

# Urban Building Energy Consumption in New York City

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## Introduction

According to "NYC Mayor's Office of Climate and Environmental Justice's report of New York City Energy and Water Performance" in 2017, over 70 percent of the energy consumption in NYC comes from buildings. The research examines the spatial distribution of urban building energy consumption and its relationship to building functions of 2019. It aims to answer the following research questions: what are the estimated annual electricity intensities? What is the fraction of each type of energy consumed by end use? What is the spatial distribution of building energy consumption? By examining the energy consumption patterns of building in NYC, the research provides insights into opportunities for cost-effective retrofitting to improve energy efficiency. For example, spatial proximity can allow cost-effective re-use of waste heat streams from gas-fired distributed generation, also called cogeneration or combined heat and power (CHP).

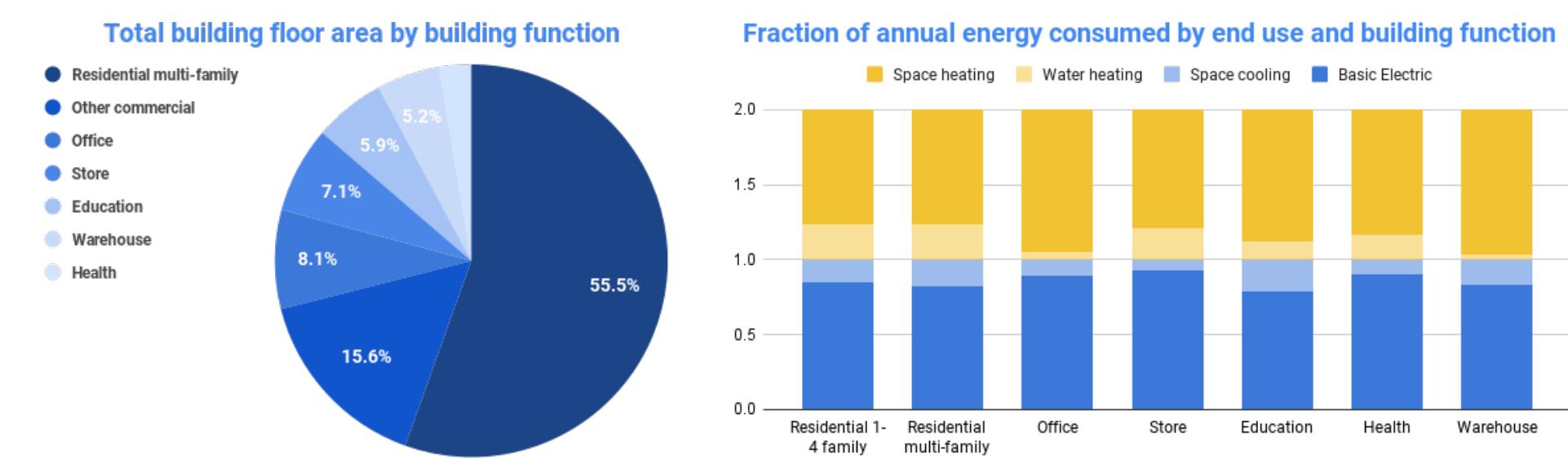
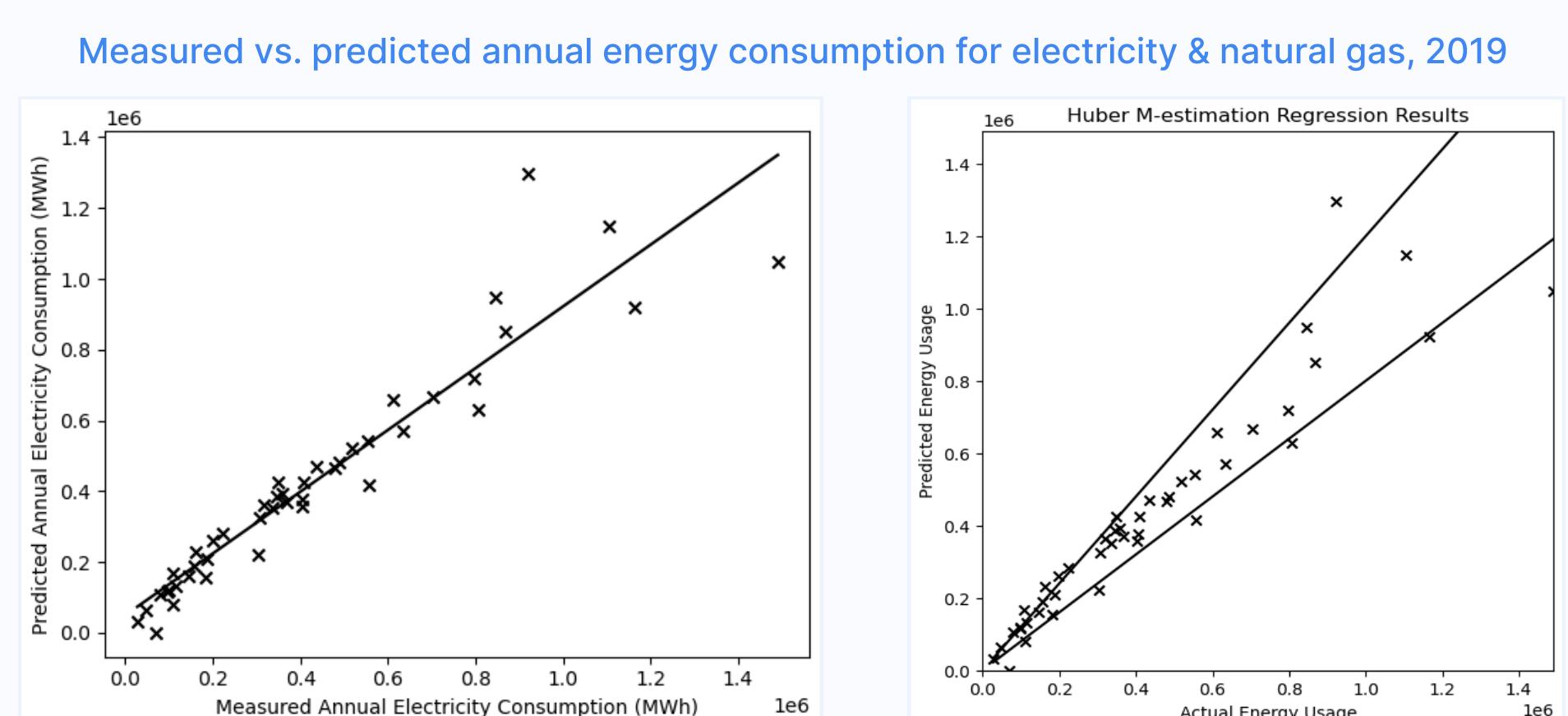
## Data Source

- New York State Energy Research and Development Authority (NYSERDA)
- NYC City Planning Department – The Primary Land Use Tax Lot Output (PLUTO)
- Residential Energy Consumption Survey (RECS) and the Commercial Building Energy Consumption Survey (CBECS)

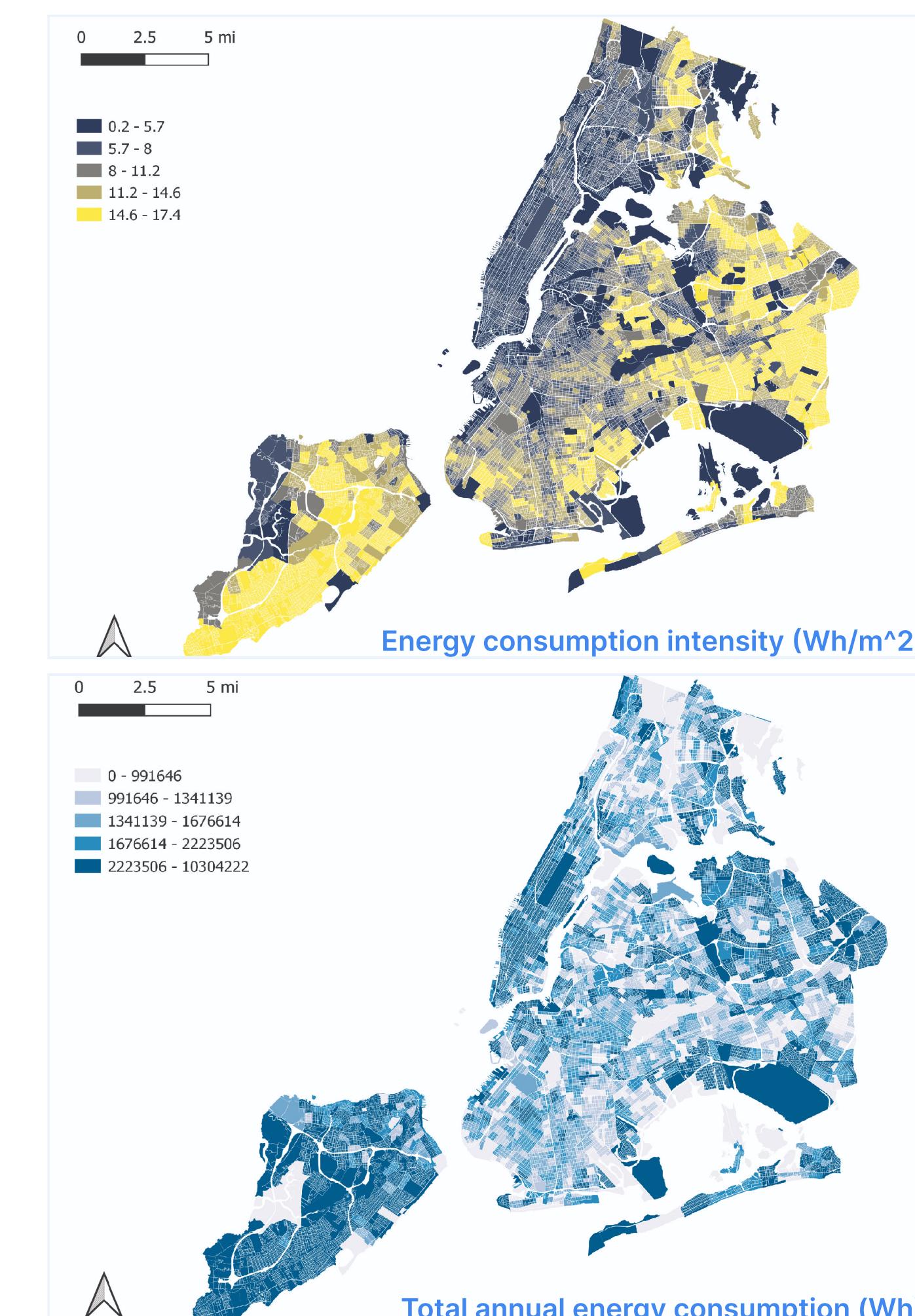
## Methodology

The data we used includes energy usage data, building stock information, and energy consumption survey data. For energy usage data we obtained from NYSERDA, we extracted monthly electricity and natural gas consumption value in 2019 by zip code and coordinate. For building stock data we obtained from PLUTO data file, we collected building locations (coordinate, zip code, census tract), building characteristics (building area, building front, building depth etc.) and building functions (residential 1-4 family, residential multi-family, office, store, education, health, warehouse and other commercial). For energy consumption survey data from RECS and CBECS, we apportioned them into four end use types: base electric, space heating, water heating, and space cooling.

After getting the datasets, we used Python to clean and merge the energy use data with building block data. Then we run a robust multiple linear regression to determine the electric intensity and fuel intensity of each building type. Finally, we used QGIS to make the maps to visualize the spatial distribution of building energy consumption. Additionally, we created bar charts presenting annual building energy consumption intensities by end use and building function.



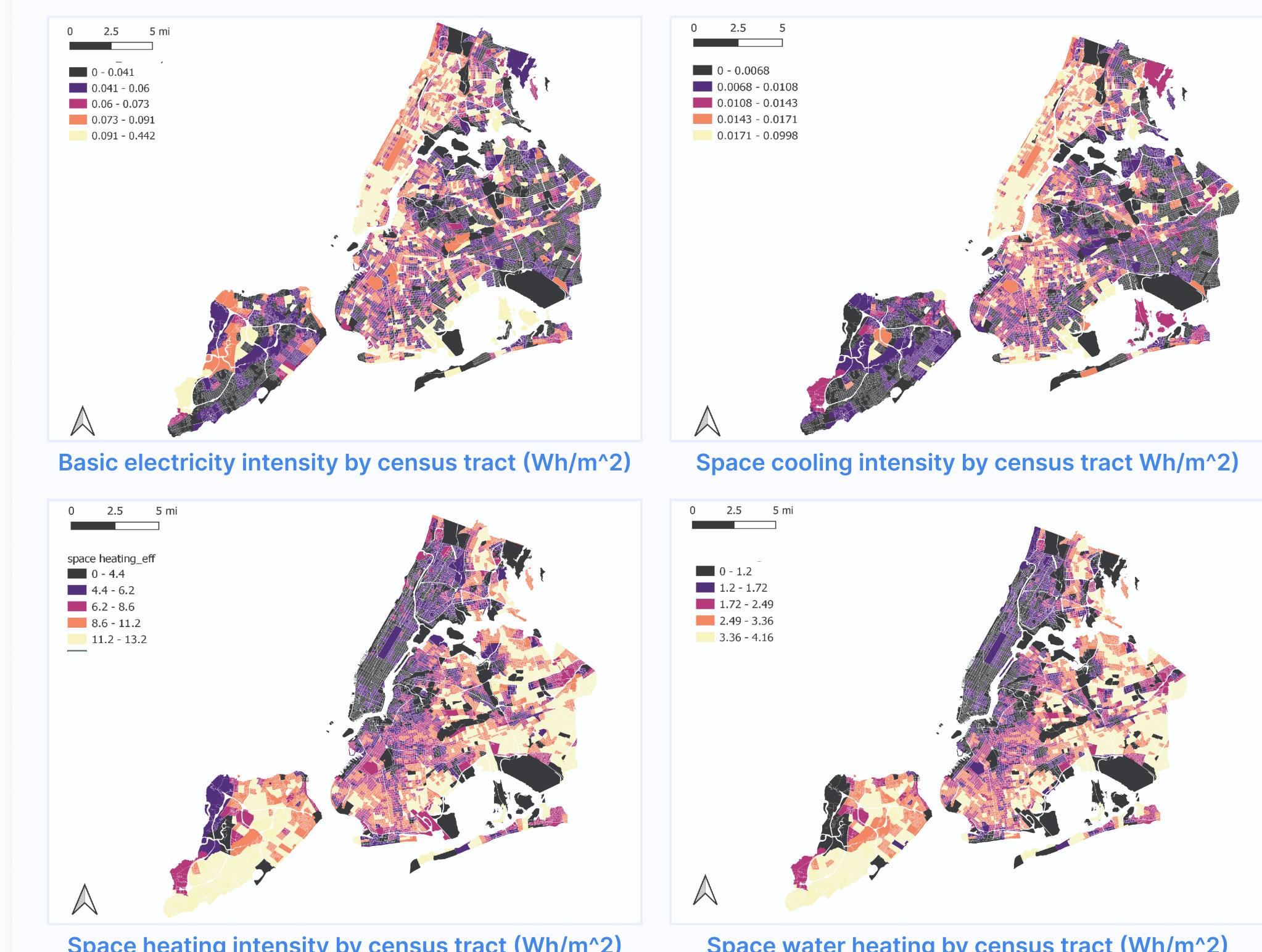
## Spatial distribution of energy consumption



## Conclusion

It is expected that areas with tall and tightly packed buildings would have high levels of consumption. Consequently, a city block situated in midtown Manhattan has one of the highest annual energy consumption rates. The central business and financial districts, where tall buildings are mostly found, have large tracts of such high energy consumption. Meanwhile, neighborhoods like Harlem, East and West Greenwich Village have the lowest consumption rates in Manhattan. Beyond Manhattan, some areas that have large energy consumption rates include downtown Brooklyn, eastern Bronx, Astoria, and a few specific areas along major transportation routes.

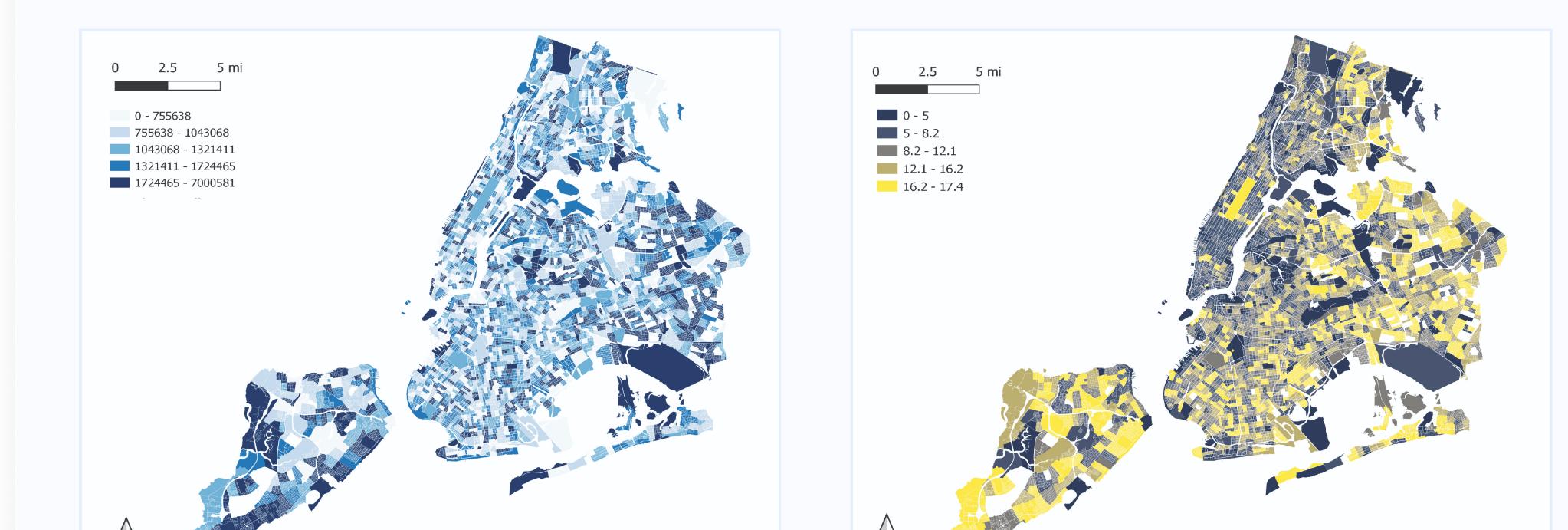
## Spatial distribution by end use



## Conclusion

As shown in the maps above, space cooling and basic electricity use density is significantly higher in midtown and downtown Manhattan, Harlem, west Bronx, and downtown Brooklyn compared to other areas. Also, the highest space heating and water heating usage can be observed in eastern Bronx and parts of Staten Island.

## Spatial distribution of residential buildings



## Conclusion

The energy consumption level shows a hybrid pattern across NYC. Although the total residential energy consumption is similar to other boroughs, the intensity is generally lower than those in Bronx and Brooklyn. This suggests that areas with tightly packed and tall buildings have higher energy consumption efficiency and could further imply that spatial proximity enables cost-effective energy reuse.

## References

- [1] Energy benchmarking. Energy Benchmarking - Mayor's Office of Sustainability. (n.d.). Retrieved March 14, 2023, from <https://www.nyc.gov/site/sustainability/codes/energy-benchmarking.page>
- [2] Howard, B., Parshall, L., Thompson, J., Hammer, S., Dickinson, J., & Modi, V. (2012). Spatial distribution of urban building energy consumption by end use. *Energy and Buildings*, 45, 141–151. <https://doi.org/10.1016/j.enbuild.2011.10.061>
- [3] Ye, Z., Cheng, K., Hsu, S.-C., Wei, H.-H., & Cheung, C. M. (2021). Identifying critical building-oriented features in city-block-level building energy consumption: A data-driven machine learning approach. *Applied Energy*, 301, 117453. <https://doi.org/10.1016/j.apenergy.2021.117453>