

2023

HARRISONBURG GHG EMISSIONS REPORT



CITY OF HARRISONBURG, VIRGINIA

**ICLEI GOVERNMENT EMISSIONS INVENTORY
2023 SUMMARY REPORT**

Sean McGinnis
Director – Virginia Tech Green Engineering Program

April 20, 2025

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EXECUTIVE SUMMARY

The City of Harrisonburg, Virginia, greenhouse gas (GHG) emissions inventory was completed for the calendar year 2023 and compared to the previous analysis for 2016 (baseline year), 2019, 2021, and 2022. This report is part of Phase 2 of the City of Harrisonburg's Environmental Action Plan (EAP). The GHG emissions inventory was completed at both the Municipal and Community levels.

The scope of the Municipal inventory includes energy (electricity, natural gas, and fuel oil) for City buildings/facilities, electricity for street/traffic lights, diesel/gasoline fuels for City fleet vehicles/equipment and City Transit buses. This scope is focused on areas in which the City has some control of decisions that can affect GHG emissions.

100-yr and 20-yr GWP values were used in the analysis to provide both shorter and longer term perspectives. These different time horizons account for the different lifetime of GHGs in the atmosphere. The primary difference in the results is the stronger contribution of methane, mainly from leakage in natural gas distribution, for the 20-yr analysis. 100-yr GWP analyses dominate most reports produced by governments and corporations to meet the Paris Agreement international treaty goal to limit global average temperatures to below 2.0, and preferably to 1.5 degrees Celsius, compared to pre-industrial levels. Given the closing window to meet this goal, there is increasing discussion to promote the use of 20-yr GWP analyses and focus more on methane reductions.

The scope of the Community inventory includes energy (electricity and natural gas) split among the following major sectors: Residential, Commercial, Industrial, Municipal, Water & Sewer, and James Madison University (JMU). Community inventory also includes estimated fuel use (gasoline and diesel) for vehicle travel within the City boundaries based on Virginia Department of Transportation (VDOT) traffic counts. GHG emissions from Solid Waste, Water Treatment, and Waste Water Treatment are included in the Community Inventory as well. This scope is focused on the broader Community GHG emissions, which are only indirectly affected by City policies/initiatives and controlled more directly by the activities and behavior of the community as a whole and its members individually.

Harrisonburg Municipal GHG emissions in 2023 were 18,483 metric tons, a 15.0% decrease from the 2016 baseline using 100-yr GWP values. Buildings/facilities accounted for 37.2% of these emissions with Electricity as the main municipal fuel source at 47.2%. School operations including electricity, natural gas, fuel oil, and diesel school buses contributed 30% of all Municipal GHG emissions. The 20-yr GWP analysis has 23% higher absolute GHG emissions due to the increased effect of methane.

Total Community GHG emissions in 2023 for Harrisonburg were 553,601 metric tons, a 12.1% decrease from the 2016 baseline level using the 100-yr GWP values. The Commercial and Transportation sectors accounted for approximately 29.2% and 30.7% of these emissions, respectively, and the dominant fuel source for the Community emissions was electricity at 34.2%. The Municipal sector accounted for 3.3% of the total Community GHG emissions.

For the 20-yr GWP analysis of the same data, total Community GHG emissions in 2023 were 716,129 metric tons, a 12.1% decrease. This higher value for GHG emissions in the 20-year timeframe is due to the higher relative GWP of methane from natural gas leakage and solid waste landfill gas.

This initial report can serve as the basis for further discussions and planning among key stakeholders in both the City and Community to develop action plans for future GHG emissions reductions.

1. INTRODUCTION

This report details both the Municipal (City operations) and Community Greenhouse Gas (GHG) emissions for the City of Harrisonburg, VA, for the calendar year 2023. These results are compared to the previous analyses for 2016 (baseline year), 2019, 2021, and 2022. These emissions are estimated based on the inventory of energy and fuel use for Harrisonburg. The 2020 data set was not considered to be representative of a typical year due to the pandemic based on the changes from normal city operations that were associated with it. In compiling and analyzing the 2023 data, several minor errors were found in the previous years' assessments and are noted in this report by red text.

This report is part of Phase 2 of the City of Harrisonburg's Environmental Action Plan (EAP). The development of the EAP will be completed in three phases (1, 2, and 3). The EAP consists of six focus areas: (1) Buildings and Energy, (2) Land Use and Green Space, (3) Regional Food Systems, (4) Sustainable Transportation, (5) Waste Reduction and Recycling, and (6) Water Resources. Phase 1 describes goals, co-benefits, and strategies, and identifies tasks and responsible parties. EAP Phase 1 was presented to City Council and adopted on January 14, 2020. Phase 2 compiles an inventory of municipal and community activities and links them to energy and GHG emissions to develop a baseline to be used for measuring progress towards achieving goals in the future. This particular analysis includes focus areas (1), (4), and (5). GHG emissions for focus areas (2), (3), and (6) are generally much harder to measure and with fewer direct GHG emissions and are therefore not part of the scope of this analysis. Land use emissions are complex and depend on many factors including the type of land and specific changes from one particular landscape to another. Increasing the tree canopy reduces emissions indirectly by shading buildings and reducing urban heat island effects, which results in less cooling during warmer months. This is in addition to direct effects of trees acting as GHG emission sinks as carbon dioxide is removed from the air in the photosynthesis process. Because trees grow slowly and sequester carbon from the atmosphere, reducing tree removal in cities is as important as planting new trees. These baseline indicators provide a snapshot of the current conditions and are useful for setting actionable and measurable targets. During Phase 3, the City will consider baseline inventory data and GHG emissions to establish targets with statements that define the desired change by a specific year.

Greenhouse gases (GHGs) are chemicals in the atmosphere that absorb radiation and therefore warm the atmosphere and the planet.¹ These gases, which include carbon dioxide, methane, and various refrigerants, are released into the atmosphere by various human activities. GHGs are characterized by a Global Warming Potential (GWP), which quantifies the potential of these chemicals to absorb heat compared to carbon dioxide over a specific time period. Carbon dioxide (CO₂) is the dominant GHG in the atmosphere by mass and is emitted due to combustion of fossil fuels including coal, natural gas, heating oil, gasoline, and diesel fuel. Methane emissions are much smaller in amount, but this chemical has a much larger GWP (see table 1) so contributes more significantly than one would expect based only on the amount. Although not in this analysis, fossil fuel combustion also leads to additional air pollution including Criteria Air Pollutants (CAPs), which harms human health and the environment.

GHGs are strongly linked through scientific research modeling to increasing global temperatures and have been increasing since the industrial revolution. Many cities, states, and countries are developing plans to reduce GHGs and mitigate the expected environmental, economic, and health impacts of global warming and climate change. According to climate scientists and based on thousands of research studies, the time window for reducing GHG emissions and thereby minimizing the negative effects on human health, the environment, and global economic systems is closing.

The primary goals of a GHG inventory are to understand the sources of GHG emissions within both the community at large and across a City's municipal operations. This information is critical to make

effective changes to both policy and practice at the municipal and community levels to reduce these emissions. Without an understanding of the specific sources and magnitude of these emissions, it is impossible to develop plans that are both feasible and cost effective for GHG reductions.

Effectively preparing for and responding to current and projected climate change requires an ongoing evaluation and a series of action steps, not a one-time assessment. It calls on our community to adopt policies and practices that make environmental sustainability and resilience a consideration in all activities and actions taken by our community. It also calls on us to strengthen existing efforts and build partnerships throughout the community to reduce Harrisonburg's vulnerability to the changing environment. The development of the EAP is designed to accomplish this goal. The EAP acknowledges existing city plans, programs and strategies, and builds upon them by proposing measures to accelerate advancements in sustainability, of which economic vitality, environmental protection, and health and well-being are collectively considered to be critical pieces of achieving sustainability goals and reducing greenhouse gas emissions. Adopting and implementing the EAP helps the City support global targets for a stable climate and a resilient community.

There is a balance between the accuracy/detail and time/effort in this type of analysis. Enough detail is required to identify areas of concern and action, but too much detail can take additional time and effort that either does not provide the necessary resolution or is not required to make broad decisions.

2. METHODOLOGY, SCOPE AND ASSUMPTIONS

The ICLEI ClearPath online software analysis (<https://clearpath.icleiusa.org/>) was used for this analysis. The baseline year data in this report is 2016. The 2016 – 2021 analyses used the 100-year global warming potentials (GWP) from the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report (AR5). Starting in 2021, the 20-yr GWP values were also calculated to consider the near-term time frame more accurately. Table 1 shows the GWPs for the most common of the emission chemicals for both the 20-yr and 100-yr timeframes.² For the 2022 - 23 assessments, the updated and more accurate IPCC AR6 GWP values were used and included feedback mechanisms. The AR5 analyses in previous reports will not be updated as the differences would be small. Also, only the fossil-origin methane GWP in Table 1 will be applied for simplicity of calculation and because the City doesn't have a significant amount of non-fossil origin methane (only those emissions from the landfill).

The 100-yr time horizon and the associated GWP values have been recommended by the IPCC and most other major reporting platforms recommend that you calculate your footprint using the 100-year GWP for GHG analyses and decision-making. However, continuing research and climate modeling are suggesting that a shorter time horizon may be a better choice for local, national, and international government policies and actions given the scientific recommendations of 50% GHG reductions by 2030 and 100% reductions by 2050. As seen in Table 1, the main difference in the GHG values for the 20-yr time horizon is a much stronger contribution for methane since it has a shorter lifetime in the atmosphere. This means that methane reductions will have a more significant effect on climate change compared to carbon dioxide over this shorter time frame.

Greenhouse Gas	100-Year Time Period				20-Year Time Period			
	AR4 2007	AR5 2014		AR6 2021	AR4 2007	AR5 2014		AR6 2021
	Feedback Not Included	Feedback Included			Feedback Not Included	Feedback Included		
CO ₂	1	1	1	1	1	1	1	1
CH ₄ fossil origin	25	28	34	29.8	72	84	86	82.5
CH ₄ non fossil origin				27.2				80.8
N ₂ O	298	265	298	273	289	264	268	273

Table 1 – Global Warming Potentials from the IPCC 6th report.

3. MUNICIPAL AND COMMUNITY INVENTORY DATA

3a. Electricity

Most of the electricity data was provided by the Harrisonburg Electric Commission (HEC). Municipal Electricity data was provided based on HEC metered accounts in detailed spreadsheets with usage by departments and by month (“City Usage By Load Month”). Grid loss of 5.1 % was based on the SRVC regional grid from the EPA eGrid database for 2022 as the 2023 regional grid data was not yet available.³ The electricity data was sorted by department and a detailed dataset is provided in Appendix 1. Additional electricity data for the Raw Water Pumping Station, Water Treatment Plant, and the Harrisonburg Rockingham Regional Sewage Authority (HRRSA) was added to the HEC data from Dominion Power accounts since these facilities are located outside of the City limits. The water facilities serve more than just the City, but the City controls them and therefore has decided to explicitly include all of this energy and the associated emissions instead of allocating based on the fraction of City customers. Sewage electricity is still allocated by percent sewage flow by jurisdiction.

A summary of all of the electricity data is provided in Table 2 and in the pie chart in Figure 1. Note that the pie chart does not include categories less than 1%. Electricity is dominated by *Schools* with 36.4% of the total usage in 2023 and *Sewer plus Water* with a combined contribution of 37.1%. Overall, electricity usage increased 1.3% from the 2016 baseline but was 4.5% less than 2022. The percent difference calculated in the final columns of Table 2, and throughout the report, is the current year value minus the previous value divided by the previous value, which gives a percent increase or decrease from another year.

DEPARTMENT/FUNCTION	2016		2019		2021		2022		2023		Difference 2023 vs 2016 (%)	Difference 2023 vs 2019 (%)
	kWh	% of Total	kWh	% of Total	kWh	% of Total	kWh	% of Total	kWh	% of Total		
SCHOOLS	11,364,115	36.3%	12,584,293	38.7%	11,439,828	36.0%	12,089,655	36.4%	11,540,090	36.4%	1.5%	-8.3%
SEWER AUTHORITY	7,260,657	23.2%	7,304,352	22.5%	7,951,502	25.0%	7,895,319	23.7%	7,398,998	23.3%	1.9%	1.3%
WATER DEPT, TREATMENT, & PUMPING	3,524,084	11.2%	3,442,868	10.6%	3,775,230	11.9%	4,604,045	13.8%	4,073,780	12.8%	15.6%	18.3%
TRAFFIC & STREET LIGHTS	3,026,731	9.7%	3,041,823	9.4%	2,998,843	9.4%	2,998,824	9.0%	2,993,434	9.4%	-1.1%	-1.6%
RECREATION DEPT	1,770,972	5.6%	1,771,940	5.5%	1,520,684	4.8%	1,533,004	4.6%	1,675,595	5.3%	-5.4%	-5.4%
FIRE DEPT	1,621,085	5.2%	1,777,509	5.5%	1,682,096	5.3%	1,650,830	5.0%	1,630,992	5.1%	0.6%	-8.2%
TRANSPORTATION DEPT	1,088,028	3.5%	891,593	2.7%	742,191	2.3%	779,528	2.3%	824,900	2.6%	-24.2%	-7.5%
COMMUNITY DEVELOPMENT*	790,385	2.5%	771,089	2.4%	789,400	2.5%	780,945	2.3%	751,976	2.4%	-4.9%	-2.5%
PUBLIC WORKS	375,779	1.2%	410,153	1.3%	405,317	1.3%	435,132	1.3%	388,347	1.2%	3.3%	-5.3%
PARKING SERVICES	264,139	0.8%	238,848	0.7%	226,148	0.7%	223,063	0.7%	205,274	0.6%	-22.3%	-14.1%
EMERGENCY COMMUNICATIONS CENTER (HRECC)	189,058	0.6%	217,225	0.7%	204,618	0.6%	214,345	0.6%	219,725	0.7%	16.2%	1.2%
CENTRAL STORES	65,086	0.2%	46,264	0.1%	36,391	0.1%	37,239	0.1%	35,344	0.1%	-45.7%	-23.6%
POLICE DEPT	6,819	0.02%	10,014	0.03%	10,878	0.03%	8,162	0.02%	4,320	0.01%	-36.6%	-56.9%
TOTALS	31,346,938	100%	32,507,971	100%	31,783,126	100%	33,250,091	100%	31,742,775	100%	1.3%	-2.4%
ELECTRICITY GRID LOSS (%)	4.5%		5.1%		4.5%		5.1%		5.1% (2022 value)			
ELECTRICITY GRID LOSS Total	1,410,612		1,657,907		1,430,241		1,695,755		1,618,882			

*City Hall Complex

Table 2 – Harrisonburg Municipal Electricity Usage by Department/Function

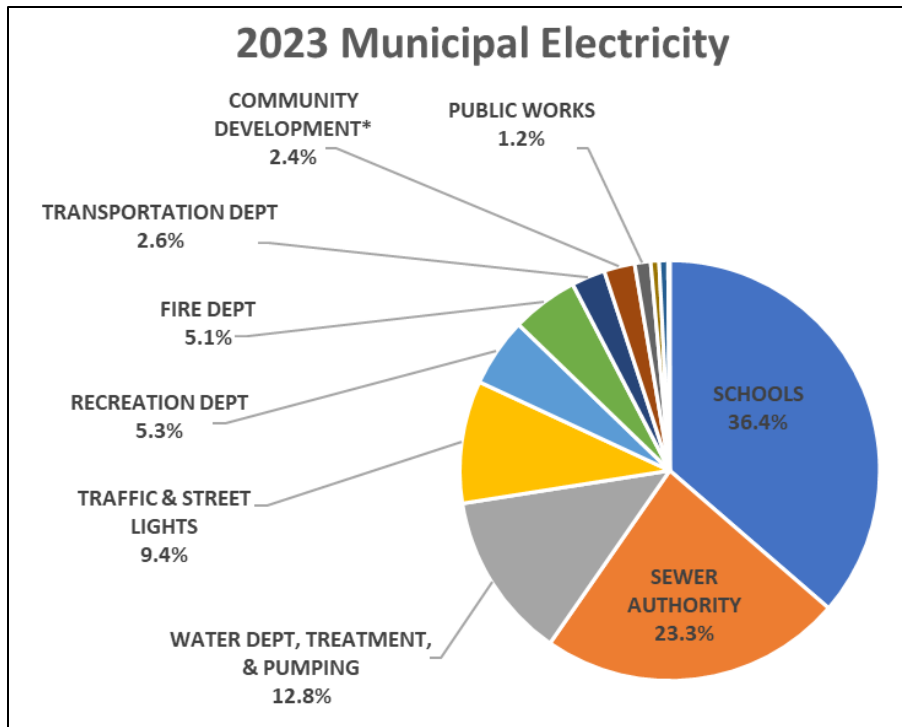


Figure 1 – Harrisonburg 2023 Municipal Electricity Pie Chart by Department/Function

As one of the largest Municipal electricity users at 36%, the Schools category for electricity usage was further broken down in Table 3 and Figure 2. Harrisonburg High School used 31% of the school system electricity in 2023. School system electricity increased 1.5% from 2016 to 2023, with 4.5% decrease from 2022. Stone Spring Elementary (Account # 13653-6) and the School Board Office (Account # 13653-34) electricity as down significantly in 2023 – 28% and 78%, respectively. These large decreases can be explained by a new chiller at Stone Spring Elementary and the installation of a 35-kW solar system on April 24, 2023 for the School Board Office.

Harrisonburg City School Electricity Summary			2016		2019		2021		2022		2023		2023 (%)	Δ 2016	Δ 2022
Account	School	Address	kWh	Total	kWh	Total	kWh	Total	kWh	Total	kWh	Total			
13653-27	Harrisonburg High School	1001 GARBERS CHURCH RD	1,324,800	1,469,760	1,815,200	1,959,720	1,202,880	1,347,840	1,292,160	1,437,120	1,290,240	1,435,200			
13653-28	Harrisonburg High School	1001 GARBERS CHURCH RD	1,826,880	2,322,240	1,815,200	2,310,720	2,148,480	2,016,960	2,016,960	1,946,880					
13653-29	Harrisonburg High School Stadium	1001 GARBERS CHURCH RD	178,944	188,544	178,944	188,544	139,776	147,072	147,072	159,360					
13653-35	Harrisonburg High School	1001 GARBERS CHURCH RD	17,161	35,931	17,161	35,931	31,018	27,550	27,550	14,884					
13653-36	Harrisonburg High School	1001 GARBERS CHURCH RD	17,920	54,160	17,920	54,160	40,960	59,920	59,920	47,280					
13653-38	Harrisonburg High School	1001 GARBERS CHURCH RD	-	54,240	-	54,240	37,200	36,320	36,320	29,680					
13653-39	Harrisonburg High School	1001 GARBERS CHURCH RD	-	26,960	-	26,960	23,680	38,000	38,000	28,560					
13653-40	Harrisonburg High School	1001 GARBERS CHURCH RD	-	24,800	-	24,800	24,080	26,320	26,320	25,920					
13653-41	Harrisonburg High School	1001 GARBERS CHURCH RD	-	-	-	-	27,815	23,198	23,198	27,621					
13653-43	Harrisonburg High School	1001 GARBERS CHURCH RD	-	3,365,705	-	4,176,635	-	3,675,889	80,700	3,748,200	57,600	3,628,025	31.4%	7.8%	-3.2%
13653-33	Smithland Elementary School/Skyline Middle School/Elon Rhodes Early Learning Center	470 LINDA LN	2,344,320	2,344,320	2,453,760	2,453,760	2,365,440	2,365,440	2,374,080	2,374,080	2,400,000	2,400,000	20.8%	2.4%	1.1%
13653-19	Thomas Harrison Middle School	1311 W MARKET ST	1,815,200	1,819,200	1,815,200	1,350,720	1,080,000	1,080,000	1,155,840	1,155,840	1,171,200	1,171,200	10.1%	-35.6%	1.3%
13653-6	Stone Spring Elementary School	1575 PEACH GROVE AVE	1,008,960	1,008,960	1,123,200	1,123,200	987,840	987,840	1,215,360	1,215,360	880,320	880,320			
13653-7	Stone Spring Elementary School	1575 PEACH GROVE AVE	16,290	16,290	32,443	32,443	13,305	14,892	14,892	14,573					
13653-8	Stone Spring Elementary School	1575 PEACH GROVE AVE	66,435	66,435	79,557	79,557	63,260	54,808	54,808	54,029					
13653-30	Stone Spring Elementary School	1575 PEACH GROVE AVE	34,726	1,126,411	43,742	1,278,942	44,371	1,108,776	40,942	1,326,002	37,664	986,586	8.5%	-12.4%	-25.6%
13653-14	Spotswood Elementary School	375 S CARLTON ST	191,760	191,760	193,000	193,000	192,560	192,560	198,200	198,200	192,880	192,880			
13653-15	Spotswood Elementary School	375 S CARLTON ST	563,520	563,520	622,560	622,560	535,120	535,120	679,200	679,200	660,000	660,000			
13653-16	Spotswood Elementary School	375 S CARLTON ST	46,257	46,257	47,627	47,627	55,387	55,387	55,008	55,008	50,361	50,361			
13653-17	Spotswood Elementary School	400 MOUNTAIN VIEW DR	27,297	828,834	21,047	884,234	16,948	800,015	36,695	969,103	37,103	940,344	8.1%	13.5%	-3.0%
13653-3	Keister Elementary School	100 MARYLAND AVE	514,560	514,560	516,480	516,480	524,160	534,720	534,720	560,640	560,640	560,640			
13653-4	Keister Elementary School	100 MARYLAND AVE	101,777	101,777	99,023	99,023	104,588	100,342	100,342	88,423	88,423	88,423			
13653-5	Keister Elementary School	100 MARYLAND AVE	222,240	838,577	237,840	847,343	230,640	859,388	227,760	862,822	225,120	874,183	7.6%	4.2%	1.3%
13653-20	Waterman Elementary School	451 CHICAGO AVE SEC LIGH	6,300	6,300	6,300	6,300	6,300	2,400	2,400	2,400	2,400	2,400			
13653-21	Waterman Elementary School	451 CHICAGO AVE	714,240	714,240	718,560	718,560	709,200	725,040	725,040	760,320	760,320	760,320			
13653-22	Waterman Elementary School	451 CHICAGO AVE	52,785	52,785	55,653	55,653	52,166	52,591	52,591	44,748	44,748	44,748			
13653-23	Waterman Elementary School	451 CHICAGO AVE	46,943	820,268	47,726	828,239	51,634	819,300	48,795	828,826	45,927	853,395	7.4%	4.0%	3.0%
13653-37	Bluestone Elementary School	750 GARBERS CHURCH RD	-	536,100	536,100	536,100	516,300	516,300	520,800	520,800	532,500	532,500	4.6%	0.4%	2.2%
13653-34	School Board Office	1 COURT SQ	220,800	220,800	228,320	228,320	214,720	214,720	218,720	218,720	47,680	47,680	0.4%	-78.4%	-78.2%
13653-42	Family Resource Center	640 S MAIN ST	-	-	536,100	536,100	516,300	516,300	520,800	520,800	85,262	106,177	0.9%		
Totals			11,364,115	11,364,115	12,584,293	12,584,293	11,439,828	11,439,828	12,089,655	12,089,655	11,540,090	11,540,090	100.0%	1.5%	-4.5%

* Bluestone Elementary School and Elon Rhodes Early Learning Center first opened in August 2017

Table 3 – Harrisonburg School Electricity Usage by School

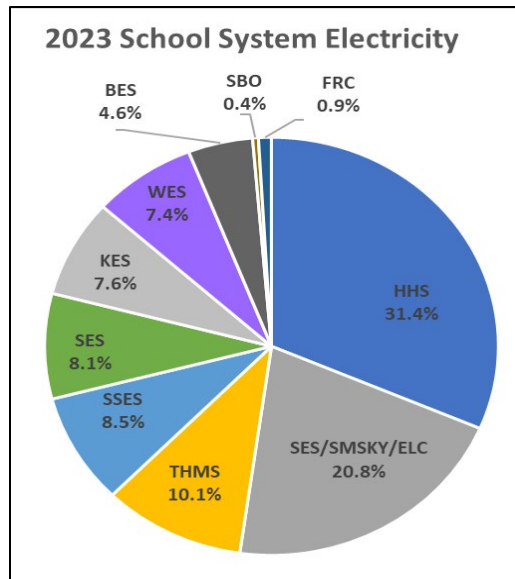


Figure 2 – Harrisonburg School Electricity Pie Chart

Community-wide electricity for Harrisonburg was provided by from HEC and is shown in Table 4 and Figure 3. The Residential sector includes all residential users while the Industrial sector includes all customers with a demand of 1000 kW or greater. JMU includes all accounts in the name of the university including the JMU Foundation, even those not located on the main campus. The Commercial sector consists of all non-Residential accounts that do not fall into any of the aforementioned categories. The Commercial electricity value is the sum of Rate Categories 206, 314, 315, 400 and State categories while and Industrial value is the sum of Rate Categories 405, 525 and CPS. The Municipal sector includes all HEC accounts on the Municipal rate and was used from the Community Electricity HEC data rather than the detailed HEC account data used in the Municipal report in order to more easily separate out Water and Sewer electricity. Direct HPU Energy Report and HRRSA electricity values were used in 2023 instead of the detailed individual account values. All Water Treatment electricity is again attributed to the City since it has control of this system and processes even though it is also supplying some water to the surrounding County.

The electricity data shows a 0.7% decrease in electricity use for 2023 compared to 2016. In 2023, the Commercial sector and Residential sectors contributed 32.5% and 28.7%, respectively, while Industrial and JMU were 18.4% and 15.8% respectively. Note that while Municipal electricity is the sector that the City has the most control over, it contributed only 2.9% of the total Community usage.

Year	Electricity Sector					Water & Sewer** (kWh)	Totals (kWh)	Grid Loss (%)	Grid Loss (kWh)
	Residential (kWh)	Commercial (kWh)	Industrial (kWh)	Municipal* (kWh)	JMU (kWh)				
2016	197,228,099	232,571,151	117,197,400	20,562,197	115,370,687	10,784,741	693,714,275	4.5%	31,217,142
2019	207,255,483	234,960,057	116,416,689	21,760,751	113,493,551	10,747,220	704,633,751	5.1%	35,936,321
2021	212,213,233	214,253,579	112,928,760	20,056,394	117,749,833	11,726,732	688,928,531	4.5%	31,001,784
2022	208,840,366	228,920,377	131,097,240	20,750,727	116,098,951	12,499,364	718,207,025	4.5%	32,319,316
2023	197,730,047	224,232,028	126,552,600	20,269,997	108,692,195	11,472,778	688,949,645	4.2%	28,935,885
% Difference (2023 to 2016)	0.3%	-3.6%	8.0%	-1.4%	-5.8%	6.4%		-0.7%	
Sector (%) 2023	28.7%	32.5%	18.4%	2.9%	15.8%	1.7%	100%		

*HEC Detailed Account Summary excluding Water Dept, Water Treatment, and Sewer Authority
 **Water & Sewer data from City summaries and not summed HEC detailed electricity accounts

Table 4 – Harrisonburg Community Electricity Usage by Sector

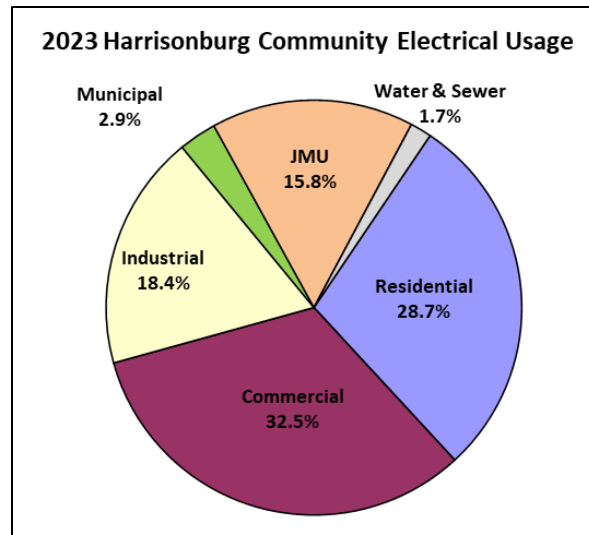


Figure 3 – Harrisonburg 2023 Community Electricity Pie Chart by Sector

Harrisonburg electricity is provided through the HEC by Dominion Energy from their regional fuel generation mix. The EEI Utility Specific Residual Mix Emissions Rate data is used rather than the Utility Average Emissions Rate. The latter is a simpler calculation, representing the overall carbon footprint of a utility company's entire electricity generation mix. The Residual mix is a more precise calculation without the emissions associated with renewable energy certificates or contracts that a company has purchased, giving a more accurate picture of the carbon intensity of the consumed electricity.

For 2022 and 2023, this EEI data came directly from Dominion Power since it was not available in the public database. This EEI database does not include methane and nitrous oxide emissions factors or grid losses so the most recent 2023 EPA eGrid values for the Southeast Region Virginia Carolina (SRVC) regional electricity grid were used since the 2023 data are not yet published. Slight reductions are seen for each of these emissions factors. These parameters are summarized in Table 5 and were the inputs for the ClearPath *Electricity Factor Sets*. More details from the regional grid emissions are provided in Appendix 2 noting that the carbon dioxide factors are slightly different for Dominion Energy of Virginia compared to the entire SRVC region. The Transmission and Distribution (T&D) grid loss which is electricity lost due to resistance and inefficiencies between the power plant and the final electricity use, is included in both the Municipal and Community-level assessments based on the total electricity usage for each case. The 2023 SRVC grid loss was also from the June 2024 EPA eGrid report.

Chemical	Electricity Emission Factors (lb/MWh)				
	2016	2019	2021	2022	2023
CO ₂	745 ⁵	751 ⁴	693 ⁴	668 ⁴	579 ⁴
CH ₄	0.067	0.058	0.052 ³	0.052 ³	0.045 ³
N ₂ O	0.011	0.008	0.007 ³	0.007 ³	0.006 ³
Grid Loss (%)	4.5	5.1 ³	4.5 ³	4.5 ³	4.2 ³

³EPA eGrid summary data for SRVC Region

⁴EEI Database, Edison Electric Institute (2022-3 directly from Dominion EEI info)

⁵Dominion Energy 2019 Sustainability and Corporate Responsibility Report

Table 5 –Emissions Factors from Dominion Energy and EPA eGrid (SRVC) database

Table 6 shows the fuel mix for delivered Dominion Power Virginia Electricity. This data also was obtained directly from Dominion Energy since it was not yet available in the EEI database. The details on the Purchased Electricity was not provided. Coal continues to be replaced by natural gas due to higher supply and local costs. In 2021, electricity produced from coal in the US had an average emissions factor of 2260 lb CO₂/MWh compared to 970 lb CO₂/MWh for natural gas.⁶ The emissions values in table 5 and 6 are decreasing and less than both of these fossil fuels due to the lower carbon emissions of nuclear and renewable fuel sources. Note that these emissions factors are only for the generation and use stages of the life cycle of electricity and do not account for upstream (mining, processing and fuel transportation) or downstream (waste disposal) emissions.

Year	2019	2020	2021	2022*	2023**
Total Electricity Delivered (MWh)	86,474,382	83,282,826	90,013,155	93,932,709	92,930,774
Utility Specific Residual Mix Emissions Rate (lbs/MWh)	762	712	693	668	608
Coal	10%	9%	9%	8%	5%
Natural Gas	51%	49%	41%	42%	37%
Nuclear	37%	32%	30%	31%	30%
Petroleum	0%	0%	0%	0%	0%
Biomass/Biogas	1%	1%	1%	1%	1%
Geothermal	1%	0%	0%	0%	0%
Hydroelectric	0%	1%	1%	1%	0%
Solar	0%	1%	1%	0%	1%
Wind	0%	0%	0%	0%	0%
Purchased Power/Other	0%	7%	18%	17%	25%
Totals	100%	100%	101%	100%	99%
*2022 EEI data directly from Elizabeth Gayne, Dominion Energy, 9/6/23 email					1% Rounding Error
**2023 EEI data directly from Dell Cheatham, Dominion Energy, 1/6/25 email					

Table 6 – Electricity Fuel Mix from delivered electricity from Dominion Power Virginia

3b. Natural Gas

Natural gas data for 2023 came from a City spreadsheet compiled from Usage History graphs provided in gas company account bills and a *HCPS All Utilities* spreadsheet. The data is summarized in Table 7. Figure 4 shows a breakdown of the natural gas usage for 2023. The school data was provided in units of hundred cubic feet (ccf) of natural gas and converted to therms using a gas utility bill conversion factor of 1.0639 therms/ccf. Overall, the Municipal natural gas usage decreased by 7.5% for 2023 compared to the 2016 baseline. Gas usage is down in all subcategories compared to 2022 and down 4.2% overall. Schools dominate natural gas usage at approximately 67% in 2023 with the Department of Parks and Recreation following at approximately 16%, the Fire Department at approximately 8%, and the rest of the categories all less than 5%. Municipal natural gas usage for categories outside of schools is reduced 26% since 2016.

Building & Address	Meter #	CY 2016		CY 2019		CY 2021		CY 2022		CY 2023		Difference 2023 - 2016 (%)	
		Therms		Therms		Therms		Therms		Therms	% of Total		
Schools - Smithland Elementary & Skyline Middle School (SMSKY)		46,896		58,701		60,575		59,363		56,628		14.6%	
Schools - Stone Spring Elementary School (SSES)		38,457		42,151		48,409		65,083		65,083		16.8%	
Schools - Thomas Harrison Middle School (THMS)		80,111		34,565		28,811		31,105		31,105		8.0%	
Schools - Spotswood Elementary School (SES)		27,686		32,140		31,927		41,238		41,238		10.6%	
Schools - Keister Elementary School (KES)		24,105		29,830		32,340		31,826		31,826		8.2%	
Schools - Waterman Elementary School (WES)		21,044		21,728		21,785		25,887		25,887		6.7%	
Schools - Maintenance Building		4,858		5,563		5,299		5,587		5,587		1.4%	
Schools - School Board Office (SBO)		1,687		1,485		1,370		1,432		1,432		0.4%	
Schools - Harrisonburg High School (HHS)		0		0		0		0		0		0.0%	
Schools - Bluestone Elementary School (BES)		0		0		0		0		0		0.0%	
Schools - Elon Rhodes Early Learning Center (ELC)		0		0		30		192		192		0.0%	
Schools - High School Stadium		0	244,843	0	226,163	0	230,547	0	261,712	0	258,977	0.0%	5.8%
Parks & Rec - Westover Pool - 305 S. Dogwood Dr	901118	48,620		35,058		40,824		41,556		37,428		9.7%	
Parks & Rec - Lucy Simms - 620 Simms Ave	M4700071	27,996		26,268		22,263		21,867		17,673		4.6%	
Parks & Rec - Community Activities Center - 305 S. Dogwood Dr	9013433	6,808		5,982		7,648		5,239		4,328		1.1%	
Parks & Rec - Golf Course Maintenance 1583 W. Market St B	6112198	3,857	87,281	3,298	70,606	2,258	72,993	2,032	70,694	1,667	61,096	0.4%	-30.0%
Fire Department - Public Safety Building - 101 N. Main St.	8461631	28,581		32,459		25,757		24,447		24,217		6.3%	
Fire Department Station #1 80 Maryland Ave	M8600409	1,895		4,613		4,540		5,400		5,395		1.4%	
Fire Department Station #1 Annex 90 Maryland Ave	U766302	1,048	31,524	1,104	38,176	1,098	31,395	1,091	30,938	882	30,494	0.2%	-3.3%
Transportation - Central Garage - 473 E. Washington St	13600365	24,909		15,097		15,405		16,196		14,509		3.7%	
Transportation - Administration Building - 475 E. Washington St	10600339	269	25,178	282	15,379	251	15,656	269	16,465	271	14,780	0.1%	-41.3%
Public Works - City Shops/Traffic Signal/Eng - 320 Mosby Rd zone 3	6074588	4,745		4,899		4,306		4,369		3,779		1.0%	
Public Works - Central Stores Warehouse - 2111 Beery Rd	M6600026	2,973		3,833		3,405		2,243		1,306		0.3%	
Public Works - City Shops/Traffic Signal/Eng - 320 Mosby Rd zone 4	97800115	3,168		2,779		3,218		2,999		3,165		0.8%	
Public Works - City Shops/Traffic Signal/Eng - 320 Mosby Rd zone 1	R171893	3,821		2,451		2,177		1,992		2,122		0.5%	
Public Works - City Shops/Traffic Signal/Eng - 320 Mosby Rd zone 2	M7400649	1,841		1,624		1,313		1,723		1,920		0.5%	
Public Works - City Shops/Traffic Signal/Eng - 320 Mosby Rd zone 5	9277707	939	17,487	744	16,330	919	15,338	963	14,289	939	13,231	0.2%	-24.3%
General Properties - City Hall - 409 S. Main St	M7900196	4,582	4,582	4,458	4,458	4,234	4,234	3,883	3,883	3,007	3,007	0.8%	-34.4%
Water Department 2155 Beery Rd	9015735	3,946	3,946	3,482	3,482	3,449	3,449	3,322	3,322	2,974	2,974	0.8%	-24.6%
Tourism - Hardesity Higgins House - 212 S. Main St	M4490516	3,598	3,598	2,914	2,914	2,832	2,832	2,973	2,973	2,734	2,734	0.7%	-24.0%
Harrisonburg Water Pump House 1790 Reservoir St	3345924	207	207	113	113	107	107	106	106	105	105	0.0%	-49.3%
Totals		418,646	418,646	377,621	377,621	376,551	376,551	404,382	404,382	387,398	387,398	100%	-7.5%
Municipal Totals w/o Schools		173,803		151,458		146,004		142,670		128,421			-26.1%

Table 7 – Harrisonburg Municipal Natural Gas Usage

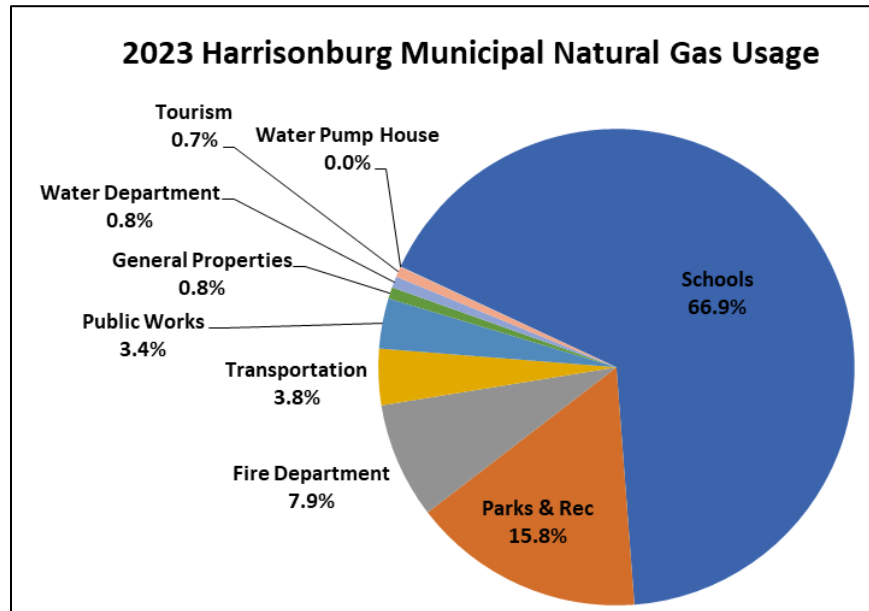


Figure 4 – Harrisonburg Municipal Natural Gas Usage 2023

Community-level natural gas usage for Harrisonburg was provided by Keith Thomas via NiSource Inc., the utility parent company of Columbia Gas of Virginia, which supplies natural gas to the City. The data provided is delineated by the City of Harrisonburg tax district.

The Community-wide natural gas data is summarized in Table 8 and Figure 5. It shows an overall decrease in natural gas use from 2023 compared to 2016 of 6.1%. In 2023, the Commercial sector was the largest at 42% and it includes the municipal natural gas usage detailed above, which was only 2% of the total Community-wide usage. This decrease in gas usage is despite the almost 9% increase in total heating degree days (HDD) compared to 2016. HDD estimate the amount of heating needed by

comparing the average daily temperature to a setpoint of 65 °F and summing the temperature differences across the entire year.

Year	Residential (therms)	Commercial (therms)	JMU (therms)	Industrial (therms)	Totals (therms)	Year-to-Year Change	HDD
2016	1,733,830	6,379,270	7,837,770	4,531,220	20,482,090	---	4,922
2019	1,944,600	8,056,610	6,873,850	4,597,840	21,472,900	4.8%	4,746
2021	1,910,455	7,818,585	5,923,260	5,077,554	20,729,854	-3.5%	4,727
2022	1,853,660	8,076,744	5,915,670	4,433,741	20,279,815	-2.2%	5,468
2023	1,670,320	8,098,480	4,711,100	4,745,330	19,225,230	-5.2%	5,348
Sector (%)	8.7%	42.1%	24.5%	24.7%	100%		
Baseline Difference	-3.7%	26.9%	-39.9%	4.7%	-6.1%	2023 vs. 2016	8.7%

Table 8 – Harrisonburg Community Natural Gas Usage

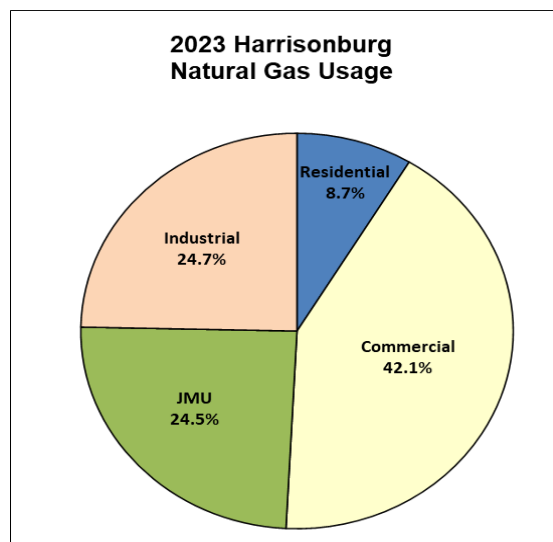


Figure 5 – Harrisonburg Community Natural Gas Usage by Sector

3c. Natural Gas Leakage

Methane emissions associated with natural gas leakage due to upstream mining, processing, and distribution are included in both the Municipal or Community-wide assessment in the ClearPath software under the *Process and Fugitive Emissions* main tab and *Fugitive Emissions From Natural Gas Distribution* subcategory. This source of GHGs is growing in the public’s awareness in recent years. The total direct municipal natural gas consumption above was used along with the indirect natural gas estimates back-calculated from utility electricity production and the fuel mix. The fossil fuel power plant efficiency of 39.5% was used from the most recent EIA data.⁷ Leakage was assumed at 4% for municipal gas distribution and 2% for utility natural gas use for electricity production based on a number of recent references.⁸⁻¹⁰ Grid loss was also included to get primary electricity use. Several other assumptions had to be made for these estimates including the density of natural gas at 0.713 kg/m³, energy density of 1.037 MMBtu/MCF, and a composition of 99% methane in natural gas which is on the high end of typical gas sources but more accurate for this analysis since the other contaminants in natural gas are often hydrocarbons which also release carbon dioxide upon combustion.¹¹⁻¹²

3d. Fuel Oil

Municipal use of Fuel Oil was reported for several of the City schools for heating and is detailed in Table 9. These values came from the *HCPS All Utilities* spreadsheet and Fiscal Year data was combined to get Calendar Year values. Other municipal uses of fuel oil, like for backup generators, were considered minimal and not assessed in this report.

Location	Fuel Oil Usage (gallons)					Difference
	2016	2019	2021	2022	2023	2023 – 2016 (%)
Harrisonburg High School (HHS)	49,462	54,222	62,911	59,624	24,722	-50%
Smithland Elementary & Skyline Middle School (SMSKY)	79	0	0	0	0	-100%

Table 9 – Harrisonburg Municipal Fuel Oil Usage 2023

Community-wide use of Fuel Oil for heating is difficult to measure directly and accurately since this fuel is purchased directly from various commercial suppliers by individual residents and business owners. However, the use of heating oil is too large to omit from this analysis so an estimate was used. Residential fuel oil use was estimated since consumption averages are reasonable for a large sample of households. This analysis does not include Commercial and Industrial fuel oil use since good estimates were not available for these sectors, which are much more variable than residential housing. The 2023 Census American Community Survey (ACS) database estimates 17,331 households using fuel oil for heating as shown in the table 10.¹³ The Energy Information Administration (EIA) Residential Energy Consumption Survey (RECS) in 2020 estimates fuel oil/household energy consumption for the South Atlantic region, which is representative for Harrisonburg.¹⁴ Using a conversion factor of 139,000 BTU per gallon for fuel oil provided a conversion to the average gallons/household of fuel oil for ClearPath.

Year	Total Households ¹³	Households Heating w/ Fuel Oil ¹³	Average Annual Fuel Oil/Household ¹³ (Million BTU)	Average Annual Fuel Oil/Household (gallons)	Total Fuel Use (gallons)
2016	16,626	1,530	57.1	411	628,830
2019	16,723	1,121	57.1	411	460,731
2021	17,102	938	57.1	411	385,518
2022	17,102	941	52.4	377	354,757
2023	17,331	831	46.7	336	279,216

Table 10 – Harrisonburg Community Fuel Oil Usage Estimates

3e. Vehicle Transportation and Equipment Fuels

Municipal fuel use (diesel and gasoline) was compiled from the Harrisonburg *Fuel Equipment Summary* spreadsheet. A summary and graph of this data is shown in Table 11 and Figure 6. The Count columns in the tables are the number of vehicles in each category. The detailed analysis tables are provided in a supplemental appendix rather than this report given the large amount of data. For some of the diesel fuel fleet vehicles, diesel exhaust fluid (DEF) gallons were also reported. This fluid is added to diesel exhaust emissions to reduce nitrogen oxide (NO_x) emissions from diesel exhaust and is not considered in this GHG analysis since it is only 1% of the total fuel amount. No biofuels were used in the municipal fleet.

Diesel transit buses are the largest fleet contributor at 28% of the GHG emissions. Gas fleet vehicles and diesel school buses also contribute significantly at approximately 22% and 15%, respectively. Total

fuel usage has decreased 4% since 2016 but is 1% higher than in 2022, primarily due to increases in Diesel Equipment and Gas ParaTransit vehicles. Diesel Fleet Trucks and Fire Trucks/Ambulances fuel usage are down significantly from last year.

Vehicle/Equipment Fuels	2016	2019	2021	2022	2023		2023 Count	Difference 2023 - 2016 (%)	Difference 2023 - 2022 (%)
	Gallons	Gallons	Gallons	Gallons	Gallons	%			
Diesel Transit Buses	177,985	188,625	174,600	148,820	151,575	27.9%	42	-14.8%	1.9%
Gas Fleet Vehicles	121,920	118,590	104,625	115,386	119,504	22.0%	277	-5.4%	3.6%
Diesel School Buses	89,569	98,518	67,379	83,024	82,588	15.2%	65	-7.3%	-0.5%
Diesel Fleet Trucks	60,231	58,749	63,864	60,077	54,280	10.0%	91	-0.3%	-9.6%
Diesel Equipment	34,439	37,658	24,180	23,839	27,608	5.1%	40	-30.8%	15.8%
Gas Police Vehicles	28,939	37,597	40,311	44,702	45,970	8.5%	45	54.5%	2.8%
Gas ParaTransit Buses	21,208	24,833	25,270	29,284	33,056	6.1%	19	38.1%	12.9%
Diesel Fire Trucks/Ambulances	23,728	19,490	20,526	23,837	19,594	3.6%	15	0.5%	-17.8%
Gas Equipment	4,070	3,417	6,949	9,689	9,792	1.8%	25	138.1%	1.1%
TOTALS	562,089	587,477	527,703	538,658	543,965	100%	619	-4.2%	1.0%

Table 11 – Harrisonburg Municipal Fleet Vehicle/Equipment Fuel Usage

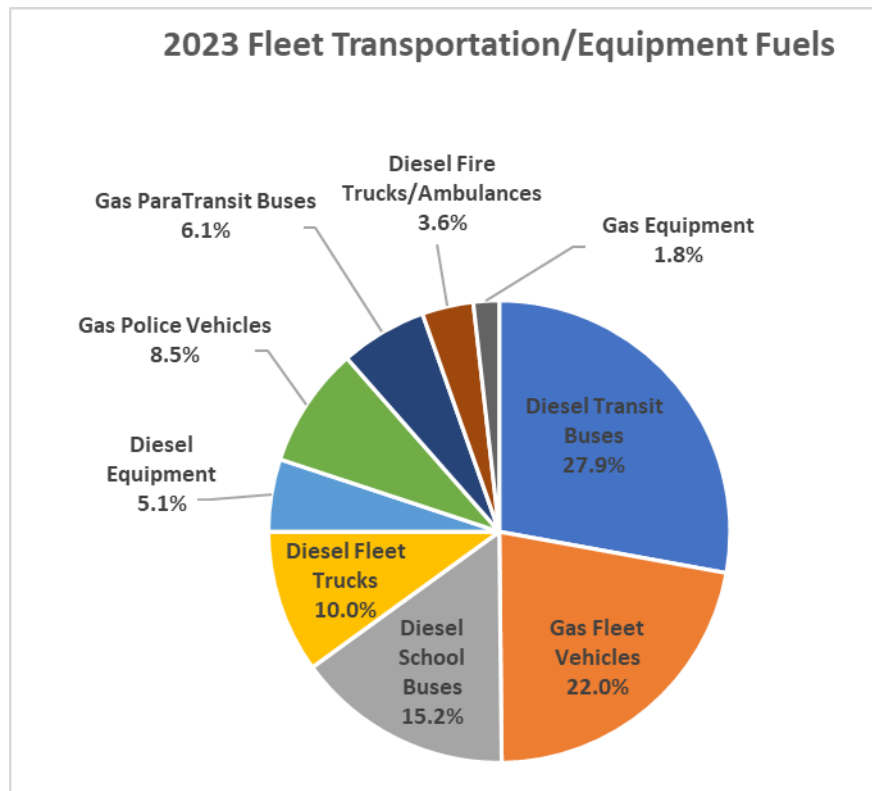


Figure 6 – Harrisonburg Vehicle/Equipment Fuel Usage in 2023

For Community-wide fuel use, the transportation sector was analyzed using Vehicle Miles Travelled (VMT) data from the Virginia Department of Transportation (VDOT) report 1220.¹⁵ Daily VMT was measured through VDOT traffic counts and were multiplied by 365 days to determine the Annual VMT. Table 12 provides a summary of the VMT by Road Type. 2023 VMT was 1.4% lower than the 2016

baseline. Miles driven on the I-81 through Harrisonburg are the largest category at 40% as shown in Figure 7, with Primary roads at 17%, and Secondary Roads at 43%. These percentages are somewhat different from previous years due to a VDOT update in the amount and breakdown of Road Miles. Secondary road miles are now almost a factor of 4 higher while Primary road miles dropped by a factor of 2. VMT values were converted to emissions using the default US National Vehicle Fuel economy and emissions factor sets provided in ClearPath. VDOT federal vehicle class info from Report 1220 was again used for the percentage of the vehicle types shown in Table 13. This data does not distinguish fuel type for passenger and light trucks which were all assigned gasoline while diesel was assumed for all heavy trucks. More vehicle categories were available in ClearPath, but the additional detail was not considered to make enough differences for the additional analysis. The Transportation Factor Set in Appendix 3 used for this analysis was the National Default for 2022 (updated in 2024) since the 2023 Factor Set is not yet available. Fuel economies (gallons/mile) and GHG emissions (grams CH₄/mile and grams N₂O/mile) by vehicle types provided the conversion from VMT to gallons of fuel and GHG emissions.

Year	DVMT By Road Type (miles)				Annual VMT (miles)	Difference (%)	Road Miles		
	Secondary	Primary	Interstate	Total			Secondary	Primary	Interstate
2016	255,020	304,428	358,494	917,942	335,048,830	baseline	n/a	n/a	n/a
2019	264,760	302,838	382,063	949,661	346,626,265	3.5%	n/a	n/a	n/a
2021	235,384	278,385	346,136	859,906	313,865,545	-6.3%	n/a	n/a	n/a
2022	257,716	295,066	358,615	911,397	332,659,956	-0.7%	35.77	21.29	6
2023	388,083	152,082	365,364	905,529	330,518,241	-1.4%	128.59	9.99	6.44
Percentages	42.9%	16.8%	40.3%	100.0%					

Table 12 – VDOT Vehicle Miles Traveled (VMT) data for Harrisonburg

Sub Totals	Fuel	VMT (%)	Federal Vehicle Class	#	Clear Path Label
288,881,572	Gasoline	0.3%	Motorcycles	01	Motorcycles
		68.0%	Passenger Cars	02	Passenger Cars
		19.1%	Two Axle, 4 Tire Single Unit Vehicles	03	Light Trucks
		87.4%	Gasoline Subtotal		
41,636,669	Diesel	0.6%	Busses	04	Heavy Trucks
		1.1%	Two Axle, 6 Tire Single Unit Trucks	05	
		0.7%	Three Axle Single Unit Trucks	06	
		0.1%	Four or More Axle Single Unit Trucks	07	
		0.5%	Four Axle or Fewer Single Trailers	08	
		8.9%	Five Axle Single Trailers	09	
		0.1%	Six or More Axle Single Trailers	10	
		0.4%	Five Axle or Fewer Multi-Trailers	11	
		0.2%	Six Axle Multi-Trailers	12	
		0.0%	Seven or More Axle Multi-Trailers	13	
		12.6%	Diesel Subtotal		
330,518,241		100.0%	Total Transportation		

Table 13 – VDOT Vehicle Percentages in 2023

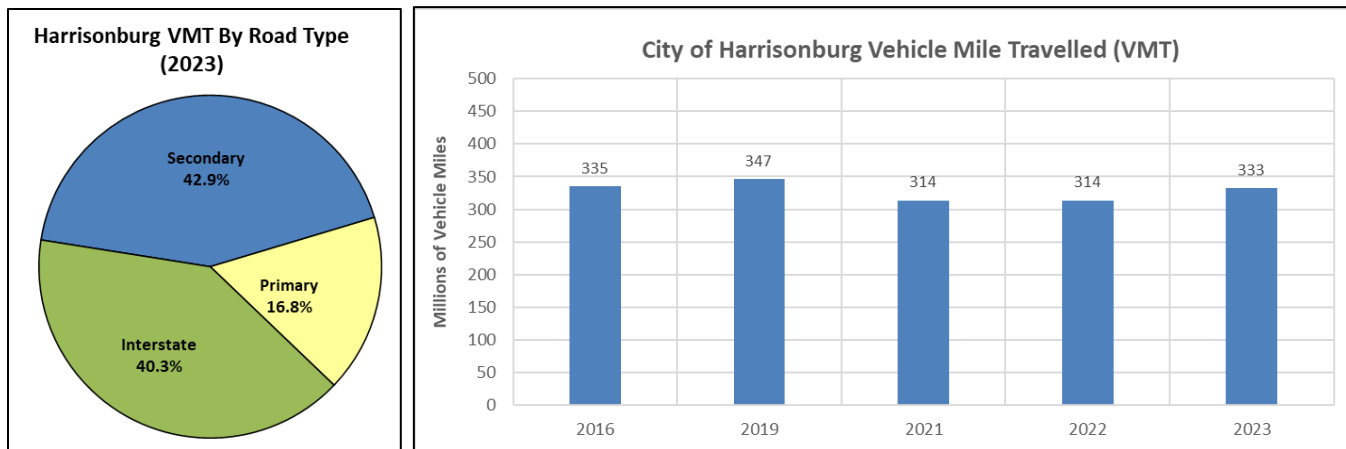


Figure 7 – Harrisonburg Vehicle Miles Traveled (VMT) By Year and 2023 Road Type

Note that vehicle emissions will be slightly overcounted in the results section using this methodology. VMTs are a reliable way to quantify Community level transportation miles, but the method depends on a vehicle and mile count so it can't differentiate electric from gasoline (or diesel) vehicles. Therefore, electric vehicle VMTs are included with associated carbon dioxide emissions. In reality, the carbon dioxide emissions for electric vehicles occur at the utility power plants rather than at the tailpipe since there is no combustion. This means that a small number of VMTs from the electric and hybrid-electrics vehicles shown in Table 14 are double-counted since their carbon emissions are included in the electricity usage and in the VMT analysis. Future analyses should account for avoided EV tailpipe emissions, but the electric vehicle penetration is currently so low that the errors are not significant. Gasoline hybrid vehicles are accounted for properly as their higher fuel economies result in less gasoline use which is factored into the vehicle fuel economy estimates by year.

Year	2016	2019	2021	2022	2023	%
Hybrid Vehicles	288	530	716	734	856	2.0%
Electric Vehicles	5	26	65	78	115	0.27%
Totals Cars Registered in the City				35,468	42,000	

Table 14 - City of Harrisonburg alternative vehicle counts

3f. Waste Disposal

Harrisonburg City Community solid waste is sent to the Rockingham County Landfill. Waste tonnage data was obtained from the Area MSW Annual Data spreadsheet provided by the City of Harrisonburg Department of Public Works. The data is summarized for past report years in Table 15. Even though the solid waste is broken down by several categories, the Mixed Solid Waste (MSW) default (100%) method in ClearPath based on the EPA WARM v14 model was used since these waste data categories do not match up well with the detailed categories in the ClearPath Waste Factor sets. The default waste percentages are based on the US municipal averages since specific waste percentages were not available for the City of Harrisonburg municipal waste. These differences are important in the interpretation of the landfill methane in the 20-yr GHG totals. Municipal-level solid waste was not analyzed due to the lack of detailed waste data at city facilities.

Harrisonburg City Waste	Municipal Solid Waste (residential refuse)	Commercial Refuse ¹	Non-chargeable on report	Concrete, Dirt, Rock	Construction/ Demolition/ Wood Debris	Industrial Waste ²	Vegetative/ Yard Waste ³	Unsorted Rubbish	Sludge	Total
2016	2,732	7,249	48	510	4,224	48	1,002	126	22	15,961
2019	11,584	18,218	419	64	3,954	126	465	59	434	35,323
2021	10,623	15,079	374	8	2,943	237	863	29	8	30,164
2022	10,380	16,070	362	580	67	2,213	-	973	29	30,674
2023	10,262	11,523	402	174	1,649	268	610	89	-	24,977
¹ Includes agriculture and cows										
² Includes flyash										
³ Includes commercial brush, re-route brush, xmas trees										
⁴ The accuracy of the waste tonnage reported is dependent on the Rockingham County Landfill customers, including private haulers, providing the attendant with the correct source of their refuse.										

Table 15 – Harrisonburg Waste Summary

Annual rainfall in Harrisonburg in the 35 - 40 inches range which led to selecting “Moderate” moisture for the ClearPath Landfill Model. Landfill gas is flared from this landfill so “Typical” was chosen for Landfill Collection Scenario in the model.

The ClearPath waste calculator is based on the EPA Waste Reduction Model (WARM). This calculation method estimates all future methane emissions from the fraction of the organic (carbon-based) mass sent to landfill and attributes them all to the current Inventory Year. Details have been provided in previous GHG emissions reports.

3g. Biogas from Waste Water Treatment

Biogas is generated by various processes in the Harrisonburg Rockingham Regional Sewer Authority (HRRSA). The biogas has a composition of approximately 67% methane (CH₄) and 33% carbon dioxide (CO₂). Prior to 2019, biogas was combusted (flared) in a waste gas burner to convert the methane which is a much stronger GHG than carbon dioxide. This combustion process is estimated to be 98% efficient at methane conversion. Starting in 2019, some of the biogas was combusted and used to heat the HRRSA biosolids dryer and anaerobic digester heat exchangers. The volumes of biogas are provided in Table 16. The City of Harrisonburg contributes approximately half of the water to the waste water treatment facility (WWTF) so the biogas was attributed to the City based on the percentage in both the Municipal and Community inventories. This analysis estimates emissions from the combustion of Digester Gas according to the ICLEI US Community Protocol Appendix F: *Wastewater and Water Emission Activities and Sources methods WW.1.a for CH₄, WW.2.a for N₂O and WW.3 for biogenic CO₂.*

Year	Biogas Flared (cubic feet)	Biogas Use in Biosolids Dryer (cubic feet)	% Attributed to Harrisonburg City
2016 (fiscal)	67,673,385	0	53%
2019 (fiscal)	67,673,385	12,121,322	53%
2021 (calendar)	25,525,000	86,368,196	56.4%
2022 (calendar)	31,917,000	85,224,515	56.3%
2023 (calendar)	51,736,000	70,544,289	54.24%

Table 16 – Harrisonburg Rockingham Regional Sewer Authority (HRRSA) biogas data

3h. Recycling

Community-wide recycling data was obtained from the Harrisonburg Public Works Department Year-to-Date Solid Waste Report and detailed in Table 17. Note that ClearPath does not give emissions credits for recycled materials as this methodology is not considered appropriate by all GHG emissions methods. However, these estimates are useful metrics as recycling is an important community activity.

Therefore, the EPA WARM model (v.15) was used to estimate avoided emissions due to recycling.¹⁷ The recycling amounts for the various categories in Table 17 were multiplied by the associated WARM emissions savings and summed. The emissions savings are across the life cycle due to the recycled materials being used instead of virgin materials. These absolute recycling emissions can be considered as unofficial offsets to the Community emissions.

Category	Waste Amount (tons)				Savings (tons CO ₂ /ton waste)	WARM v15 Categories
	2019	2021	2022	2023		
Cardboard	188.7	285	333.4	305	3.14	Corrugated containers
Glass	99.3	103.3	111.4	89.3	0.28	Glass
Tin/Scrap	95.7	49.9	35.2	44.9	4.39	Mixed Metals
Mixed Paper	78.2	82.39	62.8	80.7	3.55	Mixed Paper
Plastic 1	19.8	26	27.1	25.8	1.04	PET
Plastic 2	9.6	11.7	12.1	13.1	0.76	HDPE
Plastic Bags	7.6	8.8	10.5	11.5	0.00	LDPE
Aluminum	3.0	10.3	11	15.6	9.13	Aluminum Cans
Totals	502	577	604	586		
Carbon Emissions (mt CO₂)	1,245	1,420	1,445	1,492	EPA WARM v15 estimate	

Table 17 – Harrisonburg Solid Waste Management Recycling Data

4. ANALYSIS RESULTS

The ICLEI ClearPath online software was used to analyze the data detailed in the previous sections to provide estimates of the GHG emissions for Harrisonburg in 2023 and compare to previous years including the 2016 (baseline year). The 2023 greenhouse gas emissions are normalized to carbon dioxide (CO₂) using the IPCC 6th report global warming potentials (GWPs), which account for the impact of the specific chemical emissions relative to this standard reference. Total GHG emissions are therefore reported in mass units of CO₂ equivalent (CO_{2e}) in metric tons, which are 1.1 times heavier than US (short) tons. Analyses are shown for both the 100-yr and 20-yr GWP values.

4a. Municipal Greenhouse Gas Emissions

Total Municipal GHGs calculated by ClearPath using the inventory data, assumptions, and factor sets detailed above are shown in Tables 18 and 19 at both the broad sector and fuel source level. The small differences in the Sector and Source table totals are due to rounding of subtotals in the calculations. Total Municipal GHG emissions were 15.0% less and 14.4% less in 2023 than in 2016 for the 100-yr and 20-yr analyses, respectively. The main difference for the 20-yr analysis are Natural Gas leakages values which roughly triple in the 20-yr analysis due to the higher GWP over this time frame. Municipal emissions are dominated by the Buildings/Facilities sector, which are 37.2% and 30.3%, respectively, for the 100-yr and 20-yr analysis. Electricity is the dominant municipal source of GHGs contributing 47.2% and 38.5% of the emissions, respectively, for the 100-yr and 20-yr analysis.

<i>ClearPath Inventory by Sector Report</i>		100-yr GWP						
Sector	ClearPath 2016 (mtons)	ClearPath 2019 (mtons)	ClearPath 2021 (mtons)	ClearPath 2022 (mtons)	ClearPath 2023 (mtons)	2023 Sector (%)	Previous Year Difference (%)	2016 Baseline Difference (%)
Buildings/Facilities	8,698	8,974	7,980	8,132	6,876	37.2%	-15.4%	-20.9%
Water & Sewer	3,920	3,932	3,812	3,910	3,228	17.5%	-17.4%	-17.7%
Vehicle Fleet	3,473	3,590	3,129	3,438	3,423	18.5%	-0.4%	-1.4%
Natural Gas (Methane) Leakage	2,130	2,306	2,194	2,244	1,977	10.7%	-11.9%	-7.2%
Transit Fleet	2,003	2,143	2,004	1,776	1,837	9.9%	3.4%	-8.3%
Street/Traffic Lights	1,029	1,041	947	903	790	4.3%	-12.5%	-23.2%
Electric Grid Loss	479	567	531	531	352	1.9%	-33.7%	-26.5%
Totals	21,732	22,553	20,597	20,934	18,483	100.0%	-11.7%	-15.0%

<i>ClearPath Inventory by Sector Report</i>		20-yr GWP						
Sector	ClearPath 2016 (mtons)	ClearPath 2019 (mtons)	ClearPath 2021 (mtons)	ClearPath 2022 (mtons)	ClearPath 2023 (mtons)	2023 Sector (%)	Previous Year Difference (%)	2016 Baseline Difference (%)
Buildings/Facilities	8745	9017	8018	8,169	6,908	30.3%	-15.4%	-21.0%
Natural Gas (Methane) Leakage	6467	6998	6661	6,211	5,872	25.7%	-5.5%	-9.2%
Water & Sewer	4452	4463	4038	4,169	3,623	15.9%	-13.1%	-18.6%
Vehicle Fleet	3473	3590	3129	3,438	3,423	15.0%	-0.4%	-1.4%
Transit Fleet	2003	2143	2004	1,776	1,837	8.1%	3.4%	-8.3%
Street/Traffic Lights	1034	1045	950	907	793	3.5%	-12.6%	-23.3%
Electric Grid Loss	482	570	534	533	353	1.5%	-33.8%	-26.8%
Totals	26,656	27,826	25,334	25,203	22,809	100.0%	-9.5%	-14.4%

Table 18 – Harrisonburg Municipal ClearPath GHG Emissions by Sector (100-yr and 20-yr GWP)

<i>ClearPath Detailed Report</i>		100-yr GWP						
Emissions Source	ClearPath 2016 (mtons)	ClearPath 2019 (mtons)	ClearPath 2021 (mtons)	ClearPath 2022 (mtons)	ClearPath 2023 (mtons)	2023 Sector (%)	Previous Year Difference (%)	2016 Baseline Difference (%)
Electricity	11,141	11,697	10,570	10,553	8,735	47.2%	-17.2%	-21.6%
Natural Gas	4,356	4,314	4,142	4,413	4,038	21.8%	-8.5%	-7.3%
Diesel	3,930	4,115	3,579	3,467	3,432	18.6%	-1.0%	-12.7%
Gasoline	1,546	1,619	1,555	1,748	1,829	9.9%	4.7%	18.3%
Fuel Oil	509	557	646	613	254	1.4%	-58.6%	-50.1%
Biogas	252	253	109	143	199	1.1%	38.5%	-21.3%
Totals	21,736	22,556	20,602	20,937	18,487	100%	-11.7%	-14.9%

<i>ClearPath Detailed Report</i>		20-yr GWP						
Emissions Source	ClearPath 2016 (mtons)	ClearPath 2019 (mtons)	ClearPath 2021 (mtons)	ClearPath 2022 (mtons)	ClearPath 2023 (mtons)	2023 Sector (%)	Previous Year Difference (%)	2016 Baseline Difference (%)
Electricity	11,198	11,748	10,613	10,596	8,772	38.5%	-17.2%	-21.7%
Natural Gas	8,705	9,018	8,620	8,391	7,944	34.8%	-5.3%	-8.7%
Diesel	3,930	4,115	3,579	3,467	3,432	15.0%	-1.0%	-12.7%
Gasoline	1,546	1,619	1,555	1,748	1,829	8.0%	4.7%	18.3%
Fuel Oil	513	562	652	618	256	1.1%	-58.5%	-50.1%
Biogas	766	768	320	387	581	2.5%	50.2%	-24.2%
Totals	26,659	27,830	25,339	25,207	22,815	100.0%	-9.5%	-14.4%

Table 19 – Harrisonburg Municipal ClearPath GHG Emissions by Source (100-yr and 20-yr GWP)

Total Municipal GHGs in the 100-yr analysis are plotted in Figures 8 and 9 for the sectors and sources. The 20-yr plots are not shown here as they are primarily different only for natural gas leakage. It is clear from these plots that Buildings and Electricity are the biggest contributors and opportunities for future GHG reductions. It is important to remember that reductions to electricity use will also lead to less natural gas leakage and GHG emissions due to the use of natural gas by Dominion to generate 37% of the utility electricity in 2023 as seen in Table 6.

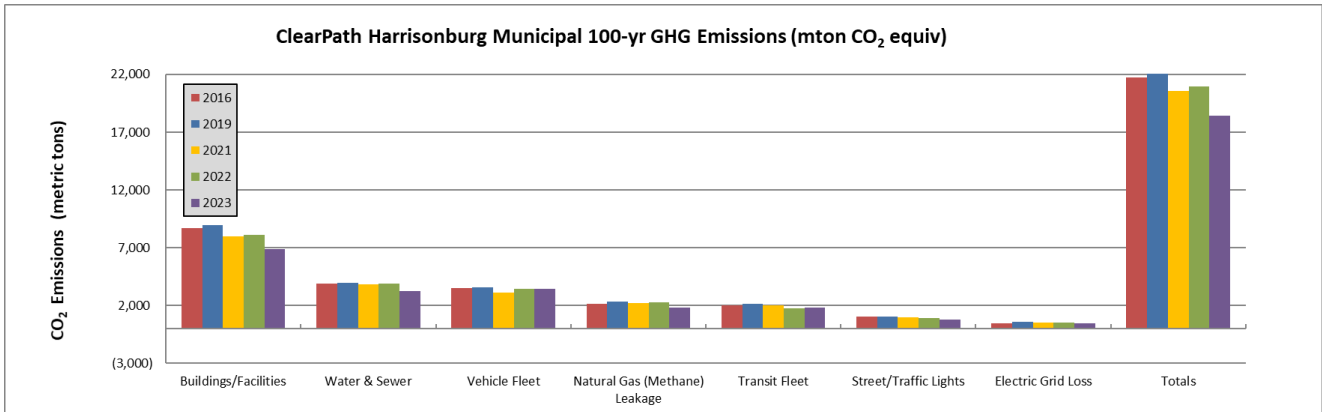


Figure 8 – Harrisonburg Municipal 100-yr GHGs by Sector

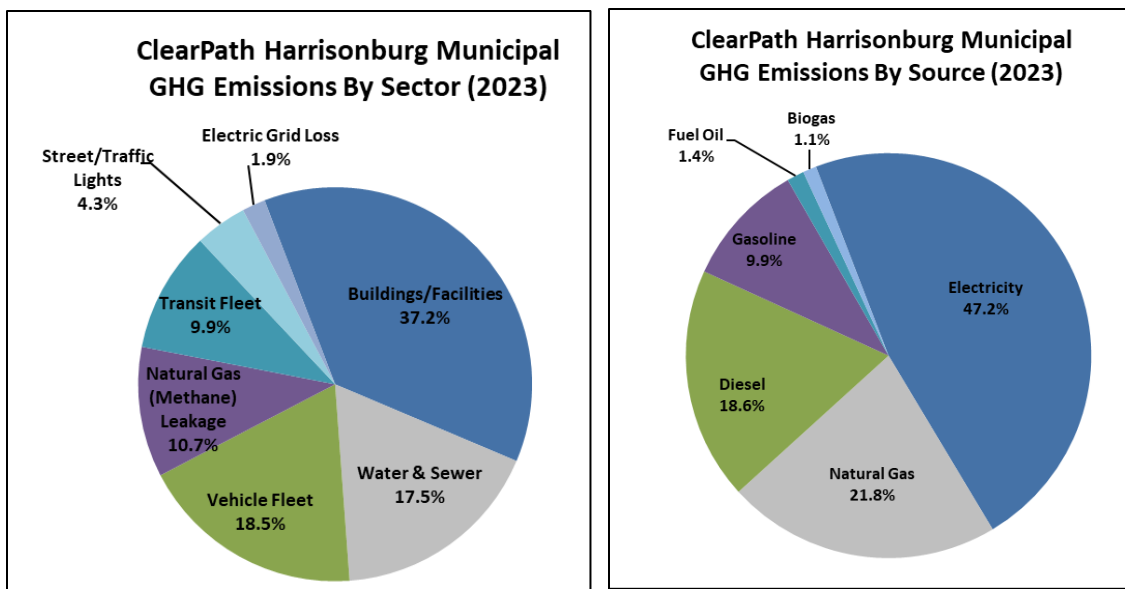


Figure 9 – Harrisonburg Municipal 100-yr GHG emissions by Sector and Source 2023

Table 20 provides the 100-yr GHG municipal emissions results at a more detailed level for the category, sector and fuel source. School electricity is the largest emissions contributor at 16.5% followed by Sewer Authority electricity, diesel for City Transit Buses, and natural gas leakage from utility fuel consumption.

School operations (buildings and buses) have emissions from multiple fuel sources and are also 4 of the top dozen categories as seen in Table 20. The four school energy sources of electricity, natural gas, fuel oil, and diesel fuel (school buses) contribute 30% of all Municipal emissions in 2023. Therefore, to provide more insight and detail, the School sector emissions are broken down further in Table 21. In the school category, electricity accounts for the largest contribution to GHG emissions at 55% as seen in the pie chart of Figure 10. Overall, School GHG Emissions have decreased in 2023 by approximately 16.2% from 2016.

Category	Sector	Fuel Source	CO _{2e} (mton)					Category (%)	Past Year Difference (%)	2023 vs 2016 Difference (%)
			2016	2019	2021	2022	2023			
SCHOOLS	Buildings/Facilities	Electricity	3,865	4,308	3,613	3,644	3,047	16.5%	-16.4%	-21.2%
SEWER AUTHORITY	Water & Sewer	Electricity	2,469	2,501	2,511	2,380	1,954	10.6%	-17.9%	-20.9%
CITY TRANSIT BUSES	Transit Fleet	Diesel	1,817	1,926	1,783	1,519	1,548	8.4%	1.9%	-14.8%
NATURAL GAS (METHANE) LEAKAGE	Utility	Natural Gas	1,190	1,458	1,380	1,277	1,132	6.1%	-11.4%	-4.9%
WATER DEPT	Water & Sewer	Electricity	1,199	1,179	1,192	1,388	1,076	5.8%	-22.5%	-10.2%
SCHOOLS	Buildings/Facilities	Natural Gas	1,302	1,203	1,153	1,392	1,377	7.5%	-1.1%	5.8%
TRAFFIC & STREET LIGHTS	Street/Traffic Lights	Electricity	1,029	1,041	947	904	790	4.3%	-12.5%	-23.2%
FLEET VEHICLES	Vehicle Fleet	Gasoline	1,106	1,071	919	1013	1,049	5.7%	3.6%	-5.1%
NATURAL GAS (METHANE) LEAKAGE	Municipality	Natural Gas	941	848	815	967	845	4.6%	-12.6%	-10.1%
SCHOOL BUSES	Vehicle Fleet	Diesel	914	1,006	688	848	843	4.6%	-0.5%	-7.8%
DIESEL TRUCKS	Vehicle Fleet	Diesel	847	799	652	613	560	3.0%	-8.8%	-33.9%
SCHOOLS	Buildings/Facilities	Fuel Oil	509	557	646	613	254	1.4%	-58.6%	-50.1%
ELECTRICAL GRID LOSS	Buildings/Facilities	Electricity	480	568	532	531	352	1.9%	-33.7%	-26.6%
FIRE DEPT	Buildings/Facilities	Electricity	551	609	531	498	431	2.3%	-13.4%	-21.9%
PARKS & REC DEPT	Buildings/Facilities	Electricity	602	607	480	462	442	2.4%	-4.2%	-26.5%
PARKS & REC DEPT	Buildings/Facilities	Natural Gas	464	376	388	376	325	1.8%	-13.6%	-30.0%
POLICE CARS	Vehicle Fleet	Gasoline	254	330	354	392	404	2.2%	2.8%	58.9%
COMMUNITY DEVELOPMENT	Buildings/Facilities	Electricity	269	264	249	235	199	1.1%	-15.6%	-26.1%
DIESEL EQUIPMENT	Vehicle Fleet	Diesel	352	384	247	243	282	1.5%	15.8%	-19.8%
TRANSPORTATION DEPT	Buildings/Facilities	Electricity	370	305	234	235	218	1.2%	-7.3%	-41.1%
PARATRANSIT BUSES	Transit Fleet	Gasoline	186	218	222	257	290	1.6%	12.9%	55.9%
DIESEL FIRE/AMBULANCE	Transit Fleet	Diesel	w/ diesel trucks		210	243	200	1.1%	-17.8%	
FIRE DEPT	Buildings/Facilities	Natural Gas	168	203	167	165	162	0.9%	-1.5%	-3.3%
PUBLIC WORKS	Buildings/Facilities	Electricity	128	74	128	131	103	0.6%	-21.8%	-19.8%
SEWER AUTHORITY	Water & Sewer	Biogas	252	252	101	135	192	1.0%	42.5%	-24.0%
TRANSPORTATION DEPT	Buildings/Facilities	Natural Gas	134	82	83	88	79	0.4%	-10.3%	-41.3%
PUBLIC WORKS	Buildings/Facilities	Natural Gas	93	87	82	76	70	0.4%	-7.4%	-24.3%
PARKING SERVICES	Buildings/Facilities	Electricity	90	3	71	67	54	0.3%	-19.4%	-39.7%
EMERGENCY COMM CENTER (HRECC)	Buildings/Facilities	Electricity	64	82	65	65	58	0.3%	-10.2%	-9.8%
FLEET GASOLINE EQUIPMENT	Transit Fleet	Gasoline	w/ gasoline fleet		61	85	86	0.5%	1.1%	
MISCELLANEOUS MUNICIPAL	Buildings/Facilities	Natural Gas			56	55	31	0.2%	-43.2%	
WATER DEPT	Buildings/Facilities	Natural Gas	21	19	18	18	16	0.1%	-10.2%	-24.4%
CENTRAL STORES	Buildings/Facilities	Electricity	22	16	11	11	9	0.1%	-16.8%	-57.8%
SEWER AUTHORITY	Water & Sewer	Biogas	0	1	7	9	7	0.0%	-22.9%	
POLICE DEPT	Buildings/Facilities	Electricity	2	140	3	2	1	0.0%	-53.6%	-50.8%
CITY HALL	Buildings/Facilities	Natural Gas	24	24						
SEWER AUTHORITY	Water & Sewer	Electricity	0.3	0.4						
TOURISM	Buildings/Facilities	Natural Gas	19	15						
TOTALS			21,736	22,556	20,602	20,937	18,486	100.0%	-11.7%	-14.9%

Table 20 – Harrisonburg Municipal ClearPath Detailed 100-yr GHG Emissions by Source and Fuel

School Category/Detail	Sector	Fuel Source	CO _{2e} (mton)					Category (%)	Past Year Difference (%)	2023 vs 2016 Difference (%)
			2016	2019	2021	2022	2023			
Harrisonburg High School	Buildings/Facilities	Electricity	1,145	1,430	1,161	1,130	958	17.4%	-15%	-16.3%
Smithland Elementary & Skyline Middle			797	840	747	716	634	11.5%	-11%	-20.5%
Thomas Harrison Middle School			619	462	341	348	309	5.6%	-11%	-50.0%
Stone Spring Elementary School			383	438	350	400	261	4.7%	-35%	-32.0%
Spotswood Elementary School			282	303	253	292	248	4.5%	-15%	-11.9%
Keister Elementary School			285	290	271	260	231	4.2%	-11%	-19.1%
Waterman Elementary School			279	284	259	250	225	4.1%	-10%	-19.2%
Bluestone Elementary School			0	184	163	157	141	2.5%	-10%	
School Board Office + FRC			75	78	68	109	40	0.7%	-64%	-47.2%
School Electricity Totals					3,865	4,308	3,613	3,644	3,047	55.2%
Smithland Elementary & Skyline Middle	Buildings/Facilities	Natural Gas	249	312	303	316	301	5.5%	-5%	20.7%
Stone Spring Elementary School			205	224	242	346	346	6.3%	0%	69.2%
Keister Elementary School			128	159	162	169	165	3.0%	-2%	29.0%
Thomas Harrison Middle School			426	184	144	165	219	4.0%	33%	-48.5%
Spotswood Elementary School			147	171	160	219	169	3.1%	-23%	14.9%
Waterman Elementary School			112	116	109	138	138	2.5%	0%	23.0%
Maintenance Building			26	30	26	30	30	0.5%	0%	15.0%
School Board Office			9	8	7	8	8	0.1%	0%	-15.1%
Elon Rhodes Early Learning Center (ELC)			-	-	0	1	1	0.0%	-1%	
School Natural Gas Totals					1,302	1,203	1,153	1,392	1,377	24.9%
School Bus Diesel Fuel Totals	Vehicle Fleet	Diesel	914	1,006	688	848	843	15.3%	-0.5%	-7.8%
Harrisonburg High School	Buildings/Facilities	Fuel Oil	508	557	646	613	254	4.6%	-58.6%	-50.0%
Smithland Elementary & Skyline Middle			1	-	-	-	-	0%		
School Fuel Oil (Heating) Totals			509	557	646	613	254	4.6%	-59%	-50.1%
TOTALS			6,591	7,074	6,100	6,496	5,522	100%	-15%	-16.2%

Table 21 – Harrisonburg School Detailed 100-yr GHG Emissions by Source and Fuel

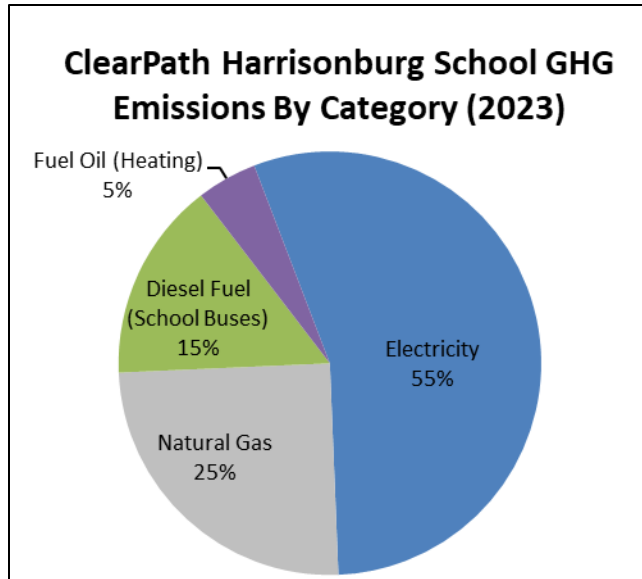


Figure 10 – Harrisonburg School-Related 100-yr GHG emissions by Category

4b. Community GHG Emissions

Community GHGs calculated by ClearPath are shown in Tables 22 and 23 and Figures 11 - 13 by sector and fuel source based on both 20-yr and 100-yr GWP values. The 20-yr GWP values are roughly 30% higher due to the GWP of methane which is approximately 3 times higher relative to carbon dioxide due to its shorter lifetimes in the atmosphere.

Total emissions decreased 12.1% in 2023 compared to 2016 for both the 100-yr GWP values and 20-yr GWP values. Community emissions were dominated by the Commercial and Transportation sectors in the 100-yr analysis at approximately 30% of the total. In the 20-yr analysis, Natural Gas leakage was the largest category. Estimated methane leakage from natural gas lines in the community and indirectly from natural gas used for electricity generation is 13.2% and 28.1% in the 100-yr analysis and 20-yr analysis, respectively. For both, the 2023 GHG totals continue to drop in part due to the lower carbon emissions factor for electricity from Dominion Power listed in Table 5.

<i>From ClearPath Inventory by Sector Report</i>		100-yr GWP						
Sector	ClearPath 2016 (mtons CO2e)	ClearPath 2019 (mtons CO2e)	ClearPath 2021 (mtons CO2e)	ClearPath 2022 (mtons CO2e)	ClearPath 2023 (mtons CO2e)	2016 Baseline Difference (%)	2023 Sector (%)	
Commercial	200,943	206,151	184,274	184,968	161,396	-19.7%	29.2%	
Transportation	179,691	182,964	169,626	174,580	169,707	-5.6%	30.7%	
Residential	81,672	85,497	80,477	76,433	63,968	-21.7%	11.6%	
Natural Gas Leakage	72,359	79,837	76,487	76,144	72,812	0.6%	13.2%	
Industrial	63,908	64,257	62,613	63,035	58,605	-8.3%	10.6%	
Solid Waste	16,914	23,072	19,703	19,463	16,244	-4.0%	2.9%	
Electricity Grid Loss	10,616	12,302	11,531	9,738	7,641	-28.0%	1.4%	
Water & Wastewater	3,920	3,932	3,813	3,898	3,228	-17.7%	0.6%	
Totals	630,023	658,012	608,524	608,259	553,601	-12.1%	100.0%	

<i>From ClearPath Inventory by Sector Report</i>		20-yr GWP						
Sector	ClearPath 2016 (mtons CO2e)	ClearPath 2019 (mtons CO2e)	ClearPath 2021 (mtons CO2e)	ClearPath 2022 (mtons CO2e)	ClearPath 2023 (mtons CO2e)	2016 Baseline Difference (%)	2023 Sector (%)	
Natural Gas Leakage	219,608	242,306	232,137	210,758	201,535	-8.2%	28.1%	
Commercial	201,985	207,130	185,119	185,833	162,142	-19.7%	22.6%	
Transportation	180,037	183,295	169,919	174,732	169,863	-5.7%	23.7%	
Residential	82,107	85,896	80,833	76,786	64,261	-21.7%	9.0%	
Industrial	64,136	64,457	62,788	63,231	58,775	-8.4%	8.2%	
Solid Waste	51,348	70,041	59,813	59,033	48,256	-6.0%	6.7%	
Electricity Grid Loss	10,670	12,356	11,578	9,781	7,674	-28.1%	1.1%	
Water & Wastewater	4,452	4,463	4,040	4,170	3,623	-18.6%	0.5%	
Totals	814,343	869,944	806,227	784,324	716,129	-12.1%	100.0%	

Table 22 – Harrisonburg Community ClearPath GHG Emissions by Sector for 2 Time Horizons

<i>From ClearPath Detailed Report</i>		100-yr GWP						
Emissions Source	ClearPath 2016 (mtons)	ClearPath 2019 (mtons)	ClearPath 2021 (mtons)	ClearPath 2022 (mtons)	ClearPath 2023 (mtons CO2e)	Baseline Difference (%)	2023 Source (%)	
Electricity	246,549	253,532	229,106	226,492	189,577	-23.1%	34.2%	
Natural Gas	181,245	187,586	186,685	183,951	175,007	-38.8%	31.6%	
Gasoline	116,826	118,133	106,252	108,781	110,961	49.8%	20.0%	
Diesel	62,865	64,832	63,375	65,800	58,747	-6.6%	10.6%	
Solid Waste	16,915	23,072	19,703	19,463	16,245	-4.0%	2.9%	
Fuel Oil	5,374	10,609	3,296	3,645	2,869	-46.6%	0.5%	
Biogas	252	253	110	132	199	-21.3%	0.04%	
Totals	630,027	658,016	608,528	608,264	553,604	-12.1%	100.0%	

<i>From ClearPath Detailed Report</i>		20-yr GWP						
Emissions Source	ClearPath 2016 (mtons)	ClearPath 2019 (mtons)	ClearPath 2021 (mtons)	ClearPath 2022 (mtons)	ClearPath 2023 (mtons)	Baseline Difference (%)	2023 Source (%)	
Natural Gas	328,975	350,539	342,810	319,028	304,144	-7.5%	42.5%	
Electricity	247,801	254,639	230,042	227,472	190,397	-23.2%	26.6%	
Gasoline	117,162	118,452	106,532	108,922	111,095	-5.2%	15.5%	
Diesel	62,876	64,844	63,387	65,811	58,768	-6.5%	8.2%	
Solid Waste	51,349	70,041	59,814	59,034	48,256	-6.0%	6.7%	
Fuel Oil	5,418	10,665	3,324	3,674	2,891	-46.6%	0.4%	
Biogas	766	768	322	388	581	-24.1%	0.1%	
Totals	814,347	869,948	806,230	784,328	716,133	-12.1%	100.0%	

Table 23 – Harrisonburg Community ClearPath GHG Emissions by Source for 2 Time Horizons

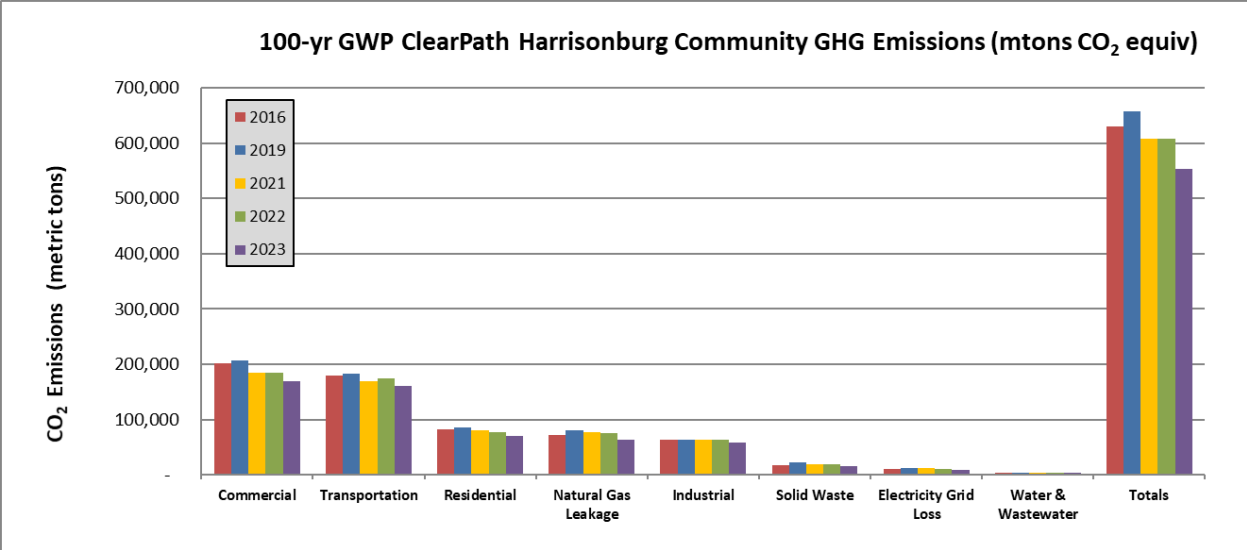


Figure 11 – Harrisonburg Community GHGs by Sector (100-yr GWP)

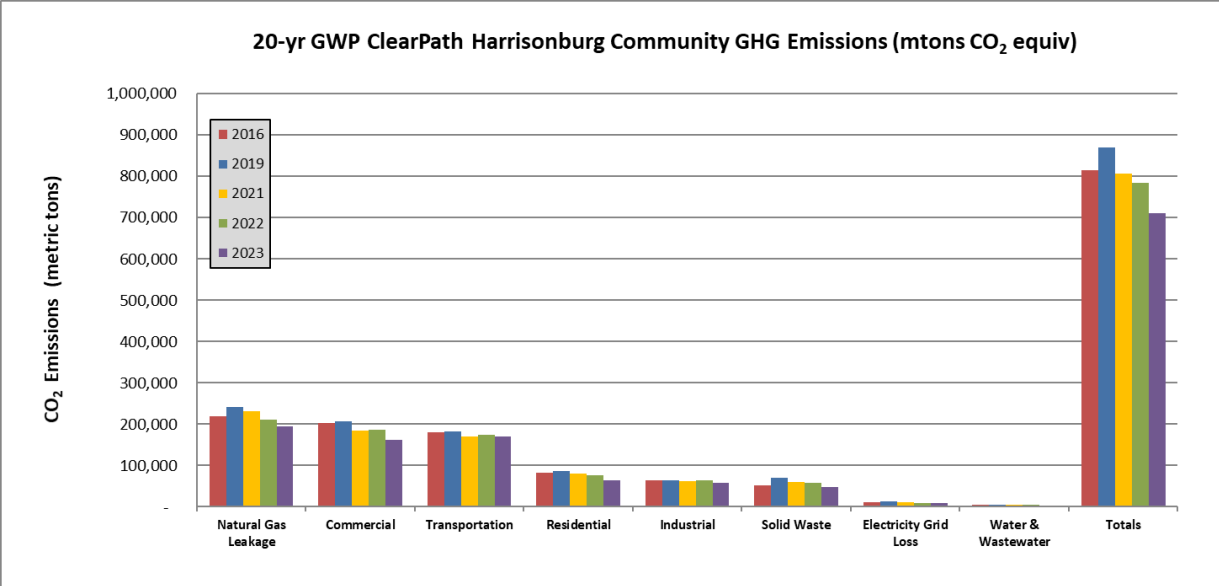


Figure 12 – Harrisonburg Community GHGs by Sector (20-yr GWP)

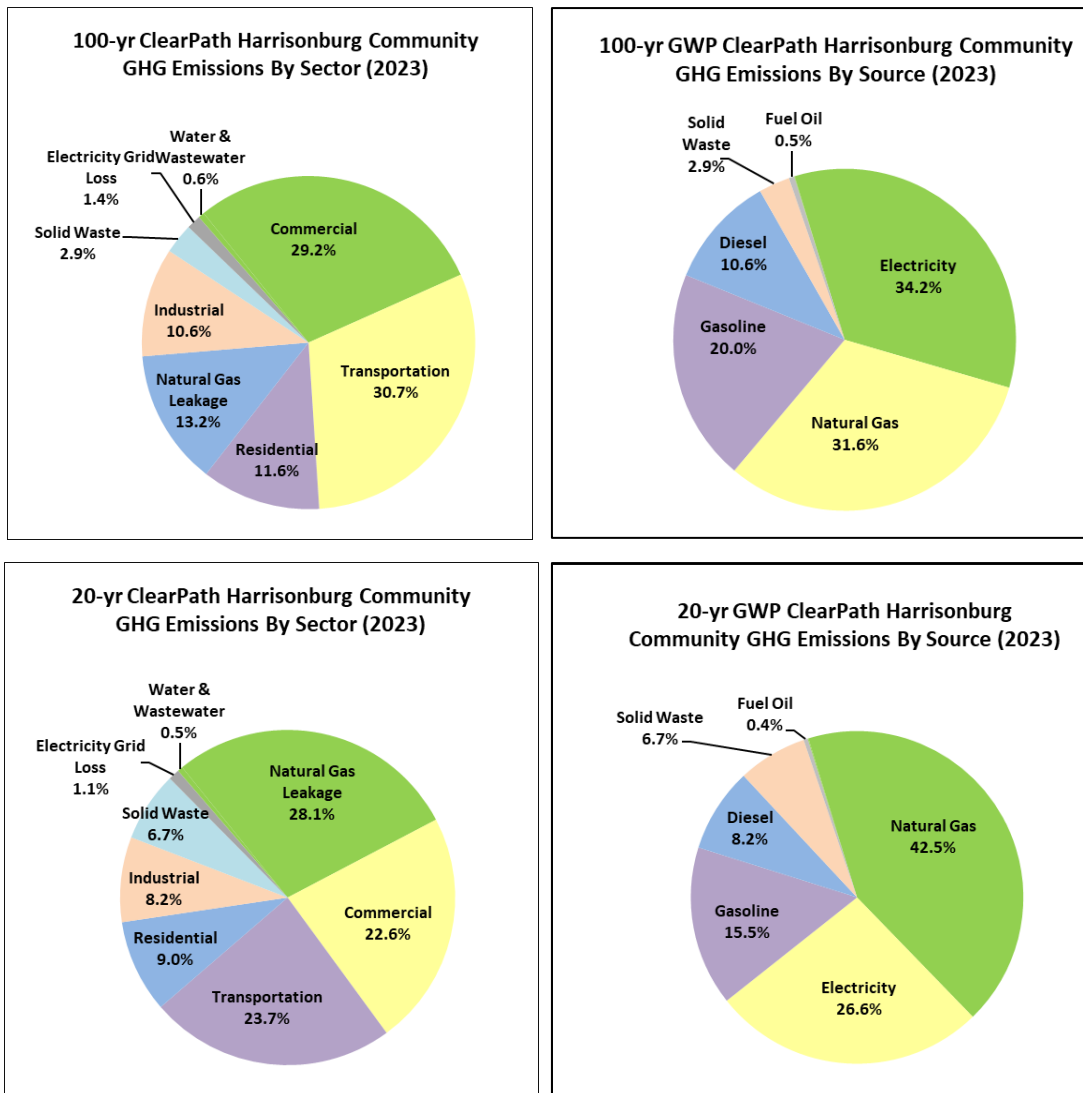


Figure 13 – Harrisonburg Community GHG emissions by Sector and Source 2023

4c. Recycling Carbon Emissions Savings

As mentioned above, recycling provides emissions savings since the virgin raw materials and some of the processing and transportation are not required for new products. Formally, the ClearPath analysis does not provide recycling credits for a number of technical reasons including the fact that recycling can increase simply because consumption increases. Consumption of materials other than energy and fuels is out of scope for this analysis, so it's not appropriate to give credit for the recycling due to consumption when consumption of materials is not counted.

Recycling is an important community activity, though, so these unofficial estimates are provided outside the ClearPath analysis. The emissions savings due to recycling is approximately 0.3% of the Community total using the 100-yr GWP analysis, so even though 586 tons of recycling is a large number, the impact on emissions savings is quite small and the recycling program should not be prioritized over the much larger emissions reductions available from conservation of energy and fuels.

Recycling is an important community activity so these unofficial estimates are provided outside the ClearPath analysis. The emissions savings due to recycling is approximately 0.3% of the Community

total using the 100-yr GWP analysis, so even though 586 tons of recycling and 1,492 tons CO_{2e} are not negligible, the impact on emissions savings is quite small and the recycling program should not be prioritized over the much larger emissions reductions available from conservation of energy and fuels. Composting emissions are also not calculated in this analysis, but organic materials which are composted instead of landfilled have GHG emissions reductions since methane is not emitted from the landfill due to anaerobic decomposition. In 2024, 50 tons of waste were collected in downtown Harrisonburg bins for composting. Emissions were calculated using the ReFED emissions tool.¹⁸ The emissions savings were 31.5 and 91.7 tons CO_{2e} using the 100-yr and 20-yr GWP values, respectively.

5. DISCUSSION AND CONCLUSIONS

This analysis allows the City to continue to set and refine GHG targets using a local action plan at the Municipal and Community levels to help achieve these goals. Recently, city-level GHG goals to reduce the effects of climate change have become much more aggressive as the significant impacts of this problem have become clearer. Many jurisdictions are adopting the goals of reducing GHG emissions to 50% by 2030 and achieving carbon neutrality by 2050. This range of targets and goals is aggressive, but in line with recommendations by climate scientists to avoid the worst scenarios of climate change.

Local action plans will generally include a mix of the following actions for reducing GHG emissions (in order of highest cost effectiveness and feasibility): Energy conservation, Efficiency improvements, Utility carbon intensity reduction, Renewable energy generation, Renewable energy credits (RECs) and Carbon offsets. Each of these options has different challenges, costs, and absolute amounts of emission reductions that are possible. Further quantitative analysis and modeling is recommended to provide additional metrics to complement this report and inform future local action plans and goals. These goals should depend not only on the results shown in the analysis above, but also on the preferences of the city stakeholders, technical feasibility, and cost effectiveness. It is a best practice for action plans for GHG reduction initiatives to include short, medium, and long-term goals.

Community and municipal GHG emissions are recommended to be assessed yearly since the data collection and analysis is relatively straightforward. It is recommended to streamline and automate some of the data compilation and analysis to simplify and shorten the analysis process. Given the contribution of JMU to city GHG emissions, interaction and coordination with JMU staff and sustainability professionals is recommended and helpful for progress in reducing GHG emissions.

Municipal goals and plans are somewhat easier to develop since the City has more control of the buildings and operations that create emissions. Recall, the Municipal emissions contribute approximately 3.3% of the total Community 100-yr GHG emissions in 2023. Programs for conservation and more efficient use of electricity will have the largest impacts and save money at the same time. Geothermal HVAC systems would increase heating and cooling efficiency for municipal projects with the appropriate space and ground characteristics. Purchasing electric vehicles as some fleet vehicles reach their replacement age will reduce emissions and save money over time. Distributed renewable generation such as solar power may be a cost-effective way to reduce GHG emissions when considered for buildings with proper orientation and roof characteristics. While solar costs have decreased significantly over the past decade, each installation must be evaluated individually for its cost effectiveness and return on investment as some sites are better suited than others for this application and costs vary significantly with the scale of the project.

Significant emissions reductions are possible for both the municipality and community with the addition of renewable energy generation by the utilities. The Virginia Clean Energy Act (VCEA) of 2020 mandates actions which will reduce GHG emissions including a renewable portfolio standard (RPS) for the state's electric grid. This RPS has slightly different requirements for Appalachian Power and Dominion Energy, the largest utilities in the state. Dominion Energy – which supplies the City of Harrisonburg with electricity – is required to transition its power sources to generate 41%, 79%, and 100% of its electricity from renewable sources by 2030, 2040, and 2045 respectively.¹⁹ If these goals are met at the state level, Harrisonburg's 48% of GHG emissions from electricity will decline in the next 20 years to zero as Dominion Energy makes changes. Continued support of the VCEA helps to ensure renewable sources for grid-supplied electricity in Harrisonburg and provide renewable energy sources for all Virginians. Thus, it is recommended for the City to strongly support the VCEA implementation and programs given the large contribution of electricity GHG emissions to its overall footprint.

A quick estimate suggests that meeting the 2030 and 2040 RPS goals will reduce electricity emission by 10% and 20%, respectively given the current Dominion electricity fuel mix of roughly 42% fossil fuels and less than 3% renewables shown in Table 6. This emissions reduction estimate does not account for the increasing penetration of electric vehicles into the Transportation sector which was shown above in table 23 and expected to accelerate. Both hybrid and electric vehicles can already reduce vehicle GHG emissions by 40% per vehicle and additional gains will come as battery technology improves and more renewably-generated electricity is added to the electrical grid. A more detailed model of the expected shifts in energy generation, product, and behavior can make more accurate predications over time and is recommend for future action plans to reduce GHG emissions.

The 20-yr analyses shown in this report highlight the significant role of methane for shorter term GHG reductions. Substitutions of renewable energy at the utility scale for natural gas for electricity will also reduce the natural gas leakage from the indirect emissions of methane from the generation of electricity. City and natural gas utility initiatives to minimize local natural gas leaks for all sectors will reduce GHGs, save money, and minimize risks of explosions.

The largest opportunities for reductions are available at the Community level, but programs and initiatives at this level are more difficult since residents, businesses, and industries are in control of their own actions, buildings, technology, and vehicles. Again, these emissions may improve over time due to market penetration of more efficient vehicles and buildings and conservation, but this is not guaranteed especially if the economy grows. Therefore, programs to incentivize efficiency and conservation, initiated by the City or by other agencies, are recommended as the effects of climate change will be felt by everyone independent of the source of the emissions.

Any actions taken to reduce emissions will have other important co-benefits. The conservation of energy or fuel saves money immediately with an infinite return on investment (ROI). The majority of GHG emissions are due to combustion processes that also create other forms of air pollution, which exacerbate both environmental and health effects. Other efficiency improvements due to new vehicles, heating systems, and novel technologies may have largest up front costs, but due to energy savings will have long-term ROI.

All of these benefits for the City and residents in the areas of costs, health, and the environment are not realized if the emphasis on more renewable energy and energy efficiency are not pushed for all levels of government and personal choice.

6. REFERENCES:

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- ³EPA Emissions & Generation Resource Integrated Database (eGRID) website, <https://www.epa.gov/egrid>
- ⁴Edison Electric Institute, Electric Company Carbon Emissions and Electricity Mix Reporting Database for Corporate Customers, <https://www.eei.org/en/issues-and-policy/national-corporate-customers/co2-emission>
- ⁵Dominion Energy 2019 Sustainability and Corporate Responsibility Report, Environmental Metrics, pp.83, <https://sustainability.dominionenergy.com/assets/pdf/metrics/dominion-energy-environmental-metrics-2019.pdf>
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- ¹³US Census Bureau Database, S2504 - Physical Housing Characteristics For Occupied Housing Units, 2023 ACS 5-Year Estimates Subject Tables, <https://data.census.gov/table?q=Harrisonburg+city,+Harrisonburg+city,+Virginia&tid=ACSST5Y2021.S2504>
- ¹⁴Energy Information Administration (EIA), 2020 Residential Energy Consumption Survey (RECS) web page, Table CE2.4 Annual household site fuel consumption in the South—totals and averages, 2020 <https://www.eia.gov/consumption/residential/data/2020/index.php?view=consumption>,
- ¹⁵Virginia Department of Transportation (VDOT) Website, Traffic Data, <http://www.virginiadot.org/info/ct-TrafficCounts.asp>
- ¹⁶EPA Waste Reduction Model (WARM) website, <https://www.epa.gov/warm/versions-waste-reduction-model-warm#WARM%20Tool%20V14>)
- ¹⁷EPA Office of Resource Conservation and Recovery, Documentation for Greenhouse Gas Emission and Energy Factors Used in the Waste Reduction Model (WARM), Management Practices Chapters, version 15, Nov. 2020.
- ¹⁸ReFED website, Impact Calculator, <https://insights.refed.org/>
- ¹⁹Virginia's Legislative Information System, 2020 Session, HB 1526 Electric utility regulation; environmental goals, <https://lis.virginia.gov/cgi-bin/legp604.exe?201+sum+HB1526#>

7. APPENDIX

APPENDIX 1 – Harrisonburg Municipal Electricity Data (2023)

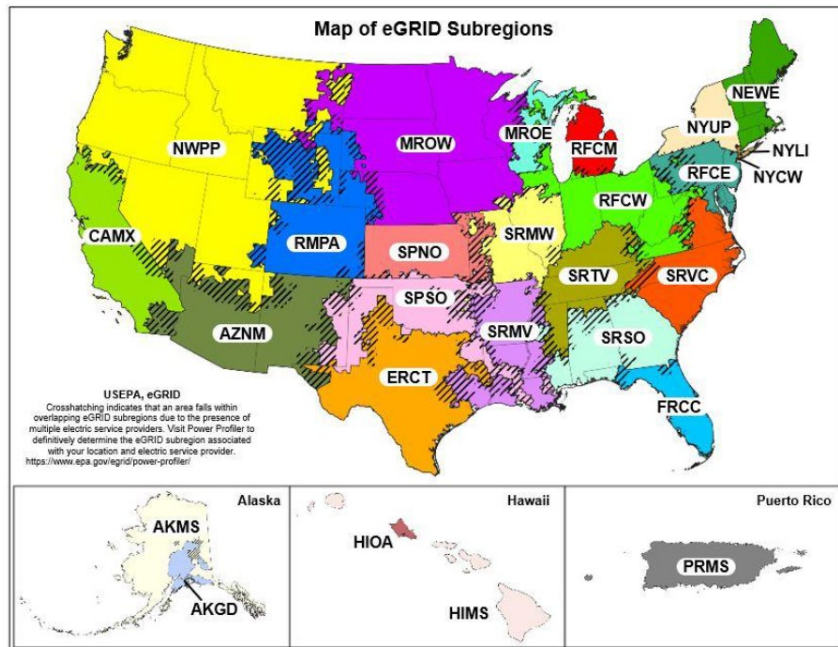
2023				
ACCOUNT	NAME	SERVICE ADDRESS	Total kWh	
103748-2	HBURG COMMUNITY DEVELOPMENT	345 S MAIN ST	123,680	
103748-3	HBURG COMMUNITY DEVELOPMENT	212 S MAIN ST	76,131	
103748-5	HBURG COMMUNITY DEVELOPMENT	228 S LIBERTY ST	15,878	
103748-6	HBURG COMMUNITY DEVELOPMENT	409 S MAIN ST	530,640	
103748-8	HBURG COMMUNITY DEVELOPMENT	1925 E MARKET ST STE 600	5,647	751,976
103749-3	HBURG TRANSPORTATION DEPT	473 E WASHINGTON ST	329,088	
103749-4	HBURG TRANSPORTATION DEPT	475 E WASHINGTON ST	471,456	
103749-5	HBURG TRANSPORTATION DEPT	475 E WASHINGTON ST	23,256	
103749-6	HBURG TRANSPORTATION DEPT- EVSE	409 S MAIN ST	1,100	824,900
10456-2	HBURG FIRE DEPT	162 N LIBERTY ST	440	
10456-3	HBURG FIRE DEPT	80 MARYLAND AVE SEC LIGHT	1,440	
10456-4	HBURG FIRE DEPT	80 MARYLAND AVE	196,560	
10456-5	HBURG FIRE DEPT	399 E MOSBY RD	20,097	
10456-6	HBURG FIRE DEPT	380 PLEASANT VALLEY RD	52,928	
10456-7	HBURG FIRE DEPT	210 E ROCK ST	163,680	
10456-8	HBURG FIRE DEPT	101 N MAIN ST	1,123,200	
10456-10	HBURG FIRE DEPT	299 LUCY DR	55,971	
10456-13	HBURG FIRE DEPT	101 N MAIN ST	128	
10456-14	HBURG FIRE DEPT	90 MARYLAND AVE	5,626	
10456-15	HBURG FIRE DEPT	80 MARYLAND AVE TEMP METER	9,605	
10456-17	HBURG FIRE DEPT	101 N MAIN ST	594	
10456-18	HBURG FIRE DEPT	101 N MAIN ST	723	1,630,992
105618-1	HBURG PURCHASING/CENTRAL STORE	2111 BEERY RD	35,344	35,344
1306-4	HBURG WATER DEPT	600 VINE ST	2,645	
1306-5	HBURG WATER DEPT	1241 OLD WINDMILL CIR	18,640	
1306-6	HBURG WATER DEPT	1002 GREYSTONE ST	1,106	
1306-10	HBURG WATER DEPT	80 GARBERS CHURCH RD	56,064	
1306-11	HBURG WATER DEPT	1751 S HIGH ST	708	
1306-17	HBURG WATER DEPT	1705 PEACH GROVE AVE	166,874	
1306-18	HBURG WATER DEPT	651 TOWER ST	134,680	
1306-23	HBURG WATER DEPT	910 UNIVERSITY BLVD	1,027	
1306-29	HBURG WATER DEPT	1905 E MARKET ST	118,008	
1306-33	HBURG WATER DEPT	1315 W MARKET ST	924	
1306-39	HBURG WATER DEPT	1600 SMITHLAND RD	24,034	
1306-40	HBURG WATER DEPT	128 CHESTNUT RIDGE DR	16,071	
1306-42	HBURG WATER DEPT	276 BLUE STONE HILLS DR	6,437	
1306-43	HBURG WATER DEPT	1790 RESERVOIR ST	179,310	
1306-44	HBURG WATER DEPT	1179 HARRISON ST	235	
1306-46	HBURG WATER DEPT	851 PORT REPUBLIC RD	52	
1306-47	HBURG WATER DEPT	2155 BEERY RD	159,920	
1306-51	HBURG WATER DEPT	1111 WILLOW SPRING RD	239	
1306-52	HBURG WATER DEPT	1491 OLD FURNACE RD	24,530	
1306-53	HBURG WATER DEPT	250 CHESTNUT RIDGE DR	71,998	
1306-54	HBURG WATER DEPT	1078 MT CLINTON PIKE	84,532	
1306-55	HBURG WATER DEPT	1300 HILLCREST DR	3,643	
1306-56	HBURG WATER DEPT	1179 HARRISON ST	2,849	1,074,526
HPU Energy Report	North River Raw Water Pumping Station Water Treatment Plant Water Distribution Pumps	100% allocated to City	4,073,780	4,073,780
13653-3	HBURG CITY SCHOOLS	100 MARYLAND AVE	560,640	
13653-4	HBURG CITY SCHOOLS	100 MARYLAND AVE	88,423	
13653-5	HBURG CITY SCHOOLS	100 MARYLAND AVE	225,120	
13653-6	HBURG CITY SCHOOLS	1575 PEACH GROVE AVE	880,320	
13653-7	HBURG CITY SCHOOLS	1575 PEACH GROVE AVE	14,573	
13653-8	HBURG CITY SCHOOLS	1575 PEACH GROVE AVE	54,029	
13653-14	HBURG CITY SCHOOLS	375 S CARLTON ST	192,880	
13653-15	HBURG CITY SCHOOLS	375 S CARLTON ST	660,000	
13653-16	HBURG CITY SCHOOLS	375 S CARLTON ST	50,361	
13653-17	HBURG CITY SCHOOLS	400 MOUNTAIN VIEW DR	37,103	
13653-19	HBURG CITY SCHOOLS	1311 W MARKET ST	1,171,200	
13653-20	HBURG CITY SCHOOLS	451 CHICAGO AVE SEC LIGHT	2,400	
13653-21	HBURG CITY SCHOOLS	451 CHICAGO AVE	760,320	
13653-22	HBURG CITY SCHOOLS	451 CHICAGO AVE	44,748	
13653-23	HBURG CITY SCHOOLS	451 CHICAGO AVE	45,927	
13653-27	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	1,290,240	
13653-28	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	1,946,880	
13653-29	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	159,360	
13653-30	HBURG CITY SCHOOLS	1575 PEACH GROVE AVE	37,664	
13653-33	HBURG CITY SCHOOLS	470 LINDA LN	2,400,000	
13653-34	HBURG CITY SCHOOLS	1 COURT SQ	47,680	
13653-35	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	14,884	
13653-36	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	47,280	
13653-37	HBURG CITY SCHOOLS	750 GARBERS CHURCH RD	532,500	
13653-38	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	29,680	
13653-39	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	28,560	
13653-40	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	25,920	
13653-41	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	27,621	
13653-42	HBURG CITY SCHOOLS	640 S MAIN ST	106,177	
13653-43	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	57,600	11,540,090

14133-1	HBURG PUBLIC WORKS	901 CHICAGO AVE	19,153	
14133-2	HBURG PUBLIC WORKS	320 E MOSBY RD	5,033	
14133-3	HBURG PUBLIC WORKS	320 E MOSBY RD	99,126	
14133-4	HBURG PUBLIC WORKS	320 E MOSBY RD	20,811	
14133-5	HBURG PUBLIC WORKS	300 E MOSBY RD	120,356	
14133-13	HBURG PUBLIC WORKS	901 CHICAGO AVE	22,080	
14133-19	HBURG PUBLIC WORKS	2115 RAMBLEWOOD RD	19,932	
14133-52	HBURG PUBLIC WORKS	2055 BEERY RD	56,640	
14133-61	HBURG PUBLIC WORKS	901 CHICAGO AVE	5,212	
14133-63	HBURG PUBLIC WORKS	1111 N MAIN ST	7,901	
14133-64	HBURG PUBLIC WORKS	1010 GREENDALE RD	3,418	
14133-65	HBURG PUBLIC WORKS	1111 N MAIN ST TEMP METER	8,685	388,347
13653-1	SCHOOL CROSSING LIGHT	1583 W MARKET ST STE A	20,049	
14133-9	Traffic Lights	345 S MAIN ST	310,044	
14133-10	Street Lights	345 S MAIN ST	1,445,160	
14133-11	Street Lights - Principal Arterial	345 S MAIN ST	517,320	
14133-12	Street Lights - Urban Minor Arterial	345 S MAIN ST	593,160	
14133-17	Traffic Lights	1486 W MARKET ST	2,896	
14133-24	Traffic Lights	1101 E MARKET ST	1,743	
14133-25	Traffic Lights	1911 S HIGH ST	3,379	
14133-26	Traffic Lights	335 STONE SPRING RD	430	
14133-28	Traffic Lights	671 UNIVERSITY BLVD	3,046	
14133-29	Traffic Lights	1100 S HIGH ST	2,967	
14133-30	Traffic Lights	1280 GARBERS CHURCH RD	2,142	
14133-31	Traffic Lights	2141 S MAIN ST	4,308	
14133-32	Traffic Lights	335 STONE SPRING RD	3,812	
14133-33	Traffic Lights	165 N HIGH ST	3,327	
14133-34	Traffic Lights	404 VIRGINIA AVE	3,112	
14133-36	Traffic Lights	1306 HILLSIDE AVE	3,380	
14133-38	Traffic Lights	2421 S MAIN ST	3,798	
14133-39	Traffic Lights	1825 S MAIN ST	5,073	
14133-40	Street Lights	460 PHEASANT RUN CIR	1,644	
14133-41	Traffic Lights	198 S MAIN ST	2,203	
14133-42	Traffic Lights	102 S MAIN ST	2,248	
14133-43	Traffic Lights	28 S MAIN ST	4,420	
14133-44	Traffic Lights	1575 PEACH GROVE AVE	2,545	
14133-45	Traffic Lights	802 S MAIN ST	4,237	
14133-46	Traffic Lights	99 BURGESS RD	4,589	
14133-47	Traffic Lights	1788 RESERVOIR ST	3,879	
14133-48	Traffic Lights	1915 RESERVOIR ST	2,970	
14133-49	Traffic Lights	2095 RESERVOIR ST	3,918	
14133-50	Traffic Lights	2396 RESERVOIR ST	2,911	
14133-51	Traffic Lights	705 S MASON ST	3,575	
14133-53	Traffic Lights	703 S MAIN ST	3,842	
14133-54	Traffic Lights	998 S MAIN ST	3,620	
14133-55	Traffic Lights	589 UNIVERSITY BLVD	3,257	
14133-57	Traffic Lights	102 N MAIN ST	1,756	
14133-58	Traffic Lights	196 N MAIN ST	1,975	
14133-59	Traffic Lights	594 PORT REPUBLIC RD	5,203	
14133-62	Traffic Lights	1241 S MAIN ST	5,369	
14133-56	Traffic Lights	250 RESERVOIR ST	127	2,993,434
14429-5	HBURG POLICE DEPT	1016 GREENDALE RD	3,399	
14429-6	HBURG POLICE DEPT	1010 GREENDALE RD TEMP METER	921	
14429-7	HBURG POLICE DEPT	1020 GREENDALE RD	-	4,320
14511-1	DOWNTOWN PARKING SERVICES	150 E ELIZABETH ST	69,495	
14511-11	DOWNTOWN PARKING SERVICES	30 W BRUCE ST	176	
14511-2	DOWNTOWN PARKING SERVICES	89 W WATER ST	119,603	
14511-3	DOWNTOWN PARKING SERVICES	135 S MAIN ST SEC LIGHT	2,200	
14511-4	DOWNTOWN PARKING SERVICES	282 N LIBERTY ST SEC LIGHT	720	
14511-5	DOWNTOWN PARKING SERVICES	345 S MAIN ST SEC LIGHT	7,680	
14511-6	DOWNTOWN PARKING SERVICES	44 NEWMAN AVE SEC LIGHT	2,520	
14511-8	DOWNTOWN PARKING SERVICES	48 E WATER ST SEC LIGHT	360	
14511-9	DOWNTOWN PARKING SERVICES	90 N MAIN ST SEC LIGHT	2,520	205,274
2128-2	HBURG RECREATION DEPT	1583 W MARKET ST STE B	17,168	
2128-5	HBURG RECREATION DEPT	100 MILLER CIR SEC LIGHT	1,920	
2128-6	HBURG RECREATION DEPT	1582 S MAIN ST	5,963	
2128-7	HBURG RECREATION DEPT	1582 S MAIN ST	7,139	
2128-8	HBURG RECREATION DEPT	1582 S MAIN ST SEC LIGHT	720	
2128-9	HBURG RECREATION DEPT	1545 HILLSIDE AVE SEC LIGHT	3,000	
2128-12	HBURG RECREATION DEPT	909 RESERVOIR ST	17,576	
2128-14	HBURG RECREATION DEPT	620 SIMMS AVE	15,229	
2128-15	HBURG RECREATION DEPT	401 E WASHINGTON ST	4,173	
2128-16	HBURG RECREATION DEPT	901 CHICAGO AVE	22,364	
2128-17	HBURG RECREATION DEPT	305 S DOGWOOD DR	2,793	
2128-18	HBURG RECREATION DEPT	305 S DOGWOOD DR	312,460	
2128-19	HBURG RECREATION DEPT	305 S DOGWOOD DR	258,900	
2128-20	HBURG RECREATION DEPT	305 S DOGWOOD DR	2,776	
2128-22	HBURG RECREATION DEPT	680 GARBERS CHURCH RD	111,360	
2128-24	HBURG RECREATION DEPT	1582 S MAIN ST	17,404	
2128-25	HBURG RECREATION DEPT	1412 SMITHLAND RD	32,506	
2128-26	HBURG RECREATION DEPT	680 GARBERS CHURCH RD	62,800	
2128-29	HBURG RECREATION DEPT	305 S DOGWOOD DR	1	
2128-31	HBURG RECREATION DEPT	1583 W MARKET ST	3,029	
2128-32	HBURG RECREATION DEPT	501 HILLDALE AVE TEMP METER	22	
2128-34	HBURG RECREATION DEPT	461 2ND ST	7,037	
2128-35	HBURG RECREATION DEPT	1542 SMITHLAND RD	6,732	
2128-37	HBURG RECREATION DEPT	1545 HILLSIDE AVE	2,175	
2128-38	HBURG RECREATION DEPT	1545 HILLSIDE AVE	18,608	
2128-39	HBURG RECREATION DEPT	1545 HILLSIDE AVE	7,630	
2128-40	HBURG RECREATION DEPT	1545 HILLSIDE AVE	22,350	
2128-45	HBURG RECREATION DEPT	501 HILLDALE AVE	24,840	
2128-49	HBURG RECREATION DEPT	177 S MAIN ST	3,407	
2128-50	HBURG RECREATION DEPT	188 N LIBERTY ST	4,660	
2128-53	HBURG RECREATION DEPT	1950 THOMAS BOWERS CIR	9,175	
2128-55	HBURG RECREATION DEPT	431 E WASHINGTON ST TEMP METER	49	
2128-57	HBURG RECREATION DEPT	431 E WASHINGTON ST SEC LIGHT	2,280	
2128-58	HBURG RECREATION DEPT	620 SIMMS AVE	598,900	
2128-61	HBURG RECREATION DEPT	431 E WASHINGTON ST	6,653	
2128-62	HBURG RECREATION DEPT	2181 RAMBLEWOOD RD	46,080	
2128-63	HBURG RECREATION DEPT	309 S DOGWOOD DR	12,500	
2128-64	HBURG RECREATION DEPT	317 S MAIN ST SEC LIGHT	480	
2128-65	HBURG RECREATION DEPT	246 S LIBERTY ST	212	
2128-66	HBURG RECREATION DEPT	248 S LIBERTY ST	234	
2128-67	HBURG RECREATION DEPT	252 S LIBERTY ST	20	
2128-68	HBURG RECREATION DEPT	1542 SMITHLAND RD	2,204	
2128-69	HBURG RECREATION DEPT	1311 W MARKET ST	17	
2128-70	HBURG RECREATION DEPT	901 CHICAGO AVE	49	1,675,595
9305-1	HBURG RHAM REG SEWER AUTH	1321 S DOGWOOD DR	893	
HBURG RHAM REG SEWER AUTH FACILITY (54.24% City)	54.24%		7,398,105	7,398,998
112263-1	HRECC	653 TOWER ST	128,731	
112263-2	HRECC	1575 PEACH GROVE AVE	43,138	
112263-5	HRECC	420 MT CLINTON PIKE	41,200	
112263-6	HRECC	424 MT CLINTON PIKE	6,656	219,725
		Total	31,742,775	31,742,775
		Municipal Electricity	kWh	20,269,997
		(minus water treatment and sewer)		

APPENDIX 2 –EPA eGRID Regional Electricity Emission Rates (2023, most recent available year)

1. Subregion Output Emission Rates (eGRID2023)																
eGRID subregion acronym	eGRID subregion name	Total output emission rates lb/MWh							Non-baseload output emission rates lb/MWh							Grid Gross Loss (%)
		CO ₂	CH ₄	N ₂ O	CO ₂ e	Annual NO _x	Ozone Season NO _x	SO ₂	CO ₂	CH ₄	N ₂ O	CO ₂	Annual NO _x	Ozone Season NO _x	SO ₂	
AKGD	ASCC Alaska Grid	899.0	0.086	0.012	904.5	5.6	6.2	0.310	1,077.1	0.116	0.016	1,084.5	6.3	7.0	0.463	4.1%
AKMS	ASCC Miscellaneous	519.4	0.026	0.004	521.4	8.1	7.9	0.707	1,548.6	0.067	0.012	1,553.6	24.4	23.6	2.110	4.1%
AZNM	WECC Southwest	740.8	0.041	0.006	743.4	0.4	0.4	0.108	1,260.4	0.067	0.009	1,264.7	0.7	0.6	0.184	4.1%
CAMX	WECC California	436.7	0.025	0.003	438.2	0.3	0.3	0.020	1,034.0	0.051	0.007	1,037.1	0.7	0.6	0.045	4.1%
ERCT	ERCOT All	738.0	0.043	0.006	740.8	0.4	0.5	0.321	1,264.9	0.076	0.010	1,269.8	0.9	0.9	0.667	4.2%
FRCC	FRCC All	801.9	0.042	0.005	804.5	0.2	0.2	0.131	1,034.0	0.045	0.006	1,036.8	0.3	0.3	0.159	4.2%
HIMS	HICC Miscellaneous	1,122.1	0.146	0.022	1,132.0	7.6	7.2	4.484	1,596.4	0.170	0.027	1,608.2	11.7	11.6	6.169	4.4%
HIOA	HICC Oahu	1,489.4	0.134	0.021	1,498.8	3.9	3.7	4.279	1,753.4	0.159	0.025	1,764.6	4.5	4.3	5.041	4.4%
MROE	MRO East	1,402.0	0.116	0.017	1,409.7	1.0	1.0	0.278	1,713.8	0.161	0.023	1,724.4	1.1	1.2	0.367	4.2%
MROW	MRO West	920.0	0.097	0.014	926.4	0.7	0.8	0.896	1,776.6	0.180	0.026	1,788.5	1.4	1.4	1.575	4.2%
NEWE	NPCC New England	537.2	0.063	0.008	541.1	0.3	0.3	0.115	885.2	0.067	0.009	889.3	0.4	0.3	0.137	4.2%
NWPP	WECC Northwest	631.7	0.054	0.008	635.2	0.6	0.5	0.268	1,613.4	0.146	0.021	1,623.0	1.6	1.6	0.752	4.1%
NYCW	NPCC NYC/Westchester	974.7	0.025	0.003	976.1	0.3	0.3	0.027	1,008.9	0.020	0.002	1,010.0	0.4	0.4	0.011	4.2%
NYLI	NPCC Long Island	1,180.7	0.140	0.018	1,189.3	0.8	0.8	0.331	1,316.6	0.050	0.006	1,319.6	0.8	0.7	0.126	4.2%
NYUP	NPCC Upstate NY	241.0	0.011	0.001	241.7	0.1	0.1	0.027	909.1	0.041	0.005	911.6	0.4	0.4	0.103	4.2%
PRMS	Puerto Rico Miscellaneous	1,543.0	0.077	0.012	1,548.4	3.9	4.1	3.695	1,636.7	0.072	0.012	1,642.0	4.4	4.7	4.735	
RFCE	RFC East	594.7	0.036	0.005	597.0	0.2	0.2	0.211	1,175.5	0.077	0.010	1,180.4	0.6	0.6	0.618	4.2%
RFCM	RFC Michigan	962.1	0.082	0.011	967.4	0.5	0.5	0.559	1,508.1	0.144	0.020	1,517.6	0.9	0.8	1.020	4.2%
RFCW	RFC West	911.3	0.071	0.010	916.0	0.4	0.4	0.412	1,757.3	0.161	0.023	1,767.9	1.0	0.8	0.877	4.2%
RMPA	WECC Rockies	1,036.0	0.090	0.013	1,042.0	0.5	0.5	0.329	1,620.6	0.124	0.018	1,628.8	0.9	0.9	0.469	4.1%
SPNO	SPP North	861.9	0.087	0.012	867.7	0.5	0.6	0.137	1,892.1	0.188	0.027	1,904.5	1.1	1.0	0.296	4.2%
SPSO	SPP South	891.1	0.055	0.008	894.7	0.7	0.8	0.673	1,508.4	0.095	0.013	1,514.6	1.4	1.3	1.208	4.2%
SRMV	SERC Mississippi Valley	739.4	0.032	0.004	741.4	0.5	0.5	0.350	1,145.5	0.061	0.008	1,149.4	0.9	1.0	0.857	4.2%
SRMW	SERC Midwest	1,238.3	0.132	0.019	1,247.0	0.8	0.6	1.634	1,818.6	0.190	0.027	1,831.1	1.7	1.1	2.157	4.2%
SRSO	SERC South	840.9	0.055	0.008	844.6	0.3	0.3	0.162	1,386.0	0.096	0.014	1,392.3	0.7	0.6	0.298	4.2%
SRTV	SERC Tennessee Valley	895.7	0.079	0.011	900.9	0.4	0.4	0.426	1,665.8	0.154	0.022	1,675.9	0.7	0.6	0.828	4.2%
SRVC	SERC Virginia/Carolina	590.2	0.045	0.006	593.1	0.3	0.3	0.151	1,286.8	0.100	0.014	1,293.3	0.7	0.7	0.376	4.2%
U.S.		771.5	0.057	0.008	775.2	0.5	0.5	0.361	1,393.7	0.104	0.015	1,400.5	0.9	0.9	0.694	4.2%

Created: 01/17/2025



APPENDIX 3 – ClearPath Transportation Factor Sets

(2022 data that was updated in 2024 was used – the 2023 factor set data not yet released)

* Name	
2022 US National Defaults (Updated 2024)	
Year	2023 <input type="button" value="v"/>
Gas Passenger Vehicle Fuel Economy (MPG)	24.8
Gas Passenger Vehicle g CH4/mi	.0078
Gas Passenger Vehicle g N2O/mi	.0061
Gas Light Truck Fuel Economy (MPG)	18.1
Gas Light Truck g CH4/mi	.011
Gas Light Truck g N2O/mi	.0073
Gas Heavy Truck Fuel Economy (MPG)	7.3
Gas Heavy Truck g CH4/mi	.032
Gas Heavy Truck g N2O/mi	.0041
Gas Transit Bus Fuel Economy (MPG)	7.3
Gas Transit Bus g CH4/mi	.032
Gas Transit Bus g N2O/mi	.0041
Gas Para Transit Bus Fuel Economy (MPG)	7.3
Gas Para Transit Bus g CH4/mi	.032
Gas Para Transit Bus g N2O/mi	.0041
Gas Motorcycle Fuel Economy (MPG)	44
Gas Motorcycle g CH4/mi	.0672
Gas Motorcycle g N2O/mi	.0069
Electric Vehicle Fuel Economy (MPGe)	91
Diesel Passenger Vehicle Fuel Economy (MPG)	24.8
Diesel Passenger Vehicle g CH4/mi	.0302
Diesel Passenger Vehicle g N2O/mi	.0192
Diesel Light Truck Fuel Economy (MPG)	18.1
Diesel Light Truck g CH4/mi	.029
Diesel Light Truck g N2O/mi	.0214
Diesel Heavy Truck Fuel Economy (MPG)	7.3
Diesel Heavy Truck g CH4/mi	.0095
Diesel Heavy Truck g N2O/mi	.0431
Diesel Transit Bus Fuel Economy (MPG)	7.3
Diesel Transit Bus g CH4/mi	.0095
Diesel Transit Bus g N2O/mi	.0431
Diesel Para Transit Bus Fuel Economy (MPG)	7.3
Diesel Para Transit Bus g CH4/mi	.0095
Diesel Para Transit Bus g N2O/mi	.0431
Diesel Motorcycle Fuel Economy (MPG)	44
Diesel Motorcycle g CH4/mi	.0672
Diesel Motorcycle g N2O/mi	.0069