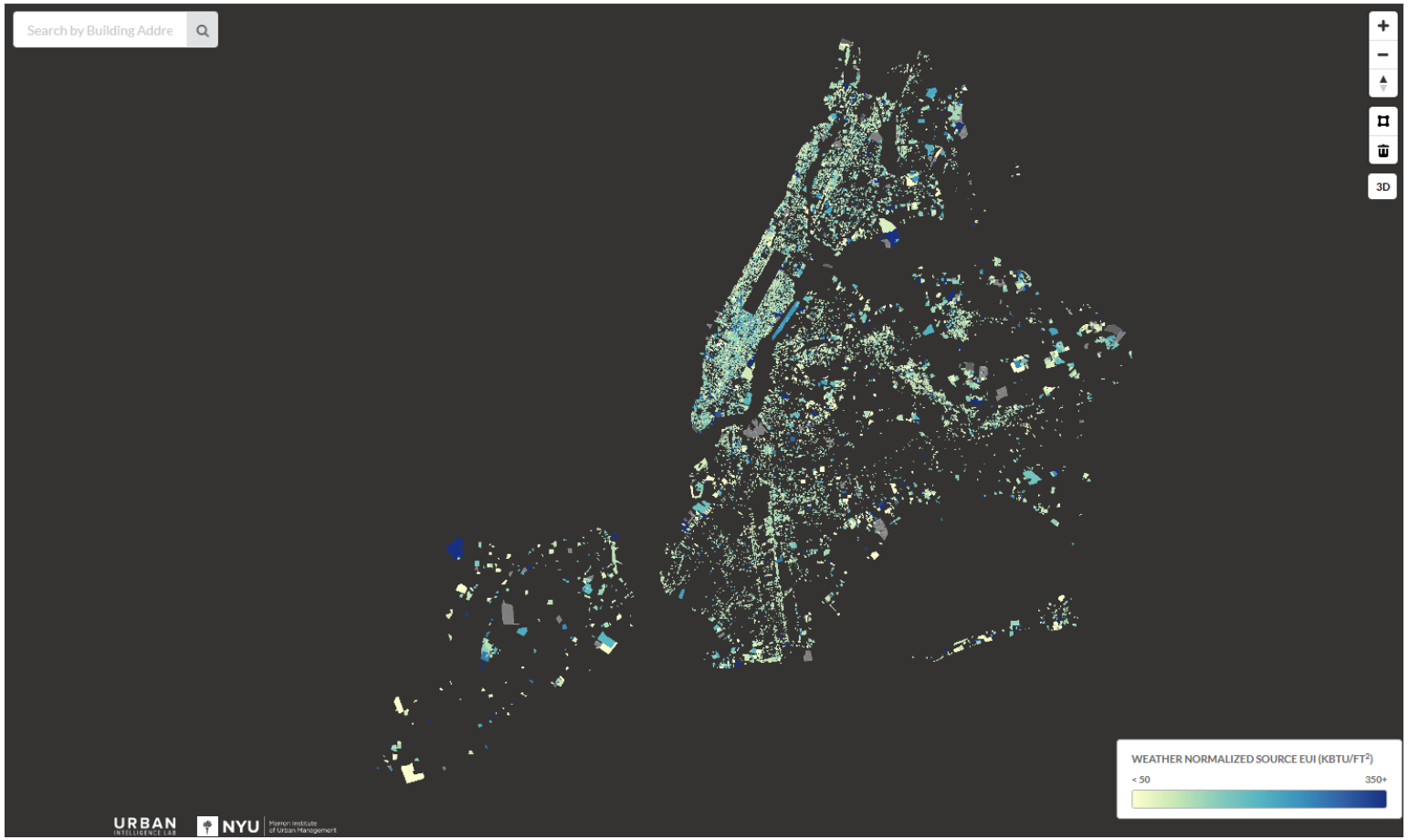
Energy Use Intensity **23.4m (kBtu/ft²)** & Green House Emissions Intensity **22.7m (kgCO2e/ft²)** in 2022



Picture sourced from **NYC Energy & Water Performance Map - Developed by the NYU Marron Institute of Urban Management's Civic Analytics Program and Urban Intelligence Lab in partnership with the Mayor's Office of Climate & Environmental Justice.**
https://energy.cusp.nyu.edu/#/

LAGCC – Python for Data Analytics
Cycle 6
Capstone Project
Marcelo Podoroisky

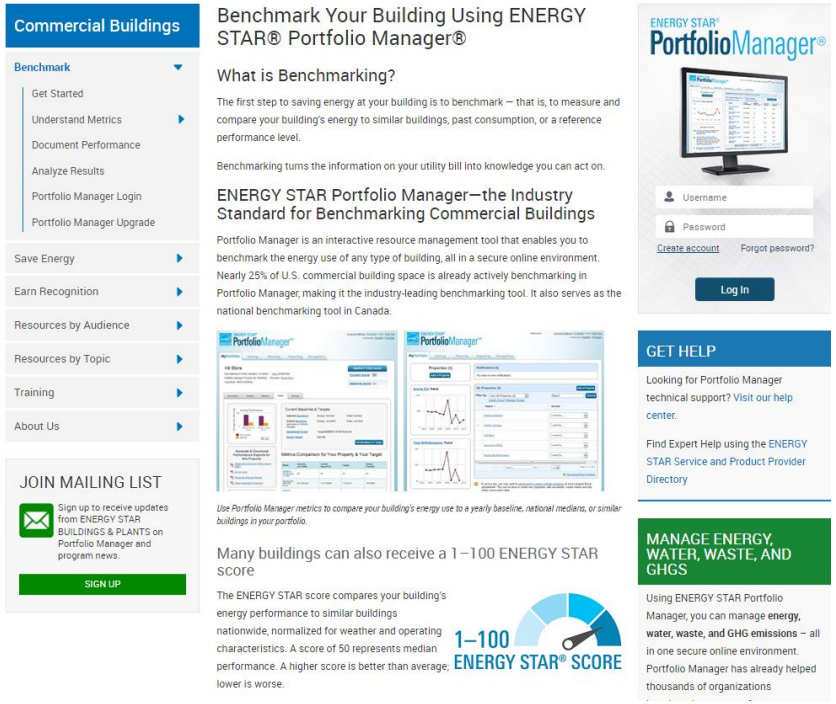
Introduction

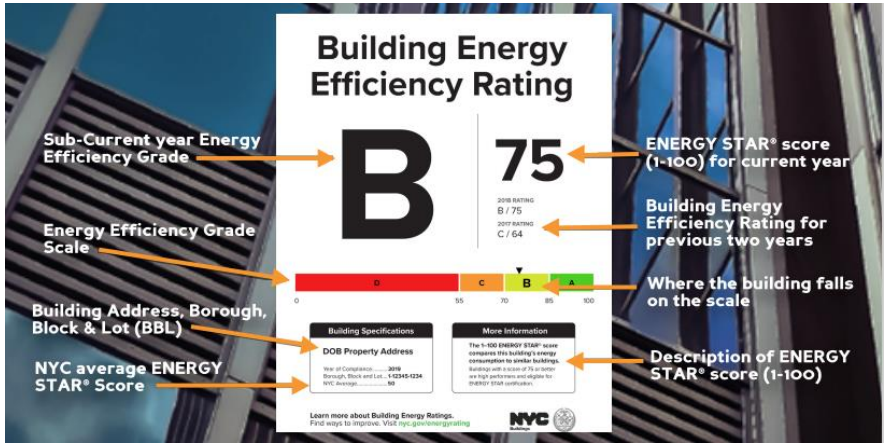
- What is the goal of your project?
  - The goal is to understand the **energy use intensity** and **greenhouse gas emissions** in **NYC** and how it **benchmarks** locally by borough.

- What are you investigating and why is it important?
  - I am investigating the **NYC Building Energy Disclosure** done by owners of buildings to comply with several local laws (i.e. 33, 84, 95 & 97).
  - That is important because the **public access** of energy use, greenhouse gas emissions, and ENERGY STAR ratings create awareness and brings **benchmarking** to the forefront allowing the city to **meet energy efficiency and greenhouse gas emissions limits.**
  - The city's **goal** is to **reduce** the **emissions** produced by the city's largest buildings **40% by 2030** and **80% by 2050**.

Data Source

- The NYC Building Energy and Water Data Disclosure for Local Law 84 (2023-Present) file was obtained from the **NYC Open Data** site.





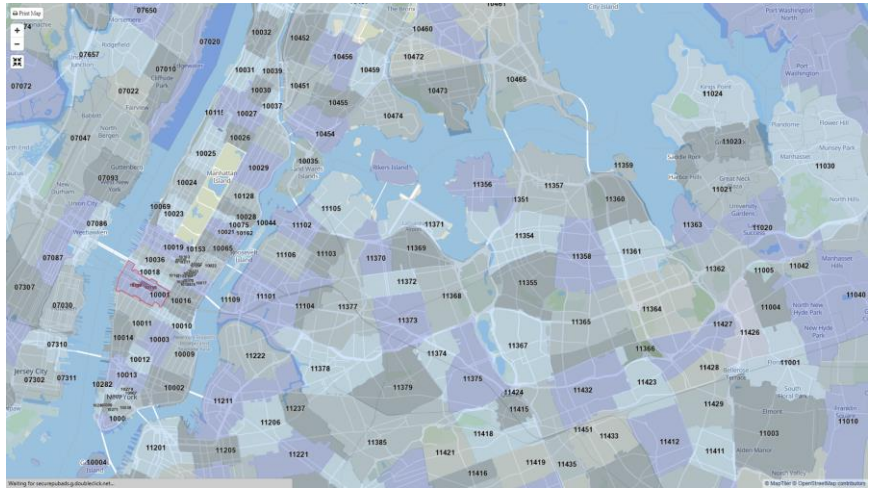

```
# A Score is equal to or greater than 85
# B Score is equal to or greater than 70 but less than 85
# C Score is equal to or greater than 55 but less than 70
# D Score is less than 55
# F Building did not submit required benchmarking information
# N Building exempted from benchmarking or not covered by the ENERGYSTAR® program

def grade(score):
    if score >= 85:
        return "A"
    elif score >= 70:
        return "B"
    elif score >= 55:
        return "C"
    else:
        return "D"
```

Methodology

- Exploratory Data Analysis
  - The file contained **30485 rows x 254 columns**
  - Each **row** represents a **building**
  - The columns represent **features** of the buildings (e.g. property use types, gross floor area (ft^2), year built, Energy STAR Score, etc.)
- Data Cleaning & Transformation
  - Removed **duplicate** Property ID (153). Addressed **null values** by removing unnecessary columns
  - Imputed values for **Boroughs** using postal codes & missing **Energy Use Intensity** by using the median of the same postal codes
  - Replaced postal codes values not properly entered and converted object **datatypes** to numeric/date.
  - Built a **Building Energy Efficiency Code** (BEER) column utilizing the Energy Star Score in a formula
- Types of Visualizations: Bar charts, scatter plots, histograms, distributions, grids, etc.

Data Journey

- Wanted to use the postal codes to create a choropleth chart to display the worst offenders by zip code
- Missed latitude and longitude values
- Missed zip codes. Imputed by looking up addresses!!!
- Used zip codes to impute missing boroughs



```
#To replace values in Postal Codes using .loc

#First, create a boolean mask that indicates which rows have the postal codes that need to be replaced.
#I can use the isin method of the pandas series object to check if the values are in a list or a set.

# Create a list or a set of the postal codes that need to be replaced
postal_codes = {10548, 10977, 11019, 11036, 11069, 11124, 11474, 12226, 111201, 112126939, 112211760, 114342300,
                '10003-1316', '10013 ', '10024-3801', '10024-3822', '10025-3621', '10031-6032', '11232-3165',
                '11385-6201', '5 East 196th St', '10013 \u200e'}

# Create a boolean mask that indicates which rows have the postal codes that need to be replaced
mask = unique_rows['Postal Code'].isin(postal_codes)

#Second, I use the .loc method to select and update the rows that match the mask.
#I can use the map method of the pandas series object to apply a dictionary to the values.

# Create a dictionary that maps the old postal codes to the new ones
replacements = {10548:10458, 10977:11207, 11019:10019, 11036:10036, 11069:10069, 11124:11224, 11474:11423, 12226:11226,
                111201:11201, 112126939:11212, 112211760:11221, 114342300:11434, '10003-1316':10003, '10013 ':10013,
                '10024-3801':10024, '10024-3822':10024, '10025-3621':10025, '10031-6032':10031, '11232-3165':11232,
                '11385-6201':11385, '5 East 196th St':10468, '10013 \u200e':10013}

# Use the .loc method to select and update the rows that match the mask
unique_rows.loc[mask, 'Postal Code'] = unique_rows.loc[mask, 'Postal Code'].map(replacements)
```

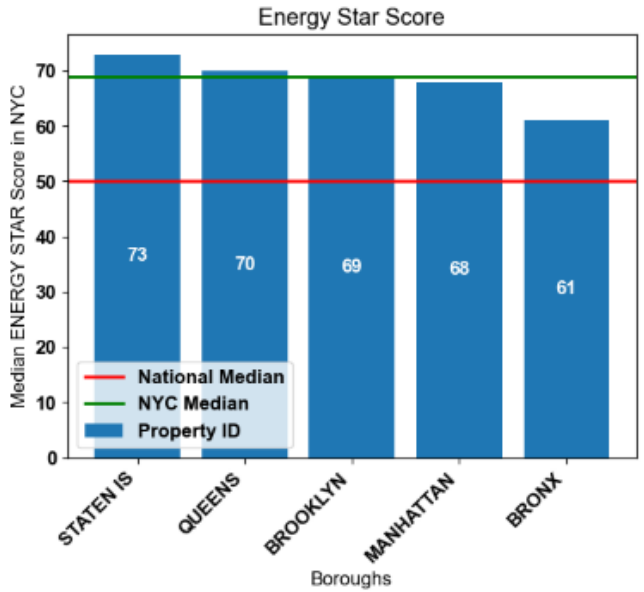
Who are the biggest offenders?

- Multifamily Housing with the largest number of buildings is the largest energy consumer and greenhouse emitter.
- The median energy star score is 50 nationally, whereas it is a median of 69 for NYC.

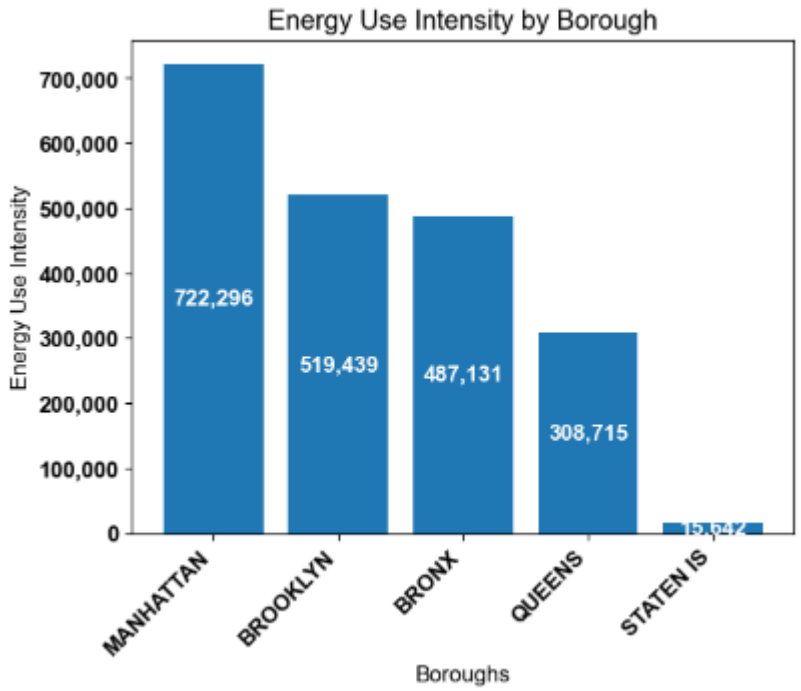
NYC Building Energy and Water Data Disclosure for Local Law 84 - Year 2022

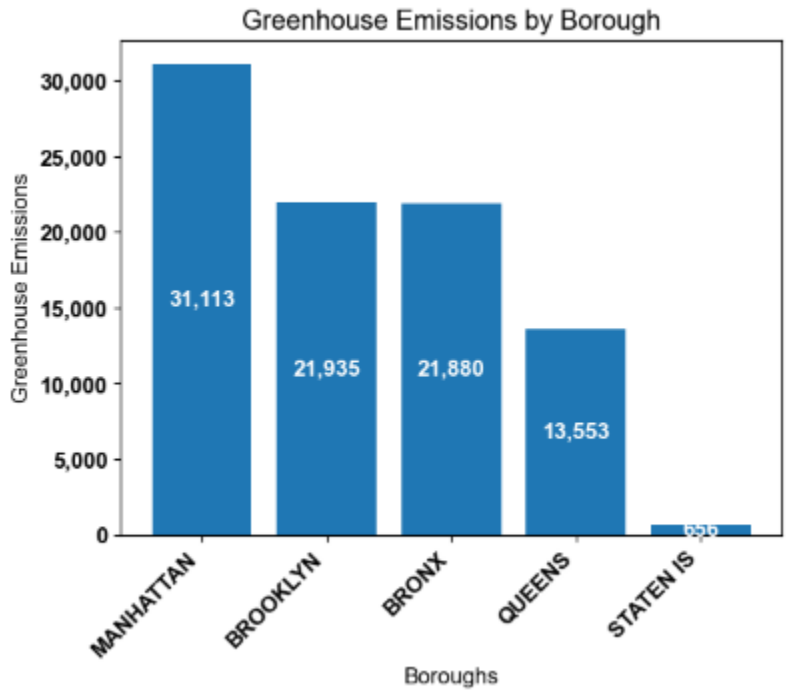
Top 5 Contributors by Property Type

#	Primary Property Type - Self Selected	Property ID (thousands)	%	Energy Use Intensity (kBtu/ft²) (millions)	%	Greenhouse Emissions Intensity (kgCO2e/ft²) (millions)	%
1	Multifamily Housing	19.7	65%	21.3	91%	1.0	93%
2	Office	2.4	8%	0.3	1%	0.0	1%
3	K-12 School	1.8	6%	0.2	1%	0.0	1%
4	Hotel	0.6	2%	0.1	0%	0.0	0%
5	College/University	0.5	2%	0.2	1%	0.0	1%
Sub-Total (Top 5)		**25.0**	**82%**	**22.2**	**95%**	**1.1**	**96%**
Grand-Total (Entire Set)		**30.5**	**100%**	**23.4**	**100%**	**1.1**	**100%**



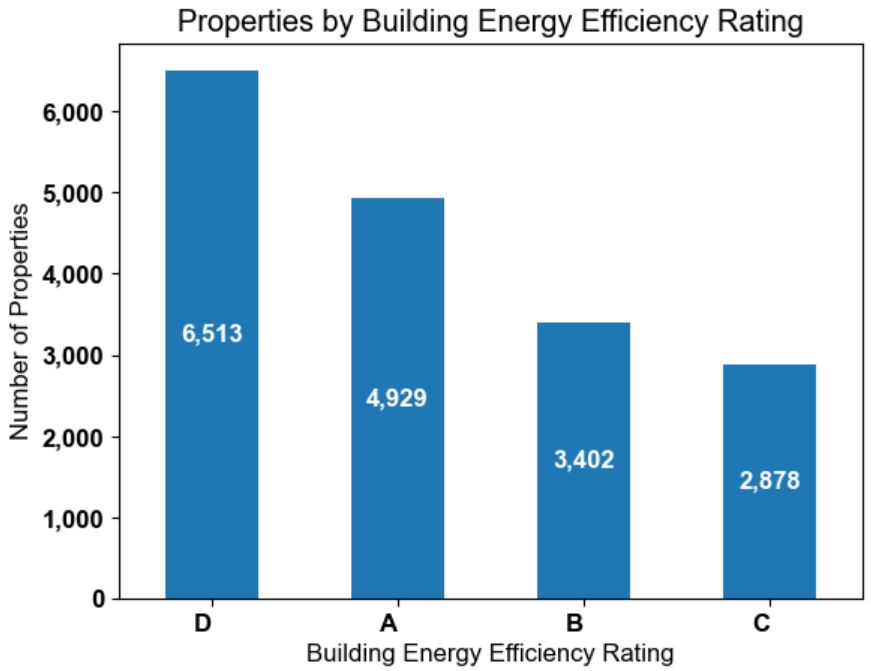
How is the energy consumption and greenhouse emission by borough?

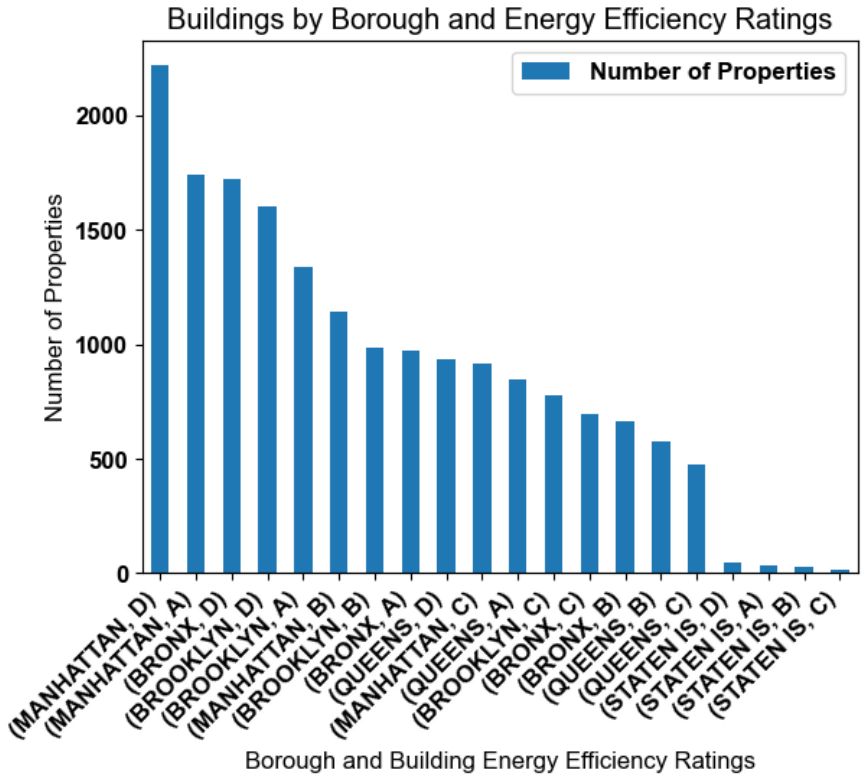




The focus is on **Multifamily Housing Buildings** comprised of the following number of properties:
6,016 Manhattan; 4,698 Brooklyn; 4,055 Bronx; 2,828 Queens & 125 Staten Island

How is the Building Energy Efficiency Rating distributed?

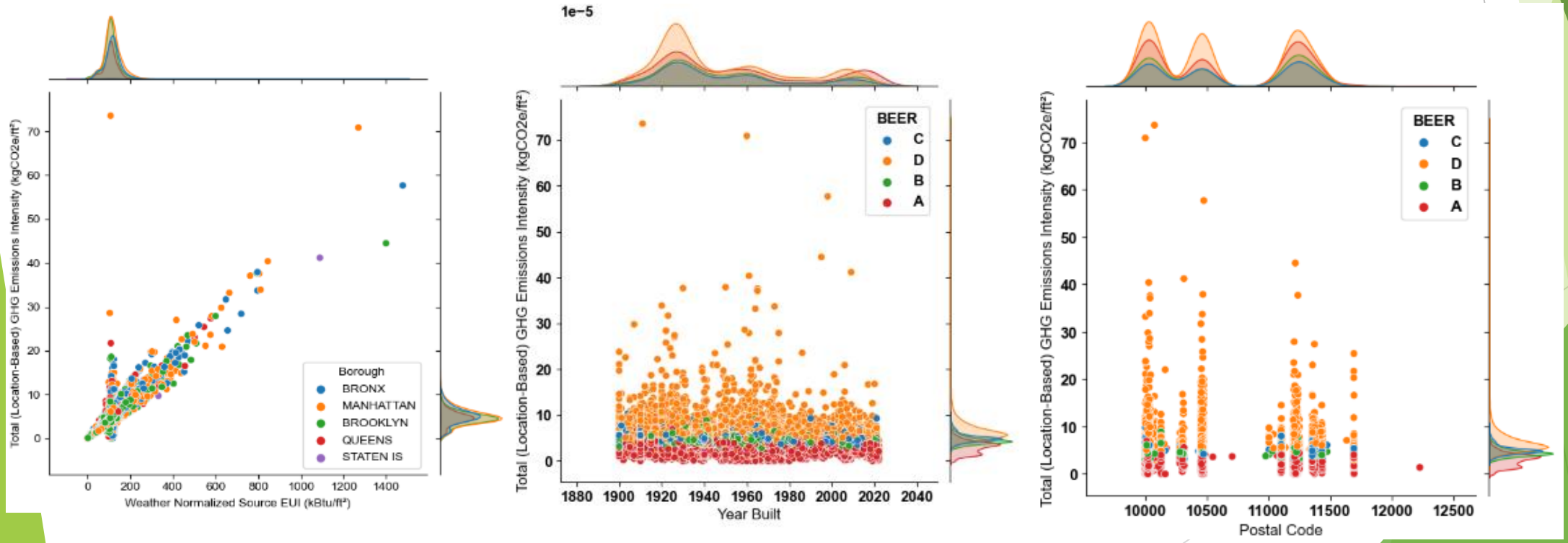




Number of “D” rated buildings across NYC:
2,216 Manhattan; 1,722 Bronx; 1,599 Brooklyn; 932 Queens & 44 Staten Island

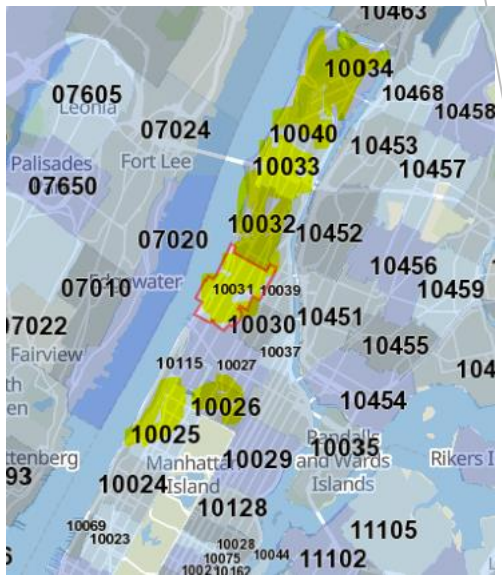
What are the potential drivers of greenhouse emissions?

- There is a direct relationship between energy usage and greenhouse emissions
- The year properties were built plays a role with the level of greenhouse emissions and those buildings seem to be concentrated in a handful of zip codes



Conclusions

- **Multifamily Housing** is the **largest contributor** with 65% of the 30K reported buildings, uses 94% of the energy (EUI) and emits 95% of greenhouse gases
- The **worst offenders** are located in **Manhattan** and coincide with the lowest Building Energy Efficiency Rating equal to **"D"**. The zip codes of those buildings happen to be located in **Washington Heights, Hamilton Heights, Inwood, Upper West Side, East Village and Harlem**.
- Those buildings were **built before 1950** when different materials were used for construction but could not discern if the type of fuel used played a role.
- My recommendation would be for building owners and tenants to look at upgrading **lighting**, adding or replacing **insulation** and checking on their **appliances efficiencies**. For further information look at the following link: Save Energy | ENERGY STAR



Year Built	Bldgs	% to Total	EUI (K's)	% to Total	Washington Heigths 10033 Bldgs	Washington Heigths 10033 EUI	Washington Heigths 10032 Bldgs	Washington Heigths 10032 EUI	Hamilton Heights 10031 Bldgs	Hamilton Heights 10031 EUI	Washington Heights 10040 Bldgs	Washington Heights 10040 EUI	Inwood 10034 Bldgs	Inwood 10034 EUI	Upper West 10025 Bldgs	Upper West 10025 EUI	East Village 10003 Bldgs	East Village 10003 EUI	Harlem 10026 Bldgs	Harlem 10026 EUI	Sum 8 Zip Codes Statistics for 8 Zip codes Bldgs	Sum 8 Zip Codes Statistics for 8 Zip codes EUI	Bldgs %	EUI%
1920	**190**	**9%**	**32.0K**	**9%**	21	3.4K	18	2.9K	23	3.8K	18	2.8K	5	0.8K	6	0.9K	6	1.2K	14	2.1K	111	17.8K	58%	56%
1910	**101**	**5%**	**17.2K**	**5%**	7	1.1K	15	2.7K	8	1.4K					7	1.3K	3	0.5K	6	0.9K	46	7.9K	46%	46%
1900	**81**	**4%**	**14.7K**	**4%**	1	0.2K	4	0.6K	2	0.4K					7	1.2K	7	1.8K	2	0.3K	23	4.6K	28%	31%
1925	**76**	**3%**	**13.0K**	**4%**	8	1.3K	1	0.2K	2	0.3K	10	1.8K	15	2.5K	7	1.3K	1	0.2K	3	0.4K	47	8.1K	62%	62%
1930	**73**	**3%**	**11.4K**	**3%**	6	0.8K	7	1.2K	2	0.3K	6	1.1K	8	1.2K	3	0.4K	1	0.3K	2	0.3K	35	5.7K	48%	50%
1926	**58**	**3%**	**9.5K**	**3%**	4	1.0K	1	0.1K	11	1.8K	7	1.1K	10	1.7K	1	0.2K					34	5.9K	59%	61%
1950	**50**	**2%**	**7.7K**	**2%**	6	0.8K	3	0.4K	2	0.3K					1	0.2K	2	0.3K	1	0.2K	15	2.1K	30%	28%
Sub-Total	**629**	**29%**	**105.5K**	**30%**	**53**	**8.5K**	**49**	**8.1K**	**50**	**8.4K**	**41**	**6.7K**	**38**	**6.2K**	**32**	**5.6K**	**20**	**4.3K**	**28**	**4.3K**	**311**	**52.0K**	**49%**	**49%**
Grand Total	**2.2K**	**100%**	**349.0K**	**100%**	**111**	**17.8K**	**106**	**16.9K**	**85**	**14.0K**	**97**	**15.7K**	**74**	**11.3K**	**88**	**14.2K**	**77**	**13.5K**	**52**	**8.0K**	**690**	**111.4K**	**31%**	**32%**

Glossary

- Weather Normalized Source EUI (kBtu/ft²): The source energy use your property would have consumed during 30-year average weather conditions. It accounts for changes in weather.
- Total (Location-Based) GHG Emissions Intensity (kgCO2e/ft²): Greenhouse Gas (GHG) Emissions are the carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O) gases released into the atmosphere as a result of energy consumption at the property. GHG emissions are expressed in carbon dioxide equivalent (CO2e), a unit of measure that combines the quantity and global warming potential of each greenhouse gas. Emissions are reported in four categories, each is available as a total amount in metric tons (Metric Tons CO2e) or as an intensity value in kilograms per square foot (kgCO2e/ft2).
- The **ENERGY STAR Score** is a measure of how well your property is performing relative to similar properties, when normalized for climate and operational characteristics. The scores are based on data from national building energy consumption surveys of key variables affecting a building's energy performance, including climate, hours of operation, and building size. Buildings from around the country subject to different weather patterns, can be compared side-by-side in order to see how they stack up in terms of energy performance. The 1-100 scale is set so that 1 represents the worst and 100 represents the best performing buildings.
- kBtu: British thermal units measures heat energy needed to raise one pound of water 1°F. 1kBtu = 1,000 Btus
- kgCO2: CO2e is the exchange rate of other greenhouse gases to carbon. How many kg of carbon dioxide emissions warm the climate equally as 1 kg of another greenhouse gas, over a certain period of time (most often 100 years).

References

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