

City of Helena
Energy Use Inventory &
Greenhouse Gas Assessment

(Final accepted 3/10/22 by CCB; prepared by Patrick Judge using 2020 data)

Executive Summary

2020 marks an important year in the history of Helena's energy & carbon reduction efforts. The 2009 Climate Action Plan (2009 CAP)¹ documented impressive reductions of approximately 20% in both energy use and associated carbon emissions between the years 2001 and 2007 (looking at municipal government operations only). It also established a goal of further reducing these numbers "20% by 2020," as compared to 2007 levels. Now, at the end of that planning horizon, it's appropriate to evaluate the progress that's been made, and apply the lessons learned to the City's future goals (including the target of "100% clean electricity by 2030").² The following table summarizes the key metrics:

Summary Table

	2001	2007	2020	% Change
Energy (mmBtu)	115,341	89,856	83,631	-7%
CO ₂ e (U.S. tons)	12,691	10,397	7,231	-30%

While the energy use reductions came in less the desired 20%, the City should still be proud of the 7% savings. In addition to the environmental benefits of having more efficient operations, the avoidance of 6,225 mmBtu in energy purchases into substantial financial benefits to the taxpayers. In comparison to 2007 usage levels, the City is avoiding \$131,000 in avoided energy purchases annually.³ And compared to the 2001, the savings are even greater: the avoidance of 31,710 mmBtu is worth more than \$667,000 annually (see **Figure 5** below).

With respect to carbon emissions, the news is even better: with a 30% reduction, the City far surpassed its "20% by 2020" goal. As to the question of how a 30% decline in greenhouse gas (GHG) emissions can be achieved with a 7% reduction in energy use, part of the explanation has to do with electricity purchases. Simply put, the electrical grid has gotten substantially cleaner over the period 2007-2021. Utilities in the Pacific Northwest continue to shift their mix of generating resources away from carbon-

¹ The 2009 Climate Action Plan can be accessed at the following link:
https://www.helenamt.gov/fileadmin/user_upload/Commission/Citizen_Conservation_Board_Document_s/Climate_Task_Force_Report_8-19-09.pdf

² See Resolution 20592 (adopted 2-24-20) can be viewed at the following link:
<https://www.helenamt.gov/government/departments/city-commission/ordinances-resolutions>

³ This calculation is based on the City's 2022 average price of energy purchased, \$21.05/mmBtu.

intensive fuels (such as coal) and toward renewables (such as wind and solar), as can be seen in **Table 1** and **Figure 3** below. In that sense, the City was assisted in its efforts by broader societal, economic, and technological trends.

As a final note, it's important to recognize that the absolute measures of energy use and carbon emissions reported above have not been "normalized" to account for changes in weather, economic conditions, etc. Most significantly, they have not been adjusted to account for the impact of the COVID-19 pandemic. To be fair, it's likely that some portion of the energy savings stems from pandemic-related changes (teleworking, reduction in some services such as transit, etc.) that may be temporary in nature. As a consequence, it should not be surprising to see at least some "bounce-back" when the 2021 dataset becomes available. Still, the overall downward trend in energy use, associated emissions, and associated expenditures over the past 20 years is undeniable, and should be both celebrated and continued.

Updated Charts

The overall methodology employed in this analysis tracks closely the approach taken in the Helena Sustainability Report 2020 (HSR 2020).⁴ This section contains updates to each of the charts contained in Chapter 3 of that report.

Figure 1 shows the energy use totals from all four test years (2001, 2007, 2019, 2020). The "goal-setting brackets" were originally developed in the 2009 CAP (Appendix H), and while the goal of landing within those brackets was not achieved, the reductions are still important and impressive. *Note that due to a recently discovered error, the 2019 energy use value has been revised upward from 86,248 mmBtu to 92,821 mmBtu.*

Figure 2 displays the successful achievement of the "20% by 2020" goal. As mentioned previously, the City saw an impressive 30% reduction in GHG emissions since 2007, and even more impressive, a 43% decline since 2001.

Table 1 and **Figure 3** illustrate the reduction in the carbon intensity of Pacific Northwest grid power since 2007.

Figure 4 shows the detailed breakdown of the 6,560 tonnes (7,231 U.S. tons) of CO₂e emissions attributable to the City government's operations in 2020. This figure was generated as one of the outputs of the ICLEI ClearPath program.

Table 2 gives additional details about energy consumption, costs, and associated GHG emissions (with slightly different categories than those used in **Figure 4**).

⁴ The 2020 City of Helena Sustainability Report can be found at the following link: https://www.helenamt.gov/fileadmin/user_upload/Commission/Citizen_Conservation_Board_Documents/Helena_Sustainability_Report_2020.pdf

Figure 5 captures visually the magnitude of energy bill savings arising from the City's efficiency improvements – all the more impressive given the growth in population and City services over that timeframe.

Figure 1

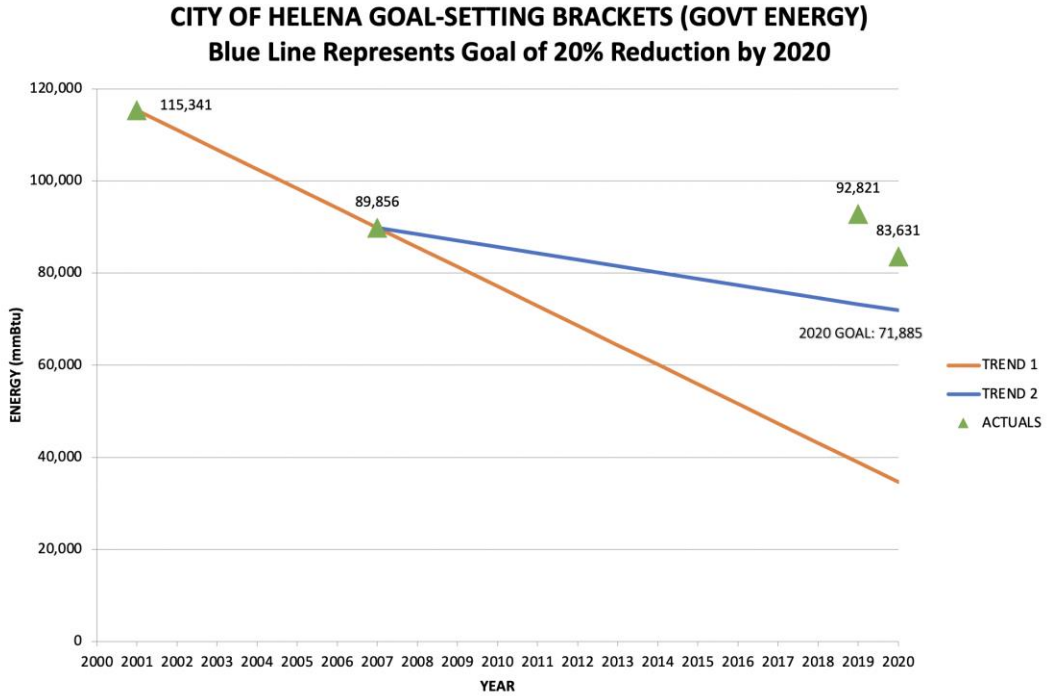


Figure 2

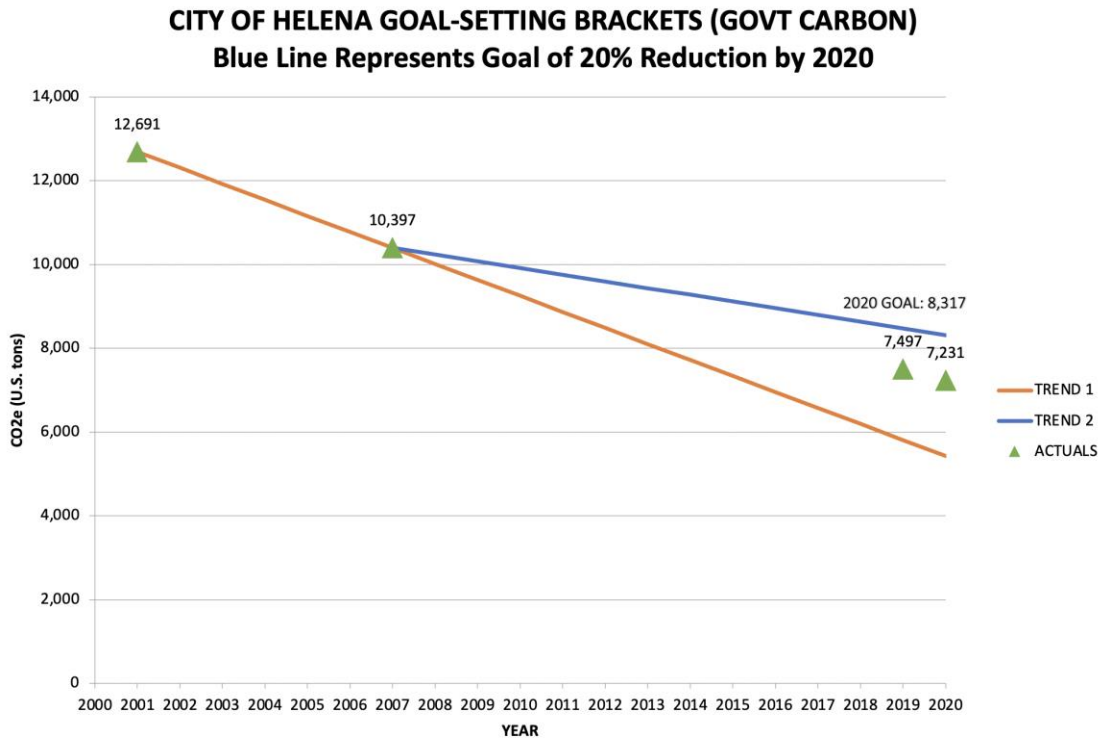
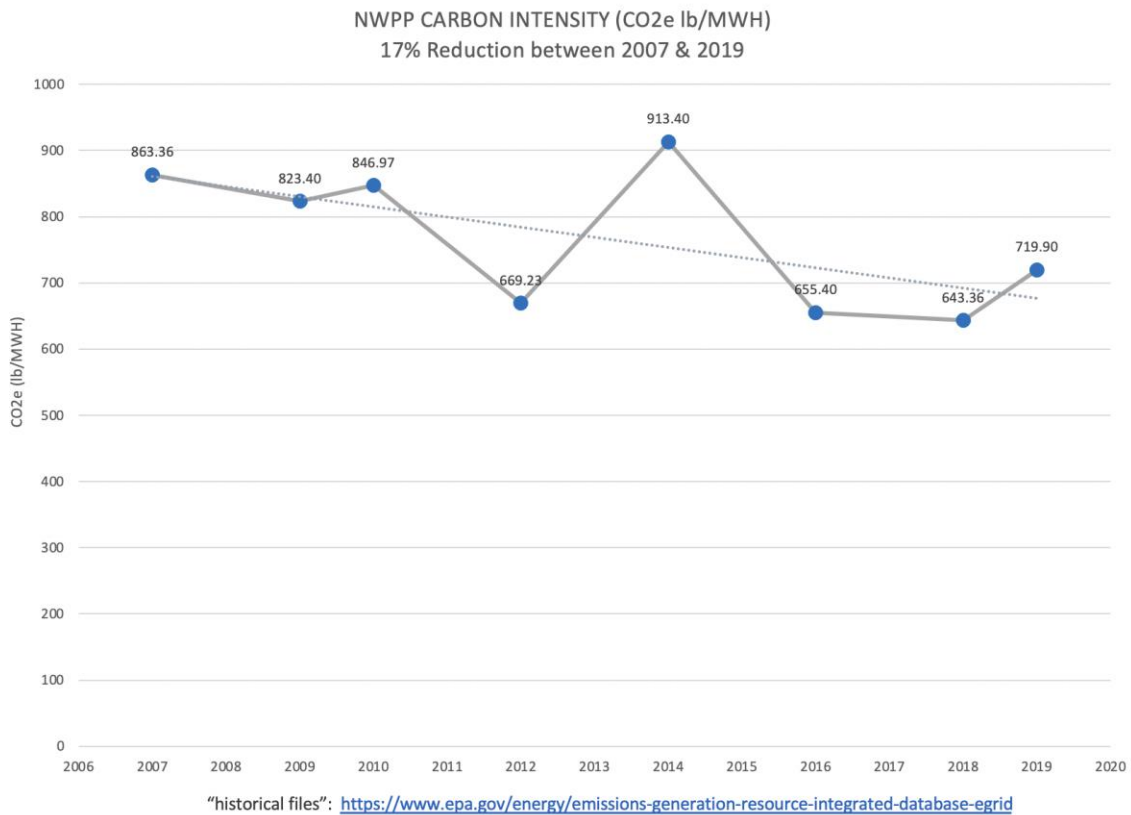


Table 1⁵

NWPP GHG	2007 (lb/MWh)	2019 (lb/MWh)	% Change
CO ₂	858.79	715.241	-16.7%
CH ₄	0.01634	0.068	+316%
N ₂ O	0.01364	0.010	-26.7%
CO₂e	863.36	719.90	-16.6%

As explained in the HSR 2020 (p. 35): *the CO₂e values above represent a weighted sum of the three different GHGs considered here. Such a sum takes into account their varying values of Global Warming Potential (GWP). For example, according to the IPCC's 5th Assessment Report, on a 100-year time horizon, methane is 28 times more powerful than carbon dioxide (always given a GWP reference value of 1), and nitrous oxide is 265 times more powerful.⁶*

Figure 3



⁵ The "eGRID 2019" dataset was released 2/23/2021, and can be accessed here:

<https://www.epa.gov/egrid/summary-data>

⁶ https://ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_1.pdf

Figure 4 (2020)
(emissions in tonnes)

Inventory By Sector

CO2e by sector for the selected inventory year.

Sector	CO2e
Buildings & Facilities	1,508
Street Lights & Traffic Signals	641
Vehicle Fleet	1,760
Employee Commute	455
Solid Waste Facilities	124
Water & Wastewater Treatment Facilities	2,070

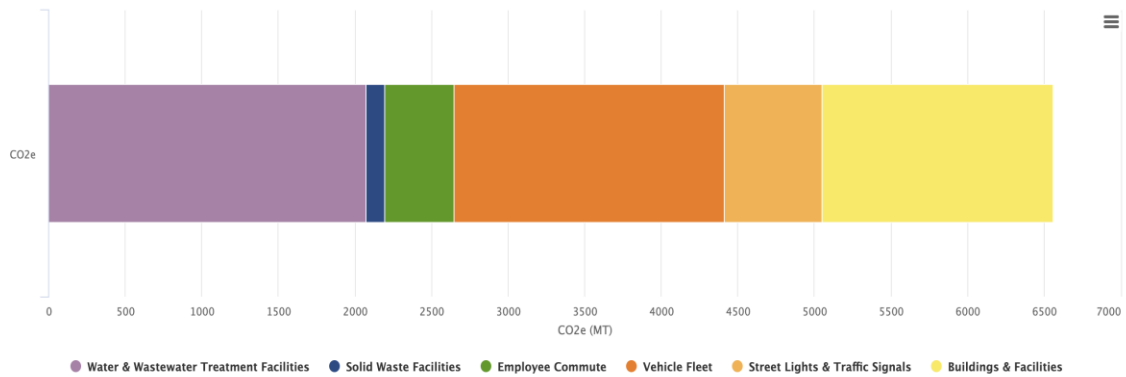


Figure 4 Comparison Table
(metric tons of CO2e)

Sector	2019	2020	% Change
Buildings & Facilities	1,787	1,508	-15.6%
Street Lights & Traffic Signals	700	641	-8.4%
Vehicle Fleet & Transit	1,975	1,760	-10.9%
Employee Commute	455	455	(assumed constant)
Solid Waste (Internal)	124	124	(assumed constant)
Water & Wastewater Treatment	1,760	2,070	+17.6%
TOTAL	6,801	6,558	-3.6%

Table 2

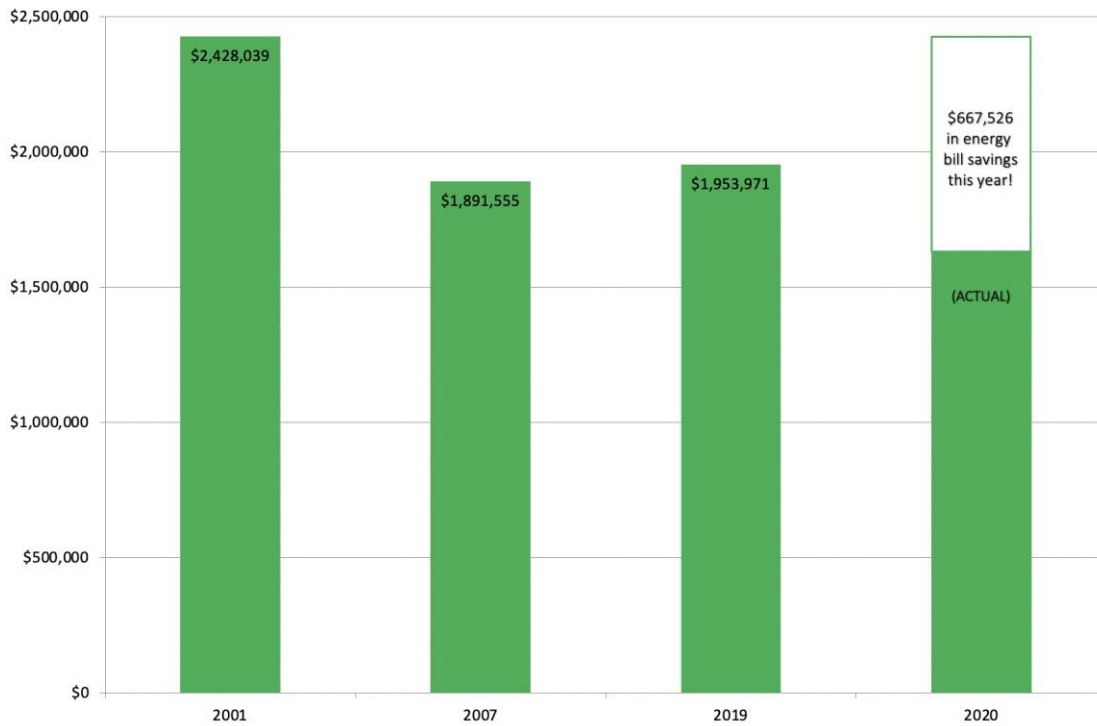
ENERGY SOURCE	AMOUNT	MMBTU	COST*	AVG PRICE*	CO2e (U.S. Tons)
ELECTRICITY	9,734,570 kWh	33,223	\$1,107,364	\$0.11/kWh	3,503
NATURAL GAS	195,806 therm	19,581	\$134,318	\$0.69/therm	1,147
GASOLINE	73,225 gal	9,150	\$152,516	\$2.08/gal	709
DIESEL	109,414 gal	15,104	\$227,947	\$2.08/gal	1,231
COMMUTE	52,565 gal	6,573	NA	NA	502
WASTE	NA	NA	NA	NA	138
2020 TOTAL		83,631	\$1,622,145	\$21.05/mmBtu	7,231
2019 TOTAL		92,821	\$1,802,478	\$20.90/mmBtu	7,497
2007 TOTAL		89,856	\$1,990,059	\$25.06/mmBtu	10,397
2001 TOTAL		115,341	\$1,233,607	\$11.72/mmBtu	12,691

Note: MMBTU conversions and CO₂e data are outputs from ICLEI's ClearPath software.

*The cost of energy to the City & Avg Price figures do not include Employee Commute.

Figure 5

**City of Helena Municipal Govt Energy Costs
Based on 2020 Prices (\$21.05/mmBtu)**



Appendix A: List of Abbreviations

- Btu** – British Thermal Unit (unit of energy often used as a common metric for electricity, natural gas, gasoline, etc. – roughly equivalent to the energy in a kitchen match)
- CACP** – Clean Air and Climate Protection (software used in 2009 Climate Action Plan)
- CAP (or 2009 CAP)** – Helena's 2009 Climate Action Plan
- CH₄** – Methane (a powerful greenhouse gas)
- CO₂** – Carbon Dioxide (the most prevalent anthropogenic greenhouse gas)
- CO₂e** – CO₂ equivalent (includes the effects of other greenhouse gases as well as CO₂)
- gal** – gallon (unit of fuel, used for gasoline or diesel)
- EPA** – U.S. Environmental Protection Agency
- GHG** – Greenhouse Gas
- GWP** – Global Warming Potential (weighting factors representing the relative strength of GHGs)
- HSR (or HSR 2020)** – City of Helena Sustainability Report 2020
- ICLEI** – International Council for Local Environmental Initiatives (organization)
- IPCC** – Intergovernmental Panel on Climate Change
- kg** – standard unit of mass in the metric system
- kW** – kilowatt (unit of electrical power = 1,000 watts)
- kWh** – kilowatt-hour (unit of electrical energy = 1,000 watt-hour)
- lb** – pound (imperial unit of force or mass, depending on context; 1/2000 of a U.S. ton)
- mmBtu** – millions of BTUs (each "m" = one-thousand); used as a uniform unit for energy
- MT** – Metric Tons (aka "tonnes"); convert to U.S. tons by multiplying by 1.1023
- MW** – megawatt (unit of electrical power = 1,000,000 watts)
- MWh** – megawatt-hour (unit of electrical energy = 1,000,000 watt-hour)
- N₂O** – Nitrous Oxide (a powerful greenhouse gas)
- NO_x** – Nitrogen Oxides (a class of air pollutants regulated by the EPA)
- NWE** – NorthWestern Energy (electric & natural gas utility serving the Helena area)
- NWPP** – Northwest Power Pool (sub-area of the WECC representing the Pacific Northwest)
- VMT** – Vehicle Miles Traveled
- WECC** – Western Electricity Coordinating Council (transmission area for western U.S.)

Appendix B: Methodology

General Conventions

- energy use & cost data used in this 2021 report: calendar year (CY) 2020
- software: ICLEI ClearPath
- GWP values: IPCC 5th Assessment (most recent), 100 Year Values
- carbon emissions are expressed in “U.S. tons of CO₂e” for consistency with the 2009 CAP
- The outputs generated by ClearPath are in metric tons (1 MT = 1000 kg), which is the international convention. These are converted to U.S. tons (aka "short tons") by multiplying by the following conversion factor: (2204.6 lbs per MT / 2000 lbs per short ton = 1.1023)

ClearPath Training Resources

- 1) General ClearPath
<http://icleiusa.org/clearpath/>
- 2) ClearPath User Guides (password required)
<https://clearpath.icleiusa.org/>
- 3) ClearPath online training modules (password required – unsure if this is still available)
<http://icleiusa.org/member-resources/>

"ClearPath is built for ease of use, but as part of ICLEI membership, ICLEI provides additional support through in-depth training on each step of ClearPath's setup and use. These trainings are delivered through both live webinars and through online, self-paced learning modules that you can access at any time."

ClearPath Reports

The following report options proved to be the most useful:

- Report 1 – Inventory by Scope (graph)
 - Scope 1 = Gas (combustion within city boundary)
 - Scope 2 = Electricity (grid-delivered electricity, district heating, etc.)
 - Scope 3 = Emissions not under the control of the City (employee commute, waste)
- Report 2 – Inventory by Scope and Sector (graph)
 - Scope 1 = Gas (combustion within city boundary)
 - Scope 2 = Electricity (grid-delivered electricity, district heating, etc.)
 - Scope 3 = Emissions not under the control of the City (employee commute, waste)
- Report 3 – Inventory by Sector (graph)
- Report 5 – Detailed Report (data)

City Government Analysis (“Government Track” in ClearPath)

- electricity (kWh) and natural gas (therm)
 - usage and cost data from DEQ (Dave LeMieux)
 - see more detailed notes below
- for simplicity, grouped all natural gas accounts under “buildings & facilities” in ClearPath
- entered electricity accounts under the following ClearPath categories:
 - buildings & facilities
 - streetlights & traffic signals
 - included SILDs, parking garages, park lighting, scoreboards, etc.
 - water & wastewater treatment facilities (electricity only)
 - included reservoirs, lift stations, wells, pumps, ponds, headgates, etc.
- vehicle fuels (gasoline and diesel)

- usage and cost data from Fleet Coordinator JD Foreman, & Brandi Dalton
- combined fleet AND transit
(although they could be analyzed separately in ClearPath)
- percent biofuel: assumed E-10 for all gasoline – ENTER 10% ethanol in all fields
curious that this percentage doesn't seem to change anything
perhaps "Ethanol" needs to be selected instead of "Gasoline"
(this wasn't done for CY 2019 or 2020)

- to convert energy totals to common units of mmBtu . . .
multiply kWh by 0.003412
multiply THERM by 0.1
multiply gasoline gallons by ≈ 0.120286
multiply diesel gallons by ≈ 0.137381
- electricity factor set: most recent WECC NWPP eGrid values
(curious that the 2019 values were higher than 2018 – generally, the grid trends cleaner)

	<u>2018</u>	<u>2019</u>
CO2 lbs/MWh:	639.037	715.241
CH4 lbs/MWh:	0.064	0.068
N2O lbs/MWh:	0.009	0.010
CO2e lbs/MWh:	643.36	719.90

“historical files”:

<https://www.epa.gov/energy/emissions-generation-resource-integrated-database-egrid>

- city government waste (e.g. waste generated by city employees in their offices)
Due to unknowns regarding how the waste figures were calculated in the 2009 CAP, the current analysis substitutes a simple linear extrapolation of the growth that occurred in this category between 2001 and 2007. While less-than-ideal, this approach seemed acceptable due to the relatively minor role played by this sector in the overall inventory in the previous analysis.

Linear equation used for calculating emissions from City govt waste category:
tons of CO₂e = (2)(Year) - 3900

This formula yields the following values:

102 tons in 2001, 114 tons in 2007, and 138 tons in 2019.

The first two values are indeed in agreement with the 2009 CAP (p. 10).

Stick with the 2019 value for 2020 (office garbage was probably less, due to COVID).

To obtain that value:

Factor Set:	2020, 100% Mixed MSW
Calculator:	Waste Generation (Alternative)
Name?	2020 Landfilled Waste Estimate
Waste Characterization?	Mixed MSW
Direct Entry Record?	No
Total Waste Landfilled?	82.67 Tons
Methane Collection?	No
Result:	125 MT = 138 tons

City Government – Employee Commute

- 2020 employee commute was probably artificially depressed by COVID
- so again, use the 2019 values to be conservative
had some difficulty getting the emissions to agree, even using the same factor sets . . .
2020 Employee Commute - Gas

VMT: 798,935
 Cars: 54%
 Light Trucks: 43.6%
 Heavy Trucks: 2.4%

2020 Employee Commute - Ethanol
 VMT: 52,969
 Biofuel Blend: 85%
 Cars: 100%

2020 Employee Commute - Diesel
 VMT: 57,509
 Cars: 0%
 Light Trucks: 16.4%
 Heavy Trucks: 83.6%

. . . so instead, used "Direct Entry Record" with the following 2019 values:

2020 Employee Commute - Gas
 Fuel: 41,270 gallons
 CO2: 365.762 MT

2020 Employee Commute - Ethanol (E85)
 Fuel: 3,033 gallons
 CO2: 4.887 MT

2020 Employee Commute - Diesel
 Fuel: 8,262 gallons
 CO2: 84.425 MT

2020 Employee Commute - Totals
Fuel: 52,565 gallons
CO2: 455 MT = 502 U.S. Tons

Commute Summary	gallons	mmbtu	CO₂e (MT)
• Gasoline	41,270	5,159	366
• Diesel	8,262	1,141	84
• Ethanol	3,033	273	5
TOTAL	52,565	6,573	455 (502 U.S. tons)

City Government Analysis – Additional Notes for Electric Data

- copy the original spreadsheet
- create tables for easy sorting
- sort by account number
- sum usage and cost data – note some accounts have multiple sub-meters, and that's okay
- remove any obvious duplicates (2020):
 - 100504 February
 - 723282 June
 - 723731 April & May
 - 723804 May & December
 - 723868 January
 - 724433 August
 - 725726 April
 - 841534 June
 - 858116 February

1623185 May & December

- confirm the count on each (should be "some multiple of 12" unless there's a good reason)
- duplicate the sheet as "Electric Summary" & delete all rows except totals for each account
make sure total usage and total cost still check
- add in a CATEGORY column
 - buildings & facilities
 - streetlights & traffic signals
include SILDs, parking garages, park lighting, scoreboards, etc.
 - water & wastewater treatment facilities (electricity only)
include reservoirs, lift stations, wells, pumps, ponds, headgates, etc.

City Government Analysis – Additional Notes for Gas Data

- copy the original spreadsheet
- create tables for easy sorting
- sort by account number
- sum usage and cost data – note some accounts have multiple sub-meters, and that's okay
- remove any obvious duplicates (2020):
 - 723275 December
 - 724011 December
 - 1341905 April (for both sub-meters)
- follow other "Electric" steps, as appropriate