Spatial and demographic patterns of building-level emissions in Washington D.C.

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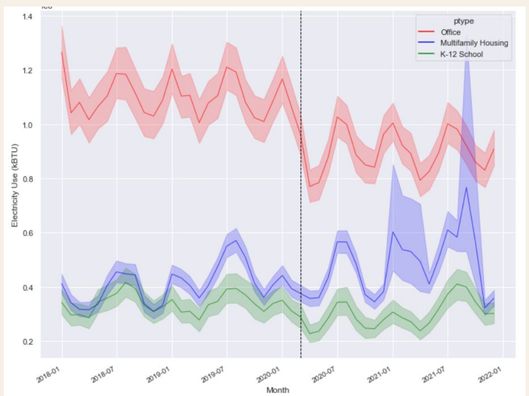
Case Study: Washington D.C.

Building energy usage generates 40% of total U.S. emissions and 75% of U.S. cities’ total emissions. To meet climate commitments, recent legislation takes aggressive steps towards building energy efficiency, such as **D.C Clean Energy Law 2018** and the **Inflation Reduction Act 2022.** This includes assistance for energy efficiency upgrades assistance for buildings serving low-income areas. This analysis identifies areas where the funding is most needed.

Datasets

1. **D.C. Building Benchmarking data:** Buildings above 25,000 sq ft have to report annual energy and water consumption to the D.C. Dept. of Energy.
2. **D.C. Building Energy Performance Standards (BEPS)**: The city marked each building as either meeting or not meeting the standard in 2019.
3. **U.S. Census Bureau: 5 year American Community Survey (ACS) estimates:** Block-group level demographic data for 2019.

Monthly average electricity use by sector (2018-2022)



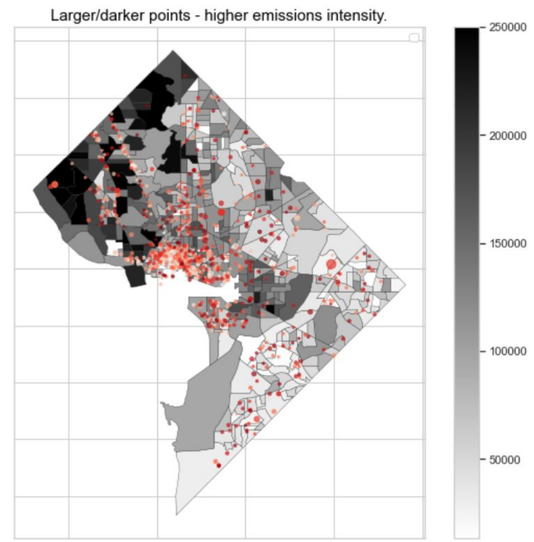
Initial findings

1. There was a structural break and decline in 2020, mainly led by educational institutions.
2. Multifamily housing electricity use has slowly increased with a spike in late 2021.

Spatial Methods

First, we overlay the coordinates of the 935 buildings that failed the building energy performance standards on polygon shapefiles of census block groups in Washington D.C. Based on the spatial dispersion of buildings, we observe an intense concentration of buildings not meeting the standards in downtown Washington D.C. The majority of such buildings were **multifamily housing (39%)** and **offices (26%).**

Buildings that failed BEPS by census block group median income (2019)



Emissions intensity is measured in kilograms of carbon dioxide equivalent (CO_2e) per square foot.

These patterns highlight significant income differences between Northwest D.C. and Southeast D.C. In the NW, the median incomes reach as high as $250,000, and most of them either pass the BEPS or are single-family homes (an excluded category from energy reporting). In the southeast, median incomes are much lower, and there are considerably more buildings that failed BEPS because many are multifamily housing (which have to report energy usage).

Analytical Methods

We specify a l**ogistic regression**, with the binary dependent variable being whether a building met the BEPS standards. The independent variables are median income, racial composition, and site energy use intensity (site EUI). The coefficients for minority share and site EUI are statistically significant, suggesting that non-white areas tend to have buildings with lower energy efficiency.

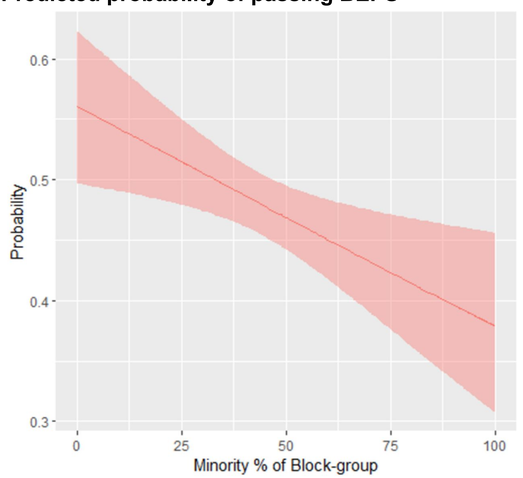
Logit Regression Results
Dependent variable: whether building meets BEPS

GHG emissions intensity	-0.327 (0.048) ***
Minority %	-0.007(0.003)**
Log Median Income	-0.126 (0.15)
Constant	3.554 (1.92)
Observations	1841
Pseudo-R squared	0.1033

*** p < 0.01, ** p < 0.05. * p < 0.1
Standard errors clustered the block group level.

As the minority percentage of a block group increases, the predicted probability of passing BEPS decreases, suggesting that there are ample opportunities for energy efficiency investments in non-white areas.

Predicted probability of passing BEPS



Next Steps

We would like to expand this analysis in several ways:

1. **Include building-level energy data from other cities.** While this particular study uses Washington D.C. as a case study, we anticipate that these trends are common across many cities in the United States. Most cities publish, in some form, energy benchmarking data that we could run through the same analytical and spatial methods.
2. Add data for **single-family homes**, a subset of buildings that we expect comprise a significant share of overall emissions.
3. Acquire data on building-level characteristics, like **insulation and heating technology**. New federal, state and city policies provide considerable funds for such upgrades.
4. An **interactive visualization tool** that will allow users to overlay other relevant data layer, like surface temperatures, locations of green spaces (e.g. parks, green roofs) and tree canopy coverage, among others.

Consistently, we find that building energy efficiency tends to be lower particularly in areas with multifaily housing and high non-white populations. In light of recent legislation that specifically targets building energy efficiency upgrades, this analysis has sought to identify types of buildings and neighborhoods where investments would be most effective.

References

1. Washington D.C. Open Data Portal: Washington D.C. Energy Benchmarking
2. U.S. Census Bureau: 5 year American Community Survey (ACS) estimates

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