

ICLEI GOVERNMENT EMISSIONS INVENTORY 2016/2019 SUMMARY REPORT

CITY OF HARRISONBURG, VA



SEPTEMBER 12, 2021

CITY OF HARRISONBURG

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CITY OF HARRISONBURG, VIRGINIA

**ICLEI GOVERNMENT EMISSIONS INVENTORY
2016/2019 SUMMARY REPORT**

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EXECUTIVE SUMMARY

The City of Harrisonburg, Virginia, greenhouse gas (GHG) emissions inventory was completed for the calendar years 2016 and 2019. The baseline year chosen for future comparisons was 2016. 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.

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.

Total Municipal GHG emissions in 2019 for Harrisonburg were 16,600 metric tons, a 16% decrease from the 2016 baseline level. Buildings/facilities accounted for 43% of these emissions and the dominant fuel source for the City was electricity at 49%. School operations including electricity, natural gas, fuel oil, and diesel fuel (school buses) contribute 34% of all Municipal GHG emissions.

Total Community GHG emissions in 2019 for Harrisonburg were 530,000 metric tons, a 9% decrease from the 2016 baseline level. The Transportation (34%) and Commercial (31%) sectors each accounted for approximately 1/3 of Community GHG emissions and the dominant fuel source for the Community was electricity at 32%. The Municipal sector accounted for approximately 3% of the total Community GHG emissions.

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 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 years 2016 and 2019. These emissions are estimated based on the inventory of energy and fuel use for Harrisonburg. A baseline year of 2016 was chosen by the City and the current analysis year is 2019. 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.

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. Phase 1 of the EAP 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 small 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. Adding trees to increase the tree canopy also reduces emissions indirectly by shading buildings and lower the urban heat island effects, which results in less cooling needed 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 as part of the photosynthesis process. Because trees grow slowly and sequester carbon from the atmosphere, reducing the removal of trees in cities is as important as planting new trees. These baseline indicators provide a snapshot of the current conditions and can be 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. Although not the focus of this analysis, the combustion of fossil fuels also leads to additional air pollution including Criteria Air Pollutants (CAPs), which can also harm 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 always 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 and 2019 data has been analyzed and reported as well. This analysis uses the 100-year global warming potentials (GWP) from the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report (AR5). Table 1 shows the GWPs for the most common of the emission chemicals.²

Chemical	IPCC 5 – 100 yr GWP (kg CO2e/kg)
Carbon Dioxide (CO ₂)	1
Methane (CH ₄)	28
Nitrous Oxide (N ₂ O)	265

Table 1 – Global Warming Potentials from the IPCC 5th reports.

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 for 2016 and 2019. Grid loss was estimated based on the SRVC regional grid from the EPA eGrid database.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. Because these facilities serve more than just the City, their electricity totals were apportioned based on the fraction of City customers in 2016 and 2019. These values were 85% and 83%, respectively, for water pumping and treatment and 73% and 57%, respectively, for the Sewer Authority. 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 38.7% of the total usage in 2019 followed by Sewer and Water with a combined contribution of 33.1%. Overall, electricity usage increased 3.7% in 2019 compared to 2016. The difference calculated in the final column of Table 2, and throughout the report, is the 2019 value minus the 2016 value divided by the 2016 value, which gives a percent increase or decrease from the baseline year.

DEPARTMENT/FUNCTION	2016		2019		Difference 2019 vs 2016 (%)
	kWh	% of Total	kWh	% of Total	
SCHOOLS	11,364,115	36.3%	12,584,293	38.7%	10.7%
SEWER AUTHORITY	7,260,657	23.2%	7,304,352	22.5%	0.6%
WATER DEPT, TREATMENT, & PUMPING	3,524,084	11.2%	3,442,868	10.6%	-2.3%
TRAFFIC & STREET LIGHTS	3,026,731	9.7%	3,041,823	9.4%	0.5%
RECREATION DEPT	1,770,972	5.6%	1,771,940	5.5%	0.1%
FIRE DEPT	1,621,085	5.2%	1,777,509	5.5%	9.6%
TRANSPORTATION DEPT	1,088,028	3.5%	891,593	2.7%	-18.1%
COMMUNITY DEVELOPMENT*	790,385	2.5%	771,089	2.4%	-2.4%
PUBLIC WORKS	375,779	1.2%	410,153	1.3%	9.1%
PARKING SERVICES	264,139	0.8%	238,848	0.7%	-9.6%
EMERGENCY COMMUNICATIONS CENTER (HRECC)	189,058	0.6%	217,225	0.7%	14.9%
CENTRAL STORES	65,086	0.2%	46,264	0.1%	-28.9%
POLICE DEPT	6,819	0.02%	10,014	0.03%	46.9%
TOTALS	31,346,938	100%	32,507,971	100%	3.7%
ELECTRICITY GRID LOSS (4.5%)	1,410,612		1,462,859		
<i>*City Hall Complex</i>					
<i>Eastum House omitted from totals - it was sold in October 2016.</i>					

Table 2 – Harrisonburg Municipal Electricity Usage by Department/Function

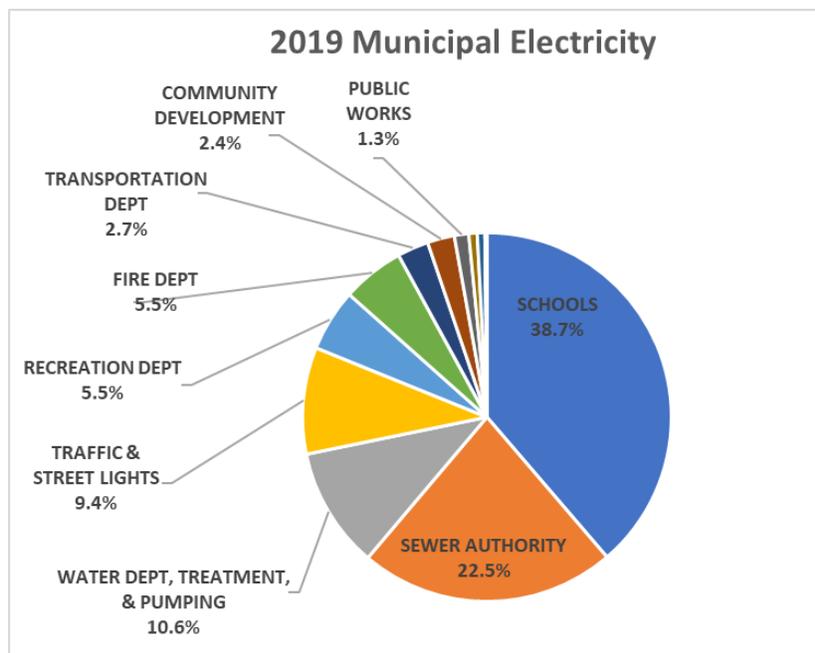


Figure 1 – Harrisonburg 2019 Municipal Electricity Pie Chart by Department/Function

As the largest electricity user, the Schools category for electricity usage was further broken down in Table 3 and Figure 2. Harrisonburg High School used 33% of the school system electricity in 2019. School system electricity increased approximately 10% from 2016 to 2019. Note that Thomas Harrison Middle School also has a relatively small 2.4 kW Skystream wind turbine which generates electricity that offsets this school's electricity usage. Wind speed and energy-generation data for this wind turbine can be found at https://openei.org/wiki/Thomas_Harrison_Middle_School_Wind_Project.

School Summary			2016		2019		Difference	
Account	School	Address	kWh	Total	kWh	Total	2019 (%)	2019 vs 2016 (%)
13653-27	Harrisonburg High School	1001 GARBERS CHURCH RD	1,324,800		1,469,760			
13653-28	Harrisonburg High School	1001 GARBERS CHURCH RD	1,826,880		2,322,240			
13653-29	Harrisonburg High School Stadium	1001 GARBERS CHURCH RD	178,944		188,544			
13653-35	Harrisonburg High School	1001 GARBERS CHURCH RD	17,161		35,931			
13653-36	Harrisonburg High School	1001 GARBERS CHURCH RD	17,920		54,160			
13653-38	Harrisonburg High School	1001 GARBERS CHURCH RD			54,240			
13653-39	Harrisonburg High School	1001 GARBERS CHURCH RD			26,960			
13653-40	Harrisonburg High School	1001 GARBERS CHURCH RD		3,365,705	24,800	4,176,635	33.2%	24.1%
	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	19.5%	4.7%
13653-19	Thomas Harrison Middle School	1311 W MARKET ST	1,819,200	1,819,200	1,350,720	1,350,720	10.7%	-25.8%
13653-6	Stone Spring Elementary School	1575 PEACH GROVE AVE	1,008,960		1,123,200			
13653-7	Stone Spring Elementary School	1575 PEACH GROVE AVE	16,290		32,443			
13653-8	Stone Spring Elementary School	1575 PEACH GROVE AVE	66,435		79,557			
13653-30	Stone Spring Elementary School	1575 PEACH GROVE AVE	34,726	1,126,411	43,742	1,278,942	10.2%	13.5%
13653-14	Spotswood Elementary School	375 S CARLTON ST	191,760		193,000			
13653-15	Spotswood Elementary School	375 S CARLTON ST	563,520		622,560			
13653-16	Spotswood Elementary School	375 S CARLTON ST	46,257		47,627			
13653-17	Spotswood Elementary School	400 MOUNTAIN VIEW DR	27,297	828,834	21,047	884,234	7.0%	6.7%
13653-3	Keister Elementary School	100 MARYLAND AVE	514,560		516,480			
13653-4	Keister Elementary School	100 MARYLAND AVE	101,777		93,023			
13653-5	Keister Elementary School	100 MARYLAND AVE	222,240	838,577	237,840	847,343	6.7%	1.0%
13653-20	Waterman Elementary School	451 CHICAGO AVE SEC LIGH	6,300		6,300			
13653-21	Waterman Elementary School	451 CHICAGO AVE	714,240		718,560			
13653-22	Waterman Elementary School	451 CHICAGO AVE	52,785		55,653			
13653-23	Waterman Elementary School	451 CHICAGO AVE	46,943	820,268	47,726	828,239	6.6%	1.0%
13653-37	Bluestone Elementary School	750 GARBERS CHURCH RD		-	536,100	536,100	4.3%	
13653-34	School Board Office	1 COURT SQ	220,800	220,800	228,320	228,320	1.8%	3.4%
Totals			11,364,115	11,364,115	12,584,293	12,584,293	100%	

Table 3 – Harrisonburg School Electricity Usage by School

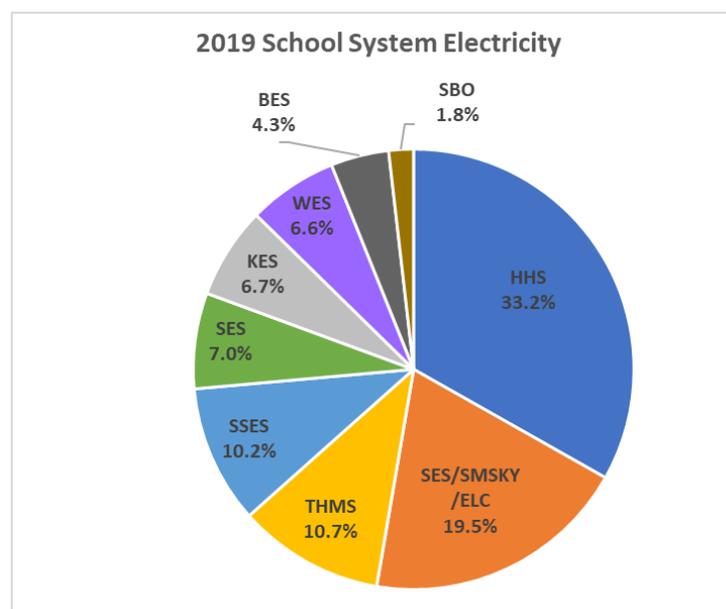


Figure 2 – Harrisonburg School Electricity Pie Chart

Community-wide electricity for Harrisonburg was provided by Brian O’Dell at 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. For future reference and data consistency, the Commercial electricity value is the sum of Rates 206, 314 and 315 and Industrial value is the sum of Rates 525 and 405. The Municipal sector includes all HEC accounts on the Municipal rate except the Water Department electricity and Sewer Flume Station which were included under the Water & Sewer sector along with the Water Treatment, Raw Water Pumping, and Sewer Authority electricity from Dominion accounts.

The electricity data shows an overall small increase in electricity use of 1.6% for 2019 compared to 2016. In 2019, the Commercial sector had the highest usage at 33%, the Residential sector used 29%, Industrial and JMU were each approximately 16%. Note that while Municipal electricity is the sector that the City has the most control over, it contributed only 3.1% of the total Community usage.

Year	Electricity Sector					Water & Sewer	Totals (kWh)	Grid Loss (4.5%)
	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	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	31,708,519
% Difference	5.1%	1.0%	-0.7%	5.8%	-1.6%	-0.3%	1.6%	
Sector (%) 2019	29.4%	33.3%	16.5%	3.1%	16.1%	1.5%	100%	

Table 4 – Harrisonburg Community Electricity Usage by Sector

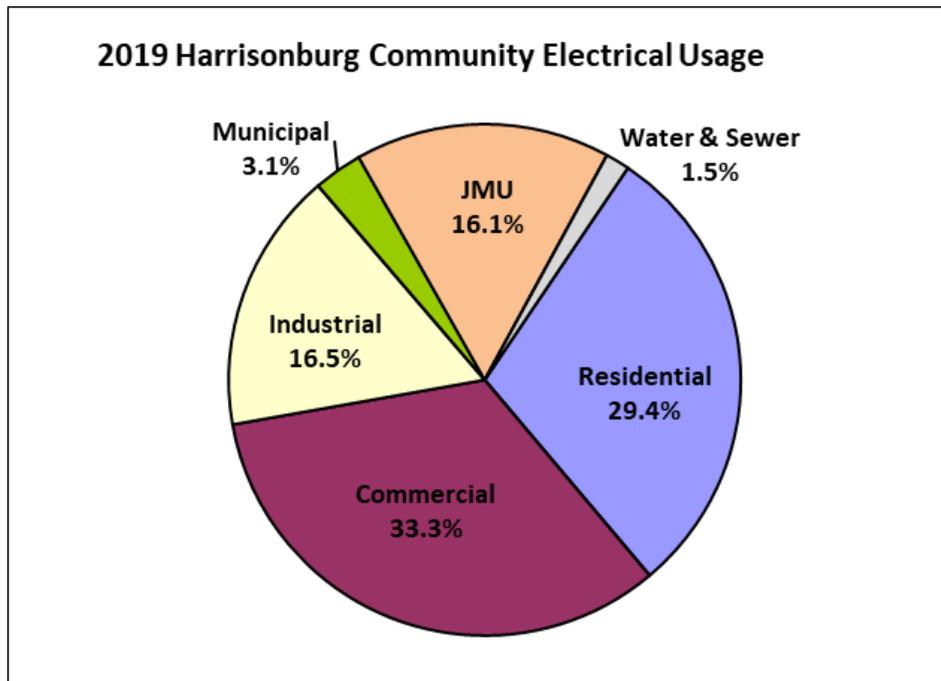


Figure 3 – Harrisonburg 2019 Community Electricity Pie Chart by Sector

Harrisonburg electricity is provided through the HEC by Dominion Energy from the generation mix they have across the regional grid. Carbon dioxide emissions factors were obtained from the Dominion Energy Virginia data in the Dominion Environmental Metrics 2019 report.⁴ This report did not include the methane and nitrous oxide emissions factors or grid losses for the ClearPath analysis so the EPA eGrid³ values for the Southeast Region Virginia Carolina (SRVC) regional electricity grid were used. These parameters are summarized in Table 5 and are 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 somewhat different for Dominion Energy of Virginia compared to the entire SRVC region. The grid loss, electricity lost due to resistance and inefficiency between the power plant and the final electrical connections, was included in both the Municipal and Community-level assessments based on the total electricity usage for each case.

Chemical	Electricity Emission Factors (lb/MWh)	
	2016	2019
CO ₂	745	507
CH ₄	0.067	0.058
N ₂ O	0.011	0.008
Grid Loss (%)	4.5	5.1

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

Table 6 shows the fuel mix for this Dominion Power Virginia Electricity. Note the increase in natural gas and the larger decrease in coal use since 2016. In 2019, electricity produced from coal in the US had an average emissions factor of 2.21 lb CO₂/kWh compared to 0.91 lb CO₂/kWh for natural gas.⁵ This utility fuel switch in recent years, therefore, had a significant effect on reducing GHGs from electricity use for 2019. The factors in Table 5 show a reduction in electricity GHG emissions by more than 30%. 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	Total and Fuel-Specific Electricity Generation (MWH)								
	2000	2005	2015	2016	2016 (%)	2017	2018	2019	2019 (%)
Total	71,536,133	109,328,723	98,455,046	108,368,094		102,060,029	100,659,937	94,855,233	
Coal	37,772,810	51,607,246	22,613,052	21,947,757	20.3%	15,376,307	12,302,427	7,177,447	7.6%
Natural Gas	3,698,671	7,728,873	28,858,084	38,370,996	35.4%	37,654,007	38,838,261	38,386,925	40.5%
Nuclear	26,552,901	44,164,092	42,888,281	43,951,909	40.6%	44,548,239	43,541,335	43,833,345	46.2%
Petroleum	3,021,949	4,710,344	847,768	459,162	0.4%	271,644	626,111	123,323	0.1%
Total Renewable Energy	489,802	1,118,168	3,247,861	3,638,270	3.4%	4,209,832	5,351,803	5,334,193	5.6%
- Biomass/Biogas		540,007	1,193,180	1,266,746	1.2%	1,163,454	1,196,101	1,007,679	1.1%
- Hydroelectric	489,802	578,161	613,069	771,100	0.7%	488,627	850,529	690,754	0.7%
- Solar			747,748	934,322	0.9%	1,983,498	2,686,996	3,037,885	3.2%
- Wind			693,864	666,103	0.6%	574,253	618,177	597,876	0.6%

Table 6 – Electricity Fuel Mix from Dominion Power Virginia

3b. Natural Gas

Natural gas data was provided from a City Natural gas report and City Schools utilities report and is summarized in Table 7 for 2016 and 2019. Figure 4 shows a breakdown of the natural gas usage for 2019. 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 approximately 10% for 2019 compared to the 2016 baseline. Usage is down in all subcategories except the Fire Department, which increased by about 20%. Schools dominate natural gas usage at approximately 60% in 2019 with the Department of Parks and Recreation following at approximately 19%, the Fire Department at 10%, and the rest of the categories all less than 10%.

Building & Address	Meter #	2016		2019		Difference 2019 - 2016 (%)	
		Therms		Therms	% of Total		
Schools - Smithland Elementary & Skyline Middle School (SMSKY)		46,896		58,701	15.5%		
Schools - Stone Spring Elementary School (SSES)		38,457		42,151	11.2%		
Schools - Thomas Harrison Middle School (TMHS)		80,111		34,565	9.2%		
Schools - Spotswood Elementary School (SES)		27,686		32,140	8.5%		
Schools - Keister Elementary School (KES)		24,105		29,830	7.9%		
Schools - Waterman Elementary School (WES)		21,044		21,728	5.8%		
Schools - Maintenance Building		4,858		5,563	1.5%		
Schools - School Board Office (SBO)		1,687		1,485	0.4%		
Schools - Harrisonburg High School (HHS)		0		0	0.0%		
Schools - Bluestone Elementary School (BES)		0		0	0.0%		
Schools - Elon Rhodes Early Learning Center (ELC)		0		0	0.0%		
Schools - High School Stadium		0	244,843	0	226,163	0.0%	-7.6%
Parks & Rec - Westover Pool - 305 S. Dogwood Dr	901118	48,620		35,058		9.3%	
Parks & Rec - Lucy Simms - 620 Simms Ave	M4700071	27,996		26,268		7.0%	
Parks & Rec - Community Activities Center - 305 S. Dogwood Dr	9013433	6,808		5,982		1.6%	
Parks & Rec - Golf Course Maintenance 1583 W. Market St B	6112198	3,857	87,281	3,298	70,606	0.9%	-19.1%
Fire Department - Public Safety Building - 101 N. Main St.	8461631	28,581		32,459		8.6%	
Fire Department Station #1 80 Maryland Ave	M8600409	1,895		4,613		1.2%	
Fire Department Station #1 Annex 90 Maryland Ave	U766302	1,048	31,524	1,104	38,176	0.3%	21.1%
Transportation - Central Garage - 473 E. Washington St	13600365	24,909		15,097		4.0%	
Transportation - Administration Building - 475 E. Washington St	10600339	269	25,178	282	15,379	0.1%	-38.9%
Public Works - City Shops/Traffic Signal/Eng - 320 Mosby Rd zone 3	6074588	4,745		4,899		1.3%	
Public Works - Central Stores Warehouse - 2111 Beery Rd	M6600026	2,973		3,833		1.0%	
Public Works - City Shops/Traffic Signal/Eng - 320 Mosby Rd zone 4	97800115	3,168		2,779		0.7%	
Public Works - City Shops/Traffic Signal/Eng - 320 Mosby Rd zone 1	R171893	3,821		2,451		0.6%	
Public Works - City Shops/Traffic Signal/Eng - 320 Mosby Rd zone 2	M7400649	1,841		1,624		0.4%	
Public Works - City Shops/Traffic Signal/Eng - 320 Mosby Rd zone 5	9277707	939	17,487	744	16,330	0.2%	-6.6%
General Properties - City Hall - 409 S. Main St	M7900196	4,582	4,582	4,458	4,458	1.2%	-2.7%
Water Department 2155 Beery Rd	9015735	3,946	3,946	3,482	3,482	0.9%	-11.8%
Tourism - Hardesity Higgins House - 212 S. Main St	M4490516	3,598	3,598	2,914	2,914	0.8%	-19.0%
Harrisonburg Water Pump House 1790 Reservoir St	3345924	207	207	113	113	0.0%	-45.4%
Total		418,646	418,646	377,621	377,621	100%	-9.8%

Table 7 – Harrisonburg Municipal Natural Gas Usage (2016 and 2019)

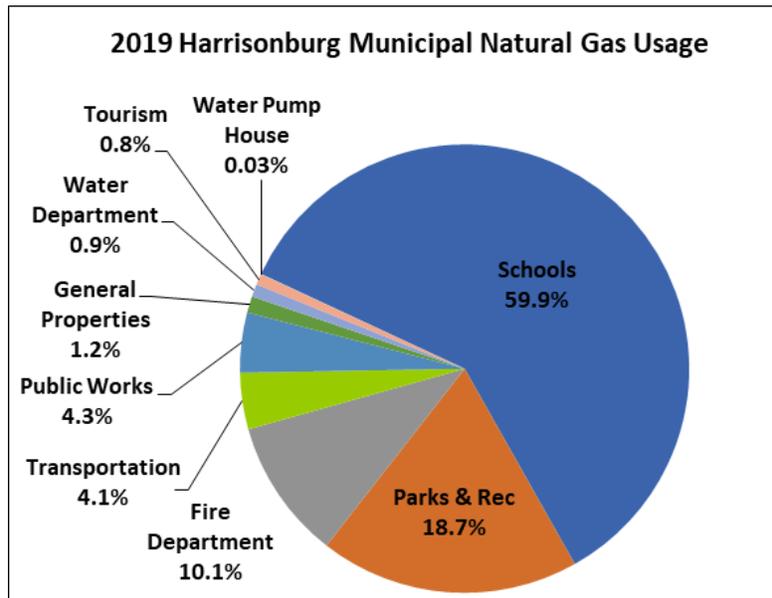


Figure 4 – Harrisonburg Municipal Natural Gas Usage

Community-level natural gas usage for Harrisonburg was provided by Stephen Holcomb, Environmental Policy & Sustainability Manager for 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.

Since 2012, Columbia Gas of Virginia has accelerated the replacement of certain infrastructure throughout its operating area in order to enhance the safety and reliability of its natural gas system and to reduce greenhouse gas emissions. As of 2020, Columbia Gas has reduced cumulative GHG emissions by more than 7,500 metric tons of carbon dioxide equivalent (CO₂e) through its infrastructure replacement efforts.

The Community-wide natural gas data is summarized in Table 8 and Figure 5. It shows an overall increase in natural gas use from 2019 compared to 2016 of 4.8%. In 2019, the Commercial sectors was the largest at 37.5% and it includes the municipal natural gas usage detailed above, which was only 1.8% of the total Community-wide usage.

Methane emissions associated with natural gas leakage due to mining, processing, and distribution are not included in either the Municipal or Community-wide assessment in ClearPath.

Year	Residential (therms)	Commercial (therms)	JMU (therms)	Industrial (therms)	Totals (therms)
2016	1,733,830	6,379,270	7,837,770	4,531,220	20,482,090
2019	1,944,600	8,056,610	6,873,850	4,597,840	21,472,900
Sector (%)	9.1%	37.5%	32.0%	21.4%	100%
Baseline Difference	12.2%	26.3%	-12.3%	1.5%	4.8%

Table 8 – Harrisonburg Community Natural Gas Usage (2016 and 2019)

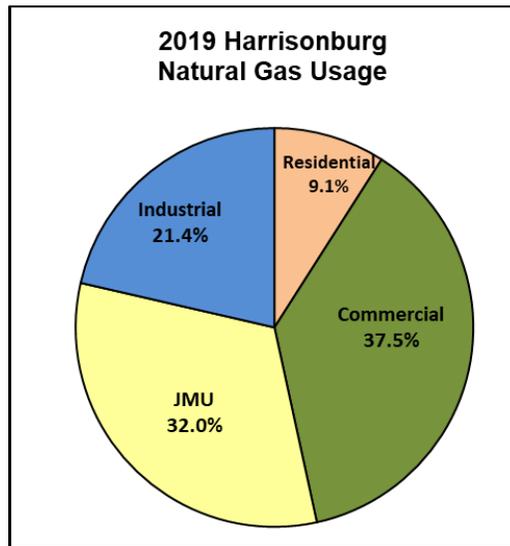


Figure 5 – Harrisonburg Community Natural Gas Usage by Sector

3c. Fuel Oil

Municipal use of Fuel Oil was reported for several of the City schools for heating and is detailed in Table 9. Other municipal uses of fuel oil were considered minimal and not assessed in this report.

Location	Fuel Oil Usage (gallons)		Difference
	2016	2019	2019 – 2016 (%)
Harrisonburg High School	49,462	54,222	9.6
Smithland Elementary & Skyline Middle School	79	0	-100

Table 9 – Harrisonburg Municipal Fuel Oil Usage (2016 and 2019)

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 2019 Census database estimates for total Harrisonburg households and households using fuel oil for heating are shown in the table 10.⁶ The Energy Information Administration (EIA) Residential Energy Consumption Survey (RECS) in 2015 estimates fuel oil/household energy use for the South Atlantic region, which is representative for Harrisonburg.⁷ The same values were used for both 2016 and 2019 since the RECS survey is only done every 5 years. 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	Households Heating w/ Fuel Oil	Average Annual Fuel Oil/Household (Million BTU)	Average Annual Fuel Oil/Household (gallons)	Total Fuel Use (gallons)
2016	16,626	1,530	47.6	342	523,000
2019	16,723	1,121	47.6	342	383,000

Table 10 – Harrisonburg Community Fuel Oil Usage Estimates (2016 and 2019)

3d. Vehicle Transportation and Equipment Fuels

Municipal fuel use (diesel and gasoline) was compiled from the Harrisonburg *Equipment Gallon, Equipment Class* report (EGEC) and a Fuel Summary report for 2016 and 2019. A summary and graph of this data is shown in Table 11 and Figure 6. The detailed analysis tables are provided in a supplemental appendix rather than this report given the large amount of data. The EGEC report details the Equipment number by class with the total amount of fuel gallons used for each vehicle. The fuel type column list the primary type of fuel assigned, but could have other types assigned to the vehicle.

For some of the diesel fuel vehicles, diesel exhaust fuel (DEF) gallons were reported. To separate out the diesel fuel from this data, the percent diesel fuel (Diesel gallons divided by Diesel + DEF gallons) was calculated from the Fuel Summary report and applied this fuel category. The detailed EGEC data was used to analyze the fuels by category. There was a small discrepancy (1 – 2%) between the detailed and summary fuel data in terms of gasoline and diesel totals, but the detailed data set was used to better understand the distribution of fuel use. No biofuels were used in the municipal fleet.

Vehicle/Equipment Fuels	2016		2019		Difference 2019 - 2016 (%)
	Gallons	%	Gallons	%	
Diesel Transit Bus	177,985	31.7%	188,625	32.1%	6.0%
Gas Vehicles	125,990	22.4%	122,007	20.8%	-3.2%
Diesel School Bus	89,569	15.9%	98,518	16.8%	10.0%
Diesel Truck	60,231	10.7%	58,749	10.0%	-2.5%
Diesel Equipment	34,439	6.1%	37,658	6.4%	9.3%
Gas Police	28,939	5.1%	37,597	6.4%	29.9%
Gas ParaTransit	21,208	3.8%	24,833	4.2%	17.1%
Fire/Ambulance	23,728	4.2%	19,490	3.3%	-17.9%
TOTALS	562,089	100%	587,477	100%	4.5%

Table 11 – Harrisonburg Municipal Vehicle/Equipment Fuel Usage (2016 and 2019)

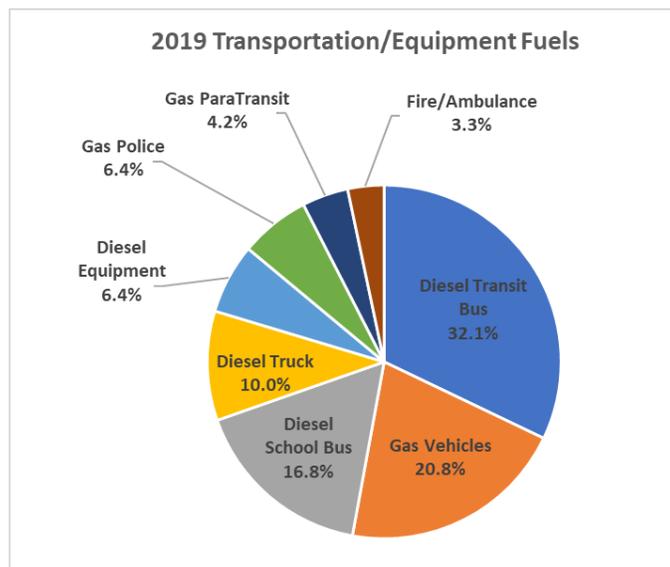


Figure 6 – Harrisonburg Vehicle/Equipment Fuel Usage

For Community-wide fuel use, the transportation sector was analyzed using Vehicle Miles Travelled (VMT) data from the 2016 and 2019 Virginia Department of Transportation (VDOT) report 1220.⁸ 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. 2019 VMT was 3.5% higher 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 32%, and Secondary Roads at 28%. 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 was used for the percentage of the vehicle types shows in Table 13; more vehicle categories were available as seen in Appendix 3, but the additional detail was not considered to make enough differences for the additional analysis. 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)			Total	Annual VMT (miles)	Difference 2019 - 2016 (%)
	Secondary	Primary	Interstate			
2016	255,020	304,428	358,494	917,942	335,048,761	
2019	264,760	302,838	382,063	949,661	346,626,172	3.5%

Table 12 – VDOT VMT data for Harrisonburg in 2016 and 2019.

Vehicle Class	Percentage (%)	Fuel	Year
Passenger Vehicles	72.4	Gasoline	2019
Light Trucks	15.6	Gasoline	2019
Heavy Trucks	11.7	Diesel	2019
Motorcycles	0.2	Gasoline	2019
Totals	100		

Table 13 – VDOT Vehicle Percentages in 2016 and 2019.

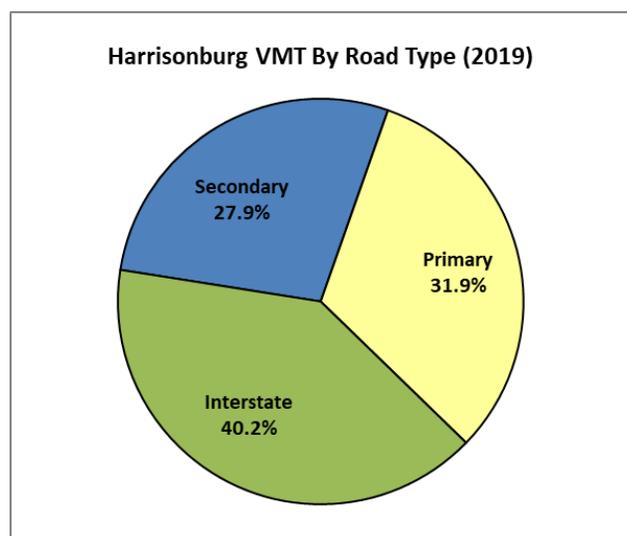


Figure 7 – Harrisonburg Vehicle Miles Traveled By Road Type (2019)

3d. 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 Harsit Patel, Support Services Manager in the City of Harrisonburg Department of Public Works. The data is summarized in Table 14 for 2016 and 2019. 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 the 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. This difference is expected to be insignificant in the final GHG totals. The Municipal solid waste was not analyzed due to the lack of detailed waste data at the Municipal level.

Harrisonburg City Waste	Municipal Solid Waste (residential refuse)	Commerical 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
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 14 – Harrisonburg Waste Summary for 2016 and 2019

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 “None” was chosen for Landfill Collection Scenario in the model. This will overestimate the GHG emissions somewhat since methane leaking from the landfill would have a higher GWP than the CO₂ emissions from the flaring.

The ClearPath waste calculator has recently been updated to better align with advancements to 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. The calculation uses a Waste Characterization Factor Set and methane emission factors from EPA's WARM model, version 14, with equation 1 to estimate total methane landfill emissions.⁹ This calculator differs from WARM slightly by using a simplified calculation for oxidation of methane passing through soil on top of the landfill. WARM uses an oxidation factor of 10 - 30%, depending on the stage of the life of the landfill. For simplicity, this calculator uses a constant 10% oxidation rate, resulting in a slightly higher emissions estimate. Each material in the Waste Factor set produces a certain amount of methane emissions per ton of waste material over its lifetime in the landfill.

$$\text{Methane Emissions} = \text{Waste Tonnage} \times (1 - X_{ox}) \times \sum(\%_m \times EF_m \times (1 - LFG_m)) \quad (\text{Equation 1})$$

where X_{ox} is Percent Oxidation Rate (0.1),
 $\%_m$ is the percent of each material type, m , in the landfill waste stream,
 EF_m is the lifetime methane emissions factor for each material type, m , and
 LFG is the lifetime landfill gas capture percentage for each material type, m

3e. 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 used to heat the HRRSA biosolids dryer. The volumes of biogas are provided in Table 15. The City of Harrisonburg contributes roughly 53% of the waste water treatment facility (WWTF) so the biogas was attributed to the City at this percentage in both the Municipal and Community inventories. This analysis computes 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)
2016	67,673,385	0
2019	67,673,385	12,121,322

Table 15 – Harrisonburg Rockingham Regional Sewer Authority (HRRSA) biogas data.
53% of these natural gas volumes were attributed to the City of Harrisonburg.

3f. Recycling

Community-wide recycling data was obtained for 2019 from the Harrisonburg Public Works Department Year-to-Date Solid Waste Report and detailed in Table 16. This particular recycling data was not available for 2016. 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.¹⁰ The recycling amounts for the various categories in Table 16 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	Amount (tons)	Savings (tons CO ₂ /ton)	WARM v15 Categories
Cardboard	188.7	3.14	Corrugated containers
Glass	99.3	0.28	Glass
Tin/Scrap	95.7	4.39	Mixed Metals
Mixed Paper	78.2	3.55	Mixed Paper
Plastic 1	19.8	1.04	PET
Plastic 2	9.6	0.76	HDPE
Plastic Bags	7.6	0.00	LDPE
Aluminum	3.0	9.13	Aluminum Cans
Totals	502	1,245	metric tons CO₂

Table 16 – Harrisonburg Solid Waste Management Recycling Data (2019)

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 2016 (baseline year) and in 2019. All greenhouse gas emissions are normalized to carbon dioxide (CO₂) using the IPCC 5th 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.

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 17 and 18 and Figures 8 and 9 at the broad sector and fuel source level. Total emissions were 16.3% less in 2019 than in 2016. The small differences in the Sector and Source table totals are due to rounding of subtotals in the calculations. Municipal emissions are dominated by the Buildings/Facilities sector, which contributes 42.9% of the total. Electricity is the dominant municipal source of GHGs contributing 48.5% of the emissions. The distribution of GHGs by sector and source are similar in both years and therefore only the 2019 pie chart is shown in Figure 9.

Sector	ClearPath 2016 (mtons)	ClearPath 2019 (mtons)	2019 Sector (%)	2019 - 2016 Baseline Difference (%)
Buildings/Facilities	8,973	7,125	42.9%	-20.6%
Vehicle Fleet	3,473	3,590	21.6%	3.4%
Water & Sewer	3,896	2,724	16.4%	-30.1%
Transit Fleet	2,003	2,143	12.9%	7.0%
Street/Traffic Lights	1,022	699	4.2%	-31.6%
Electric Grid Loss	476	336	2.0%	-29.4%
Totals	19,843	16,617	100.0%	-16.3%

Table 17 – Harrisonburg Municipal ClearPath GHG Emissions by Sector for 2016 and 2019

Emissions Source	ClearPath 2016 (mtons)	ClearPath 2019 (mtons)	2019 Sector (%)	2019 - 2016 Baseline Difference (%)
Electricity	11,384	8,067	48.5%	-29.1%
Diesel	3,930	4,115	24.8%	4.7%
Natural Gas	2,226	2,008	12.1%	-9.8%
Gasoline	1,546	1,619	9.7%	4.7%
Fuel Oil	509	557	3.4%	9.4%
Biogas	252	253	1.5%	0.4%
Totals	19,847	16,619	100.0%	-16.3%

Table 18 – Harrisonburg Municipal ClearPath GHG Emissions by Source for 2016 and 2019

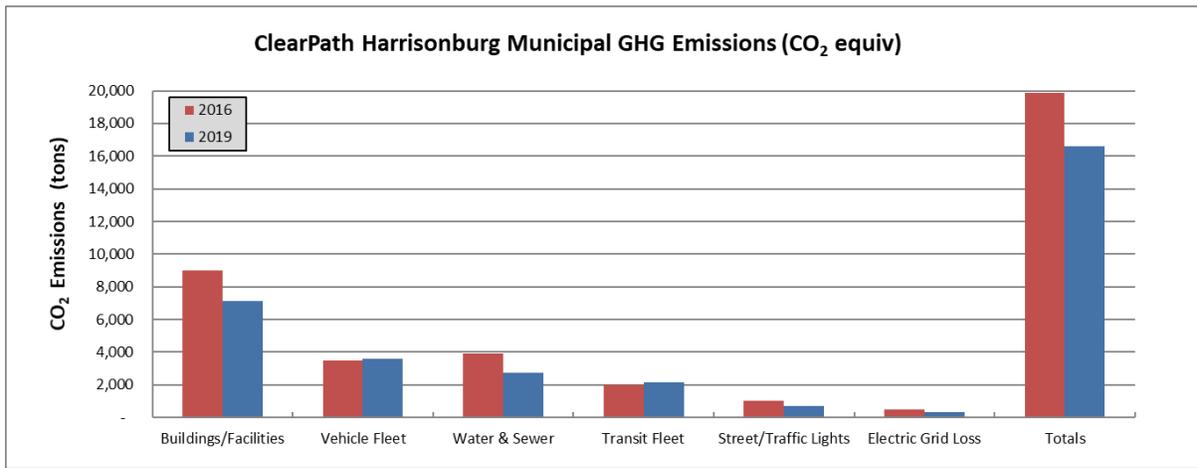


Figure 8 – Harrisonburg Municipal GHGs by Sector

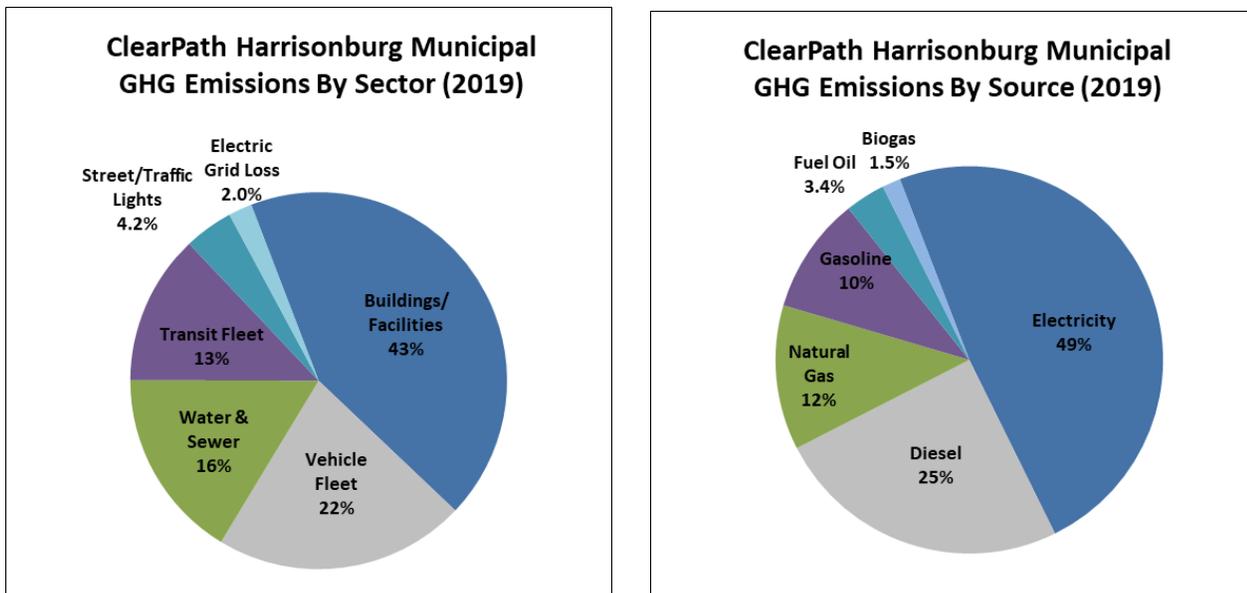


Figure 9 – Harrisonburg Municipal GHG emissions by Source (2019)

Table 19 provides the GHG emissions results at a more detailed level for the category, sector and fuel source. School electricity is the largest emissions contributor at 17.4%, but emissions in this category decreased from 2016 to 2019 by 25% even though electricity use increased by 10%. This is due to the lower electricity GHG emissions factor in 2019. School electricity emissions are followed by City Transit Bus and Sewer Authority emissions.

School operations (buildings and buses) have emissions from multiple fuel sources and are also 4 of the top 11 categories as seen in Table 19. The four school energy sources of electricity, natural gas, fuel oil, and diesel fuel (school buses) contribute 34% of all Municipal emissions in 2019. Therefore, to provide more insight and detail, the School sector emissions are broken down further in Table 20. In the school category, electricity accounts for the largest contribution to GHG emissions at 51% as seen in the pie chart of Figure 10. Overall, School GHG Emissions have decreased in 2019 by almost 14%.

	Sector	Fuel Source	CO2e (mton)		2019	Difference
			2016	2019	Category (%)	2019 vs 2016 (%)
SCHOOLS	Buildings/Facilities	Electricity	3,840	2,894	17.4%	-24.6%
CITY TRANSIT BUSES	Transit Fleet	Diesel	1,817	1,926	11.6%	6.0%
SEWER AUTHORITY	Water & Sewer	Electricity	2,454	1,680	10.1%	-31.5%
SCHOOLS	Buildings/Facilities	Natural Gas	1,302	1,203	7.2%	-7.6%
FLEET VEHICLES	Vehicle Fleet	Gasoline	1,106	1,071	6.4%	-3.2%
SCHOOL BUSES	Vehicle Fleet	Diesel	914	1,006	6.1%	10.0%
DIESEL TRUCKS	Vehicle Fleet	Diesel	847	799	4.8%	-5.7%
WATER DEPT	Water & Sewer	Electricity	1,191	792	4.8%	-33.5%
TRAFFIC & STREET LIGHTS	Street/Traffic Lights	Electricity	1,023	700	4.2%	-31.6%
ELECTRICAL GRID LOSS	Buildings/Facilities	Electricity	790	591	3.6%	-25.2%
SCHOOLS	Buildings/Facilities	Fuel Oil	509	557	3.4%	9.4%
RECREATION DEPT	Buildings/Facilities	Electricity	598	407	2.5%	-31.9%
FIRE DEPT	Buildings/Facilities	Electricity	548	409	2.5%	-25.4%
DIESEL EQUIPMENT	Vehicle Fleet	Diesel	352	384	2.3%	9.3%
RECREATION DEPT	Buildings/Facilities	Natural Gas	464	376	2.3%	-19.1%
SEWER AUTHORITY	Water & Sewer	Biogas	252	253	1.5%	0.4%
POLICE CARS	Vehicle Fleet	Gasoline	254	330	2.0%	29.9%
TRANSPORTATION DEPT	Buildings/Facilities	Electricity	368	205	1.2%	-44.2%
COMMUNITY DEVELOPMENT	Buildings/Facilities	Electricity	267	177	1.1%	-33.6%
PARATRANSIT BUSES	Transit Fleet	Gasoline	186	218	1.3%	17.1%
FIRE DEPT	Buildings/Facilities	Natural Gas	168	203	1.2%	21.1%
PUBLIC WORKS	Buildings/Facilities	Electricity	127	94	0.6%	-25.7%
TRANSPORTATION DEPT	Buildings/Facilities	Natural Gas	134	81.8	0.5%	-38.9%
PUBLIC WORKS	Buildings/Facilities	Natural Gas	93.0	86.9	0.5%	-6.6%
PARKING SERVICES	Buildings/Facilities	Electricity	89.3	54.9	0.3%	-38.5%
EMERGENCY COMM CENTER (HRECC)	Buildings/Facilities	Electricity	63.9	50.0	0.3%	-21.8%
CENTRAL STORES	Buildings/Facilities	Electricity	22.0	10.6	0.1%	-51.6%
CITY HALL	Buildings/Facilities	Natural Gas	24.4	23.7	0.1%	-2.7%
WATER DEPT	Buildings/Facilities	Natural Gas	21.0	19.1	0.1%	-8.9%
TOURISM	Buildings/Facilities	Natural Gas	19.1	15.5	0.1%	-19.0%
POLICE DEPT	Buildings/Facilities	Electricity	2.3	2.3	0.0%	-0.1%
			19,847	16,620	100.0%	

Table 19 –Harrisonburg Municipal ClearPath Detailed GHG Emissions by Source and Fuel for 2016 and 2019

School Category/Detail	Sector	Fuel Source	CO2e (mton)		2019 Category (%)	Difference 2019 vs 2016 (%)
			2016	2019		
Harrisonburg High School	Buildings/Facilities	Electricity	1,137	961	17.0%	-15.5%
Smithland Elementary & Skyline Middle Schools			792	564	10.0%	-28.8%
Thomas Harrison Middle School			615	311	5.5%	-49.5%
Stone Spring Elementary School			381	294	5.2%	-22.7%
Spotswood Elementary School			280	203	3.6%	-27.4%
Keister Elementary School			283	195	3.4%	-31.2%
Waterman Elementary School			277	190	3.4%	-31.3%
Bluestone Elementary School			0	123	2.2%	
School Board Office			75	53	0.9%	-29.6%
School Electricity Totals					3,840	2,894
Harrisonburg High School	Buildings/Facilities	Natural Gas	0	0	0%	
Smithland Elementary & Skyline Middle Schools			249.4	312.2	5.5%	25.2%
Thomas Harrison Middle School			426.1	183.8	3.2%	-56.9%
Stone Spring Elementary School			204.5	224.2	4.0%	9.6%
Spotswood Elementary School			147.3	170.9	3.0%	16.1%
Keister Elementary School			128.2	158.7	2.8%	23.7%
Waterman Elementary School			111.9	115.6	2.0%	3.3%
Bluestone Elementary School			0	0	0%	
Maintenance Building			25.8	29.6	0.5%	14.5%
School Board Office			9.0	7.9	0.1%	-12.0%
School Natural Gas Totals			1,302	1,203	21.3%	-7.6%
School Bus Diesel Fuel Totals	Vehicle Fleet	Diesel	914	1,006	17.8%	10.0%
Harrisonburg High School	Buildings/Facilities	Fuel Oil	508	557	9.8%	9.6%
Smithland Elementary & Skyline Middle Schools			1	0	0%	
School Fuel Oil (Heating)Totals			509	557	9.8%	9.4%
TOTALS			6,566	5,660	100.0%	-13.8%

Table 20 –Harrisonburg School Detailed GHG Emissions by Source and Fuel for 2016 and 2019

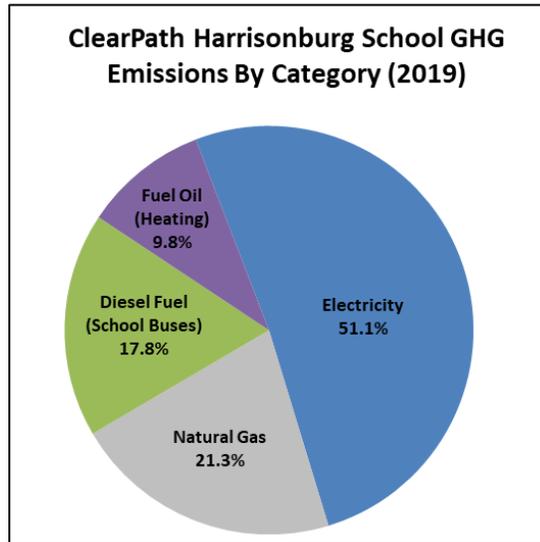


Figure 10 – Harrisonburg School-Related GHG emissions by Category (2019)

4b. Community GHG Emissions

Community GHGs calculated by ClearPath are shown in Tables 21 and 22 and Figures 11 and 12 by sector and fuel source. Total emissions decreased 8.9% in 2019 compared to 2016. Again, the small differences in these table totals are due to rounding of subtotals in the calculations. Community emissions dominated by the Commercial and Transportation sectors at approximately 1/3 of the total each. Considering the sources of emissions, electricity is the dominant Community source of GHGs at 32%, but emissions are down 30% from 2016 mainly due to the lower electricity emission factor as discussed above. The distribution of GHGs by sector and source are similar in both years and therefore only plotted in the pie charts of Figure 12 for 2019. All sectors have significant decreases from 2016

except Transportation, which increased approximately 2% and waste GHG emissions, which showed a 36% increase. It is not uncommon for waste emissions to vary significantly from year-to-year due to changing tonnages from construction and other large, but periodic, community projects. Comparing the Municipal analysis above to these Community values, the Municipal emissions contribute only 3.1% of the total Community emissions in 2019.

Sector	ClearPath 2016 (mtons)	ClearPath 2019 (mtons)	2016 Baseline Difference (%)	2019 Sector (%)
Commercial	200,143	164,549	-17.8%	31.1%
Transportation	179,691	182,964	1.8%	34.5%
Residential	81,244	62,207	-23.4%	11.7%
Industrial	63,653	51,175	-19.6%	9.7%
Solid Waste	42,287	57,681	36.4%	10.9%
Grid Loss	10,549	8,264	-21.7%	1.6%
Water & Wastewater	3,896	2,724	-30.1%	0.5%
Totals	581,463	529,564	-8.9%	100.0%

Table 21 –Harrisonburg Community ClearPath GHG Emissions by Sector for 2016 and 2019

Emissions Source	ClearPath 2016 (mtons)	ClearPath 2019 (mtons)	Baseline Difference (%)	2019 Source (%)
Electricity	244,976	170,311	-30.5%	32.2%
Gasoline	116,826	118,133	1.1%	22.3%
Natural Gas	108,886	114,422	5.1%	21.6%
Diesel	62,865	64,832	3.1%	12.2%
Waste	42,287	57,681	36.4%	10.9%
Fuel Oil	5,374	3,935	-26.8%	0.7%
Biogas	252	253	0.4%	0.0%
Totals	581,466	529,567	-8.9%	100.0%

Table 22 –Harrisonburg Community ClearPath GHG Emissions by Source for 2016 and 2019

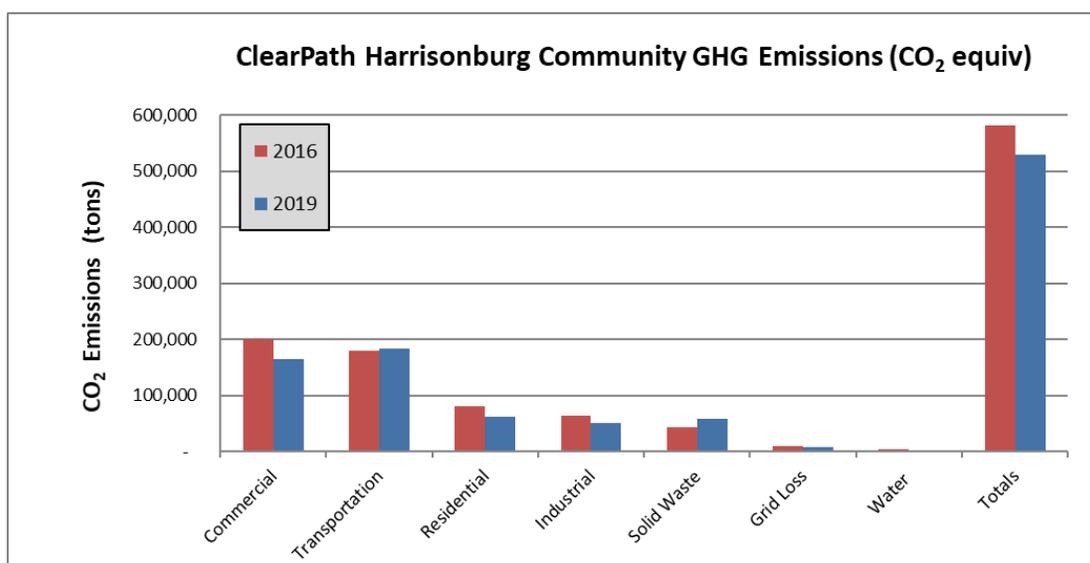


Figure 11 – Harrisonburg Community GHGs by Sector

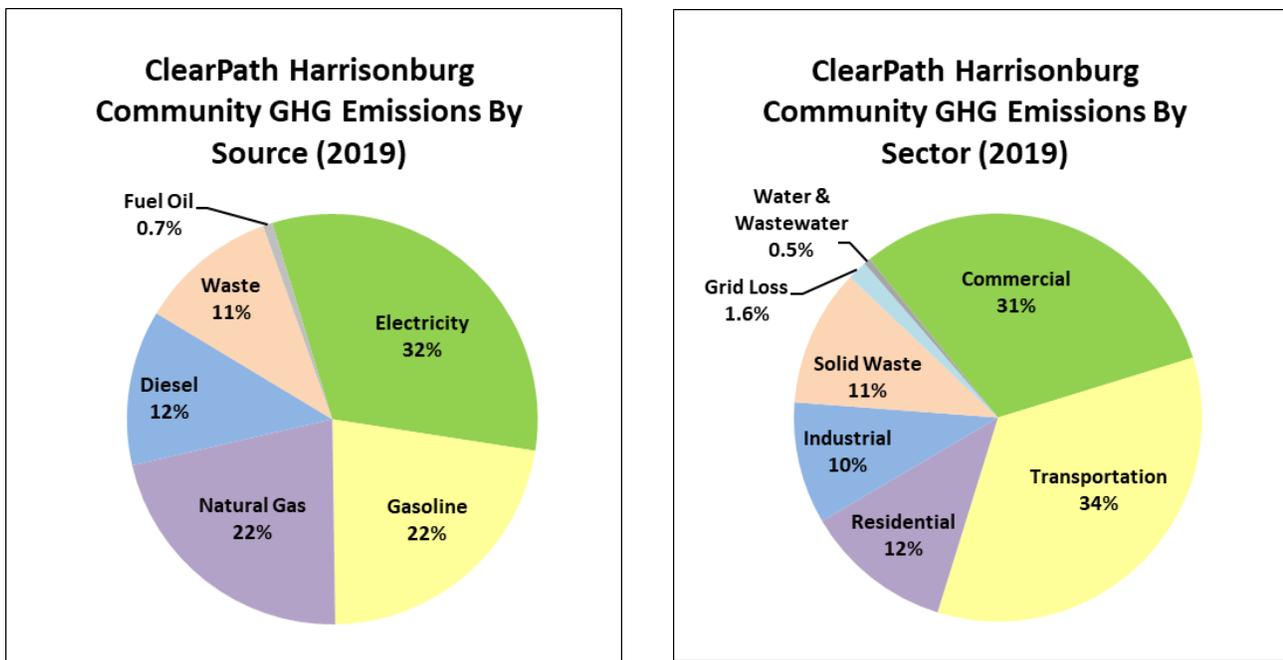


Figure 12 – Harrisonburg Community GHG emissions by Sector and Source (2019)

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, ClearPath and most emissions protocols do 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 0.2% of the Community total, so even though 502 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.

5. DISCUSSION AND CONCLUSIONS

With this GHG emissions analysis complete, the next step is to set goals and GHG targets using a local action plan at the Municipal and Community levels to help achieve these goals. In the last few years, GHG goals to reduce the effects of climate change have become much more aggressive as the significant impacts of this problem have become more clear. For example, in July 1, 2019, the City Council of Charlottesville, VA, adopted the goals of reducing GHG emissions to 45% below 2011 levels by 2030 and achieving carbon neutrality by 2050.¹¹ This set of goals is aggressive, but in line with recommendations by climate scientists to avoid the worst scenarios of climate change. Many universities, states, and the federal government are contemplating goals in this range.

Local action plans will generally include a mix of the following actions for reducing GHG emissions: 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. Some options that are popular among residents or city administrators are often found to have low return on investment once a detailed analysis is completed. It is a best practice for action plans for GHG reduction initiatives to include short, medium, and long term goals.

Given the size and influence of JMU in the City with regard to GHG emissions, interaction and coordination with JMU staff and sustainability professionals is strongly recommended and helpful for progress in reducing GHG emissions.

Community GHG emissions are recommended to be assessed yearly since the data collection and analysis is relatively straightforward. Due to the much larger data set, Municipal GHG reports can be completed every 2nd or 3rd year. However, if the data collection process can be automated and streamlined, it is recommended to complete an analysis every year as well in order to observe changes and adjust actions, if necessary, on a shorter timeline.

Municipal goals and plans are somewhat easier to develop since the City is mostly in control of the buildings and operations that result in emissions. Programs for conservation and more efficient use of electricity will have the largest impacts and save money at the same time. Some emissions reductions will occur over time without major changes due to the addition of renewable energy generation by the utilities. However, these are mostly out of the control of the City unless programs are initiated to develop solar panel projects for City buildings. Also, the overall reduction of Municipal emissions is small relative to the overall Community footprint.

Conversely, the largest opportunities are available at the Community level but programs and initiatives at this level are harder 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 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.

It should also be noted the actions taken to reduce emissions will have other co-benefits. The conservation of energy or fuel saves money immediately with an infinite return on investment. Most 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 cost more up front, but often have long term return on investment.

There are many resources including check sheets, best-practice guides, and case studies available from other organizations and cities that can be leveraged in developing an action plan for Harrisonburg. The City's challenges are much the same as many other cities in the US. ICLEI has worked with hundreds of cities in the US and around the world and has compiled information, reports, and examples for many

best practices which can vary depending on the size, location, weather, economic, housing, and commercial characteristics of a city.

While reducing emissions seems daunting, it is critical to develop plans and take action sooner rather than later. Education is a great place to start since it is hard to promote action if the public is unaware or confused about the issues. For example, the City of Roanoke, VA, offers a “Clean and Green Academy” each year in which citizens learn about environmental issues and their GHG emissions as well as initiatives and opportunities to improve. The key is that local action plans start as soon as possible to reduce emissions sooner rather than later to minimize environmental and societal impacts.

6. REFERENCES:

¹Environmental Protection Agency, Greenhouse Gas (GHG) Emissions website, <https://www.epa.gov/ghgemissions>

²Greenhouse Gas Protocol, Global Warming Potential Values, https://www.ghgprotocol.org/sites/default/files/ghgp/Global-Warming-Potential-Values%20%28Feb%2016%202016%29_1.pdf

³EPA Emissions & Generation Resource Integrated Database (eGRID) website, <https://www.epa.gov/egrid>

⁴Dominion Energy 2019 Sustainability and Corporate Responsibility Report, Environmental Metrics, <https://sustainability.dominionenergy.com/assets/pdf/metrics/dominion-energy-environmental-metrics-2019.pdf>

⁵Energy Information Administration (EIA), Frequently Asked Questions web page, <https://www.eia.gov/tools/faqs/faq.php?id=74&t=11>

⁶US Census Bureau Database, Physical Housing Characteristics For Occupied Housing Units, <https://data.census.gov/cedsci/table?q=Harrisonburg%20city,%20Harrisonburg%20city,%20Virginia&tid=ACSS15Y2019.S2504>

⁷Energy Information Administration (EIA), 2015 Residential Energy Consumption Survey (RECS) web page, <https://www.eia.gov/consumption/residential/data/2015/c&e/pdf/ce2.4.pdf>

⁸Virginia Department of Transportation (VDOT) Website, Traffic Data, <http://www.virginiadot.org/info/ct-TrafficCounts.asp>

⁹EPA Waste Reduction Model (WARM) website, <https://www.epa.gov/warm/versions-waste-reduction-model-warm#WARM%20Tool%20V14>

¹⁰EPA 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, November 2020.

¹¹City of Charlottesville, VA, Climate Protection web page, <https://www.charlottesville.gov/292/Climate-Protection>

7. APPENDIX

APPENDIX 1 – Harrisonburg Municipal Electricity Data (2016 and 2019)

2016					
ACCOUNT	NAME	SERVICE ADDRESS	Total kWh	Total Cost	Sub-Totals
103748-2	HBURG COMMUNITY DEVELOPMENT	345 S MAIN ST (Municipal Bldg)	115,040	\$10,835	
103748-3	HBURG COMMUNITY DEVELOPMENT	212 S MAIN ST	109,537	\$10,259	
103748-5	HBURG COMMUNITY DEVELOPMENT	228 S LIBERTY ST	13,392	\$1,354	
103748-6	HBURG COMMUNITY DEVELOPMENT	409 S MAIN ST	552,000	\$51,372	
103748-7	HBURG COMMUNITY DEVELOPMENT	252 S LIBERTY ST (Grassy Lot)	416	\$77	790,385
103749-3	HBURG TRANSPORTATION DEPT	473 E WASHINGTON ST (Central Garage)	569,856	\$53,262	
103749-4	HBURG TRANSPORTATION DEPT	475 E WASHINGTON ST (HDPT Admin Building)	508,920	\$49,168	
103749-5	HBURG TRANSPORTATION DEPT	475 E WASHINGTON ST	9,252	\$993	1,088,028
10456-2	HBURG FIRE DEPT	162 N LIBERTY ST	480	\$122	
10456-3	HBURG FIRE DEPT	80 MARYLAND AVE SEC LIGHT	3,780	\$735	
10456-4	HBURG FIRE DEPT	80 MARYLAND AVE (Fire Station #1)	158,400	\$14,906	
10456-5	HBURG FIRE DEPT	399 E MOSBY RD (Training Grounds)	27,595	\$2,715	
10456-6	HBURG FIRE DEPT	380 PLEASANT VALLEY RD (Fire Station #2)	50,266	\$4,799	
10456-7	HBURG FIRE DEPT	210 E ROCK ST (Fire Station #4)	210,660	\$20,110	
10456-8	HBURG FIRE DEPT	101 N MAIN ST (Public Safety Building)	1,073,256	\$101,426	
10456-10	HBURG FIRE DEPT	299 LUCY DR (Fire Station #3)	61,830	\$5,906	
10456-13	HBURG FIRE DEPT	101 N MAIN ST (PSB Parking Lot Outlets)	285	\$141	
10456-14	HBURG FIRE DEPT	90 MARYLAND AVE (Annex Building)	17,015	\$1,699	
10456-15	HBURG FIRE DEPT	80 MARYLAND AVE TEMP METER (Temp Traylor)	17,518	\$1,696	1,621,085
105618-1	PURCHASING/CENTRAL STORE	2111 BEERY RD (Central Stores)	65,086	\$6,190	65,086
1306-4	HBURG WATER DEPT	600 VINE ST	5,084	\$594	
1306-5	HBURG WATER DEPT	1241 OLD WINDMILL CIR	17,791	\$1,768	
1306-6	HBURG WATER DEPT	1002 GREYSTONE ST	80,928	\$7,635	
1306-7	HBURG WATER DEPT	979 SUMMIT AVE	1,223	\$228	
1306-10	HBURG WATER DEPT	80 GARBERS CHURCH RD	90,432	\$8,526	
1306-11	HBURG WATER DEPT	1751 S HIGH ST	510	\$161	
1306-17	HBURG WATER DEPT	1705 PEACH GROVE AVE	167,728	\$15,777	
1306-18	HBURG WATER DEPT	651 TOWER ST	99,874	\$9,408	
1306-23	HBURG WATER DEPT	910 UNIVERSITY BLVD	385	\$150	
1306-29	HBURG WATER DEPT	1905 E MARKET ST	111,281	\$10,437	
1306-33	HBURG WATER DEPT	1315 W MARKET ST	1,774	\$279	
1306-39	HBURG WATER DEPT	1600 SMITHLAND RD	29,888	\$2,907	
1306-40	HBURG WATER DEPT	128 CHESTNUT RIDGE DR	15,122	\$1,528	
1306-42	HBURG WATER DEPT	276 BLUE STONE HILLS DR	10,276	\$1,084	
1306-43	HBURG WATER DEPT	1790 RESERVOIR ST	172,105	\$16,188	
1306-44	HBURG WATER DEPT	1179 HARRISON ST	218	\$134	
1306-46	HBURG WATER DEPT	851 PORT REPUBLIC RD	1	\$114	
1306-47	HBURG WATER DEPT	2155 BEERY RD (Water Department Building)	160,880	\$15,151	
1306-51	HBURG WATER DEPT	1111 WILLOW SPRING RD	9	\$115	
1306-52	HBURG WATER DEPT	1491 OLD FURNACE RD	19,062	\$1,895	
1306-53	HBURG WATER DEPT	250 CHESTNUT RIDGE DR	63,021	\$6,003	1,047,592
13653-1	HBURG CITY SCHOOLS	1583 W MARKET ST STE A	19,255	\$1,910	
13653-3	HBURG CITY SCHOOLS	100 MARYLAND AVE	514,560	\$47,844	
13653-4	HBURG CITY SCHOOLS	100 MARYLAND AVE	101,777	\$9,649	
13653-5	HBURG CITY SCHOOLS	100 MARYLAND AVE	222,240	\$20,715	
13653-6	HBURG CITY SCHOOLS	1575 PEACH GROVE AVE	1,008,960	\$94,105	
13653-7	HBURG CITY SCHOOLS	1575 PEACH GROVE AVE	16,290	\$1,652	
13653-8	HBURG CITY SCHOOLS	1575 PEACH GROVE AVE	66,435	\$6,375	
13653-14	HBURG CITY SCHOOLS	375 S CARLTON ST	191,760	\$18,009	
13653-15	HBURG CITY SCHOOLS	375 S CARLTON ST	563,520	\$52,839	
13653-16	HBURG CITY SCHOOLS	375 S CARLTON ST	46,257	\$4,485	
13653-17	HBURG CITY SCHOOLS	400 MOUNTAIN VIEW DR	27,297	\$2,693	
13653-19	HBURG CITY SCHOOLS	1311 W MARKET ST	1,819,200	\$168,231	
13653-20	HBURG CITY SCHOOLS	451 CHICAGO AVE SEC LIGHT	6,300	\$1,225	
13653-21	HBURG CITY SCHOOLS	451 CHICAGO AVE	714,240	\$66,489	
13653-22	HBURG CITY SCHOOLS	451 CHICAGO AVE	52,785	\$5,057	
13653-23	HBURG CITY SCHOOLS	451 CHICAGO AVE	46,943	\$4,515	
13653-27	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	1,324,800	\$123,124	
13653-28	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	1,826,880	\$169,470	
13653-29	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	178,944	\$16,701	
13653-30	HBURG CITY SCHOOLS	1575 PEACH GROVE AVE	34,726	\$3,383	
13653-33	HBURG CITY SCHOOLS	470 LINDA LN	2,344,320	\$218,692	
13653-34	HBURG CITY SCHOOLS	1 COURT SQ	220,800	\$20,594	
13653-35	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	17,161	\$1,716	
13653-36	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	17,920	\$1,728	11,383,370
14133-1	HBURG PUBLIC WORKS	901 CHICAGO AVE	12,817	\$1,319	
14133-2	HBURG PUBLIC WORKS	320 E MOSBY RD (Public Works Building)	38,097	\$3,681	
14133-3	HBURG PUBLIC WORKS	320 E MOSBY RD	124,735	\$11,711	
14133-4	HBURG PUBLIC WORKS	320 E MOSBY RD	25,806	\$2,498	
14133-5	HBURG PUBLIC WORKS	300 E MOSBY RD (Shop/Office Building)	90,742	\$8,590	
14133-7	HBURG PUBLIC WORKS	2055 BEERY RD (Recycling Center)	32,376	\$3,145	
14133-13	HBURG PUBLIC WORKS	901 CHICAGO AVE	39,080	\$3,781	
14133-19	HBURG PUBLIC WORKS	2115 RAMBLEWOOD RD	11,715	\$1,206	
14133-26	HBURG PUBLIC WORKS	335 STONE SPRING RD	411	\$152	375,779

14133-9	TRAFFIC LIGHTS	345 S MAIN ST (Traffic Lights)	310,044	\$19,472	
14133-10	STREET LIGHTS	345 S MAIN ST (Street Lights)	1,455,230	\$313,041	
14133-11	STREET LIGHTS - PRINCIPAL ARTERIAL	345 S MAIN ST (Principal Arterial Street Lights)	539,880	\$101,440	
14133-12	STREET LIGHTS - URBAN MINOR ARTERIAL	345 S MAIN ST (Urban Minor Arterial Street Lights)	606,490	\$122,800	
14133-17	TRAFFIC LIGHTS	1486 W MARKET ST (Traffic Light)	2,930	\$386	
14133-24	TRAFFIC LIGHTS	1101 E MARKET ST (Traffic Light)	1,960	\$296	
14133-25	TRAFFIC LIGHTS	1911 S HIGH ST (Traffic Light)	4,547	\$536	
14133-28	TRAFFIC LIGHTS	671 UNIVERSITY BLVD (Traffic Light)	3,321	\$424	
14133-29	TRAFFIC LIGHTS	1100 S HIGH ST (Traffic Light)	2,951	\$390	
14133-30	TRAFFIC LIGHTS	1280 GARBERS CHURCH RD (Traffic Light)	1,497	\$253	
14133-31	TRAFFIC LIGHTS	2141 S MAIN ST (Traffic Light)	4,337	\$520	
14133-32	TRAFFIC LIGHTS	335 STONE SPRING RD (Traffic Light)	4,056	\$493	
14133-33	TRAFFIC LIGHTS	165 N HIGH ST (Traffic Light)	25,430	\$2,474	
14133-34	TRAFFIC LIGHTS	404 VIRGINIA AVE (Traffic Light)	3,178	\$409	
14133-36	TRAFFIC LIGHTS	1306 HILLSIDE AVE (Traffic Light)	3,444	\$436	
14133-37	TRAFFIC LIGHTS	2230 RESERVOIR ST TEMP METER	13,066	\$1,347	
14133-38	TRAFFIC LIGHTS	2421 S MAIN ST (Traffic Light)	4,190	\$505	
14133-39	TRAFFIC LIGHTS	1825 S MAIN ST (Traffic Light)	4,564	\$540	
14133-40	STREET LIGHTS	460 PHEASANT RUN CIR (Street Light)	3,077	\$402	
14133-41	TRAFFIC LIGHTS	198 S MAIN ST (Traffic Light)	2,304	\$329	
14133-42	TRAFFIC LIGHTS	102 S MAIN ST (Traffic Light)	2,320	\$331	
14133-43	TRAFFIC LIGHTS	28 S MAIN ST (Traffic Light)	3,748	\$463	
14133-44	TRAFFIC LIGHTS	1575 PEACH GROVE AVE (Traffic Light)	2,569	\$354	
14133-45	TRAFFIC LIGHTS	802 S MAIN ST (Traffic Light)	1,359	\$174	
14133-46	TRAFFIC LIGHTS	99 BURGESS RD (Traffic Light)	351	\$42	
14133-47	TRAFFIC LIGHTS	1788 RESERVOIR ST (Traffic Light)	431	\$69	
14133-48	TRAFFIC LIGHTS	1915 RESERVOIR ST (Traffic Light)	202	\$38	3,007,476
14429-5	HBURG POLICE DEPT	1016 GREENDALE RD (Police House)	5,253	\$613	
14429-6	HBURG POLICE DEPT	1010 GREENDALE RD TEMP METER	1,566	\$262	6,819
14483-1	EASTUM HOUSE	317 S MAIN ST	22,440	\$2,202	22,440
14511-1	DOWNTOWN PARKING SERVICES	135 N MASON ST (Parking Deck)	100,259	\$9,409	
14511-2	DOWNTOWN PARKING SERVICES	89 W WATER ST (Parking Deck)	142,556	\$13,334	
14511-3	DOWNTOWN PARKING SERVICES	135 S MAIN ST SEC LIGHT	5,580	\$1,414	
14511-4	DOWNTOWN PARKING SERVICES	282 N LIBERTY ST SEC LIGHT	1,440	\$366	
14511-5	DOWNTOWN PARKING SERVICES	345 S MAIN ST SEC LIGHT	7,680	\$1,951	
14511-6	DOWNTOWN PARKING SERVICES	44 NEWMAN AVE SEC LIGHT	2,520	\$492	
14511-8	DOWNTOWN PARKING SERVICES	48 E WATER ST SEC LIGHT	480	\$122	
14511-9	DOWNTOWN PARKING SERVICES	90 N MAIN ST SEC LIGHT	2,520	\$490	
14511-11	DOWNTOWN PARKING SERVICES	30 W BRUCE ST	1,104	\$219	264,139
2128-1	HBURG RECREATION DEPT	305 S DOGWOOD DR	3,057	\$398	
2128-2	HBURG RECREATION DEPT	1583 W MARKET ST STE B (Golf Course Maintenance)	29,196	\$2,821	
2128-5	HBURG RECREATION DEPT	100 MILLER CIR SEC LIGHT	4,440	\$978	
2128-6	HBURG RECREATION DEPT	1582 S MAIN ST (East Side)	4,968	\$575	
2128-7	HBURG RECREATION DEPT	1582 S MAIN ST (West Side)	6,178	\$686	
2128-8	HBURG RECREATION DEPT	1582 S MAIN ST SEC LIGHT	1,740	\$367	
2128-9	HBURG RECREATION DEPT	1545 HILLSIDE AVE SEC LIGHT	3,840	\$975	
2128-10	HBURG RECREATION DEPT	348 S WILLOW ST (Armory)	60,380	\$5,847	
2128-12	HBURG RECREATION DEPT	909 RESERVOIR ST (Tennis Courts)	11,056	\$1,137	
2128-14	HBURG RECREATION DEPT	620 SIMMS AVE (BB court)	7,181	\$776	
2128-15	HBURG RECREATION DEPT	401 E WASHINGTON ST (Ralph Sampson Restroom)	1,031	\$210	
2128-16	HBURG RECREATION DEPT	901 CHICAGO AVE (Park View Shops)	26,405	\$2,573	
2128-17	HBURG RECREATION DEPT	305 S DOGWOOD DR (Westover Pavilion Lgts)	1,894	\$288	
2128-18	HBURG RECREATION DEPT	305 S DOGWOOD DR (Pool)	263,920	\$25,781	
2128-19	HBURG RECREATION DEPT	305 S DOGWOOD DR (Community Activities Center)	255,600	\$23,854	
2128-20	HBURG RECREATION DEPT	305 S DOGWOOD DR Westover Shelter 3&4)	1,893	\$286	
2128-22	HBURG RECREATION DEPT	680 GARBERS CHURCH RD (Golf Course Pumping Station)	69,312	\$6,514	
2128-24	HBURG RECREATION DEPT	1582 S MAIN ST (Purcell Consession)	14,719	\$1,470	
2128-25	HBURG RECREATION DEPT	1412 SMITHLAND RD (Pump House)	5,604	\$637	
2128-26	HBURG RECREATION DEPT	680 GARBERS CHURCH RD (Heritage Oaks Proshop)	106,620	\$10,610	
2128-29	HBURG RECREATION DEPT	305 S DOGWOOD DR (Skate Park)	327	\$145	
2128-31	HBURG RECREATION DEPT	1583 W MARKET ST (Golf Course Stor. Shed)	5,135	\$592	
2128-32	HBURG RECREATION DEPT	501 HILLANDALE AVE TEMP METER	38	\$13	
2128-33	HBURG RECREATION DEPT	501 HILLANDALE AVE TEMP METER	-	\$10	
2128-34	HBURG RECREATION DEPT	461 2ND ST (Morrison BB court)	3,558	\$752	
2128-35	HBURG RECREATION DEPT	1542 SMITHLAND RD (Smithland Restrooms)	7,198	\$779	
2128-37	HBURG RECREATION DEPT	1545 HILLSIDE AVE (Purcell Playground)	2,429	\$338	
2128-38	HBURG RECREATION DEPT	1545 HILLSIDE AVE (Purcell Restroom)	1,030	\$209	
2128-39	HBURG RECREATION DEPT	1545 HILLSIDE AVE (Kids Castle Fountain)	2,177	\$317	
2128-40	HBURG RECREATION DEPT	1545 HILLSIDE AVE (Hillandale Little League Park)	17,150	\$1,695	
2128-45	HBURG RECREATION DEPT	501 HILLANDALE AVE (Athletic Stor. Shop)	23,660	\$2,324	
2128-49	HBURG RECREATION DEPT	177 S MAIN ST (Denton Park)	6,833	\$744	
2128-50	HBURG RECREATION DEPT	188 N LIBERTY ST (Liberty Park)	1,473	\$251	
2128-53	HBURG RECREATION DEPT	1950 THOMAS BOWERS CIR (Dream Come True Playground)	4,356	\$518	
2128-56	HBURG RECREATION DEPT	431 E WASHINGTON ST TEMP METER	-	\$10	
2128-57	HBURG RECREATION DEPT	431 E WASHINGTON ST SEC LIGHT	2,400	\$611	
2128-58	HBURG RECREATION DEPT	620 SIMMS AVE (Simms School)	727,680	\$67,796	
2128-61	HBURG RECREATION DEPT	431 E WASHINGTON ST (Ralph Sampson #2)	3,170	\$407	
2128-62	HBURG RECREATION DEPT	2181 RAMBLEWOOD RD (Rablewood Consessions)	52,224	\$4,975	
2128-63	HBURG RECREATION DEPT	309 S DOGWOOD DR	31,100	\$3,135	1,770,972
9305-1	HBURG RHAM REG SEWER AUTH	1321 S DOGWOOD DR	765	\$187	765
112263-1	HRECC	653 TOWER ST (Radio Tower)	103,023	\$9,728	
112263-2	HRECC	1575 PEACH GROVE AVE (Radio Tower)	56,502	\$5,398	
112263-5	HRECC	420 MT CLINTON PIKE (radio Shop)	28,000	\$2,734	
112263-6	HRECC	424 MT CLINTON PIKE (Radio Storage Shop)	1,533	\$16	189,058
			21,632,994	\$2,324,440	21,632,994
			kWh		

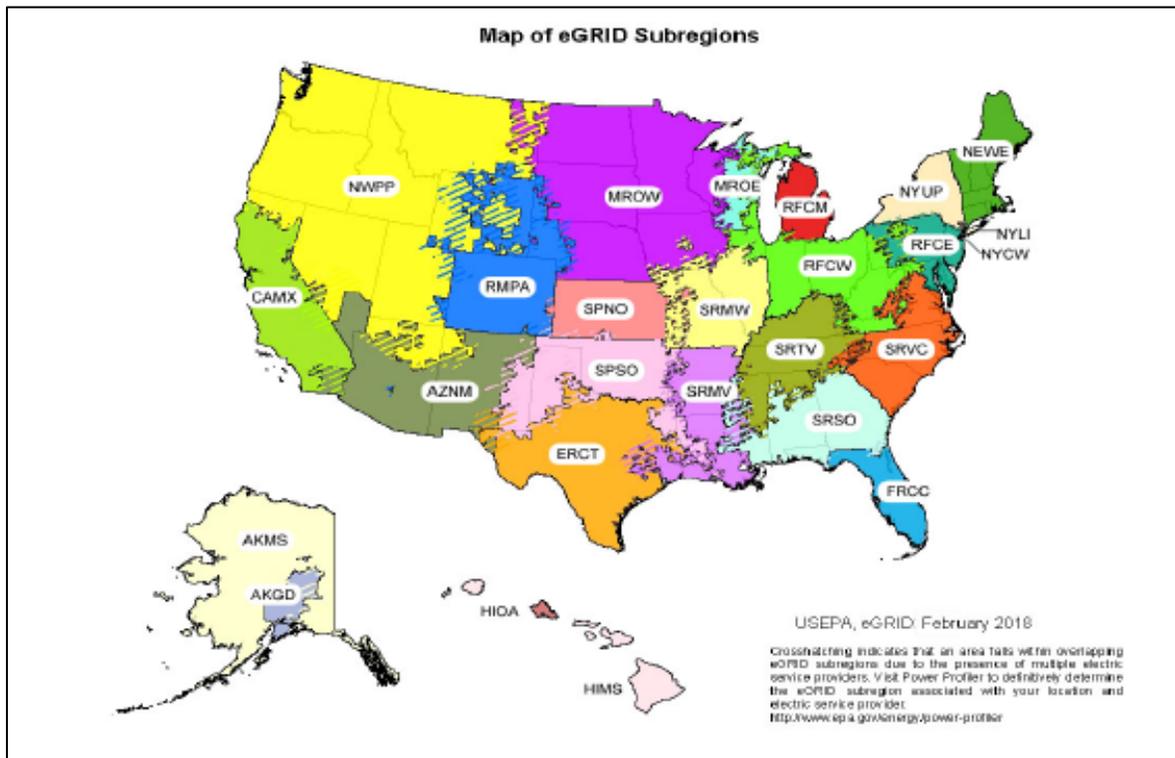
2019					
ACCOUNT	NAME	SERVICE ADDRESS	Total kWh	Total Cost	Sub-Totals
103748-2	HBURG COMMUNITY DEVELOPMENT	345 S MAIN ST	120,080	\$12,236	
103748-3	HBURG COMMUNITY DEVELOPMENT	212 S MAIN ST	79,170	\$8,026	
103748-5	HBURG COMMUNITY DEVELOPMENT	228 S LIBERTY ST	14,915	\$1,680	
103748-6	HBURG COMMUNITY DEVELOPMENT	409 S MAIN ST	549,540	\$58,011	
103748-8	HBURG COMMUNITY DEVELOPMENT	1925 E MARKET ST STE 600	7,384	\$853	771,089
103749-3	HBURG TRANSPORTATION DEPT	473 E WASHINGTON ST (Central Garage)	324,480	\$32,805	
103749-4	HBURG TRANSPORTATION DEPT	475 E WASHINGTON ST (HDPT Admin Building)	534,648	\$55,336	
103749-5	HBURG TRANSPORTATION DEPT	475 E WASHINGTON ST	32,465	\$3,425	891,593
10456-2	HBURG FIRE DEPT	162 N LIBERTY ST	480	\$124	
10456-3	HBURG FIRE DEPT	80 MARYLAND AVE SEC LIGHT	3,780	\$754	
10456-4	HBURG FIRE DEPT	80 MARYLAND AVE (Fire Station #1)	215,280	\$21,689	
10456-5	HBURG FIRE DEPT	399 E MOSBY RD (Training Grounds)	23,236	\$2,451	
10456-6	HBURG FIRE DEPT	380 PLEASANT VALLEY RD (Fire Station #2)	49,653	\$5,099	
10456-7	HBURG FIRE DEPT	210 E ROCK ST (Fire Station #4)	219,240	\$22,519	
10456-8	HBURG FIRE DEPT	101 N MAIN ST (Public Safety Building)	1,175,406	\$119,620	
10456-10	HBURG FIRE DEPT	299 LUCY DR (Fire Station #3)	63,058	\$6,466	
10456-13	HBURG FIRE DEPT	101 N MAIN ST (PSB Parking Lot Outlets)	88	\$123	
10456-14	HBURG FIRE DEPT	90 MARYLAND AVE (Annex Building)	5,606	\$675	
10456-15	HBURG FIRE DEPT	80 MARYLAND AVE TEMP METER (Temp Trailor)	21,179	\$2,246	
10456-17	HBURG FIRE DEPT	101 N MAIN ST	503	\$164	1,777,509
105618-1	PURCHASING/CENTRAL STORE	2111 BEERY RD	46,264	\$4,752	46,264
1306-4	HBURG WATER DEPT	600 VINE ST	5,799	\$700	
1306-5	HBURG WATER DEPT	1241 OLD WINDMILL CIR	18,639	\$1,988	
1306-6	HBURG WATER DEPT	1002 GREYSTONE ST	24,899	\$2,650	
1306-7	HBURG WATER DEPT	979 SUMMIT AVE	762	\$191	
1306-10	HBURG WATER DEPT	80 GARBERS CHURCH RD	36,288	\$3,773	
1306-11	HBURG WATER DEPT	1751 S HIGH ST	518	\$166	
1306-17	HBURG WATER DEPT	1705 PEACH GROVE AVE	206,620	\$20,835	
1306-18	HBURG WATER DEPT	651 TOWER ST	131,604	\$13,304	
1306-23	HBURG WATER DEPT	910 UNIVERSITY BLVD	601	\$174	
1306-29	HBURG WATER DEPT	1905 E MARKET ST	135,466	\$13,676	
1306-33	HBURG WATER DEPT	1315 W MARKET ST	1,677	\$282	
1306-39	HBURG WATER DEPT	1600 SMITHLAND RD	28,825	\$3,019	
1306-40	HBURG WATER DEPT	128 CHESTNUT RIDGE DR	17,573	\$1,879	
1306-42	HBURG WATER DEPT	276 BLUE STONE HILLS DR	12,105	\$1,342	
1306-43	HBURG WATER DEPT	1790 RESERVOIR ST	171,210	\$17,322	
1306-44	HBURG WATER DEPT	1179 HARRISON ST	243	\$139	
1306-46	HBURG WATER DEPT	851 PORT REPUBLIC RD	-	\$114	
1306-47	HBURG WATER DEPT	2155 BEERY RD (Water Department Building)	169,760	\$17,143	
1306-51	HBURG WATER DEPT	1111 WILLOW SPRING RD	210	\$135	
1306-52	HBURG WATER DEPT	1491 OLD FURNACE RD	17,089	\$1,832	
1306-53	HBURG WATER DEPT	250 CHESTNUT RIDGE DR	67,359	\$6,884	
1306-54	HBURG WATER DEPT	1078 MT CLINTON PIKE	59,914	\$6,075	
1306-55	HBURG WATER DEPT	1300 HILLCREST DR	3,689	\$534	1,110,850
13653-1	HBURG CITY SCHOOLS	1583 W MARKET ST STE A	21,221	\$2,246	
13653-3	HBURG CITY SCHOOLS	100 MARYLAND AVE	516,480	\$51,693	
13653-4	HBURG CITY SCHOOLS	100 MARYLAND AVE	93,023	\$9,476	
13653-5	HBURG CITY SCHOOLS	100 MARYLAND AVE	237,840	\$23,878	
13653-6	HBURG CITY SCHOOLS	1575 PEACH GROVE AVE	1,123,200	\$112,459	
13653-7	HBURG CITY SCHOOLS	1575 PEACH GROVE AVE	32,443	\$3,367	
13653-8	HBURG CITY SCHOOLS	1575 PEACH GROVE AVE	79,557	\$8,145	
13653-14	HBURG CITY SCHOOLS	375 S CARLTON ST	193,000	\$19,497	
13653-15	HBURG CITY SCHOOLS	375 S CARLTON ST	622,560	\$62,637	
13653-16	HBURG CITY SCHOOLS	375 S CARLTON ST	47,627	\$4,957	
13653-17	HBURG CITY SCHOOLS	400 MOUNTAIN VIEW DR	21,047	\$2,264	
13653-19	HBURG CITY SCHOOLS	1311 W MARKET ST	1,350,720	\$134,945	
13653-20	HBURG CITY SCHOOLS	451 CHICAGO AVE SEC LIGHT	6,300	\$1,257	
13653-21	HBURG CITY SCHOOLS	451 CHICAGO AVE	718,560	\$72,070	
13653-22	HBURG CITY SCHOOLS	451 CHICAGO AVE	55,653	\$5,729	
13653-23	HBURG CITY SCHOOLS	451 CHICAGO AVE	47,726	\$4,923	
13653-27	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	1,469,760	\$147,277	
13653-28	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	2,322,240	\$231,718	
13653-29	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	188,544	\$18,984	
13653-30	HBURG CITY SCHOOLS	1575 PEACH GROVE AVE	43,742	\$4,542	
13653-33	HBURG CITY SCHOOLS	470 LINDA LN	2,453,760	\$245,852	
13653-34	HBURG CITY SCHOOLS	1 COURT SQ	228,320	\$22,933	
13653-35	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	35,931	\$3,703	
13653-36	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	54,160	\$5,554	
13653-37	HBURG CITY SCHOOLS	750 GARBERS CHURCH RD	536,100	\$53,837	
13653-38	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	54,240	\$5,537	
13653-39	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	26,960	\$2,812	
13653-40	HBURG CITY SCHOOLS	1001 GARBERS CHURCH RD	24,800	\$2,594	12,605,514
14133-1	HBURG PUBLIC WORKS	901 CHICAGO AVE	19,675	\$2,103	
14133-2	HBURG PUBLIC WORKS	320 E MOSBY RD (Public Works Building)	47,803	\$4,925	
14133-3	HBURG PUBLIC WORKS	320 E MOSBY RD	115,182	\$11,634	
14133-4	HBURG PUBLIC WORKS	320 E MOSBY RD	43,322	\$4,489	
14133-5	HBURG PUBLIC WORKS	300 E MOSBY RD (Shop/Office Building)	89,212	\$9,059	
14133-7	HBURG PUBLIC WORKS	2055 BEERY RD (Recycling Center)	2,294	\$336	
14133-13	HBURG PUBLIC WORKS	901 CHICAGO AVE	27,160	\$2,855	
14133-19	HBURG PUBLIC WORKS	2115 RAMBLEWOOD RD	21,248	\$2,250	
14133-26	HBURG PUBLIC WORKS	335 STONE SPRING RD	394	\$154	
14133-52	HBURG PUBLIC WORKS	2055 BEERY RD (Trf Stn)	42,432	\$4,383	
14133-55	HBURG PUBLIC WORKS	589 UNIVERSITY BLVD	1,405	\$196	
14133-56	HBURG PUBLIC WORKS	250 RESEVOIR ST	26	\$31	410,153

13653-1	SCHOOL CROSSING LIGHT	1583 W MARKET ST STE A (Traffic Light)	21,221	\$2,246	
14133-9	TRAFFIC LIGHTS	345 S MAIN ST (Traffic Lights)	310,044	\$21,043	
14133-10	STREET LIGHTS	345 S MAIN ST (Street Lights)	1,465,680	\$322,356	
14133-11	STREET LIGHTS - PRINCIPAL ARTERIAL	345 S MAIN ST (Principal Arterial Street Lights)	543,240	\$106,860	
14133-12	STREET LIGHTS - URBAN MINOR ARTERIAL	345 S MAIN ST (Urban Minor Arterial Street Lights)	606,360	\$125,938	
14133-17	TRAFFIC LIGHTS	1486 W MARKET ST (Traffic Light)	2,985	\$413	
14133-24	TRAFFIC LIGHTS	1101 E MARKET ST (Traffic Light)	1,838	\$298	
14133-25	TRAFFIC LIGHTS	1911 S HIGH ST (Traffic Light)	4,885	\$603	
14133-28	TRAFFIC LIGHTS	671 UNIVERSITY BLVD (Traffic Light)	3,301	\$446	
14133-29	TRAFFIC LIGHTS	1100 S HIGH ST (Traffic Light)	2,878	\$403	
14133-30	TRAFFIC LIGHTS	1280 GARBERS CHURCH RD (Traffic Light)	1,519	\$266	
14133-31	TRAFFIC LIGHTS	2141 S MAIN ST (Traffic Light)	4,469	\$563	
14133-32	TRAFFIC LIGHTS	335 STONE SPRING RD (Traffic Light)	4,140	\$530	
14133-33	TRAFFIC LIGHTS	165 N HIGH ST (Traffic Light)	3,064	\$421	
14133-34	TRAFFIC LIGHTS	404 VIRGINIA AVE (Traffic Light)	3,331	\$447	
14133-36	TRAFFIC LIGHTS	1306 HILLSIDE AVE (Traffic Light)	3,683	\$484	
14133-38	TRAFFIC LIGHTS	2421 S MAIN ST (Traffic Light)	4,204	\$536	
14133-39	TRAFFIC LIGHTS	1825 S MAIN ST (Traffic Light)	5,964	\$713	
14133-40	STREET LIGHTS	460 PHEASANT RUN CIR (Street Light)	3,025	\$418	
14133-41	TRAFFIC LIGHTS	198 S MAIN ST (Traffic Light)	2,644	\$379	
14133-42	TRAFFIC LIGHTS	102 S MAIN ST (Traffic Light)	2,329	\$348	
14133-43	TRAFFIC LIGHTS	28 S MAIN ST (Traffic Light)	3,775	\$493	
14133-44	TRAFFIC LIGHTS	1575 PEACH GROVE AVE (Traffic Light)	2,803	\$395	
14133-45	TRAFFIC LIGHTS	802 S MAIN ST (Traffic Light)	3,331	\$447	
14133-46	TRAFFIC LIGHTS	99 BURGESS RD (Traffic Light)	4,650	\$581	
14133-47	TRAFFIC LIGHTS	1788 RESERVOIR ST (Traffic Light)	3,860	\$501	
14133-48	TRAFFIC LIGHTS	1915 RESERVOIR ST (Traffic Light)	3,889	\$503	
14133-49	TRAFFIC LIGHTS	2095 RESERVOIR ST	3,791	\$495	
14133-50	TRAFFIC LIGHTS	2396 RESERVOIR ST	2,941	\$409	
14133-51	TRAFFIC LIGHTS	705 S MASON ST	4,028	\$517	
14133-53	TRAFFIC LIGHTS	703 S MAIN ST	4,254	\$540	
14133-54	TRAFFIC LIGHTS	998 S MAIN ST	3,697	\$505	3,041,823
14429-5	HBURG POLICE DEPT	1016 GREENDALE RD	9,559	\$1,087	
14429-6	HBURG POLICE DEPT	1010 GREENDALE RD TEMP METER	455	\$160	
14429-7	HBURG POLICE DEPT	1020 GREENDALE RD	-	\$114	10,014
14511-1	DOWNTOWN PARKING SERVICES	135 N MASON ST (Parking Deck)	88,419	\$8,970	
14511-2	DOWNTOWN PARKING SERVICES	89 W WATER ST (Parking Deck)	131,070	\$13,236	
14511-3	DOWNTOWN PARKING SERVICES	135 S MAIN ST SEC LIGHT	3,180	\$1,349	
14511-4	DOWNTOWN PARKING SERVICES	282 N LIBERTY ST SEC LIGHT	1,440	\$373	
14511-5	DOWNTOWN PARKING SERVICES	345 S MAIN ST SEC LIGHT	7,680	\$1,991	
14511-6	DOWNTOWN PARKING SERVICES	44 NEWMAN AVE SEC LIGHT	2,520	\$504	
14511-8	DOWNTOWN PARKING SERVICES	48 E WATER ST SEC LIGHT	480	\$125	
14511-9	DOWNTOWN PARKING SERVICES	90 N MAIN ST SEC LIGHT	2,520	\$503	
14511-11	DOWNTOWN PARKING SERVICES	30 W BRUCE ST	1,539	\$271	238,848
2128-1	HBURG RECREATION DEPT	305 S DOGWOOD DR	702	\$129	
2128-2	HBURG RECREATION DEPT	1583 W MARKET ST STE B (Golf Course Maintenance)	21,914	\$2,304	
2128-5	HBURG RECREATION DEPT	100 MILLER CIR SEC LIGHT	4,440	\$1,000	
2128-6	HBURG RECREATION DEPT	1582 S MAIN ST (East Side)	5,076	\$620	
2128-7	HBURG RECREATION DEPT	1582 S MAIN ST (West Side)	5,705	\$683	
2128-8	HBURG RECREATION DEPT	1582 S MAIN ST SEC LIGHT	1,740	\$376	
2128-9	HBURG RECREATION DEPT	1545 HILLSIDE AVE SEC LIGHT	3,840	\$995	
2128-12	HBURG RECREATION DEPT	909 RESERVOIR ST (Tennis Courts)	10,803	\$1,185	
2128-14	HBURG RECREATION DEPT	620 SIMMS AVE (BB court)	10,881	\$1,199	
2128-15	HBURG RECREATION DEPT	401 E WASHINGTON ST (Ralph Sampson Restroom)	4,054	\$521	
2128-16	HBURG RECREATION DEPT	901 CHICAGO AVE (Park View Shops)	21,849	\$2,321	
2128-17	HBURG RECREATION DEPT	305 S DOGWOOD DR (Westover Pavilion Lgts)	2,460	\$359	
2128-18	HBURG RECREATION DEPT	305 S DOGWOOD DR (Pool)	330,220	\$34,239	
2128-19	HBURG RECREATION DEPT	305 S DOGWOOD DR (Community Activities Center)	253,800	\$25,473	
2128-20	HBURG RECREATION DEPT	305 S DOGWOOD DR Westover Shelter 3&4	3,528	\$468	
2128-22	HBURG RECREATION DEPT	680 GARBERS CHURCH RD (Golf Course Pumping Station)	66,048	\$6,700	
2128-24	HBURG RECREATION DEPT	1582 S MAIN ST (Purcell Concession)	16,084	\$1,713	
2128-25	HBURG RECREATION DEPT	1412 SMITHLAND RD (Pump House)	21,232	\$2,229	
2128-26	HBURG RECREATION DEPT	680 GARBERS CHURCH RD (Heritage Oaks Proshop)	86,300	\$9,337	
2128-29	HBURG RECREATION DEPT	305 S DOGWOOD DR (Skate Park)	3	\$114	
2128-31	HBURG RECREATION DEPT	1583 W MARKET ST (Golf Course Stor. Shed)	4,069	\$524	
2128-32	HBURG RECREATION DEPT	501 HILLANDALE AVE TEMP METER	3	\$10	
2128-33	HBURG RECREATION DEPT	501 HILLANDALE AVE TEMP METER	1	\$10	
2128-34	HBURG RECREATION DEPT	461 2ND ST (Morrison BB court)	5,255	\$943	
2128-35	HBURG RECREATION DEPT	1542 SMITHLAND RD (Smithland Restrooms)	5,164	\$628	
2128-37	HBURG RECREATION DEPT	1545 HILLSIDE AVE (Purcell Playground)	3,321	\$445	
2128-38	HBURG RECREATION DEPT	1545 HILLSIDE AVE (Purcell Restroom)	3,499	\$465	
2128-39	HBURG RECREATION DEPT	1545 HILLSIDE AVE (Kids Castle Fountain)	4,877	\$601	
2128-40	HBURG RECREATION DEPT	1545 HILLSIDE AVE (Hillandale Little League Park)	16,100	\$1,718	
2128-45	HBURG RECREATION DEPT	501 HILLANDALE AVE (Athletic Stor. Shop)	26,440	\$2,781	
2128-49	HBURG RECREATION DEPT	177 S MAIN ST (Denton Park)	4,329	\$543	
2128-50	HBURG RECREATION DEPT	188 N LIBERTY ST (Liberty Park)	1,080	\$222	
2128-53	HBURG RECREATION DEPT	1950 THOMAS BOWERS CIR (Dream Come True Playground)	3,243	\$439	
2128-56	HBURG RECREATION DEPT	431 E WASHINGTON ST TEMP METER	5	\$10	
2128-57	HBURG RECREATION DEPT	431 E WASHINGTON ST SEC LIGHT	2,400	\$623	
2128-58	HBURG RECREATION DEPT	620 SIMMS AVE (Simms School)	741,120	\$74,353	
2128-61	HBURG RECREATION DEPT	431 E WASHINGTON ST (Ralph Sampson #2)	3,577	\$469	
2128-62	HBURG RECREATION DEPT	2181 RAMBLEWOOD RD (Ramblewood Concessions)	61,248	\$6,297	
2128-63	HBURG RECREATION DEPT	309 S DOGWOOD DR	15,050	\$1,626	
2128-64	HBURG RECREATION DEPT	317 S MAIN ST SEC LIGHT	480	\$124	1,771,940
9305-1	HBURG RHAM REG SEWER AUTH	1321 S DOGWOOD DR	1,113	\$228	1,113
112263-1	HRECC	653 Tower St (Radio Tower)	129,842		
112263-2	HRECC	1575 Peach Grove Ave (Radio Tower)	49,098		
112263-5	HRECC	420 Mt Clinton Pike (Radio Shop)	35,840		
112263-6	HRECC	424 Mt Clinton Pike (Radio Storage Shop)	2,445		217,225
			22,872,714	\$2,583,072	22,872,714
			kWh		

APPENDIX 2 –EPA eGRID Regional Electricity Emission Rates (2016 and 2019)

1. Subregion Output Emission Rates (eGRID2016)																
eGRID subregion acronym	eGRID subregion name	Total output emission rates							Non-based output emission rates							Grid Gross Loss (%)
		lb/MWh							lb/MWh							
		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 e	Annual NO _x	Ozone Season NO _x	SO ₂	
AKGD	ASCC Alaska Grid	1,072.3	0.077	0.011	1,077.3	6.5	6.5	0.5	1,387.8	0.110	0.016	1,375.0	6.8	6.7	0.7	5.25%
AKMS	ASCC Miscellaneous	503.1	0.023	0.004	504.9	7.0	6.5	0.6	1,533.8	0.068	0.012	1,538.9	21.8	20.8	2.0	5.25%
AZNM	WECC Southwest	1,043.6	0.079	0.012	1,049.0	1.0	0.9	0.3	1,394.8	0.097	0.014	1,391.2	1.3	1.1	0.4	4.23%
CAMX	WECC California	527.9	0.033	0.004	529.9	0.6	0.5	0.1	942.9	0.045	0.006	945.6	0.8	0.8	0.1	4.23%
ERCT	ERCOT All	1,009.2	0.076	0.011	1,014.1	0.5	0.6	1.0	1,402.8	0.108	0.015	1,409.8	0.8	0.7	1.6	4.89%
FRCC	FRCC All	1,011.7	0.075	0.010	1,016.4	0.5	0.5	0.4	1,188.5	0.078	0.011	1,193.3	0.6	0.6	0.4	4.49%
HIMS	HICC Miscellaneous	1,152.0	0.095	0.015	1,158.7	7.4	7.0	4.5	1,530.0	0.147	0.023	1,540.2	11.8	11.3	4.5	5.35%
HIOA	HICC Oahu	1,662.9	0.181	0.028	1,675.2	3.4	3.2	8.6	1,637.5	0.153	0.024	1,648.3	4.1	4.2	8.1	5.35%
MROE	MRO East	1,668.2	0.196	0.026	1,679.3	1.0	1.1	1.3	1,740.1	0.196	0.025	1,750.9	1.0	1.0	1.3	4.49%
MROW	MRO West	1,238.8	0.115	0.020	1,247.4	1.0	1.1	1.4	1,822.0	0.154	0.029	1,834.0	1.6	1.5	2.0	4.49%
NEWE	NPCC New England	558.2	0.090	0.012	563.7	0.4	0.4	0.1	975.1	0.086	0.011	980.5	0.5	0.4	0.2	4.49%
NWPP	WECC Northwest	651.2	0.081	0.009	655.4	0.6	0.7	0.4	1,524.9	0.124	0.020	1,533.8	1.4	1.4	0.8	4.23%
NYCW	NPCC NYC/Westchester	635.8	0.022	0.003	637.1	0.3	0.3	0.0	1,061.7	0.022	0.002	1,062.9	0.5	0.6	0.0	4.49%
NYLI	NPCC Long Island	1,178.3	0.126	0.016	1,188.0	0.9	0.8	0.2	1,338.8	0.036	0.004	1,340.9	0.9	0.9	0.3	4.49%
NYUP	NPCC Upstate NY	294.7	0.021	0.003	295.9	0.3	0.3	0.2	1,018.2	0.061	0.008	1,022.0	0.8	0.8	0.9	4.49%
RFCE	RFC East	758.2	0.050	0.009	762.1	0.6	0.6	0.6	1,434.4	0.079	0.017	1,441.4	1.2	1.1	1.2	4.49%
RFCM	RFC Michigan	1,272.0	0.087	0.018	1,278.9	0.9	0.9	1.7	1,806.1	0.101	0.025	1,816.1	1.3	1.2	2.8	4.49%
RFCW	RFC West	1,243.4	0.108	0.019	1,251.5	0.9	0.9	1.2	1,934.4	0.172	0.029	1,946.9	1.5	1.4	2.2	4.49%
RMPA	WECC Rockies	1,387.8	0.137	0.020	1,376.8	1.0	1.0	0.6	1,688.3	0.147	0.021	1,697.9	1.2	1.2	0.8	4.23%
SPNO	SPP North	1,412.4	0.149	0.022	1,422.2	0.8	0.9	0.5	1,990.8	0.202	0.029	2,004.1	1.4	1.5	1.1	4.49%
SPSO	SPP South	1,248.3	0.095	0.015	1,254.9	0.9	0.9	1.7	1,662.5	0.121	0.019	1,670.9	1.3	1.3	2.4	4.49%
SRMV	SERC Mississippi Valley	838.9	0.050	0.007	842.2	0.8	0.9	0.7	1,186.0	0.071	0.010	1,190.6	1.3	1.4	1.1	4.49%
SRMW	SERC Midwest	1,612.6	0.082	0.026	1,622.5	1.1	1.1	2.4	1,955.2	0.094	0.031	1,966.5	1.3	1.2	3.1	4.49%
SRSO	SERC South	1,089.4	0.087	0.013	1,095.1	0.5	0.5	0.4	1,453.5	0.115	0.017	1,461.1	0.8	0.7	0.6	4.49%
SRTV	SERC Tennessee Valley	1,185.4	0.093	0.017	1,192.6	0.7	0.7	1.0	1,757.4	0.135	0.025	1,767.9	1.1	1.1	1.6	4.49%
SRVC	SERC Virginia/Carolina	805.3	0.067	0.011	810.1	0.5	0.5	0.3	1,422.2	0.111	0.019	1,430.4	0.8	0.8	0.6	4.49%
U.S.		998.4	0.080	0.013	1,004.2	0.7	0.7	0.8	1,501.0	0.111	0.018	1,508.9	1.1	1.0	1.3	4.48%

Created: 2/15/2018



1. Subregion Output Emission Rates (eGRID2019)

eGRID subregion acronym	eGRID subregion name	Total output emission rates							Non-baseload output emission rates							Grid Gross Loss (%)
		lb/MWh							lb/MWh							
		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 e	Annual NO _x	Ozone Season NO _x	SO ₂	
AKGD	ASCC Alaska Grid	1,114.4	0.098	0.013	1,120.8	6.2	6.1	0.7	1,333.0	0.123	0.017	1,341.0	6.6	6.7	0.8	5.4%
AKMS	ASCC Miscellaneous	549.3	0.026	0.004	551.3	8.1	7.8	0.7	1,520.2	0.067	0.012	1,525.4	22.6	22.8	2.0	5.4%
AZNM	WECC Southwest	952.3	0.068	0.010	956.9	0.6	0.6	0.2	1,445.3	0.100	0.014	1,451.9	0.9	0.9	0.3	5.1%
CAMX	WECC California	453.2	0.033	0.004	455.3	0.4	0.4	0.0	964.0	0.058	0.007	967.6	0.8	0.8	0.1	5.1%
ERCT	ERCOT All	868.6	0.057	0.008	872.4	0.5	0.5	0.6	1,277.2	0.083	0.012	1,282.7	0.9	0.8	0.9	5.1%
FRCC	FRCC All	861.0	0.055	0.007	864.5	0.3	0.3	0.2	1,029.5	0.054	0.007	1,033.0	0.3	0.3	0.2	5.1%
HIMS	HICC Miscellaneous	1,185.6	0.143	0.022	1,195.6	8.1	8.4	4.1	1,549.5	0.107	0.018	1,557.6	12.3	12.8	5.3	5.5%
HIOA	HICC Oahu	1,694.5	0.185	0.028	1,707.6	3.7	4.1	7.0	1,704.1	0.158	0.025	1,715.6	4.5	4.6	8.1	5.5%
MROE	MRO East	1,502.6	0.147	0.022	1,512.6	0.8	0.9	0.4	1,577.7	0.145	0.021	1,587.4	0.8	0.9	0.4	5.1%
MROW	MRO West	1,098.4	0.119	0.017	1,106.4	0.8	0.8	1.1	1,806.8	0.188	0.027	1,819.6	1.4	1.3	1.7	5.1%
NEWE	NPCC New England	488.9	0.077	0.010	493.8	0.3	0.3	0.1	839.9	0.089	0.012	845.5	0.4	0.4	0.1	5.1%
NWPP	WECC Northwest	715.2	0.068	0.010	719.9	0.6	0.6	0.4	1,617.5	0.156	0.022	1,628.1	1.6	1.5	0.9	5.1%
NYCW	NPCC NYC/Westchester	553.8	0.021	0.002	555.1	0.2	0.2	0.0	1,016.2	0.022	0.002	1,017.5	0.4	0.4	0.0	5.1%
NYLI	NPCC Long Island	1,209.0	0.157	0.020	1,218.9	0.9	0.9	0.2	1,300.6	0.044	0.005	1,303.3	0.8	0.8	0.2	5.1%
NYUP	NPCC Upstate NY	232.3	0.017	0.002	233.0	0.1	0.1	0.0	890.2	0.047	0.006	892.6	0.4	0.4	0.2	5.1%
PRMS	Puerto Rico Miscellaneous	1,537.3	0.084	0.013	1,543.3	3.5	3.9	3.2	1,587.9	0.055	0.010	1,592.3	4.5	5.1	5.0	0.0%
RFCE	RFC East	695.0	0.053	0.007	698.5	0.3	0.3	0.3	1,237.9	0.089	0.012	1,243.8	0.7	0.6	0.7	5.1%
RFCM	RFC Michigan	1,189.3	0.114	0.016	1,197.0	0.7	0.7	1.0	1,766.9	0.177	0.025	1,778.8	1.2	1.2	2.1	5.1%
RFCW	RFC West	1,067.7	0.099	0.014	1,074.4	0.8	0.6	0.7	1,831.6	0.178	0.026	1,843.7	1.5	1.1	1.3	5.1%
RMPA	WECC Rockies	1,242.6	0.117	0.017	1,250.6	0.7	0.6	0.4	1,578.8	0.126	0.018	1,587.3	0.8	0.8	0.4	5.1%
SPNO	SPP North	1,070.0	0.112	0.016	1,077.6	0.6	0.6	0.2	1,958.6	0.200	0.029	1,972.2	1.1	1.2	0.4	5.1%
SPSO	SPP South	1,002.0	0.070	0.010	1,006.7	0.7	0.8	0.8	1,543.7	0.108	0.015	1,550.9	1.2	1.2	1.3	5.1%
SRMV	SERC Mississippi Valley	806.8	0.043	0.006	809.6	0.6	0.6	0.7	1,200.1	0.068	0.010	1,204.7	0.9	1.0	1.4	5.1%
SRMW	SERC Midwest	1,584.4	0.169	0.025	1,595.9	1.0	0.8	2.4	1,960.9	0.216	0.031	1,975.6	1.2	1.1	2.8	5.1%
SRSO	SERC South	969.2	0.071	0.010	974.0	0.4	0.4	0.2	1,389.5	0.101	0.015	1,396.4	0.8	0.7	0.4	5.1%
SRTV	SERC Tennessee Valley	949.7	0.087	0.013	955.6	0.5	0.5	0.6	1,565.2	0.139	0.020	1,574.6	0.7	0.8	0.9	5.1%
SRVC	SERC Virginia/Carolina	675.4	0.058	0.008	679.1	0.3	0.4	0.2	1,349.2	0.118	0.017	1,356.9	0.7	0.8	0.4	5.1%
U.S.		884.2	0.075	0.011	889.2	0.6	0.6	0.5	1,420.2	0.114	0.016	1,427.8	1.0	0.9	0.9	5.1%

Created: 2/23/2021

APPENDIX 3 – ClearPath Transportation Factor Sets

Vehicle Category	US National Default	
	2016	2019
Gas Passenger Vehicle Fuel Economy (MPG)	23.95689	24.37713
Gas Passenger Vehicle g CH4/mi	0.0196	0.0183
Gas PassengerVehicle g N2O/mi	0.0119	0.0083
Gas Light Truck Fuel Economy (MPG)	17.39756	17.86788
Gas Light Truck g CH4/mi	0.0223	0.0193
Gas Light Truck g N2O/mi	0.0214	0.0148
Gas Heavy Truck Fuel Economy (MPG)	5.35883	5.371652
Gas Heavy Truck g CH4/mi	0.1047	0.0785
Gas Heavy Truck g N2O/mi	0.0726	0.0633
Gas Transit Bus Fuel Economy (MPG)	17.39756	17.86788
Gas Transit Bus g CH4/mi	0.0223	0.0193
Gas Transit Bus g N2O/mi	0.0214	0.0148
Gas Para Transit Bus Fuel Economy (MPG)	17.39756	17.86788
Gas Para Transit Bus g CH4/mi	0.0223	0.0193
Gas Para Transit Bus g N2O/mi	0.0214	0.0148
Gas Motorcycle Fuel Economy (MPG)	23.95689	24.37713
Gas Motorcycle g CH4/mi	0.0196	0.0183
Gas Motorcycle g N2O/mi	0.0119	0.0083
Diesel Passenger Vehicle Fuel Economy (MPG)	23.95689	24.37713
Diesel Passenger Vehicle g CH4/mi	0.0005	0.0005
Diesel PassengerVehicle g N2O/mi	0.001	0.001
Diesel Light Truck Fuel Economy (MPG)	17.39756	17.86788
Diesel Light Truck g CH4/mi	0.001	0.001
Diesel Light Truck g N2O/mi	0.0015	0.0015
Diesel Heavy Truck Fuel Economy (MPG)	6.154184	6.392468
Diesel Heavy Truck g CH4/mi	0.0051	0.0051
Diesel Heavy Truck g N2O/mi	0.0048	0.0048
Diesel Transit Bus Fuel Economy (MPG)	17.39756	17.86788
Diesel Transit Bus g CH4/mi	0.001	0.001
Diesel Transit Bus g N2O/mi	0.0015	0.0015
Diesel Para Transit Bus Fuel Economy (MPG)	17.39756	17.86788
Diesel Para Transit Bus g CH4/mi	0.001	0.001
Diesel Para Transit Bus g N2O/mi	0.0015	0.0015
Diesel Motorcycle Fuel Economy (MPG)	23.95689	24.37713
Diesel Motorcycle g CH4/mi	0.0005	0.0005
Diesel Motorcycle g N2O/mi	0.001	0.001