

Exploring Use Cases for an Hourly Building Energy Benchmarking Platform

The 8760 Proof-of-Concept Platform in New York City, NY

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ABSTRACT

In this paper, we discuss the need of cities to develop a data platform to measure energy use, greenhouse gas emissions, and occupancy of the building stock. A platform like this will allow a city to evaluate individual buildings at hourly intervals and gain deeper insights for decarbonization. To assess the benefit of such a platform we have partnered with a consulting firm that has developed a proof-of-concept benchmarking platform for nine commercial buildings in New York City. Overall, we describe the purpose and design of an hourly benchmarking platform in addition to providing preliminary data analysis.

1 INTRODUCTION

The decarbonization of the urban building stock is a focus of municipalities around the world to mitigate the effects of climate change. However, urban decarbonization targets often use annual data to assess building performance and fail to capture insights on time-varying energy use and associated emissions.

New York City’s greenhouse gas (GHG) building performance standard, LL97, will fine buildings with high emissions [3]. However, in its current form, New York City’s LL97 will use annual emissions factors and will be unable to utilize hourly energy use data; therefore, it will fail to recognize real-time building emissions as the electric grid’s GHG-intensity varies hour-to-hour [4]. Without a more comprehensive view of energy usage and associated real-time emissions, current benchmarking methods are unlikely to realize the full decarbonization potential of buildings. In order fill this gap cities must deploy hourly benchmarking platforms.

We have partnered with an engineering consulting group to perform initial data analysis on the proof-of-concept hourly building data platform “Benchmark 8760” they have developed [1]. The platform collects hourly energy use and building occupancy count data in addition to collecting the GHG-intensity of the local grid and local temperature. The proof-of-concept will allow industry, policy makers, and researchers to assess the scalability, security, and affordability of moving towards hourly benchmarking. The remainder of this paper will discuss various use cases to provide support on the advantage of an hourly benchmarking platform (compared to an annual platform) and encourage the widespread adoption of such a platform.

2 DATA PLATFORM

The Benchmark 8760 platform collects hourly electric meter readings, building occupancy count, GHG-intensity, and weather data to determine the affordability, scalability, and overall feasibility of receiving and hosting this data on an hourly benchmarking platform. For the initial pilot program (on going at the time of writing) the platform received hourly data from nine non-residential buildings between June 1st, 2022, through September 30th, 2022. The properties range in size from 341,000 ft² to 2,200,000 ft².

The data hosted on the platform are not pre-processed. Electricity and occupancy data are transmitted from each building’s advanced metering infrastructure (AMI) and occupancy counters. Emissions and weather data are transmitted from the local power supply and the local weather station. For our initial analysis of the dataset, we processed and cleaned the data to minimize erroneous data.

3 RESULTS & DISCUSSION

In this section we provide an analysis to illustrate the benefits of an hourly benchmarking platform with two use cases: (1) comparison of hourly vs annual emissions factors and (2) evaluating demand flexibility strategies. This work is preliminary and does not demonstrate the complete coverage of Benchmark 8760 but rather serve as an introduction to the platform’s various use cases.

3.1 EMISSIONS FACTORS

Preliminary analysis was conducted to illustrate the benefit of using an hourly emissions factor to estimate a building’s CO₂ emissions. In Table 1 we compare the estimated emissions in July and August 2022 with two methods (1) utilizing an hourly marginal emissions factor and hourly electric data and (2) utilizing the average hourly marginal emissions factor with the total electricity use for July and August. For eight of the nine property we find that use of an average emissions factor overestimates the emissions associated with each property. The difference in estimated emissions ranges from -3% to 1%. An accurate estimate of emissions is particularly important for the ushering of LL97. LL97 will fine buildings for exceeding the set emissions limit. This may lead to buildings being incorrectly penalized and lead to a financial burden for building managers.

The emissions factor proposed in LL97 is 0.29 kg CO_{2e}/kWh; however, the hourly emissions for the NYISO region are often higher (the average emissions in July and August 2022 is 0.58 kg CO_{2e}/kWh). The difference in emissions factors may cause LL97 emission calculations to be artificially high or low and buildings may be over or under penalized. In particular, Building #4’s emissions are underestimated; therefore, the building may not be flagged as a high emitter.

Table 1: Emissions (kg CO_{2e}/ft²) estimates for 9 buildings on Benchmark 8760 for July and August 2022.

Property	Emissions Factor		Percent Change
	Hourly (kg CO _{2e} /ft ²)	Average (kg CO _{2e} /ft ²)	
1	4.94	4.98	0.77%
2	1.31	1.31	0.67%
3	27.53	27.87	1.26%
4	11.64	11.33	- 2.73%
5	15.45	15.61	1.07%
6	3.20	3.24	1.42%
7	4.57	4.58	0.67%
8	3.61	3.63	0.81%
9	0.77	0.77	0.25%

3.2 DEMAND FLEXIBILITY

Preliminary analysis is conducted to illustrate the benefit of using hourly energy use data to assess demand flexibility strategies. We utilize a load baselining method with same day adjustment to estimate each building’s electricity use [2]. Over summer 2022, five heat advisories occurred during the work week. During heat advisory buildings are often encouraged to minimize energy use to ensure grid stability. We compared the predicted electric load to the actual electric load reading to determine if the buildings conserved energy. A regression was built for each property between June 1st, 2022, and September 30th, 2022. The results are provided in Table 2.

We find a wide spread in results, indicating that buildings employ various demand flexibility strategy. For example, Building #4’s electric load reading is consistent with the values predicted during the heat advisories. Building #4 likely did not change operations nor employ demand flexibility strategies. Buildings #1, #2, and #7 decreased electric load between 10 and 14%, perhaps through energy conservation measures. However, Buildings #3, #5, #8, and #9 used more electric load than predicted during heat advisories. This is perhaps due to increasing the HVAC load for occupant comfort.

Table 2: Decrease (or increase) in electricity for 9 buildings on Benchmark 8760 for heat advisories during summer 2022.

Property	Percent Electricity Saved	Property	Percent Electricity Saved
1	10.5%	6	69.0%
2	12.6%	7	13.7%
3	- 17.12%	8	- 9.7%
4	0.68%	9	- 25.7%
5	- 20.8%		

4 CONCLUSION

In this paper, we present various use cases for a proof-of-concept hourly benchmarking platform: Benchmark 8760. Our evaluation shows that an hourly benchmarking platform may be more accurate in estimating an urban buildings GHG emissions and can provide demand flexibility insights. This is particularly important for LL97. Once the pilot program has been operational for a year (April 2023) we wish to

revisit the platform to perform an extensive analysis on the dataset. This analysis goes beyond this exploratory work to apply various next-generation benchmarking models to determine how the benchmarking scores computed differ from those calculated through Energy Star Portfolio Manager. We also plan on performing a similar task to evaluate estimated emissions under multiple scenarios that may occur under LL97.

The current limitations of New York City's building energy policy are data-driven. In the current form ESPM cannot track time-of-use energy, occupancy, or emissions data. Therefore, researchers are unable to achieve a full understanding of efficiencies and inefficiencies in the building stock. Achieving city wide deep decarbonization will require an hourly benchmarking platform, such as Benchmark 8760. If this platform is widely adopted by building managers, we expect the data to be used by researchers and policy makers. This platform may serve as an answer for the widespread call for more granular electricity data to improve and expand data-driven benchmarking models.

ACKNOWLEDGMENTS

This work was supported by the National Science Foundation (NSF) under Grant No. [1941695](#) and a NSF Graduate Research Fellowship (Andrews). We would also like to acknowledge support from Jaros, Baum & Bolles (JB&B). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the NSF or JB&B.

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