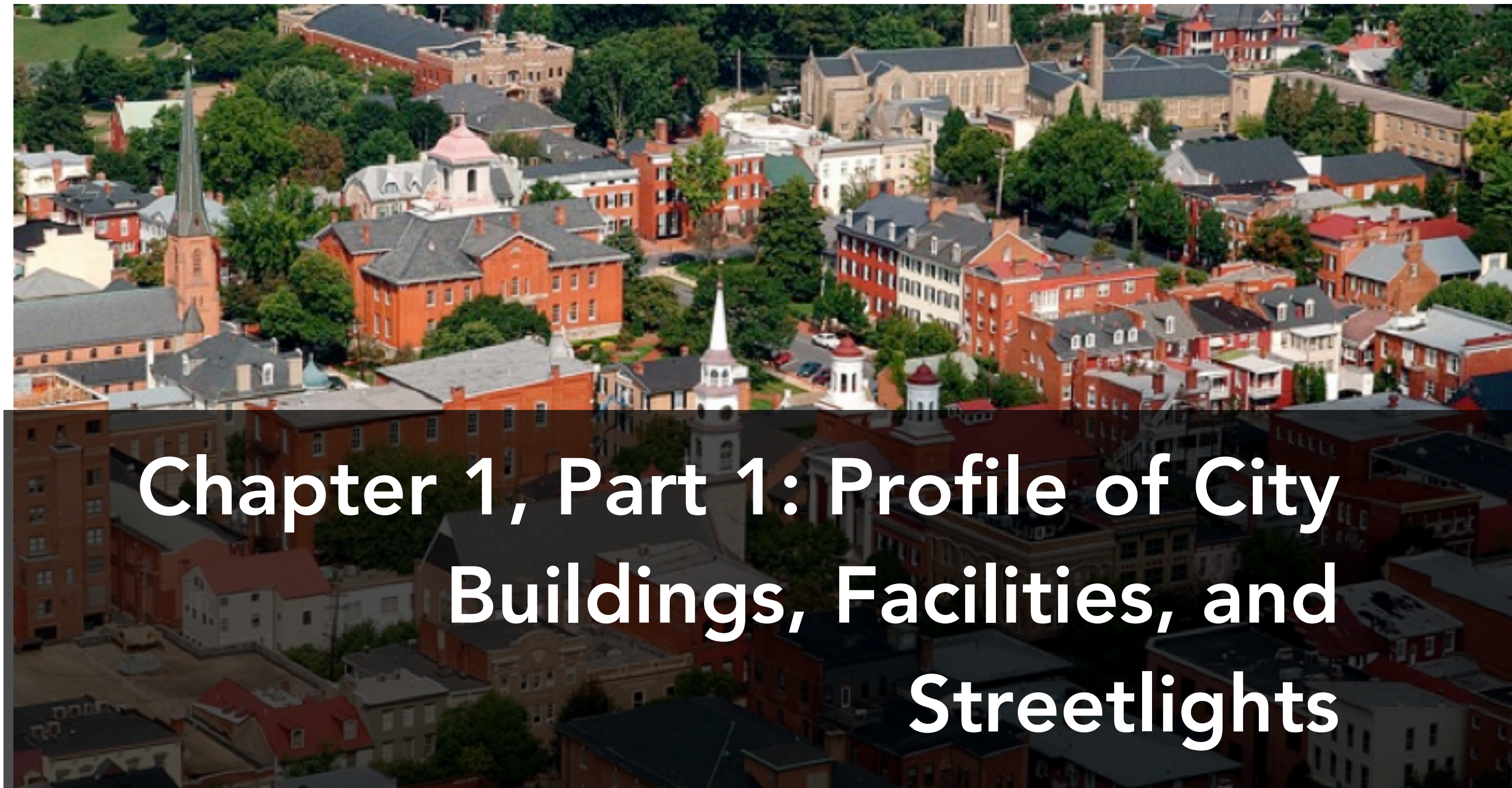

Chapter 1, Part 1: Profile of City Buildings, Facilities, and Streetlights

A Local Government Greenhouse Gas (GHG) Emissions Inventory

A collaborative partnership between

PALS

The City of Frederick Maryland

Authors: Amee Bearne, Daniel Francis, Zack Rockwell, Ashley Sampson & David Schlie

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APPENDIX

1. Introduction

It costs a great deal of energy and, consequently, money to power a city; however, the energy used to power our homes and businesses comes not only at a cost to the government, but to the community and environment as well. The byproducts associated with energy production, most notably greenhouse gas (GHG) emissions, can—if left unchecked—harm the most vulnerable in our communities. This assessment is intended to be a resource for The City of Frederick as it works to understand the level of GHGs emitted as a result of powering City facilities. With this understanding, the City will be better positioned to identify its fuel supply, implement energy efficiency improvements and reduce energy consumption where possible.

Greenhouse gas emissions—most commonly identified in this report as carbon dioxide equivalent (CO_2e) emissions—are the byproduct of consuming carbon intensive fuels. These GHGs trap heat within Earth's atmosphere, contributing over time to climate change. The purpose of this report is not to politicize any actions within City government or prioritize certain energy sources over another, but rather to examine the optimization of resources and the potential co-benefits associated with improving resource management. It is important for the City of Frederick to identify areas for improvement, not only for the sake of the environment, but for the betterment of the City's operating budget.

The City of Frederick is at a unique point in its history where it must address inefficiencies in longstanding operations during a period of rapid growth. Frederick's unique blend of historic and new buildings both within and outside of the local Historic District make it one of Maryland's most distinct cities and one of the more challenging in prioritizing energy efficiency upgrades. As of 2012, Frederick had a well-established business community with over 3,500 businesses in operation and approximately 49,000 employees who call Frederick home.[1] Its recent growth has attracted local and national attention—most recently by *The Washington Post*, which highlighted urban renewal efforts underway led in part by empty-nesters and millennials.[2] It is the sustenance and growth of these populations that the City must consider as the community grows, simultaneously expanding its tax base and services.

[1] "Five questions With Richard G. Griffin, director, Frederick Department of Economic Development," *Frederick News Post* (Frederick, MD), June 4, 2012. http://www.fredericknewspost.com/archive/five-questions-with-richard-g-griffin-director-frederick-department-of/article_f18baac0-e15f-5d14-add3-24aa8f924089.html?mode=jqm

[2] John Woodrow Cox, "Mini-D.C.'s: A small-city boom revitalizes downtowns once left for dead," *The Washington Post* (Washington, DC), October 31, 2014. http://www.washingtonpost.com/local/mini-dcs-a-small-city-boom-revitalizes-downtowns-once-left-for-dead/2014/10/31/0790173e-5f9b-11e4-91f7-5d89b5e8c251_story.html

In addressing its high-energy intensity buildings and assessing areas deemed ripe for improvement, it is this committee's belief that the City can demonstrate to the public the City's commitment to smarter use of taxpayer dollars through reduced energy consumption. Our findings support that Frederick is well-positioned to address these concerns.

This report attempts to identify and analyze energy intensive areas within Frederick city limits. It will also address the various fuels the City uses across its facilities, which include electricity and natural gas. The subsequent analysis takes a first step in examining the current emissions profile from the City's largest building sector emitters and the impact of variables such as fuel types and weather. Formal recommendations for measures to address the highest energy consumers and the candidates for the most cost-efficient upgrades will follow in a separate report. The foundations of those findings are below.

2. Data and Methodology

The data on building electricity use was provided by Potomac Edison, the City's energy utility, and Hess and Mid-America Energy, the City's electricity suppliers during 2013. Washington Gas provided the City's natural gas data. Electricity use was reported by billing account, which in most cases was the energy use for one building, but in some instances it was divided further (i.e., sub-metered), as was the case for two apartment buildings. Because only a total floor area was provided for these addresses, the multiple accounts at each address were aggregated to the building level. Electricity use data for streetlights, traffic lights and park lights was in most cases associated with a street name, while some accounts were associated with an address or an intersection. The spatial statistics and mapping associated with these accounts is therefore an approximation of the actual distribution of street, traffic, and park lights. Natural gas use was reported by billing account with an associated address. The amount of other stationary fuels consumed (heating oil, propane, diesel, and gasoline) was provided but not associated with an address or department. The graph showing carbon dioxide equivalent (CO_2e) emissions by category was created using the eGRID regional fuel mix for Frederick, which is the sub-region RFC East.[3]

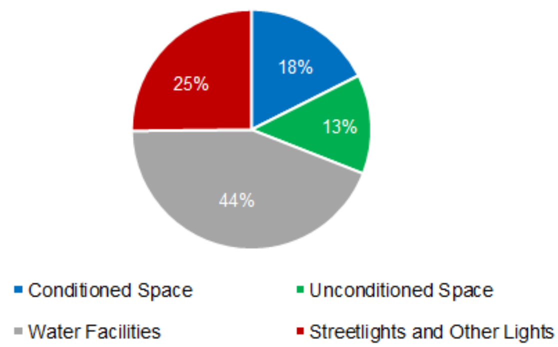
3. The City's Carbon Footprint from Purchased Energy

In 2013, energy use by City facilities, including building fuel, a Scope 1 emission, and purchased electricity, a Scope 2 emission, added 11,664 metric tonnes of CO_2e to the atmosphere, accounting for 26.9 percent of all City carbon emissions. Figure 1, pictured right, shows how carbon emissions from facility electricity use are distributed among four types of City-owned

[3] The regional fuel mix can be found here: http://www.epa.gov/cleanenergy/documents/egridzips/eGRID_9th_edition_V1-0_year_2010_Summary_Tables.pdf

property. The largest share is water facilities, which includes the wastewater treatment plant. The wastewater treatment plant accounts for 50 percent of electricity use by water facilities. A graph showing the metric tonnes of CO_2e associated with each category is located in Appendix A. Streetlights, traffic lights and other types of outdoor lighting account for the next largest share, while buildings account for the remaining third of emissions. Another part of the greenhouse gas emissions for the City is the amount produced by stationary fuels. These account for 739 metric tonnes of CO_{2e} emitted. The largest emitter for the stationary fuels is natural gas at about 98 percent of the emissions.

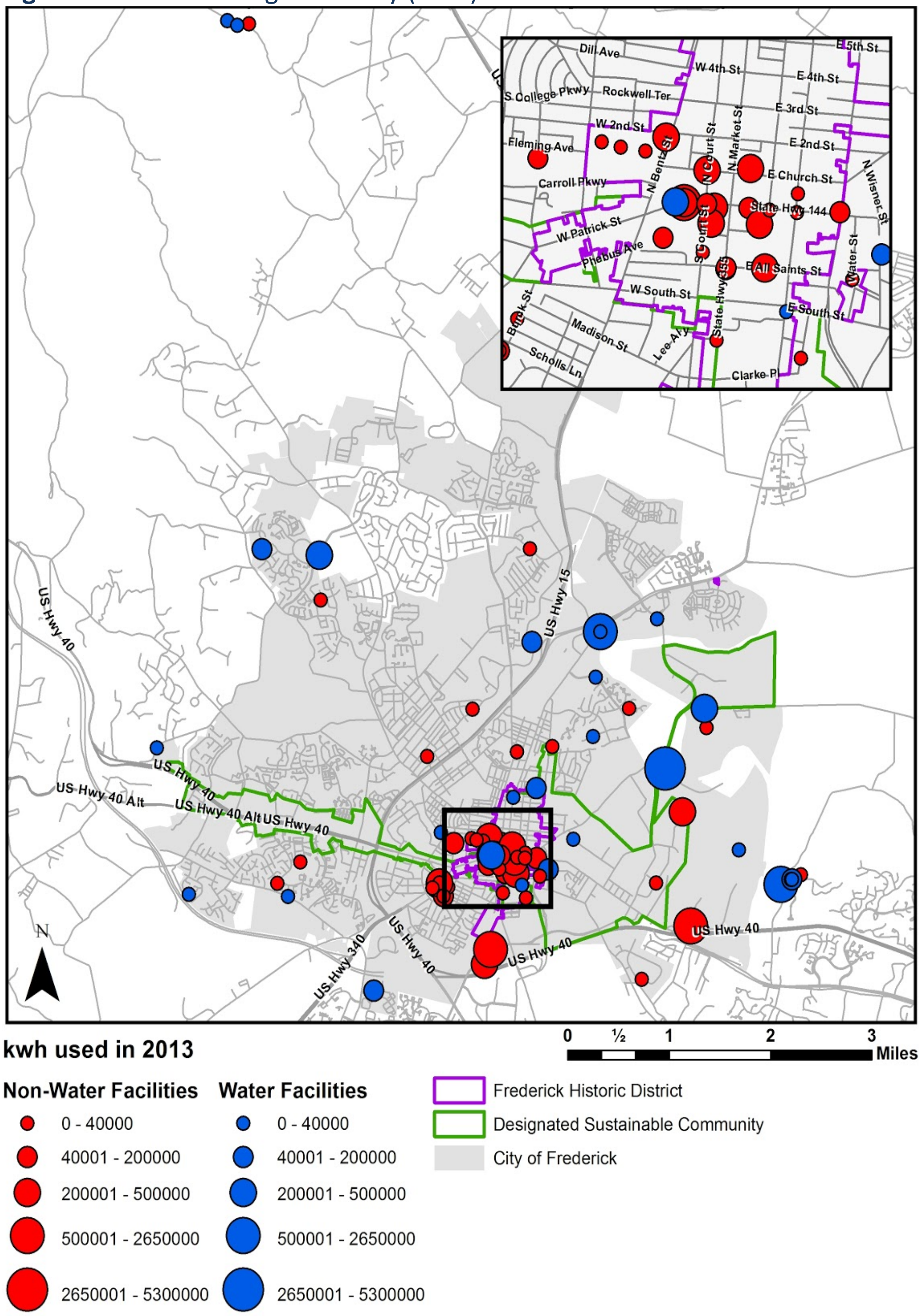
Figure 1. CO_2e Emissions from Electricity, 2013



4. Analyzing Energy Use Spatially

Figure 2 on the following page shows the locations of Frederick facilities in relation to both the Historic District (which includes the central business district) and the Sustainable Community area, a state-designated community revitalization zone. The Historic District boundary indicates where the City may face some restrictions or difficulties in making energy efficiency upgrades due to Historic District requirements, but also allows us to analyze how energy use—for street lighting in particular—may differ between the dense urban core of the City and the outer suburban and rural areas. City properties within the Sustainable Community area are eligible for certain state grants that can be used for energy efficiency retrofits or renewable energy production. The size of the bubble at each facility varies in proportion to the amount of electricity used at each facility, with the blue bubbles representing water facilities, such as pumps and wells, and the red bubbles representing structures such as park buildings and offices. The high-energy use structures in red are clustered in and around downtown, with the public works building along State Route 40 using the most electricity of non-water facilities. The wastewater treatment plant to the northeast of downtown uses the most energy of all facilities. See Appendix C for a map of just the Non-Water Facilities.

Figure 2. 2013 Building Electricity (kWh) Use



As the energy-intensive water facilities are found predominantly outside of downtown, only a quarter of electricity used for buildings is consumed within the Historic District (Figure 3). When water facilities are excluded from the analysis, 56 percent of electricity use is in the Historic District (Figure 4). Of the total amount of electricity used for occupied spaces, 58 percent is consumed in the Historic District, while only 44.5 percent of occupied space is within the

Historic District (Figure 5). This discrepancy is due to a difference in average Energy Use Intensity (EUI) between the Historic District and the rest of the City. According to ENERGY STAR® data, the median EUI for an office building in the United States is 19.72 kWh/ft^2 kilowatt-hours per square foot (kWh/ft^2). The Historic District is close to the median at 19.57 kWh/ft^2, but the rest of the City is below the median at 11.20 kWh/ft^2 (Figure 6). This may be because the City's buildings in the Historic District are more intensively used (more employees per square foot) that the outer buildings, or they may use less efficient heating and cooling systems. See Appendix A for charts showing the square footage of occupied space and natural gas use inside and outside of the Historic District. Because the Sustainable Community area includes much of the Historic District, there may be opportunities for the City to remedy this discrepancy in energy intensity—with assistance from state grants—by incorporating energy efficiency upgrades into rehabilitation projects.

Figure 4. Total Building Electricity Use (kWh)

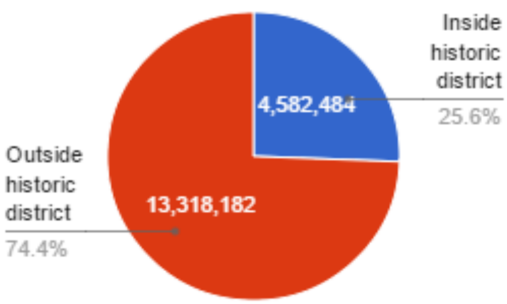


Figure 4. Building Electricity Use Excluding Water Facilities (kWh)

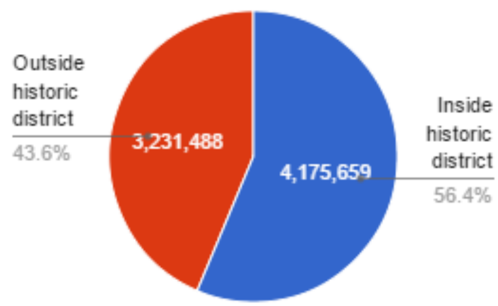


Figure 6. Occupied Space Electricity Use (kWh)

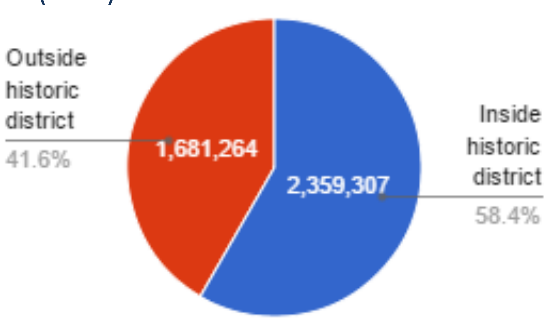
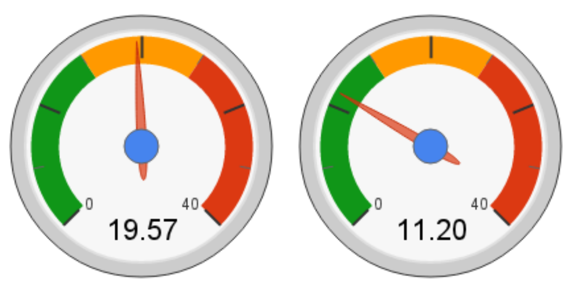


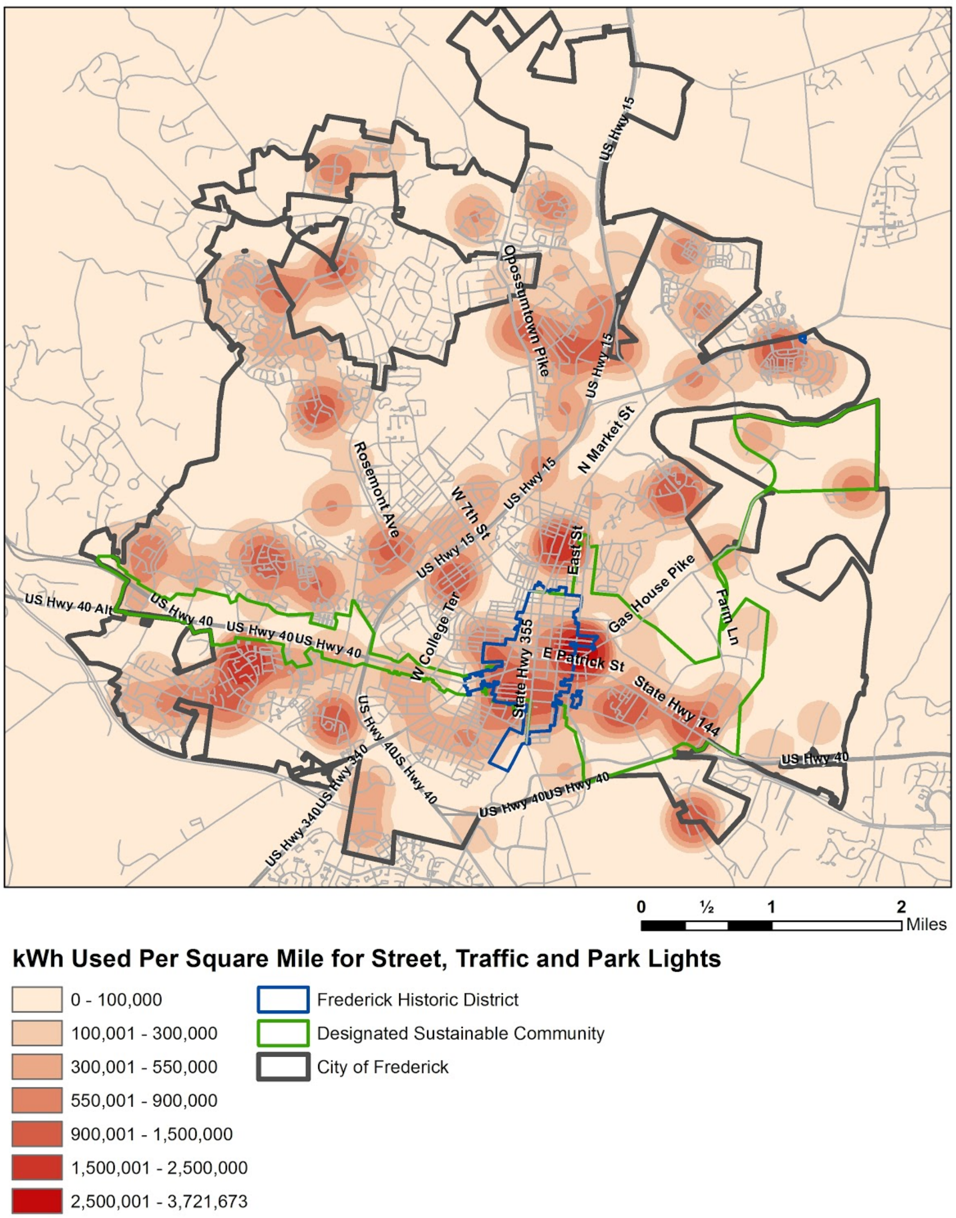
Figure 6. Average Energy Use Intensity (EUI) of Conditioned Occupied Space (kWh/Ft^2)



Inside Historic District Outside Historic District

Figure 7 below shows the density of energy used by street, traffic and park lights. Density was calculated based on the kilowatt-hours of electricity measured at meters spaced throughout the City in 2013.[4] The highest density of use is just outside the eastern edge of the Historic District, where one electricity meter measured 322,800 kilowatt-hours. It is possible that this meter accounts for more lights than others because it is near downtown, which has a high density of streets and therefore streetlights and traffic lights. It is also notable that corridors of moderate density electricity usage extend along major roads out of the downtown where new development is occurring.

Figure 7. Electricity Used for Street, Traffic, and Park Lights



[4] Data is not available at the individual light or parcel level. Mapping the meters at the city scale gives an approximation of the distribution of energy use for lighting.

Table 1 below shows that the amount of electricity used for street and traffic lighting (excluding park lights) per resident and per mile of road is lower in the Historic District, suggesting that energy consumption per person increases as density decreases. The City could reduce the energy consumption for street and traffic lighting per person by encouraging development at higher densities and closer to the city center to reduce the number of street and traffic lights needed.

Table 1. Streetlight Electricity Use

	Population Density	kWh/per resident	kWh/lane mile
Historic District	11.34	80.25	3.81
Outside the Historic District	4.28	89.74	4.09

5. Visualizing Electricity and Stationary Fuel Use

Figure 8 below shows the breakdown of the City's kilowatt-hour (kWh) usage divided into building type categories. These three groups include occupied space, streetlights and other space—which constitutes community centers, gyms, and park facilities. It is important to note that Figure 8 does not include any of the City's water facilities. There is a significant amount of uncertainty as to the future electricity use of the plant after they begin operation of a new cogeneration unit that will provide a portion of the needed electricity for wastewater treatment. Because of that uncertainty, as well as the fact that the high amount of kilowatt-hours would skew the numbers when assessing the other categories, it was decided to leave out the wastewater treatment plant when visualizing the City's overall kilowatt-hour use.

Figure 8. Percentage of Total kWh Used by Building Type

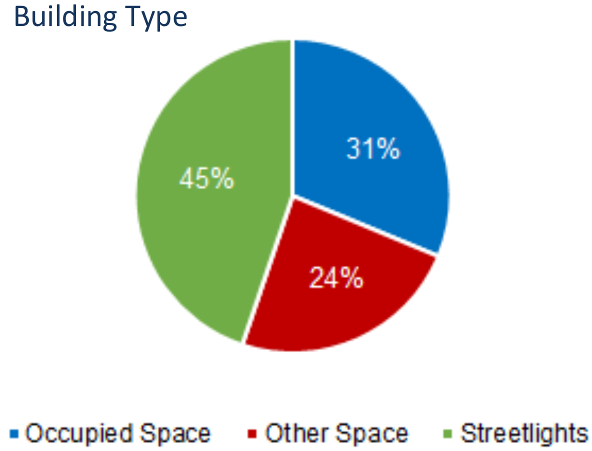


Figure 9, below, which shows kilowatt-hour intensity and annual use, can offer some insight into the energy use in City-owned occupied space. The annual kilowatt-hour use shows that the top occupied space electricity user is 111 Airport Dr. East at over 1 million kWh, with the next highest energy user being nearly half that amount. The kilowatt-hour intensity portion of the graph can help to pinpoint certain buildings that may not be energy efficient; it is derived by dividing the total annual kilowatt-hours of use for the building by the buildings gross square footage. A few of the buildings that stand out in this portion, denoted by the red squares, include 200 W 2nd St., Winchester St. and 142 W Patrick St. buildings. These buildings may require a more thorough examination, as kilowatt-hour intensity does not necessarily indicate a building's efficiency.

Figure 9. Annual Energy Use Intensity by Building (kWh)

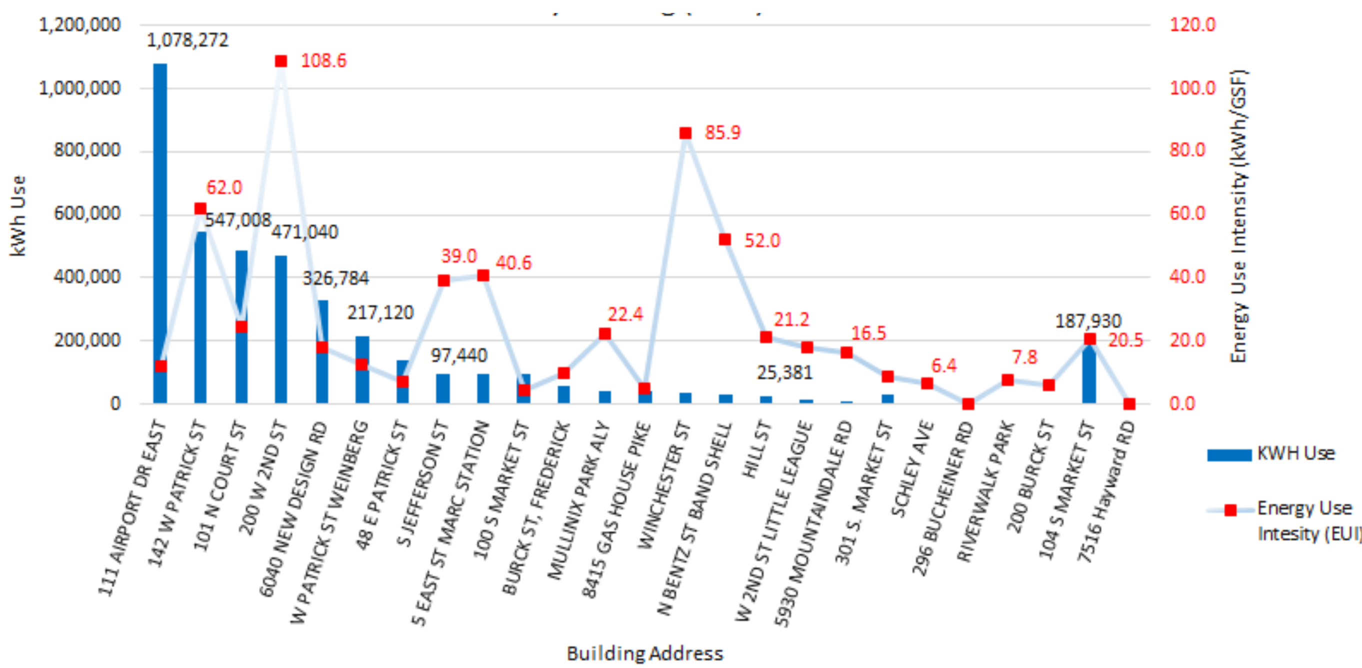


Figure 10. Percentage of Total Natural Gas Consumed Annually by Building

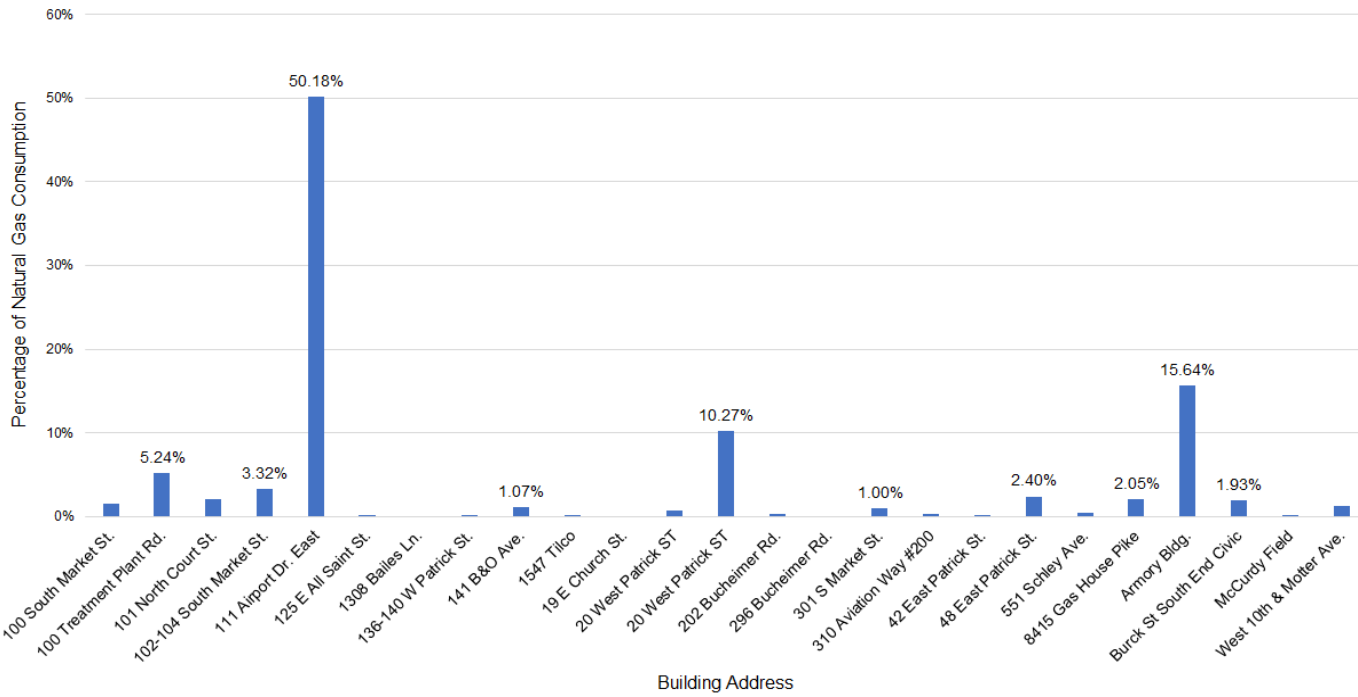


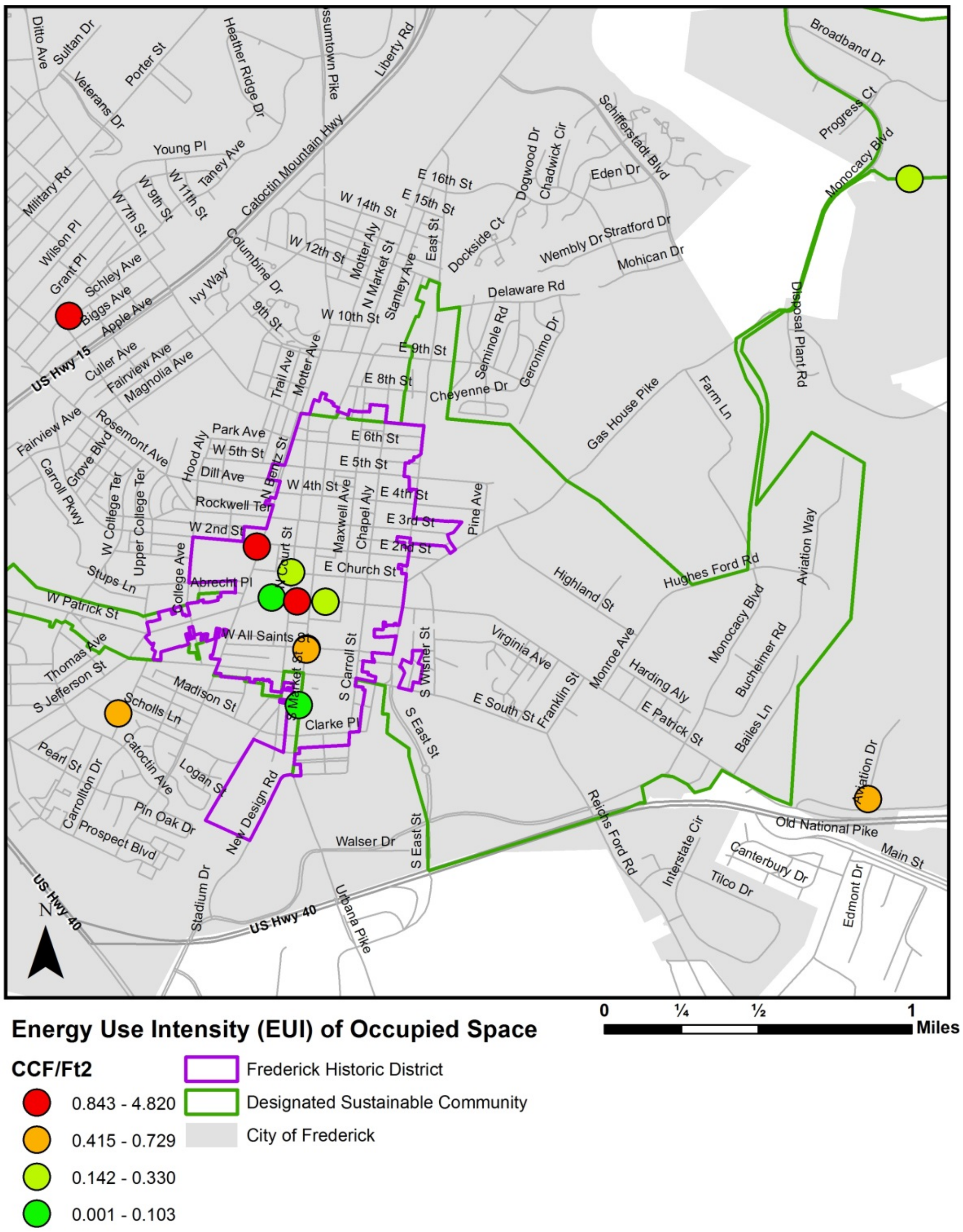
Figure 10, above, shows the percentage of annual natural gas consumption for City-owned buildings that use stationary fuel. The percentages can give insight into which buildings have the highest share of city gas usage. The most prominent of these users is the 111 Airport Drive East building, which has the highest natural gas use of the buildings graphed, at around 50 percent of the City's total consumption. The second and third highest consumers are the Amory and 20 West Patrick Street. It is also important to note that the City uses a small amount of propane, heating oil, diesel fuel, gasoline and dyed ULSD in each stationary fuel. However, these amounts were very small and did not have information to link them to a particular location or use. Therefore, these fuels were not evaluated in this section of the report.

6. Individual Building Energy Use

The maps on the next pages show electricity intensity and natural gas intensity for occupied buildings, sorted into quartiles. Buildings coded red are the most energy intensive; buildings coded green are the least intensive. The addresses of individual buildings can be found in Appendix H. The most intensive users of electricity are park and other outdoor facilities, like the Baker Park Bandshell (N Bentz Street), a portion of McCurdy Field (S Jefferson Street) and the MARC station (5 East Street). All three carry large lighting demands. The Armory building is currently the most intense user in both categories; despite being home to the William Talley Recreation Center, its rate is three times what is considered normal (370.66 kBtu/ft^2 vs. 96.8

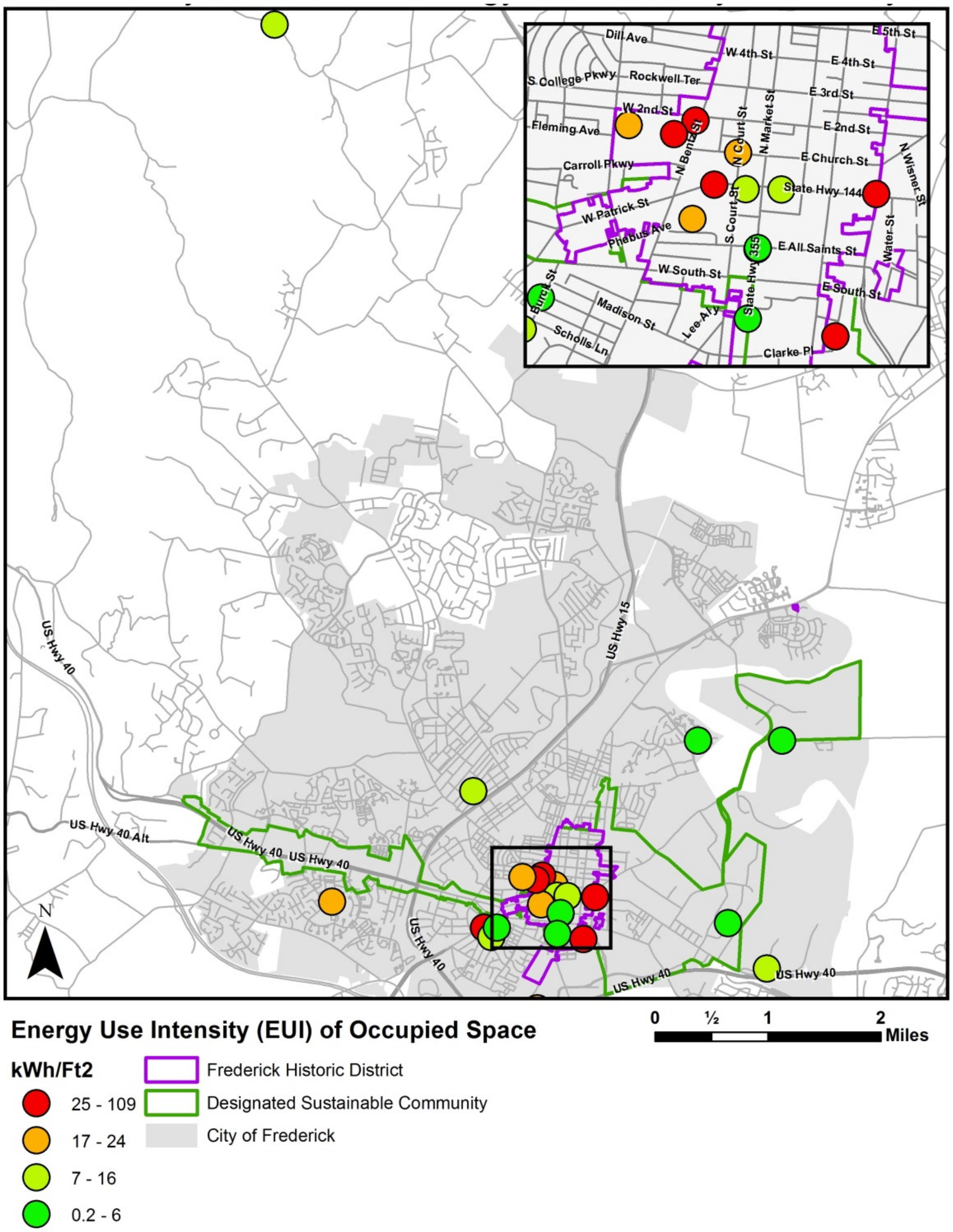
kBtu/ft^2).[5] Another anomaly is the Annex Office at 142 West Patrick Street, which has the second highest intensity of electrical use. A similar case can be found with the park building at Schley Avenue, which has the second highest use of natural gas. Neither has an obvious explanation. Appendix H shows electric and gas intensity for both occupied buildings and all buildings in full detail.

Figure 11. Energy Use Intensity: Natural Gas



[5] **"U.S. Energy Use Intensity by Property Type," Energy Star**
https://portfoliomanager.energystar.gov/pdf/reference/US%20National%20Median%20Table.pdf

Figure 12. Energy Use Intensity: Electricity



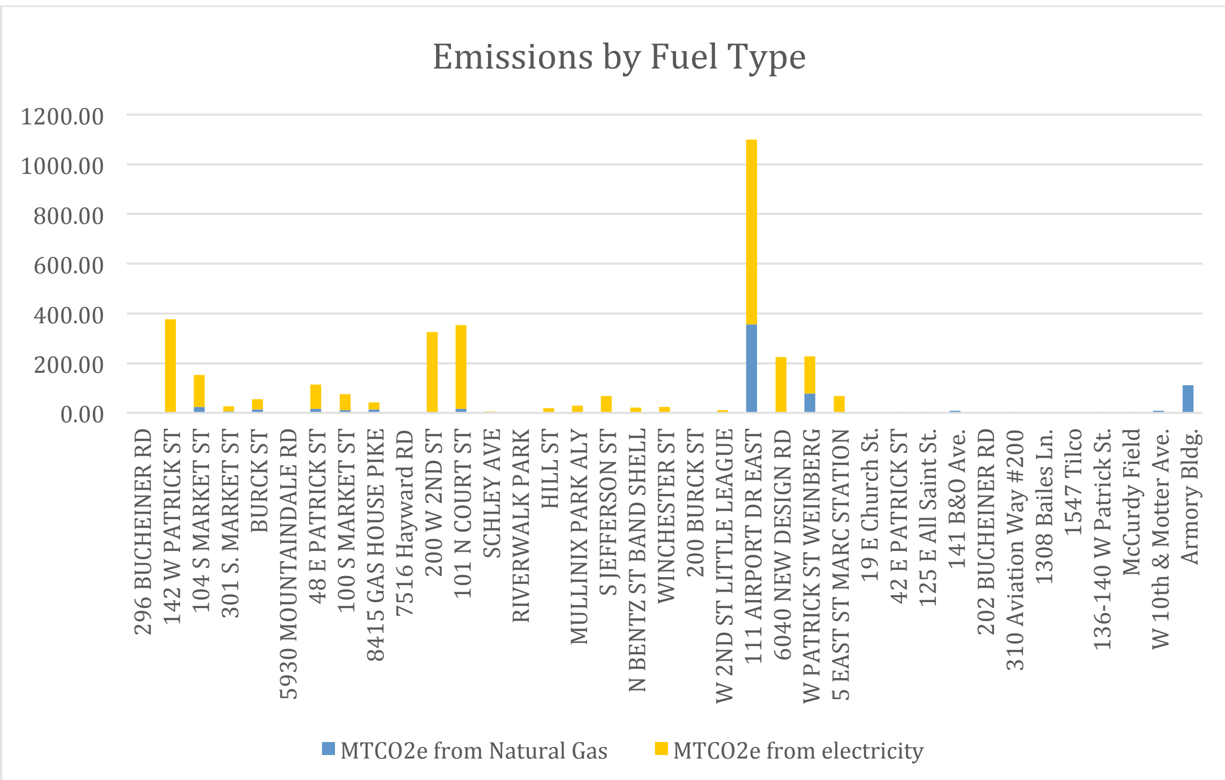
7. Fuel Mix and Emissions

It is important to know the fuel mix breakdown from energy resources provided by Potomac Edison for future projections and budgeting[8], so the City can look at fuel mix scenarios and adjust policies for reducing the City's carbon footprint.

There are several ways to determine the buildings with the best efficiency and emissions records. By looking at the emissions by fuel type, the current $MTCO_2e$ along with options for purchasing renewable energy to reduce emissions, the difference in Heating Degree Days (HDD) and Cooling Degree Days (CDD), and the occupancy rates with relation to use, all disaggregated by buildings categorized by 'occupied space,' the City of Frederick will have many options for reducing emissions for individual buildings.

The 'occupied space' buildings consumed 126,637 centum cubic feet (CCF) of natural gas and 4,040,571 kilowatt-hour (kWh) of electricity in 2013. Using the conversion rates[6] for natural gas and kilowatt-hour into $MTCO_2e$ provided by eGrid (United States Environmental Protection Agency 2014), the output of emissions by City-owned buildings sorted by the different fuel sources is represented in Figure 13 below.[7]

Figure 13. All Occupied Space Buildings with Emissions from Each Fuel Used for Operation



While the electricity provider, Potomac Edison, currently uses various renewable energy sources[8] to make up their fuel mix (Potomac Edison 2013) the amount is too small to cut emissions at a large scale without purchasing renewable energy from a distributor of clean

[6] Natural Gas conversion: 0.005302 metric tons CO_2/therm; kWh conversion: 6.89551×10^{-4} metric tons CO_2 / kWh
[7] The appendix item I shows a more detailed graph excluding 111 Airport Dr. East.
[8] Coal: 44.43%; Fuel Cell – Non-Renewable: 0.01%; Gas: 16.39%; Nuclear: 35.12%; Oil: 0.19%; Renewable Energy: 3.86% (Captured Methane Gas: 0.29%; Hydroelectric: 0.97%; Solar: 0.05%; Solid Waste: 0.52%; Wind: 1.88%; Wood or other Biomass: 0.15%)

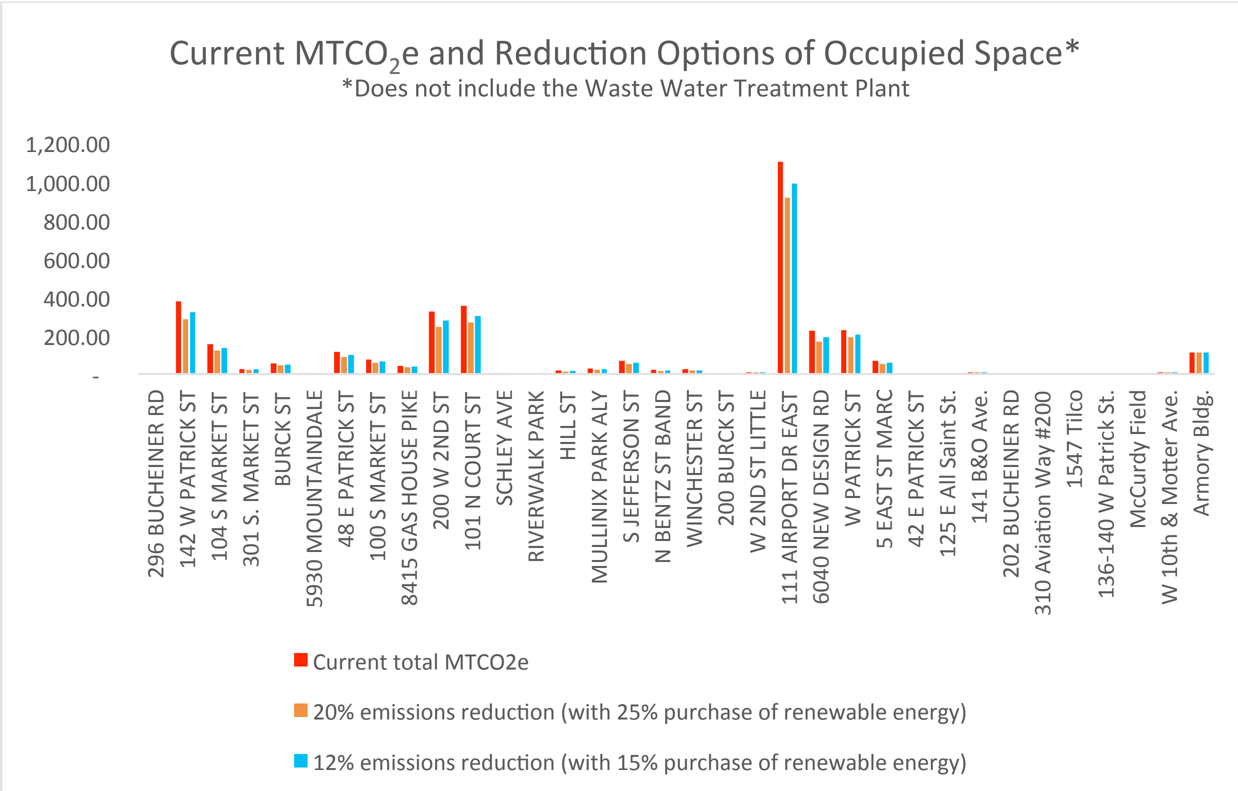
sources, which in turn reduces the carbon intensity and fuel mix of the overall electricity consumption by the City. To reduce the overall emissions by 20%—a number currently being used by many cities around the country for their long-term emissions reductions goals or 12%, a number most often used for short-term goals—of occupied space for City-owned buildings, the City would need to purchase 25% and 15% of their electricity, respectively, from renewable energy sources.[9] Because purchasing renewable energy from a supplier that distributes renewable energy options would reduce only the amount of electricity consumed through Potomac Edison, each building will see different proportions in emissions reductions, as illustrated in Figure 14 below.[10] Due to the uncertainty of the future emissions from the Waste Water Treatment Plant, it is not included in any calculations.

The calculations were determined by creating a target reduction for each scenario. As the cumulative emissions from all the buildings annually (natural gas conversion + kWh conversion) was 3,457.61 $MTCO_2e$, the target for 20% was 2,766.09 $MTCO_2e$ and the target for 15% reduction was 3,042.7 $MTCO_2e$. By reducing each building's $MTCO_2e$ converted from kWh by arbitrary amounts until meeting or going below the target, the group was able to define the necessary amount of renewable energy that must be purchased to reduce emissions. This assumes that no natural gas emissions were reduced.

[9] The two current options for purchasing renewable energy in Frederick County is through Constellation and Clean Steps Windpower, according to the following online PDF: http://frederickcountymd.gov/documents/6616/6617/6628/Powering%20your%20home%20with%20wind%20energy-10-2012%20FINAL_201211201232262550.pdf,

[10] The appendix item J shows a more detailed graph excluding 111 Airport Dr. East.

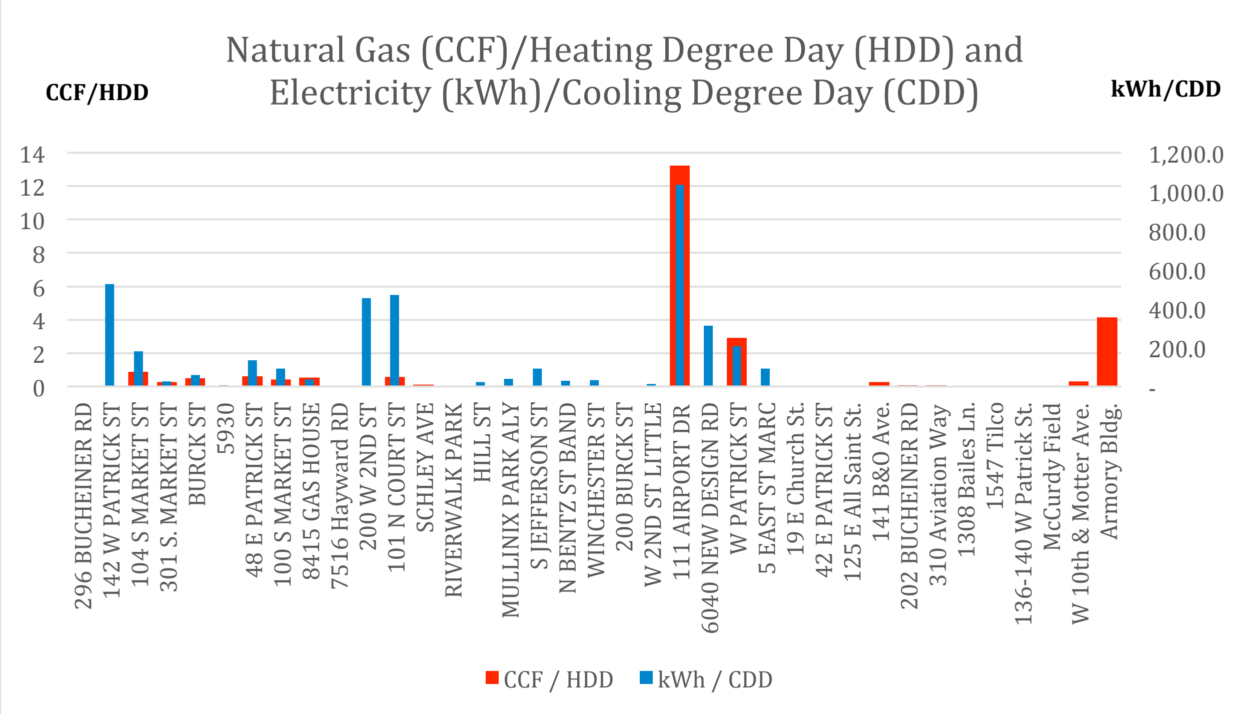
Figure 14. Comparison of Three Emissions Scenarios: The Status Quo, a Reduction of 20 Percent, and a Reduction of 15 Percent



In 2013, there were 5,063 Heating Degree Days (HDD) and 1,041 Cooling Degree Days (CDD). As natural gas is correlated with HDDs and electricity is correlated with CDDs there were 25.01 CFF of natural gas used per CDD, and 3881.43 kWh per HDD. When normalized[11] by building, one can see the difference in heating and cooling needs per site.[12] Figure 15 shows the comparison between HDD and CDD per building.

[11] Normalizing entails dividing the annual energy unit by the associated annual degree day type.
[12] The appendix item K shows a detailed breakdown of the HDD and CDD per building

Figure 15. HDD and CDD by City-Owned Buildings Categorized in 'Occupied Space'

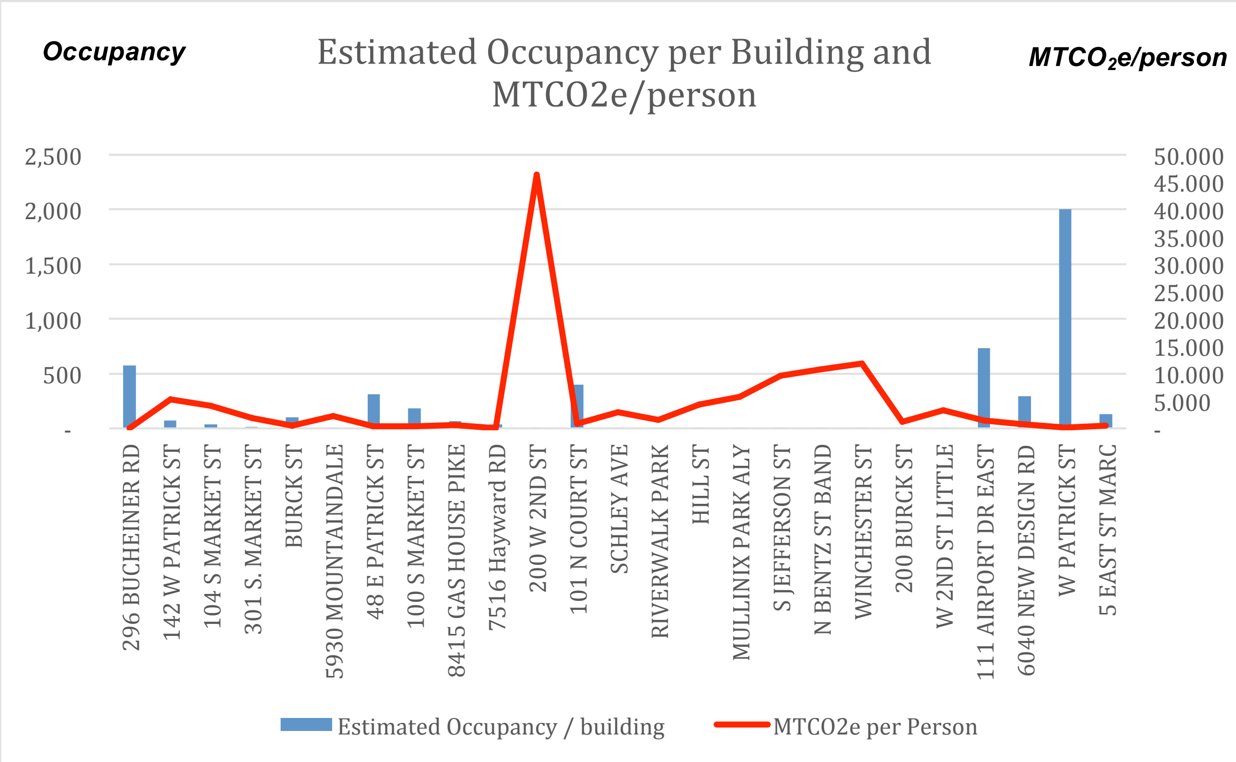


8. Occupancy and Emissions

Occupancy is also a way to determine the appropriateness of each building's energy consumption and emissions. Using "Minimum Square Feet per Occupant" estimations (Alameda County Government 2001) and an assumed occupancy of 80%[13], the energy use and GHG emissions per occupant are estimated. While its Comprehensive Annual Financial Report (City of Frederick 2013) indicated that the City of Frederick employed 852 individuals, based on the use and nature of each City-owned and operated building, as well as the likelihood that more individuals than just City employees use the buildings each day, the total number of estimated occupants for all buildings combined was 4,985 people.[14] As Figure 16 shows below, some of the buildings accounted for in earlier graphs are not present in the occupancy graph. This is due to lack of data and information regarding GSF for those buildings.

[13] The 80% proportion of the 100% Gross Square Feet (GSF) accounts space that should not or cannot be used for occupation (Oseland 2013)
[14] The appendix item L shows a detailed breakdown of the GSF minimum assignments and assumed occupancy per building.

Figure 16. Comparison of Estimated Building Occupancy to Building Emissions per Person[14]



9. Next steps

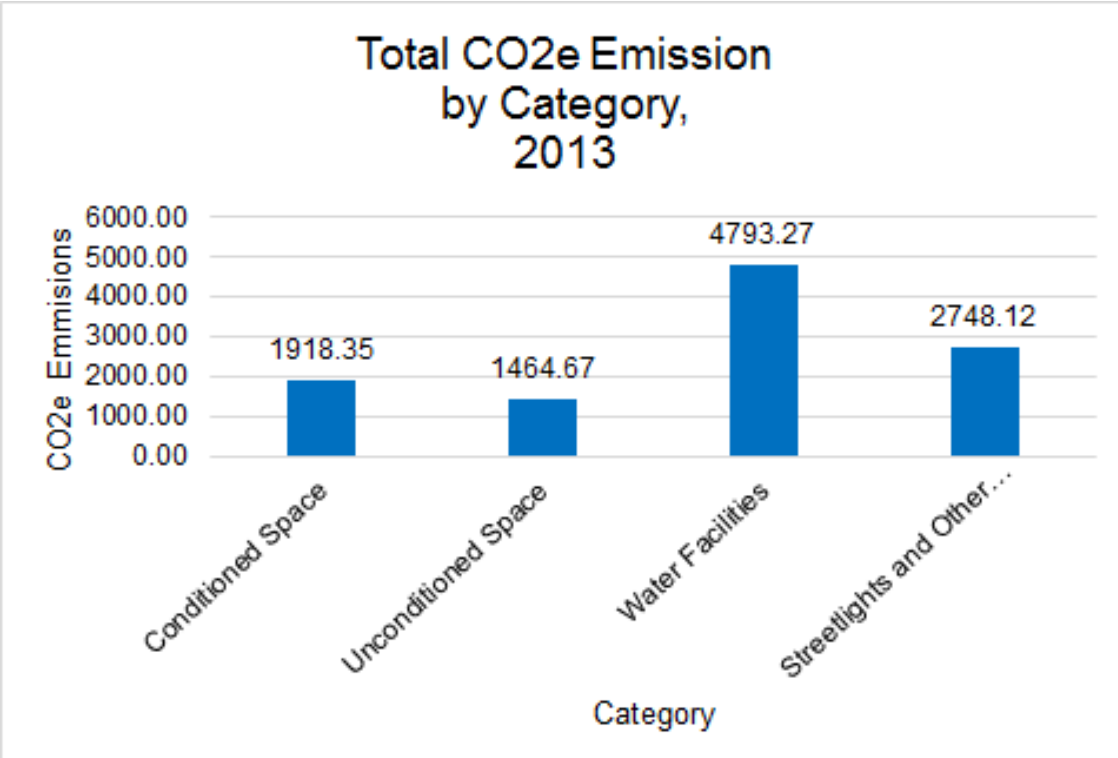
An analysis of the data provided shows varying energy usage intensity (EUI), reflected not only in energy costs from wastewater treatment, but in the growth beyond the density of downtown. Emerging themes that could be addressed in subsequent recommendations include the growth in energy consumption for facilities downtown and along the burgeoning periphery, and the irregularly high energy usage in some City buildings.

Some of these discrepancies indicate potential room for improvement, while others will require additional information to fully determine the cause of the anomaly. Finally, the emissions reduction scenarios presented in Section 7 provide a framework for decision-makers as they look to consider emissions reduction targets for the City.

Overall, we are optimistic that the City can build on its strong foundation to further reduce energy consumption costs. The City has the opportunity to implement an assortment of short-, medium- and long-term emissions reduction strategies that will put it in a better position to face anticipated and unanticipated challenges in the years ahead. Given its proximity to the nation's capital, growing prominence within the corporate business community, and existing strong relationships with leaders in Annapolis, the City has the potential to be a leading example for other municipalities of the importance of an efficient use of resources and the community benefits associated with such improvements.

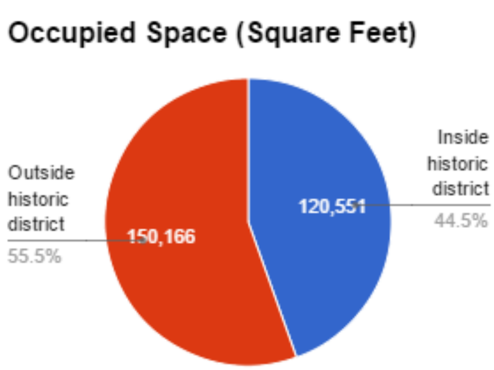
Appendix

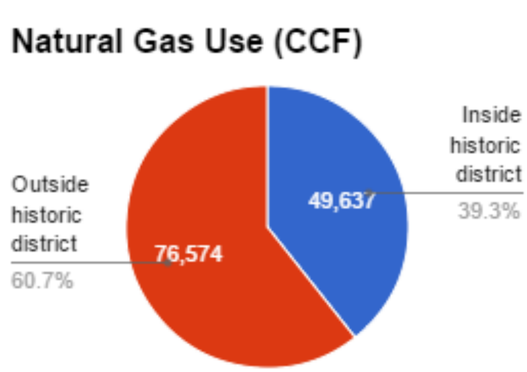
A.



This graph shows the total metric tons of CO_2e, based on electricity use, by category of space. Also, the final category is streetlights and other lighting.

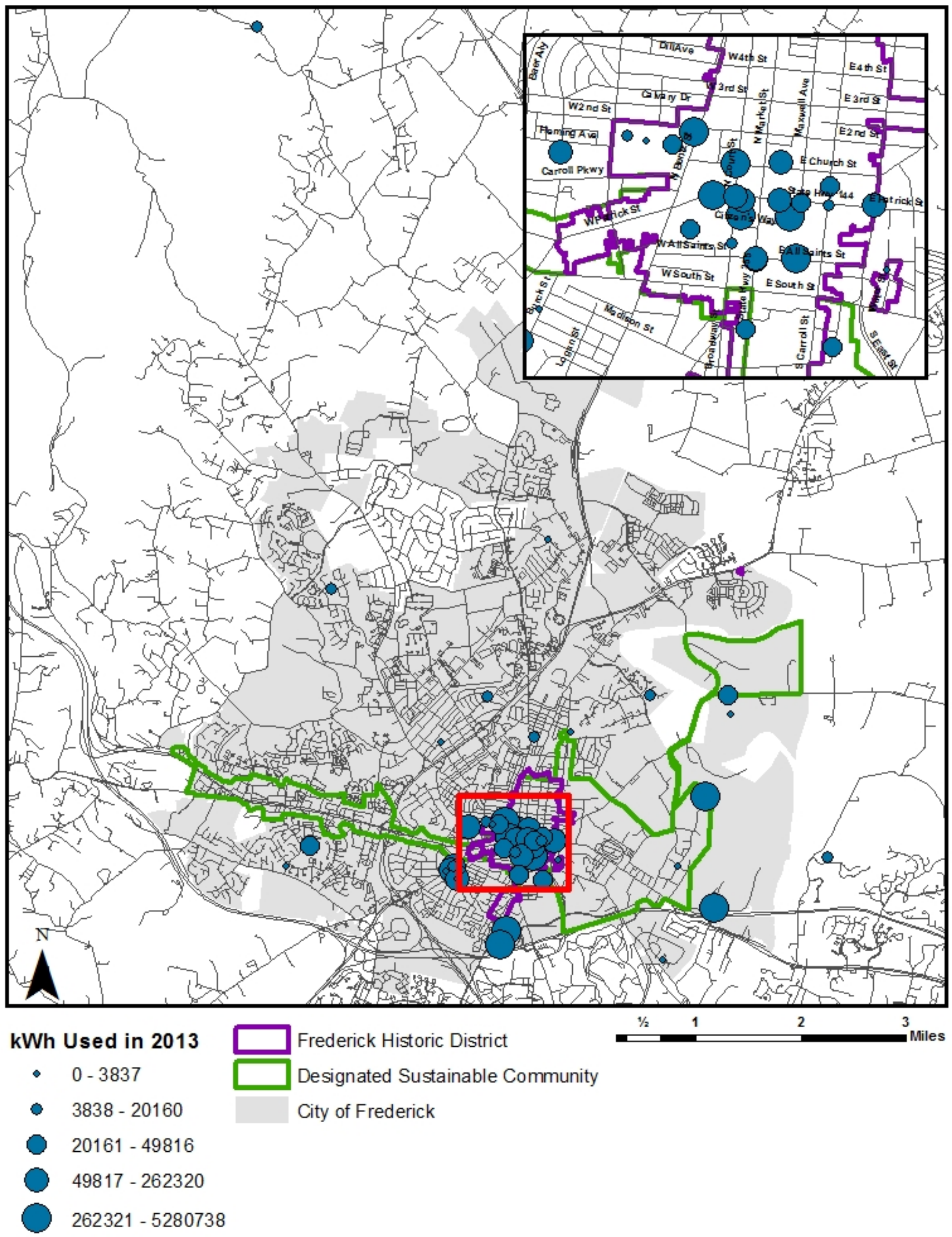
B.





C.

2013 Non-Water Facility Energy Use



D.

Buildings Information (Natural Gas)		
Building Address	Annual Natural Gas Use (ccf)	Percent of Total Annual Natural Gas Use
100 South Market St.	2058	1.54%
100 Treatment Plant Rd.	7003	5.24%
101 North Court St.	2837	2.12%
102-104 South Market St.	4443	3.32%
111 Airport Dr. East	67060	50%
125 E All Saint St.	89	0.07%
1308 Bailes Ln.	0	0.00%
136-140 W Patrick St.	8	0.01%
141 B&O Ave.	1430	1.07%
1547 Tilco	72	0.05%
19 E Church St.	0	0.00%
20 West Patrick ST	1029	0.77%
20 West Patrick ST	13723	10.27%
202 Bucheimer Rd.	379	0.28%
296 Bucheimer Rd.	0	0.00%
301 S Market St.	1343	1.00%
310 Aviation Way #200	341	0.26%
42 East Patrick St.	47	0.04%
48 East Patrick St.	3206	2.40%
551 Schley Ave.	602	0.45%
8415 Gas House Pike	2744	2.05%
Armory Bldg.	20901	15.64%
Burck St South End Civic	2573	1.93%
McCurdy Field	106	0.08%
West 10th & Motter Ave.	1646	1%
Total	133640	

Appendix table D includes all buildings that had stationary fuel information for their address. This information only included natural gas as a stationary fuel source.

E.

Buildings Information						
Address	2013 Total Electricity (KWh)	Percentage of Annual KWH	Type of Building	Building Size (GSF)	Building Age	Electricity Intensity (kWh/GSF)
111 AIRPORT DR EAST	1,078,272	26.69%	Public works	91926	1990	11.730
142 W PATRICK ST	547,008	13.54%	Annex offices	8829	2007	61.956
101 N COURT ST	489,120	12.11%	City hall	19968	1862	24.495
200 W 2ND ST	471,040	11.66%	Armory	4336	1910	108.635
6040 NEW DESIGN RD	326,784	8.09%	School	18336	1972	17.822
W PATRICK ST WEINBERG	217,120	5.37%	Theater building	17493	1926	12.412
48 E PATRICK ST	140,080	3.47%	Civil war museum	19322	1800	7.250
S JEFFERSON ST	97,440	2.41%	Park building	2500		38.976
5 EAST ST MARC STATION	97,360	2.41%	Train station	2400	2002	40.567
100 S MARKET ST	94,400	2.34%	Community action	22747	1869	4.150
BURCK ST, FREDERICK	60,063	1.49%	Boys girl club	6200	1957	9.688
MULLINIX PARK ALY	41,752	1.03%	Park building	1866	1965	22.375
8415 GAS HOUSE PIKE	38,815	0.96%	Golf course club house	8320	1991	4.665
WINCHESTER ST	34,350	0.85%	Park building	400		85.875
N BENTZ ST BAND SHELL	31,187	0.77%	Park building	600		51.978
HILL ST	25,381	0.63%	Park building	1200		21.151
W 2ND ST LITTLE LEAGUE	14,187	0.35%	Park building LL baseball	800		17.734
5930 MOUNTAINDALE RD	6,599	0.16%	Cabin	400		16.498
301 S. MARKET ST	28,123	0.70%	Apartments	3254	1865	8.643
SCHLEY AVE	3,837	0.09%	Park building	600		6.395
296 BUCHEINER RD	3,320	0.08%	Airport building	14302	1965	0.232
RIVERWALK PARK	4,661	0.12%	Park building	600		7.768
200 BURCK ST	1,742	0.04%	Park building	300		5.807
104 S MARKET ST	187,930	4.65%	Apartments	9174	1887	20.485
7516 Hayward RD	0	0.00%	House/office	4482	1895	0.000
Total	4,040,571					

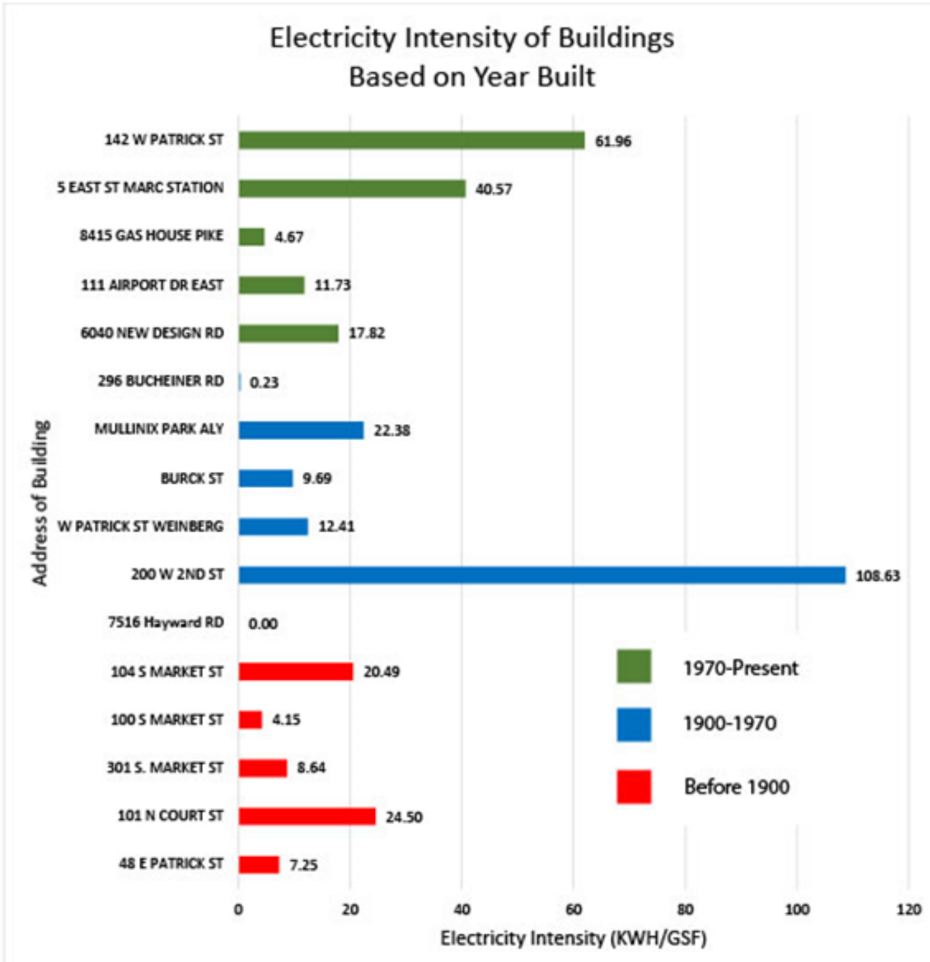
Appendix Table E includes all kWh information for buildings in the occupied space category.

F.

Buildings Information (Other Space)			
Building Address	2013 Total Electricity (kWh)	Percentage of Annual KWH	Building Use
21 STADIUM DR FREDERICK, MD 21701-0000	784,219	25.94%	Key stadium
142 W PATRICK ST FREDERICK, MD 21701-0000	345,600	11.43%	Parking deck 4
5 COURT ST FREDERICK, MD 21701-0000	321,760	10.64%	Parking deck
125 E ALL SAINTS ST FREDERICK, MD 21701-0000	312,192	10.33%	Parking deck
E PATRICK ST PARK DECK FREDERICK, MD 21701-0000	305,920	10.12%	Parking deck
E CHURCH ST FREDERICK, MD 21701-0000	262,320	8.68%	Parking deck
118 S JEFFERSON ST FREDERICK, MD 21701-0000	261,400	8.65%	Mccurdy field
2 S COURT ST FREDERICK, MD 21701-0000	149,400	4.94%	Parking deck
FLEMING AVE FREDERICK, MD 21701-0000	113,380	3.75%	Pool
100 E PATRICK WEST SIDE FREDERICK, MD 21701-5630	37,454	1.24%	Park building
N CARROLL ST FREDERICK, MD 21701-0000	30,720	1.02%	Park building
100 E PATRICK ST FREDERICK, MD 21701-0000	23,760	0.79%	Park building
200 E PATRICK ST FREDERICK, MD 21701-0000	19,440	0.64%	Park building
W 10TH ST FREDERICK, MD 21701-0000	15,688	0.52%	Park building
LINGANORE RD RIFLE RNG FREDERICK, MD 21701-0000	10,609	0.35%	Rifle range
MOTTER AVE FREDERICK, MD 21701-0000	8,291	0.27%	LL concession stand
118 S JEFFERSON ST FREDERICK, MD 21701-0000	6,528	0.22%	Mccurdy field
24 S COURT ST FREDERICK, MD 21701-0000	6,160	0.20%	Park Carroll creek
1950 E GREENLEAF DR FREDERICK, MD 21701-0000	4,569	0.15%	Park building
5 MCCAIN DR PARK BLDG FREDERICK, MD 21701-0000	1,953	0.06%	Park pavillion
W 2ND ST FREDERICK, MD 21701-0000	1,626	0.05%	Park building
N EAST ST PARK	280	0.01%	Park building
BURCK ST FREDERICK, MD 21701-0000	189	0.01%	Park building
GAS HOUSE PIKE FREDERICK, MD 21701-4884	48	0.00%	Park/golf course
210 S JEFFERSON ST	0	0.00%	Park building
Total	3,023,466		

Appendix table F includes all kWh information for buildings in the other space category.

G. Note: This section includes only buildings that had year built information available in the data received from the City of Frederick.



H.

In the charts below, buildings are categorized as high, medium-high, medium-low, and low energy usage intensity EUI. These are color coded red, orange, yellow and green respectively. The charts also highlight buildings that are exceptionally intense users of electricity, defined as three times the median, those that are exceptionally intense users of natural gas, defined as twice the median, and those that are both.

Legend	
	High EUI
	Medium-High EUI
	Medium-Low EUI
	Low EUI
	>3x Median kWh
	>2x Median NG
	Both

Occupied Space EUI

ADDRESS	Lat	Long	kWh_2013	Bldg_type	SIZE_GSF	Year_Built	kWh_GSF	Nat_Gas	NG_GSF
111 AIRPORT DR EAST FRI	-77.37703	39.404884	1,078,272	public works	91,926	1990	11.729783	67,060	0.7294998
142 W PATRICK ST FREDEI	-77.41335	39.41426	547,008	annex offices	8,829	2007	61.955827	8	0.0009061
101 N COURT ST FREDERI	-77.41219	39.415455	489,120	OS city hall	19,968	1862	24.495192	2,837	0.1420773
200 W 2ND ST FREDERICK	-77.41426	39.416668	471,040	OS Armory	4,336	1910	108.63469	20,901	4.8203413
6040 NEW DESIGN RD FRI	-77.41498	39.399635	326,784	school	18,336	1972	17.82199	0	0
20 W PATRICK ST FREDER	-77.41181	39.414094	217,120	theater build	17,493	1926	12.411822	14,752	0.8433088
7516 Hayward RD, Freder	-77.40693	39.455425	0	house/office	4,482	1895	0	0	0
48 E PATRICK ST FREDERI	-77.41008	39.414078	140,080	civil war mus	19,322	1800	7.2497671	3,206	0.1659249
S JEFFERSON ST FREDERIC	-77.42383	39.409945	97,440	park building	2,500		38.976	0	0
5 EAST ST FREDERICK, MD	-77.40546	39.41393	97,360	train station	2,400	2002	40.566667	0	0
413 BURCK ST FREDERICK	-77.42264	39.408767	60,063	boys and girl	6,200	1957	9.6875806	2,573	0.415
MULLINIX PARK ALLEY FRI	-77.4144	39.412957	41,752	park building	1,866	1965	22.375134	0	0
8415 GAS HOUSE PIKE FRI	-77.37466	39.434116	38,815	golf course c	8,320	1991	4.6652644	2,744	0.3298077
WINCHESTER ST FREDERI	-77.40741	39.408546	34,350	park building	400		85.875	0	0
21 N BENTZ ST FREDERICK	-77.41532	39.416151	31,187	Baker Park b	600		51.978333	0	0
HILL ST FREDERICK, MD 2	-77.44901	39.413213	25,381	park building	1,200		21.150833	0	0
W 2ND ST FREDERICK, MD	-77.41752	39.416485	14,187	park building	800		17.73375	0	0
5930 MOUNTAINDALE RD	-77.45927	39.525707	6,599	cabin	400		16.4975	0	0
SCHLEY AVE FREDERICK, N	-77.42575	39.427487	3,837	park building	600		6.395	602	1.0033333
296 BUCHEINER RD FREDI	-77.38344	39.41067	3,320	airport buildi	14,302	1965	0.2321354	0	0
1901 Schifferstadt Blvd FF	-77.38858	39.434074	4,661	park building	1,200		3.8841667	0	0
200 BURCK ST FREDERICK	-77.42176	39.409956	1,742	park building	300		5.8066667	0	0
104 S MARKET ST FREDER	-77.41122	39.411827	187,930	Frederick Rel	9,174	1887	20.485066	4,443	0.4843035
100 S MARKET ST FREDER	-77.41121	39.411873	94,400	community a	22,747	1869	4.1499978	2,058	0.0904735
301 S MARKET ST FREDER	-77.41168	39.409203	28,123	apartments	13,016	1865	2.1606484	1,343	0.1031807

Occ Space kWh/GSF	
Min	0.2321354
1st Quartile	6.2479167
Median	17.115625
3rd Quartile	28.115394
Max	108.63469

Occ Space NG/GSF	
Min	0.0009061
1st Quartile	0.1323532
Median	0.3724038
3rd Quartile	0.7579521
Max	4.8203413

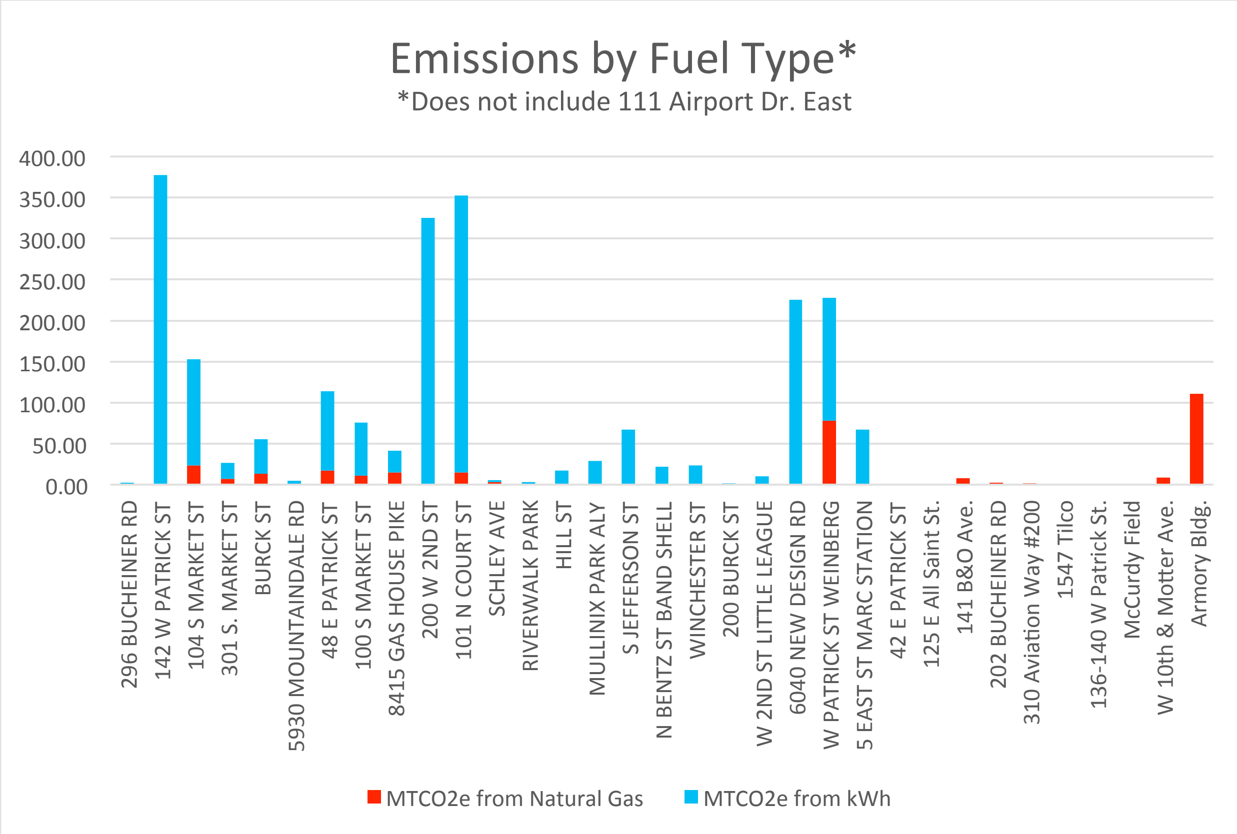
All Space (Occupied and Unoccupied EUI)

ADDRESS	Lat	Long	kWh_2013	Bldg_type	SIZE_GSF	Year_Built	kWh_GSF	Nat_Gas	NG_GSF
111 AIRPORT DR EAST FRI	-77.37703	39.404884	1,078,272	public works	91,926	1990	11.7297827	67,060	0.72949982
142 W PATRICK ST FREDE	-77.413345	39.41426	547,008	annex offices	8,829	2007	61.9558274	8	0.0009061
101 N COURT ST FREDERI	-77.412186	39.415455	489,120	OS city hall	19,968	1862	24.4951923	2,837	0.14207732
200 W 2ND ST FREDERICK	-77.414264	39.416668	471,040	OS Armory	4,336	1910	108.634686	20,901	4.82034133
6040 NEW DESIGN RD FRI	-77.414977	39.399635	326,784	school	18,336	1972	17.8219895	0	0
20 W PATRICK ST FREDER	-77.411812	39.414094	217,120	theater build	17,493	1926	12.4118219	14,752	0.84330875
7516 Hayward RD, Freder	-77.40693	39.455425	0	house/office	4,482	1895	0	0	0
48 E PATRICK ST FREDERI	-77.41008	39.414078	140,080	civil war mus	19,322	1800	7.24976711	3,206	0.16592485
S JEFFERSON ST FREDERIC	-77.423833	39.409945	97,440	park building	2,500		38.976	0	0
5 EAST ST FREDERICK, MD	-77.405464	39.41393	97,360	train station	2,400	2002	40.5666667	0	0
413 BURCK ST FREDERICK	-77.42264	39.408767	60,063	boys and girl	6,200	1957	9.68758065	2,573	0.415
MULLINIX PARK ALLEY FR	-77.414402	39.412957	41,752	park building	1,866	1965	22.375134	0	0
8415 GAS HOUSE PIKE FR	-77.37466	39.434116	38,815	golf course c	8,320	1991	4.66526442	2,744	0.32980769
WINCHESTER ST FREDERI	-77.407414	39.408546	34,350	park building	400		85.875	0	0
21 N BENTZ ST FREDERICK	-77.41532	39.416151	31,187	Baker Park b	600		51.9783333	0	0
HILL ST FREDERICK, MD 2	-77.44901	39.413213	25,381	park building	1,200		21.1508333	0	0
W 2ND ST FREDERICK, MD	-77.417519	39.416485	14,187	park building	800		17.73375	0	0
5930 MOUNTAINDALE RD	-77.459269	39.525707	6,599	cabin	400		16.4975	0	0
SCHLEY AVE FREDERICK, N	-77.425748	39.427487	3,837	park building	600		6.395	602	1.00333333
296 BUCHEINER RD FREDI	-77.38344	39.41067	3,320	airport buildi	14,302	1965	0.23213537	0	0
1901 Schifferstadt Blvd FI	-77.388584	39.434074	4,661	park building	1,200		3.88416667	0	0
200 BURCK ST FREDERICK	-77.421757	39.409956	1,742	park building	300		5.80666667	0	0
104 S MARKET ST FREDER	-77.41122	39.411827	187,930	Frederick Rel	9,174	1887	20.4850665	4,443	0.48430347
100 S MARKET ST FREDER	-77.41121	39.411873	94,400	community a	22,747	1869	4.1499978	2,058	0.09047347
301 S MARKET ST FREDER	-77.41168	39.409203	28,123	apartments	13,016	1865	2.16064843	1,343	0.1031807
310 AVIATION WAY FRED	-77.37865	39.420197	343,110	Airport	337,746		1.01588176	341	0.00100963
21 STADIUM DR FREDERIC	-77.413919	39.40163	784,219	key stadium	0	1990	0	0	
142 W PATRICK ST FREDE	-77.413345	39.41426	345,600	deck 4	0		0	0	
5 COURT ST FREDERICK, N	-77.411977	39.413502	321,760	parking deck	0		0	0	
125 E ALL SAINTS ST FRED	-77.40926	39.411873	312,192	parking deck	0		0	89	
42 E PATRICK ST PARK DE	-77.409538	39.41347	305,920	parking deck	143,580	1992	2.13065887	47	0.00032734
E CHURCH ST FREDERICK,	-77.41	39.415533	262,320	parking deck	0		0	0	
118 S JEFFERSON ST FRED	-77.42339	39.41052	261,400	Mccurdy fiel	0		0	0	
2 S COURT ST FREDERICK,	-77.4122	39.414215	149,400	L parking dec	201,270	1984	0.74228648	0	0
FLEMING AVE FREDERICK	-77.420752	39.41587	113,360	pool	5,020	1992	22.5816733	0	0
100 E PATRICK WEST SIDE	-77.40903	39.414005	37,454	park	0		0	0	

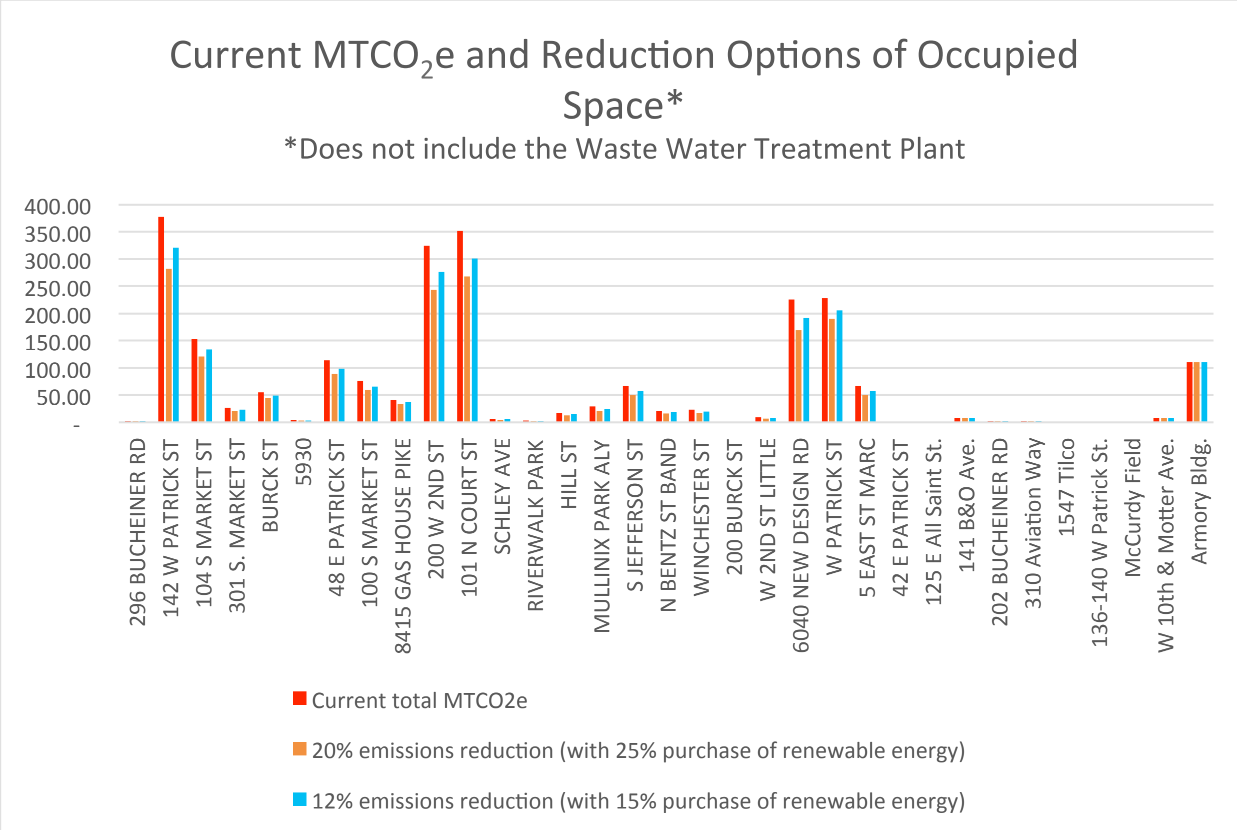
FLEMING AVE FREDERICK	-77.420752	39.41587	113,360	pool	5,020	1992	22.5816733	0	0
100 E PATRICK WEST SIDE	-77.40903	39.414005	37,454	park	0		0	0	
N CARROLL ST FREDERICK	-77.407593	39.414601	30,720	park	0		0	0	
100 E PATRICK ST FREDER	-77.40903	39.414005	23,760	park	0		0	0	
200 E PATRICK ST FREDER	-77.407646	39.41392	19,440	park	0		0	0	
W 10TH ST FREDERICK, M	-77.41739	39.433863	15,688	park	0		0	1,646	
LINGANORE RD RIFLE RNG	-77.356725	39.411847	10,609	rifle range	15,489	1970	0.6849377	0	0
MOTTER AVE FREDERICK,	-77.40918	39.428177	8,291	LL consessior	2,256	1952	3.67508865	0	0
118 S JEFFERSON ST FRED	-77.42339	39.41052	6,528	Mccurdy fiel	0		0	106	
24 S COURT ST FREDERICI	-77.412384	39.412434	6,160	park carroll c	151,424	2010	0.04068047	0	0
1950 E GREENLEAF DR FR	-77.445507	39.448408	4,569	park	0		0	0	
5 MCCAIN DR PARK BLDG	-77.453262	39.410378	1,953	park pavillior	0		0	0	
W 2ND ST FREDERICK, MI	-77.416565	39.416295	1,626	park	0		0	0	
N EAST ST PARK	-77.402665	39.428899	260	park	0		0	0	
BURCK ST FREDERICK, MI	-77.42264	39.408767	189	park	0		0	0	
8142 GAS HOUSE PIKE FR	-77.374247	39.431533	48	park/golf cou	1,500	1985	0.032	0	0
210 S JEFFERSON ST	-77.42464	39.409836	0	park	0		0	0	
100 TREATMENT PLANT R	-77.381868	39.425999	5,280,738	waste water	0		0	7,003	
6421 LINGANORE RD FREI	-77.36041	39.41055	2,190,332	water plant	0		0	0	
1950 N MARKET ST FREDI	-77.39391	39.44437	1,358,400	water plant	0		0	0	
CHRISTOPHER CROSS RD	-77.445793	39.454419	414,528	pumping stat	0		0	0	
161 W PATRICK ST FREDE	-77.41379	39.414284	377,502	pumping stat	0		0	0	
8415 GAS HOUSE PIKE FR	-77.37466	39.434116	234,560	pumping stat	26,865		0	0	0
6424 PLANT RD FREDERIC	-77.35842	39.411186	105,817	water plant	0		0	0	
2271 W GREENLEAF DR FI	-77.45638	39.455208	90,432	water	1,000	2005	0	0	0
160 THOMAS JOHNSON D	-77.406494	39.442913	63,908	pumping stat	0		0	0	
401 SAGNER AVE PUMP 3	-77.40335	39.41239	61,440	pumping stat	0		0	0	
VERNON AVE WATER TOV	-77.405596	39.423339	49,816	water tank	0		0	0	
315 BALLENGER CENTER I	-77.43543	39.396023	42,086	pumping stat	0		0	0	
5733 MOUNTAINDALE RD	-77.463266	39.526137	38,534	water reserv	2,545	1930	0	0	0
6422 PLANT RD FREDERIC	-77.358574	39.41122	31,211	Water ?	0		0	0	
626 N MARKET ST FREDEI	-77.40987	39.422043	29,323	monocacy w	0		0	0	
MONOCACY BLVD FREDEI	-77.383476	39.446106	24,105	water	2,146	1958, 1944	0	0	0
737 MONARCH RIDGE RD	-77.46957	39.408802	20,353	pumping stat	0		0	0	
506 HIGHLAND ST PUMP	-77.39874	39.416477	20,160	punping stat	0		0	0	
AIRPORT DR PUMP ST FRI	-77.368213	39.415151	18,240	pumping stat	0		0	0	
203 S CARROLL ST FREDEI	-77.40817	39.410267	7,928	water tank	0		0	0	
AIRPORT DR PUMP ST FRI	-77.368213	39.415151	18,240	pumping stat	0		0	0	
203 S CARROLL ST FREDEI	-77.40817	39.410267	7,928	water tank	0		0	0	
6262 BUTTERFLY LN FRED	-77.45128	39.408607	7,173	water tank	2,416	1909	0	0	0
7022 BOWERS RD WATR	-77.47558	39.42845	7,141	water tank	0		0	0	
W 2ND ST FREDERICK, MI	-77.423154	39.417269	6,650	park building	150		0	0	0
1950 N MARKET ST FREDI	-77.39391	39.44437	5,571	water plant	0		0	0	
773 WEMBLY DR FREDERI	-77.3952	39.430275	2,304	water	0		0	0	
SHIFFERSTADT DRIVE WEI	-77.394761	39.438254	2,112	well	0		0	0	
6424 PLANT RD FREDERIC	-77.35842	39.411186	1,573	building at w	0		0	0	
MOUNTAINDALE RD FREI	-77.461416	39.525506	1,135	water reserv	0		0	0	
EAGLEHEAD DR FREDERIC	-77.326509	39.415615	447	water dam	0		0	0	
1547 Tilco Dr Frederick, N	-77.385995	39.397711	0	natural gas o	0		0	72	
141 B&O Avenue Frederic	-77.404835	39.411466	0	natural gas o	0		0	1,430	
202 Bucheimer Rd, Frede	-77.384106	39.409661	0	natural gas o	0		0	379	

All Space kWh/GSF		All Space NG/GSF	
Min	0.032	Min	0.0003273
1st Quartile	3.2964786	1st Quartile	0.0936503
Median	10.708682	Median	0.2478663
3rd Quartile	22.426769	3rd Quartile	0.6682007
Max	108.63469	Max	4.8203413

I. All occupied space buildings with each mix of fuel used for operation, excluding 111 Airport Drive East



J. Comparison of three emissions scenarios; the status quo, a reduction of 20% and a reduction of 15%, excluding 111 Airport Drive East



K. Breakdown of Buildings HDD and CDD

ADDRESS	CCF / HDD	kWh / CDD
296 BUCHEINER RD		3.2
142 W PATRICK ST		525.5
104 S MARKET ST	0.878	180.5
301 S. MARKET ST	0.265	27.0
BURCK ST	0.508	57.7
5930 MOUNTAINDALE RD		6.3
48 E PATRICK ST	0.633	134.6
100 S MARKET ST	0.406	90.7
8415 GAS HOUSE PIKE	0.542	37.3
7516 Hayward RD		
200 W 2ND ST		452.5
101 N COURT ST	0.560	469.9
SCHLEY AVE	0.119	3.7
RIVERWALK PARK		4.5
HILL ST		24.4
MULLINIX PARK ALY		40.1
S JEFFERSON ST		93.6
N BENTZ ST BAND SHELL		30.0
WINCHESTER ST		33.0
200 BURCK ST		1.7
W 2ND ST LITTLE LEAGUE		13.6
111 AIRPORT DR EAST	13.245	1,035.8
6040 NEW DESIGN RD		313.9
W PATRICK ST WEINBERG	2.914	208.6
5 EAST ST MARC STATION		93.5
19 E Church St.		
42 E PATRICK ST	0.009	
125 E All Saint St.	0.018	
141 B&O Ave.	0.282	
202 BUCHEINER RD	0.075	
310 Aviation Way #200	0.067	
1308 Bailes Ln.		
1547 Tilco	0.014	
136-140 W Patrick St.	0.002	
McCurdy Field	0.021	
W 10th & Motter Ave.	0.325	
Armory Bldg.	4.128	
OCCUPIED SPACE SUBTOTAL	25.012	3,881.4

L. Breakdown of Assigned GSF and building occupancy with per person emissions

ADDRESS	Assigned GSF/Person	GSF	Estimated Occupancy / building	MTCO2e per Person
296 BUCHEINER RD	20	14,302	573	0.004
142 W PATRICK ST	100	8,829	71	5.313
104 S MARKET ST	200	9,174	37	4.139
301 S. MARKET ST	200	3,254	14	1.894
BURCK ST	50	6,200	100	0.551
5930 MOUNTAINDALE RD	200	400	2	2.275
48 E PATRICK ST	50	19,322	310	0.366
100 S MARKET ST	100	22,747	182	0.418
8415 GAS HOUSE PIKE	100	8,320	67	0.617
7516 Hayward RD	100	4,482	36	-
200 W 2ND ST	500	4,336	7	46.401
101 N COURT ST	40	19,968	400	0.881
SCHLEY AVE	300	600	2	2.919
RIVERWALK PARK	300	600	2	1.607
HILL ST	300	1,200	4	4.375
MULLINIX PARK ALY	300	1,866	5	5.758
S JEFFERSON ST	300	2,500	7	9.599
N BENTZ ST BAND SHELL	300	600	2	10.753
WINCHESTER ST	300	400	2	11.843
200 BURCK ST	300	300	1	1.201
W 2ND ST LITTLE LEAGUE	300	800	3	3.261
111 AIRPORT DR EAST	100	91,926	736	1.493
6040 NEW DESIGN RD	50	18,336	294	0.766
W PATRICK ST WEINBERG	7	17,493	2,000	0.114
5 EAST ST MARC STATION	15	2,400	128	0.524

References

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Chapter 1, Part 2: Creating a Pathway to Sustainability for Harry Grove Stadium

December 12, 2014

University of Maryland
School of Architecture, Planning and Preservation
URSP688R The Carbon and Energy Economy for Planners
Fall 2014

Amee Bearne, Daniel Francis, Zack Rockwell, Ashley Sampson and David Schlie

Sponsored by PALS—Partnership for Action Learning in Sustainability
A National Center for Smart Growth initiative
Gerrit Knapp, Executive Director
Uri Avin, PALS Director

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Background

Sports stadiums consume a great deal of energy and The City of Frederick's Harry Grove Stadium is no different. It is also a prominent public facility for both visitors and residents. This past season, 324,446 patrons walked through the Harry Grove gates to watch the Frederick Keys play.[a] According to one study, two-thirds of fans traveled from outside Frederick County from surrounding counties in both Maryland and Virginia.

At the same time, there is a renewed focus on greening stadiums nationwide. At the Minor League level, however, such programs are few and far between. The opportunity to elevate Frederick to the national stage with a series of stadium sustainability projects is an opportunity the City cannot overlook.

What's more, engaging national organizations like The Green Sports Alliance, a partnership between environmental scientists and over 120 sports teams including the Baltimore Orioles, as well as The Natural Resources Defense Council, could publicly reinforce the idea that the City of Frederick is committed to creating a more sustainable city. Keeping in mind that the City has committed to evaluating sustainability projects for the FY14-19 Capital Improvement Plan, in part, on their public outreach components, the projects outlined below are intended to not only create a more sustainable stadium, but to act as a very public statement that Frederick is committed to being a twenty-first century sustainable city.

Short Term: Solar Picnic Pavilions

Due to the outstanding patronage of the Frederick Keys in recent years, during many games fans have used the east grassy area for overflow parking (Appendix A). This unintended outcome of fan attendance increases groundwater pollution and decreases opportunities for community use of the open space at the stadium.

To solve this environmental and community problem, the City could employ youth innovation and public education. A partnership with Frederick High School would ensure that the City's youth act as community change agents while also learning different ways to apply renewable energy technologies within the built environment.

By using the established Maryland State-mandated high school graduation requirements for environmental literacy,[1] the City and high school should develop curricular programs and pathways or co-curricular clubs[2] to create a hands-on literacy program for STEM students focused on the design and fabrication of lighted picnic table pavilions operated with solar energy (Appendix B). These pavilions will be installed on the grassy area, creating usable community gathering space at all times of day.

The high school program will be responsible for raising funds up to $2,500 per pavilion[3]—from various local, State, and corporate grant sources funding K-12 environmental education—with a dollar for dollar match supplied by the City out of the "Community Development" budget (Appendix C, D).[4] The City should also pay for installation of the picnic tables. To ensure the program's longevity and maximize the quality of each fabricated unit, no more than two pavilions should be built and installed each year.

Design and fabrication of structures using solar energy by high school students has taken place in many places across the country (Appendix E).[5] Given the robust educational components of STEM pathways in the Frederick County Public School system, there is no doubt that the students and teachers at Frederick High School have the talent and capacity to support this partnership with the City. In teaching Frederick youth about solar power, there will be an increase in city-wide awareness of renewable energy opportunities while creating a vested interest in the stadium for those directly or indirectly involved in the program.

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[a] The Frederick Keys are a High-A affiliate of Major League Baseball's Baltimore Orioles and are contracted to be their developmental team through the 2018 season. Games averaged 5,000 attendees. Stadium capacity is 5,500.

Medium Term: Green Infrastructure and Stormwater Management

The installation of green roofs and other green infrastructure will reduce the stadium's energy use and thus the City's bottom line for operations. The benefits that come with a basic green roof installation include heating and cooling reductions, as the roof insulates the building from temperature extremes; reduction in the urban heat island effect resulting in lower energy use for cooling the space; sequestration of greenhouse gases; reduction of stormwater and pollutant runoff; and an increase in the roof's lifespan due to the added protection.[6][7]

Stadium green roofs have become more and more popular with teams like the New York Mets[8] installing green roofs and other green infrastructure projects. There is no reason that the City of Frederick cannot reap these same benefits.

The City has a number of funding options (Appendix I). This report focuses on two: the Small Watershed grant and the Green Streets, Green Jobs, Green Towns grant. In pursuing these grants, the City should emphasize the variety of green infrastructure projects, along with the outreach and education opportunities they provide. Incorporating these elements would make the City a stronger candidate for the grants.

To see this project through, the Planning and Public Works Departments will need to work jointly with the stadium management, beginning with the decision on which green infrastructure the City will pursue and the grant application process. This coordination will prove essential if the project is to succeed.

Long Term: LED Field Lighting Project

Field lighting is typically the first or second largest single consumer of energy at stadiums.[9] A significant reduction in energy use for lighting results in a significant reduction in carbon emissions and electricity costs. LED lighting is now a proven technology that can offer those benefits. Many major league sports venues and colleges have adopted indoor LED lighting, which came onto the market first. Now, outdoor LED lighting is available and is being adopted worldwide.[10]

There are many benefits to LED lights. The replacement of 180 halide fixtures with 90 LED fixtures would save 42,480 kWh, 293 metric tonnes of CO_2e, and $2,942 each year (Appendix J). LED lights last longer (50,000-225,000 hours versus 10,000-15,000 hours for halide),[11] offer better lighting quality, do not need to warm up, and can be dimmed to lower levels for non-game events or post-game clean up. The new LED system at Duke University's Field Hockey Stadium reduced energy use 60-70%, virtually eliminated cleaning and bulb replacement, and improved the quality of light.[12][13]

The main costs of this project include the up-front capital costs of purchasing and installation. The fixtures cost approximately $1,500 each,[14] but they will lower electricity costs and reduce maintenance so that the initial investment will be recouped over time. The project becomes more feasible if initial outlays can be reduced through incentives like the Potomac Edison Lighting Incentives for Business, which offers $250 per LED fixture.[15]

The timeframe for implementation will depend on a detailed analysis of the existing lighting system, which would be the first step in a likely three-year project timeline. When this project comes fruition in three to four years, LED lighting will likely have become the standard for new stadiums and much more commonplace for retrofits. Prices will also likely decrease as more companies move into the field.

Conclusion

There are many important projects the City is due to undertake in the coming years that merit examination; however, the projects presented here warrant investment because of their many economic and community co-benefits. Such projects would demonstrate to residents and visitors alike the ways Frederick can more effectively use City funds while benefitting the environment and the public.

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Appendices

Solar Picnic Pavilions

A. East grassy area where unofficial overflow parking occurs (highlighted in red). Highlighted in blue is the current picnic pavilions that are included in the use of ball field rented by community members.

B. Curricular and Co-Curricular options for school partnerships with the City.

Curricular		Co-Curricular Clubs
http://www.fcps.org/cms/lib02/MD01000577/Centricity/Domain/22/HS_CourseGuide_2013-14_WEB3.pdf		http://education.fcps.org/fhs/clubs
Title	**Page(s)**	Envirothon
Industrial Engineering and Career Pathway	10	Sustainability Club
Career & Technology Education (CTE) programs (school-based)	20	National Society of Black Engineers
Technology Education	46-48	Women in Science and Engineering

C. Approximate Budget for the necessary materials to fabricate a custom solar powered picnic pavilion.

Solar Powered Picnic Pavilion Materials	**Approx. Cost**
Item	*Total ($)*
Two solar panels (shipped)	$1,000.00
Wood	$1,500.00
Paint and laquer	$150.00
Outdoor LED track lighting	$200.00
Shingles	$325.00
DC-to-AC Converters	$75.00
Disconnect Switches	$85.00
Inverter	$400.00
Battery	$300.00
Charge Controller	$250.00
Wiring and Fuse Box Connections	$200.00
Utility Power Meters	$50.00
Other Hardware	$100.00
Racking	$100.00
Name/Description Plaque	$75.00
Data Collection Monitor	$100.00
Public Education Panel	$75.00
Total	**$4,985.00**

D. Grant opportunities and sources for K-12 environmental education program funding.

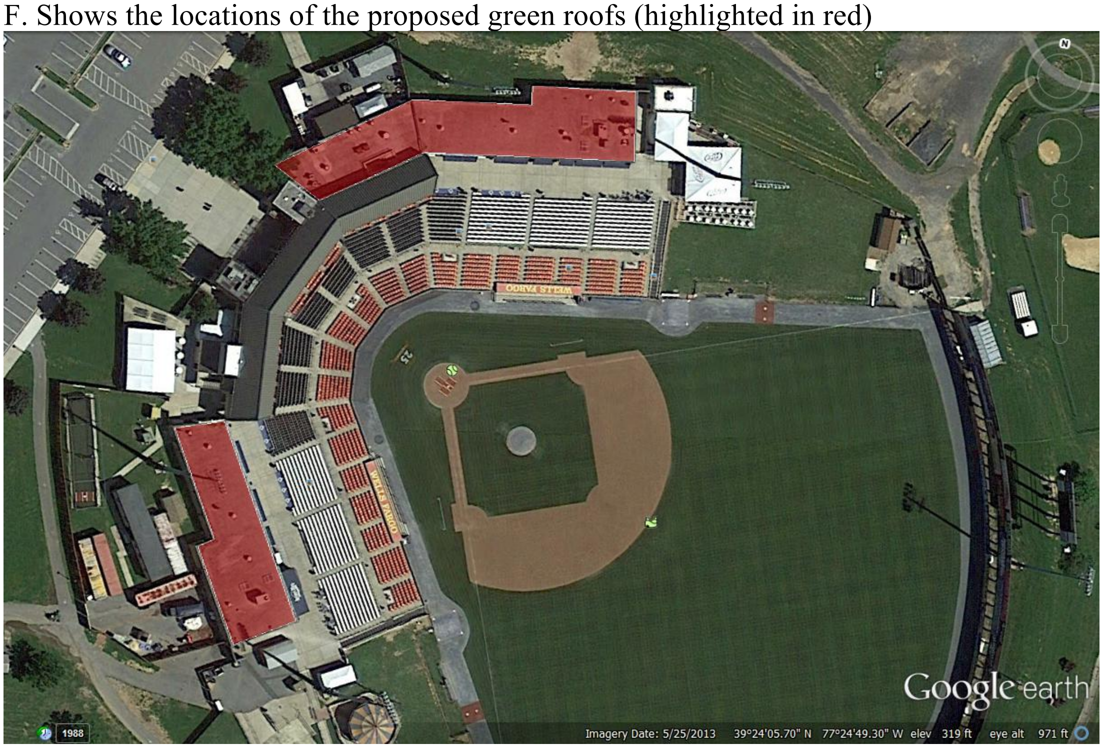
TYPE:	**SOURCE:**	**NAME:**	**MAXIMUM AMOUNT:**	**INFORMATION FOUND AT:**
Local nonprofit	Frederick Arts Council	Arts in Education Grant Program	$500	http://frederickartscouncil.org/index.php/grants-and-support/arts-in-education
Regional nonprofit	Chesapeake Bay Trust	Environmental Education K-12 Mini Grant	$5,000	http://www.cbtrust.org/site/c.miJPKXPCJnH/b.5457547/k.D6AC/K12_Environmental_Education_Mini_Grant.htm
Regional nonprofit	Chesapeake Bay Trust	Community Engagement and Restoration Mini Grant	$5,000	http://www.cbtrust.org/site/c.miJPKXPCJnH/b.8600101/k.F6D8/Community_Engagement_and_Restoration_Mini_Grant.htm

Regional nonprofit	Chesapeake Bay Trust	Outdoor Health Initiative	Unknown	http://www.cbtrust.org/site/c.miJPKXPCJnH/b.9225061/k.70E6/Outdoor_Health_Initiative.htm
County nonprofit	Community Foundation of Frederick County	Impact Grant	Unknown	http://www.cffredco.org/receive/grants
Regional nonprofit	Unity Gardens	Grants	$1,000	http://www.unitygardens.org/grants
Corporate	Honda	American Honda Foundation	$20,000 to $75,000	http://corporate.honda.com/america/philanthropy.aspx?id=ahf
Corporate	Home Depot Foundation	Community Impact Grants Program	$5,000	http://homedepotfoundation.org/page/applying-for-a-grant
Corporate	First Energy	STEM Classroom Grants	$500	https://www.firstenergycorp.com/content/fecorp/community/education/educational_grants.html
National nonprofit	NEA Foundation	Student Achievement Grant	$2,000 & $5,000	http://www.neafoundation.org/pages/nea-student-achievement-grants/
National nonprofit	Captain Planet Foundation	Small Grant	$500 -$2,500	http://www.captainplanetfoundation.org/apply-for-grants/

E. Example of off-the-grid house built by high school students from Rancho Cotage High School. While this particular structure is far more complex that the recommended picnic pavilion, this house demonstrates the capacity of what high school students can accomplish with proper teaching and tools.

Green Infrastructure and Stormwater Management

F. Shows the locations of the proposed green roofs (highlighted in red)



G. Shows the proposed location of the first parking lot permeable pavement section (highlighted in red)

H. Estimated costs for green infrastructure projects. Square footage derived from Google Earth measurements. Costs for green infrastructure installation and maintenance acquired from the Center for Neighborhood Technology's national stormwater management calculator cost sheet (http://greenvalues.cnt.org/national/cost_detail.php)

Green Infrastructure Estimated Costs					
		Installation		Maintenance	
	Total ft^2	Total cost low	Total cost high	Total cost low	Total cost high
SouthEast Building	5,146.00	$45,027.50	$163,642.80	$102.92	$2,120.15
North Building	8,131.00	$71,146.25	$258,565.80	$162.62	$3,349.97
Both Stadium Buildings	13,277.00	$116,173.75	$422,208.60	$265.54	$5,470.12
First Section of Main Lot	49,876.80	$264,347.04	$598,521.60	$498.77	$11,471.66

I. Green Infrastructure Funding Opportunities

Green Infrastructure Funding Opportunities			
Program	Agency	Type of Funding	Website
Small Watershed Grant (SWG	National Fish and Wildlife Foundation	Grant	https://ofmpub.epa.gov/apex/watershedfunding/f?p=109:2:0::NO::P2_X_PROG_NUM,P2_X_YEAR:9,2014
Green Streets, Green Jobs, Green Towns	Chesapeake Bay Trust	Grant	http://www.cbtrust.org/site/c.miJPKXPCJnH/b.7735695/k.5E92/Green_Streets_Green_Jobs_Green_Towns.htm
Clean Water State Revolving Fund	Maryland Department of the Environment	Loan	http://water.epa.gov/grants_funding/cwsrf/cwsrf_index.cfm
EmPOWER Energy Efficiency and Conservation Block Grants	Maryland Energy Administration	Grant	http://energy.maryland.gov/Govt/EECBG.html

LED Field Lighting Project

J. Assumptions for calculating cost, emissions, and energy savings of LED versus metal halide stadium lights

LED	**Metal Halide**
90 fixtures	180 fixtures
1,000 watts/fixture	1,500 watts/fixture
90,000 watts or 90 kilowatts per hour	270,000 watts or 270 kw per hour
21,240 kWh per year*	63,720 kWh per year*
$1,300.95**	$3,902.85**

*Assumes that lights are on for only 236 hours per year. This figure will be higher if the lights are used regularly outside of evening or cloudy game days.
**Assumes an electricity cost of $.06125.