An Analysis of New York heat consumption

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***Abstract: New York has always been known as an extremely hustle and bustle place. It would come as no surprise that its heating consumption is higher than that of many other cities in the US. This paper is aimed at reaching the source behind New York’s mass consumption of heat, through analyzing data.***

Keywords: Btu, heating fuel, consumption, data, MWh/year, kWh/m2/year, Steam heating, Water heating

# **Introduction**

New York is one of the biggest and busiest cities in the world. Therefore, it would come as no surprise that its heating system consumes more than the average city, given the density of the population, the concentration of corporations and businesses. For instance, an average household in New York consumed up to 103 million Btu yearly, which is 15% more compared to the US average (2009) [2].

# **Analysis and Hypothesis**

## Analyzing on the state scale:

First, we look at the consumption of heat fuels in New York over the period of 2013 - 2022. In this analysis, we are not only looking at the yearly (per cubic foot) consumption of heating fuels in New York, but we are also taking into account the monthly (per cubic foot) consumption of heating fuels in New York.

Table

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Table 1[1]

As per Table 1, the monthly per cubic foot heat content delivered to customers in  New York ranges from 1029 BTU to 1034 BTU monthly. This is on the higher end  of the spectrum. In comparison, across the same period, the monthly per cubic foot heat content delivered to customers across the USA ranges from 1026 BTU to 1040 BTU. [1]

## Hypothesis:

There could be several reasons why New York consumes as much energy as it does for heating. It ranges from the population, the population density to the different heating systems in usage and climate change. All these hypotheses could be explained in the case of New York. The next part of this paper will focus on certifying the above-mentioned hypotheses.

# **DATA IMPLEMENTATION**

In this section, each hypothesis will be examined individually. Data from different sources will be implemented with the intention to prove the proposed hypotheses.

## Population size and density:

Given the population size and density of New York State, it would be natural to make the assumption that its heating and energy consumption would be greater than cities. New York State's population ranks 4th in the nation in 2022[7]. Its population density also placed 7th in the nation in the same year [6]. In this section, research – aimed at proving the positive relationship between population density and heat consumption – will be examined.

In this research led by Pedro J. Zarco-Periñán \*, Irene M. Zarco-Soto and Fco. Javier Zarco-Soto, the whole of Spain was taken into consideration. Cities with populations starting at 50,000 inhabitants were selected as parts of the research data. In this study, cities were classified into different groups: Group 1- representing cities with a population density smaller than 100 inhabitants/hectare, Group 2 – between 100 – 200 inhabitants/hectare, Group 3 – between 200 – 300, Group 4 – between 300 – 400, and Group 5 – representing cites with a population density higher than 400 inhabitants/hectare.

Although this research took into account both thermal and electric consumption, with respect to this paper, only thermal/heat energy consumption will be examined.

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**Figure 1.** *Energy consumption per household of each group of cities [8]*

As per Figure 1, the data shows that the average household thermal energy consumption increases with every group. There was an exception of group 5, where there was a slight decrease. Figure 1 indicates that the higher the density of population of a city, the higher the average household heating consumption of that city will be.

Furthermore, this research also analyzed the average heating consumption per inhabitants of each group of cites and the result is as follows:

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**Figure 2.** *Energy consumption per household of each group of cities [8]*

The data from Figure 2 suggests that in cities with higher population density, the average heating consumption per inhabitants also grows larger compared to cities with lower population density.

## Usage of Specific Heating System:

There are two main heating systems that uses the most energy in New York, namely: Steam Space Heating and Water Heating.

### Steam Heating:

Steam Heating is a system where steam generated in a boiler moves along pipes of the radiators, with the condensed steam returning to the boiler for recirculation.

New York, as a whole, uses steam space heating as the main heating system [9]. Even though there has been the development of more efficient means of heating.

### Water Heating:

Although Steam Space Heating might be dominant in New York, there are also implementations of water heating systems. Water Heating is a system where pipes or radiators circulate hot water to produce central heating.[4]

It is proven that Water Heating systems are more efficient that Steam Space Heating

### Comparison:

When comparing the two heating systems, it is obvious that Water Heating is ahead in terms of efficiency. To be more precise, in order to heat up 1 lb. of steam, it would require 1,000 BTU. While approximately 1,200 BTU could heat up a gallon of water, which is equivalent to 8 lb. of water [5]. Moreover, in terms of energy efficiency, Water Heating is more advanced. While both heating systems are considered energy-efficient, Water Heating inches forward, as it takes longer to boil water in order to deliver the steam in Steam Space Heating.

## Impact of Climate change:

While New York’s need for heating energy continues to drive its consumption to be at the top of the United States, this might change in the near future. As the energy consumption continues to grow, so does the waste that comes with. The carbon dioxide that is part of the fuel processing, contributes greatly to the phenomenon known as climate change.

Climate change, or more specifically, the changes in

temperature and weather patterns of an area, is part of the natural process. However, with the rise in human’s consumption of fossil fuels, climate change has become more drastic that we had all anticipated. In New York State, specifically, the average temperature has raised by 3-degree Fahrenheit since 1970, at an average of 0.6-degree Fahrenheit per decade [3]. With the temperature being on the rise, the need to cooling energy would also increase as a byproduct. On the other hand, this means that the demand for heating energy would also be projected to decrease. In this section, two different research, taken place in two different countries, will be examined, under the hypothesis that an increase in temperature will decrease consumption of heating energy

### Impact of climate change on heating and cooling energy demand in houses in Brazil:

In this research, led by Andrea Invidiata along with Enedir Ghisi, the energy consumption and thermal comfort in buildings in Brazil were analyzed. They were targeting three specific cities namely Curitiba, Florianopolis, and Belem. These three cites were chosen as they were in three distinct bioclimatic zones (ZB1 – ZB8), ranging from the coldest zone to the hottest one [13].

This study placed importance on the evaluation of the thermal-energy performance of a house. While its primary goal was to develop strategies to mitigate the effect of climate change on energy consumption, it also arrived at conclusions regarding the impact that climate change might have on both heating and cooling energy consumption. With the intention to showcase the drastic effects of climate change, the researchers also chose to calculate the projection of heating and cooling energy consumption at three periods (2020, 2050, 2080) compared to the base year [13].

Table 2 shows, in percentage, the annual heating and cooling need compared to the base year in three cities in 2020, 2050 and 2080.

Compared to the base year, the table indicates that there is an inverse relationship between heating energy and cooling energy demand. While the cooling energy demand at the projected year is sometimes almost doubled that of its previous checkpoint, the heating energy demand continues to dive into the negative, as its percentage continues to drop lower and lower toward 2080 [13].

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Table 2 [11]

### Effects of climate change on variations in climatic zones and heating energy consumption of residential buildings in the southern Chile:

This is climate research, conducted by Konstantin Verichev, Montserrat Zamorano, Manuel Carpio. Their aim was to study projection of heating and cooling energy consumption in 2050, 2050 – 2065. The study centered around the southern cites of Chile [12].

The result of their finding was not at all surprising. Given the statistic of the research’s calculation, they projected that there would be a decrease between 5 kWh/m2/year and 20 kWh/m2/year during the period 2020 – 2035, a greater decrease between 10 kWh/m2/year and 25 kWh/m2/year during the period 2035 – 2050, and the decrease reaches its peak at between 12 kWh/m2/year and up to 45 kWh/m2/year during the period 2050 – 2065 [12].

# **Discussion**

Given the result from the implemented data, the two hypotheses have been proved. The data confirmed that there is a positive relationship between heat consumption and population density, where heat consumption rises if populations are denser. It also raises the suggestion that due to Steam Heating’s dominance throughout New York, the heat consumption is greater than areas where the dominant heating systems are more efficient, such as Water Heating.

However, while the case might be so for the present, with evident from Section III. C, the future trend on heating energy consumption is most likely a slight decline. This is a byproduct of climate change/global warming.

# **Future Works**

The range of data could be scoped down to as small as borough of cites and even extend to other cities with dissimilar population and heating methods. For instance, more analysis could be conducted into how different boroughs of New York City consume heat. A more detailed comparison between the implementation of the two heating systems in New York would give a clearer picture of its high heat energy demand.

Furthermore, an analysis into the relationship between heating energy and cooling energy consumption in future years.

# **ConClusion**

The main conclusions drawn from the current research shows:

* Evidence suggests that there is a positive correlation between population density and heating energy consumption
* The dominant usage of Steam Heating Systems could very well contribute to New York’s high heating energy consumption
* While heating energy demand might be high now, it would not be the same in the future, as climate change is influencing demand for heating energy positively and the demand for cooling energy negatively.

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