.57%
	In-jurisdiction Landfills - WM Madison Prairie Landfill	13	13	Metric Tons CH4	370	370	0.00%
	Biowaste Composting - Earth Stew	30	23	Tons	5	4	-20.00%
	Biowaste Composting - Curbside Composter	4,339	4,339	Tons	767	767	0.00%
	Biowaste Composting - Streets Division		5	Tons		1	
	Green Waste Composting - Streets Division	18,472	18,422	Tons	2,604	2,597	-0.27%
Solid Waste Total					38,572	34,104	-11.58%

Community-Wide Inventories Results (Continued)



Sector	Fuel or Source	2018 Usage	2022 Usage	Usage Unit	2018 Emissions (MT CO2e)	2022 Emissions (MT CO2e)	% Change (MT CO2e)
Water & Wastewater	Supply of Potable Water - Madison Water Utility (MG&E)	17,655,672 / 70,152	17,762,259 / 80,427	kWh / Therms	13,518	12,352	-8.63%
	Supply of Potable Water - Madison Water Utility (Alliant)	3,458,685	3,438,199	kWh	2,489	1,813	-27.16%
	Wastewater Treatment Energy Use - Madison Metropolitan Sewerage District	33,860,320 / 789,495	32,535,735 / 888,410	kWh / Therms	29,408	26,567	-9.66%
	In-boundary Process N2O from Wastewater Treatment - Madison Metropolitan Sewerage District	261,600	261,600	People Served	607	607	0.00%
	Imported Process N2O from Wastewater Treatment - Madison Metropolitan Sewerage District	162,400	162,400	People Served	377	377	0.00%

Sector	Fuel or Source	2018 Usage	2022 Usage	Usage Unit	2018 Emissions (MT CO2e)	2022 Emissions (MT CO2e)	% Change (MT CO2e)
Water & Wastewater	In-boundary Process N2O from Effluent Discharge - Madison Metropolitan Sewerage District	261,600	261,600	People Served	1,904	1,904	0.00%
	Imported Process N2O from Effluent Discharge - Madison Metropolitan Sewerage District	162,400	162,400	People Served	1,182	1,182	0.00%
	In-boundary Combustion of Digester Gas - Madison Metropolitan Sewerage District	534,923	534,923	scf / Day	0.30917	0.30917	0.00%
	Imported Combustion of Digester Gas - Madison Metropolitan Sewerage District	332,077	332,077	scf / Day	0.19193	0.19193	0.00%
	In-boundary Flaring of Digester Gas - Madison Metropolitan Sewerage District	43,065	43,065	Cubic Feet / Day	0	0	0.00%

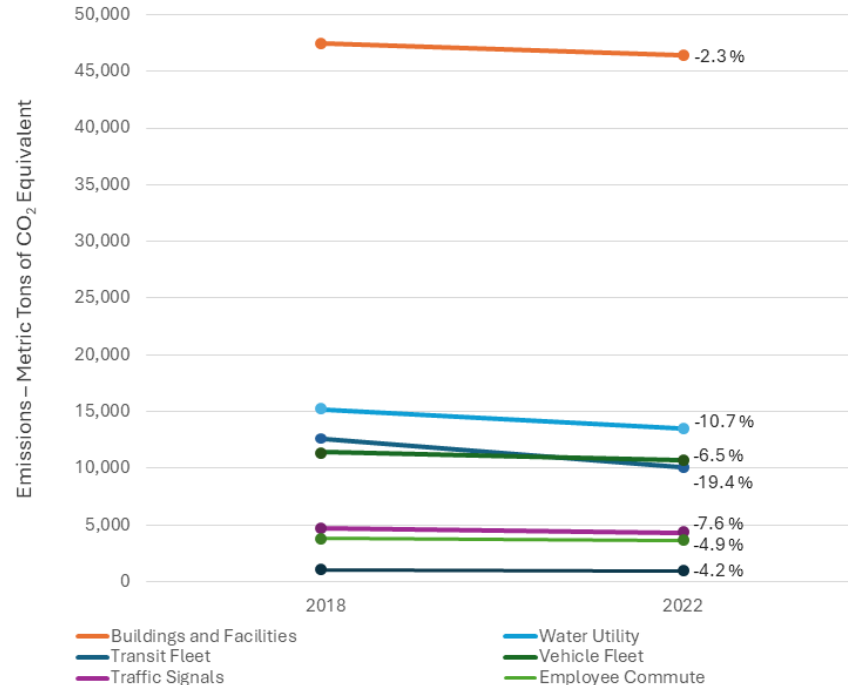
Community-Wide Inventories Results (Continued)

Sector	Fuel or Source	2018 Usage	2022 Usage	Usage Unit	2018 Emissions (MT CO2e)	2022 Emissions (MT CO2e)	% Change (MT CO2e)
Water & Wastewater	Imported Flaring of Digester Gas - Madison Metropolitan Sewerage District	26,735	26,735	Cubic Feet / Day	0	0	0.00%
	Septic Systems	130	130	People Served	16	16	0.00%
Water & Wastewater Total					49,501	44,818	-9.46%
Agriculture, Forestry, and Other Land Use (AFOLU)	Electricity - Alliant	959,443	806,472	kWh	690	425	-38.41%
Agriculture, Forestry, and Other Land Use Total					690	425	-38.41%
Process & Fugitive Emissions	Fugitive Emissions from Natural Gas Distribution - MG&E	175,417,816	174,893,383	Therms	30,434	30,343	0.00%
	Fugitive Emissions from Natural Gas Distribution - Alliant	86,769	86,769	Therms	15	15	0.00%
	Hydrofluorocarbon & Refrigerant Emissions - R-410a	0.41206031862	0.401347601	Metric Tons	711	692	-2.67%
	Hydrofluorocarbon & Refrigerant Emissions - R-134a	0.0281227	0.0281227	Metric Tons	37	37	0.00%

Sector	Fuel or Source	2018 Usage	2022 Usage	Usage Unit	2018 Emissions (MT CO2e)	2022 Emissions (MT CO2e)	% Change (MT CO2e)
Process & Fugitive Emissions	Hydrofluorocarbon & Refrigerant Emissions - R-22	0.0606594746306	0.0456909264206	Metric Tons	107	80	-25.23%
Process & Fugitive Emissions Total					31,304	31,167	-0.44%
Total Gross Emissions					4,433,691	4,075,568	-8.08%

Local Government Operations Inventories

Figure 1: Government Operations Emissions Trends (2018 to 2022)

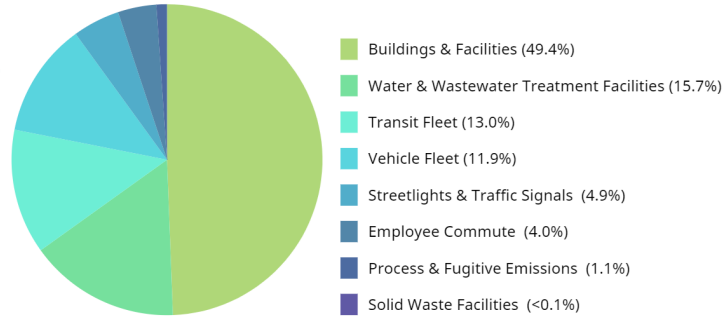


Local Government Operations Inventories

EMISSIONS AT A GLANCE 2018

- 1** Buildings & Facilities
49.4%
- 2** Water & Wastewater Treatment Facilities
15.7%
- 3** Transit Fleet
13.0%

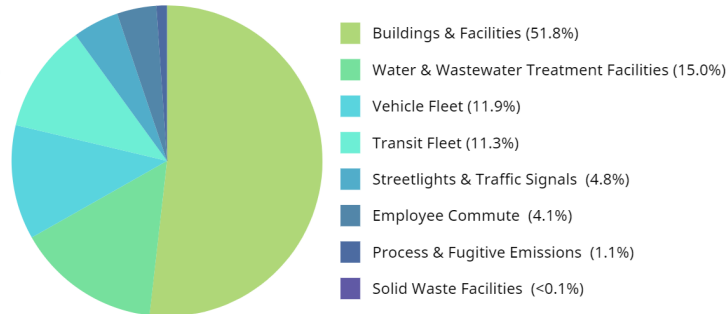
Figure 1: 2018 Government Operations Emissions by Sector



EMISSIONS AT A GLANCE 2022

- 1** Buildings & Facilities
51.8%
- 2** Water & Wastewater Treatment Facilities
15.0%
- 3** Vehicle Fleet
11.9%

Figure 2: 2022 Government Operations Emissions by Sector



Local Government Operations Inventories Results

Sector	Fuel or Source	2018 Usage	2022 Usage	Usage Unit	2018 Emissions (MT CO2e)	2022 Emissions (MT CO2e)	% Change (MT CO2e)
Buildings & Facilities	Grid Electricity - City (Residential) - MG&E	480	96	kWh	0.35736	0.064445	-129.29%
	Grid Electricity - City (Commercial) - MG&E	20,756,653	27,421,263	kWh	15,453	18,408	19.12%
	Grid Electricity - Institutional - Alliant	27,534,431	27,450,821	kWh	19,813	14,475	-26.94%
	Grid Electricity - City-owned Building - Alliant	1,221,275	1,301,615	kWh	879	686	-21.96%
	Natural Gas - City (Residential) - MG&E	109	80	Therms	1	0.42549	-57.45%
	Natural Gas - City (Commercial) - MG&E	972,738	974,531	Therms	5,174	5,183	0.17%
	Steam - City County Building	16,684	9,865	Pounds	4,058	4,206	3.65%

Sector	Fuel or Source	2018 Usage	2022 Usage	Usage Unit	2018 Emissions (MT CO2e)	2022 Emissions (MT CO2e)	% Change (MT CO2e)
Buildings & Facilities	Steam - Monona Terrace	8,610	8,064	Pounds	2,094	3,438	64.18%
Buildings & Facilities Total					47,472	46,396	-2.27%
Street Lights & Traffic Signals	Grid Electricity - MG&E	6,243,066	6,384,827	kWh	4,648	4,286	-7.79%
	Grid Electricity - Alliant	65,631	97,198	kWh	47	51	8.51%
Street Lights & Traffic Signals Total					4,695	4,337	-7.63%
Vehicle Fleet	On Road - Gasoline	190,762	302,304	Gallons	1,685	2,655	57.57%
	On Road - Diesel	441,979	388,861	Gallons	4,513	3,970	-12.03%
	On Road - Propane	168		Gallons	1		
	On Road - Biodiesel		57,124	Gallons		0	
	On Road - Ethanol		449	Gallons		4	
	On Road - Electric		40,812	kWh		22	
	Off Road - Gasoline	1,681	8,872	Gallons	15	79	426.67%
	Off Road - Diesel	77,657	118,247	Gallons	793	1,207	52.21%
	Off Road - Propane	857	9,198	Gallons	5	51	920.00%
	Biodiesel - B2	143,566		Gallons	1,436		
	Biodiesel - B5	82,014	91,592	Gallons	795	888	11.70%

Local Government Operations Inventories Results (Continued)

Sector	Fuel or Source	2018 Usage	2022 Usage	Usage Unit	2018 Emissions (MT CO2e)	2022 Emissions (MT CO2e)	% Change (MT CO2e)
Vehicle Fleet	Biodiesel - B11	238,629		Gallons	2,655		
	Biodiesel - B20		220,019	Gallons		3,970	
	Biodiesel - B100		12,692	Gallons		0	
Vehicle Fleet Total					11,411	10,673	-6.47%
Transit Fleet	Diesel Metro Transit	1,227,847	989,509	Gallons	12,539	10,105	-19.41%
Transit Fleet Total					12,539	10,105	-19.41%
Employee Commute	Gasoline	8,721,510	7,925,533	Miles	3,727	3,393	-8.96%
	Diesel	64,273	290,521	Miles	104	254	144.23%
	Electric		69,989	Miles		12	
	Public Transit - Bus	436,166	158,222	Passenger Miles/Year	25	9	-64.00%
Employee Commute Total					3,856	3,668	-4.88%
Solid Waste Facilities	CH4 - Demetral Landfill (Closed)	7	7	Pounds	0.00000085960	0.00000085960	0.00%
	CH4 - Sycamore Landfill (Closed)	0.0003	0.0003	Pounds	0.0000038612	0.0000038612	0.00%
	CH4 - Mineral Point Landfill (Closed)	0.0001	0.0001	Pounds	0.000001036	0.000001036	0.00%
	CH4 - Olin Landfill (Closed)	0.00008	0.00008	Pounds	0.0000016856	0.0000016856	0.00%

Sector	Fuel or Source	2018 Usage	2022 Usage	Usage Unit	2018 Emissions (MT CO2e)	2022 Emissions (MT CO2e)	% Change (MT CO2e)
Solid Waste Facilities	CH4 - Greentree Landfill (Closed)	0.0003	0.0003	Pounds	0.0000035084	0.0000035084	0.00%
Solid Waste Facilities Total					0	0	0.00%
Water & Wastewater Facilities	Grid Electricity - Madison Water Utility - Alliant	2,237,410	2,136,584	kWh	1,610	1,127	-30.00%
	Grid Electricity - Madison Water Utility - MG&E	17,655,672	17,762,259	kWh	13,145	11,924	-9.29%
	Natural Gas - Madison Water Utility - MG&E	70,152	80,427	Therms	373	428	14.75%
Water & Wastewater Facilities Total					15,128	13,479	-10.90%
Process & Fugitive Emissions Total	Fugitive Emissions from Natural Gas Distribution - MG&E	1,042,999	1,055,038	Therms	181	183	1.10%
	Hydrofluorocarbon & Refrigerant Emissions - R-410a	0.41206031862	0.401347601	Metric Tons	711	692	-2.67%
	Hydrofluorocarbon & Refrigerant Emissions - R-134a	0.0281227	0.0281227	Metric Tons	37	37	0.00%

Local Government Operations Inventories Results (Continued)

Sector	Fuel or Source	2018 Usage	2022 Usage	Usage Unit	2018 Emissions (MT CO2e)	2022 Emissions (MT CO2e)	% Change (MT CO2e)
Process & Fugitive Emissions Total	Hydrofluorocarbon & Refrigerant Emissions - R-22	0.060659474 6306	0.045690926 4206	Metric Tons	107	80	-25.23%
Process & Fugitive Emissions Total					1,036	992	-4.25%
Total Government Operations Emissions					96,137	89,650	-6.75%

Net-zero municipal by 2030

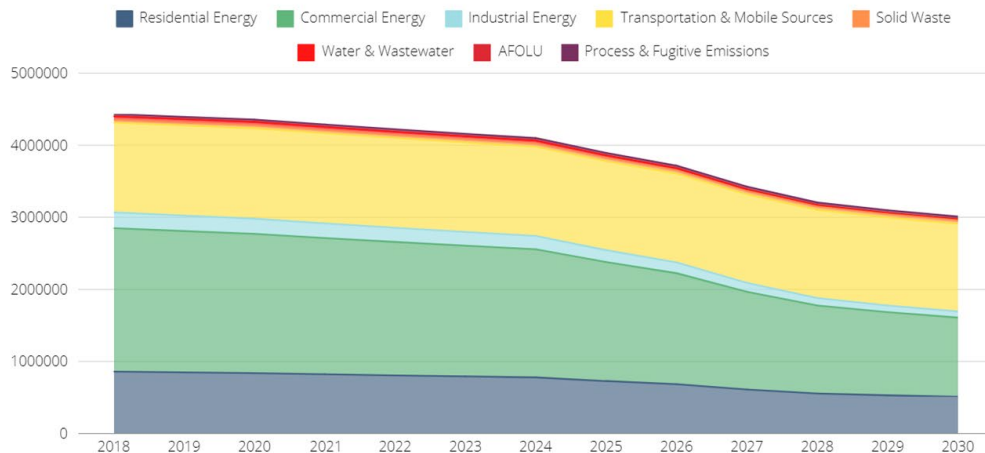
Net-zero community-wide by 2050

Science-Based Target

Science-Based Targets are calculated climate goals, in line with the latest climate science, that represent a community's fair share of the global ambition necessary to meet the Paris Agreement commitment. Community education, involvement, and partnerships will be instrumental to achieve a science-based target.

Using its 2005 baseline, the City of Madison calculated its 2030 local government and 2050 community-wide emissions goal, and is maintaining that same target with addition of the newer inventories.

BAU Forecast



Business-As-Usual (BAU) Forecast

The BAU forecast is a projection of emissions through the year 2030. The projected emissions estimated population growth, changes in automotive fuel efficiency standards, and changes to the carbon intensity of grid electricity.

Madison's 2018 emissions were 4,433,691 metric tons carbon dioxide equivalent (MT CO₂e). Based on population growth, increasing on-road vehicle fuel efficiency, and utility decarbonization plans, Madison's 2030 emissions will be 3,008,971 MT CO₂e. **This is a 32.1% reduction in emissions.**

Key Takeaways - Community-Wide

- Commercial Energy is the largest emitting sector within Madison at 44.9% in 2018 and 45.1% in 2022
- Transportation and Residential Energy are the next two highest emitting sectors totalling 47.5% of the inventory in 2018 and 47.8% in 2022
- Emissions have decreased 358,123 MT CO₂e between 2018 and 2022, an 8.1% decrease

Next Steps:

- Energy
 - Transition to renewable power for homes, businesses, and city facilities
- Transportation
 - Increase bike paths around the community
 - Expand electric vehicle charging

Key Takeaways - LGO

- Buildings & Facilities is the largest emitting sector within Madison at 49.4% in 2018 and 51.8% in 2022
- Water & Wastewater Treatment Facilities, Transit Fleet, and Vehicle Fleet are the next three highest emitting sectors totalling 40.6% of the inventory in 2018 and 38.2% in 2022
- Emissions have decreased 6,487 MT CO₂e between 2018 and 2022, a 6.8% decrease

Next Steps:

- Energy
 - Transition to renewable power for city facilities
- Transportation
 - Electrify Bus Rapid Transit
 - Expand electric vehicle charging



Key Principles for Next Steps

1. It is critical to have a **SBT**
2. Planning should incorporate rapidly **changing trends**
3. Programs should take a **holistic approach**, including health, resilience, and equity
4. Local government can't do it alone. **Collaboration with state and utilities** is essential
5. Inventories provide the foundation for **informed decisions and transparency**