RESEARCH

C02: LINKING NYC ENERGY DATABASE TO TENANT CONTRIBUTION TO ECONOMY

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ABSTRACT

This paper presents the results of a study that links the world's largest building energy benchmarking database with the world's largest commercial tenant database to reveal trends between commercial buildings' energy use and the economic contribution that the buildings' tenants bring to the economy. Combining this information allows for an understanding of the relationship between energy consumed and the building's economic contribution, weighted by tenant types. A definition emerged to define building efficiency, called the Building Economic Energy Coefficient (BEEC) - the ratio of the economic contribution of a building's tenants to the source energy consumed. Nearly one thousand buildings in Manhattan are analyzed by building height, year built, and LEED ratings (if applicable) to begin to reveal trends in commercial building's energy use and their tenant's economic contribution. As several conclusions were highlighted from the data, this paper discusses the broader implications of these metrics, and that future studies have the potential to inform infrastructure, policy and market trends in New York and cities throughout the world.

(Keywords: energy, economy, benchmarking, efficiency, tenant, commercial)

INTRODUCTION

In 2012, New York City released benchmarking data for 2,065 commercial properties. This unprecedented disclosure was mandated by Local Law 84 (2009) and represented a major milestone for the Mayor's PlaNYC initiative and for energy policy across the nation. For the first time, a major US municipality was required to disclose private sector building energy data; in addition to basic information such as building location and floor area, the data included the energy usage metrics of Site Energy Use Intensity (EUI), Weather-normalized Source EUI, operational greenhouse gas emissions, and building EnergyStar scores.

Several key trends emerged from New York's LL84 data analysis. First, the data indicated a wide range of Source EUI for commercial buildings, with the most energy-intensive 5% of buildings reporting intensities more than four times higher than the least intensive 5% of buildings. Second, older buildings generally reported both lower EUI and better EnergyStar ratings (normalized for hours of occupancy and density) than their newer counterparts. This is counter to the perception that newer buildings, which are being designed to more stringent energy codes, more sophisticated design techniques, and often LEED standards, are using less energy per square foot than older buildings. One Bryant Park (OBP), the first LEED Platinum high-rise in the US, has a Source EUI of

362.6 kBtu/sf-yr per year, significantly higher than the median NYC EUI average of 213.3.

With these metrics now publically available, some developers and operators are increasingly concerned with above-average energy consumption and are seeking justification for increased consumption based on similarly above-average, high-intensity operations. These owners and developers are suggesting that their newer, efficient-yet-energy-intensive buildings make greater economic contributions to the city, and therefore justify their energy spends per square foot that are higher than their older, outclassed predecessors.

OBJECTIVES

Key objectives for developing these new metrics are outlined below.

"REDEFINE" BUILDING EFFICIENCY

The current prevailing energy metric for buildings – EUI – is fundamentally not a measure of energy efficiency. As the name suggests, the Energy Use Intensity reflects the energy consumed per square foot of building area, rather than a ratio of energy outputs relative to inputs. EnergyStar attempts to approximate building efficiency by normalizing EUI, but it is still a metric that is associated with intensity of energy use and should not be used interchangeably with efficiency.

Traditional measures of energy efficiency compare units of usable energy out (electricity, heat, etc.) per units of fuel consumed. In developing a measure for building efficiency, the inputs – electricity and other energy consumed – are clear; the challenge is establishing the best "outputs" against which to measure. This study defines building output as the combined economic contributions of a building's tenants. The resulting metric is intended to represent a new definition of commercial building efficiency: the relative economic contribution of a building per one unit of energy.

ENRICH "TRIPPLE BOTTOM LINE" CONVERSATIONS

The "triple bottom line", coined by John Elkington in 1997[i], has provided the framework for conversations around sustainability at every scale, facilitating new discussions around the environmental, economic, and social impacts of everything from consumer products to new city blocks. At the building level, 'economics' have focused on capital and operational costs. The economic bottom line in regards to the economic 'output' of buildings has received minimal attention in the building industry.

CONTRIBUTE TO "CLASS C TO A" REAL ESTATE REPOSITIONING, ZONING, AND DENSIFICATION DEBATES

Class B and C buildings are more likely to house lower-rent tenants, with less intense energy demands and more standard business hours. In this light, it is unsurprising to see that on a per square foot basis, LL84 showed that newer buildings (which one can read as 'more desirable') on average consume more energy. The relationship between these pieces – the economic contributions of the building's tenants and its energy consumption – is what this metric seeks to define.

FACILITATE MEANINGFUL, WELL-INFORMED POLICY DISCUSSIONS

Create the potential to shape the city's development and ensure that energy efficiency and low carbon policies are sufficiently nuanced and account for the critical relationships between building energy and economic impact.

METHODOLOGY

DEFINING ECONOMIC CONTRIBUTION AT A BUIDLING SCALE

Traditional metrics for quantifying a building's economic value generally reflect the building's value to its owner or a prospective buyer, such as sale or replacement value, net operating income, or average rental rates. While there are many financial tools available to assess these factors – and establish the building's inherent value as an investment – none reflect the building's value in terms of contribution to the local economy. In beginning to consider a building's contribution in this sense, the closest existing metric is a property tax assessment, which considers the building's value to its owner and establishes what is owed as a proxy for the various municipal services provided to the building and its occupants. To understand the economic "value-add" of a given building, a new metric that accounts for not only property value but also tenant output is needed.

BUILDING ECONOMIC INTENSITY INDEX (BEII)

The BEII is a metric that quantifies a building's relative contribution to the economy based on the mix of tenants it houses. The higher the BEII, the more favorable (i.e. the more economic contribution a building's tenants generate for the economy). The following outline describes the general process for mapping economic contribution to tenant use type but is not intended to divulge the entire proprietary methodology.

To identify economic impact associated with specific buildings; this study uses the largest Commercial Tenant Database (CTD) for New York City[ii], which quantifies tenants and tenant types, areas and occupant industry, identified by Standard Industrial Classification (SIC) codes. Utilizing tenant data from December 2012, each SIC code has been assigned an economic metric based on GDP per employee for that sector at state level. The metric takes into account multiplier impacts (indirect and induced benefits) to provide a further indication of the overall economic contribution that industry sectors generate at a local level.

Each building tenant type (based on SIC codes) is assigned an economic intensity that represents an index of their industry sector's relative economic contribution. The data set includes both single tenant-type buildings (i.e. similar SIC codes), as well as buildings with hundreds of tenant types. The Empire State Building, for example, has over 260 listed tenants within the CTD. This preliminary study looks at only information on Manhattan buildings over 50,000 sf where both LL84 and CTD data are available.

A building BEII was calculated by weighting the BEII for tenant types by the proportion of building floor-space they occupy.

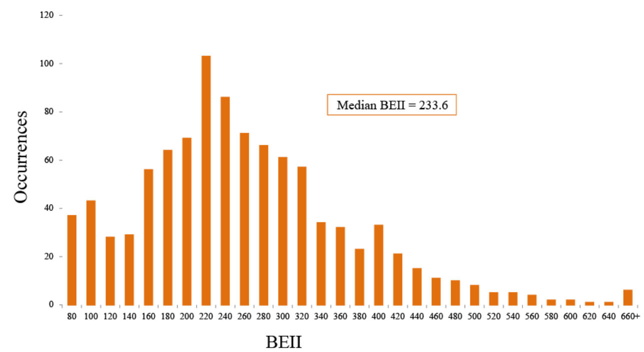

Figure 1. Histogram of Building Economic Intensity Index (BEII)

Ultimately a BEII was established for 801 buildings in Manhattan. Figure 1 shows a wide range of BEII for commercial buildings, with the median BEII as 233.6.

BUILDING ECONOMIC ENERGY COEFFICIENCT (BEEC)

The BEEC is the ratio of BEII to Weather-normalized Source Energy Use Intensity (EUI). This metric quantifies the relative economic contribution of a building per one unit of source energy. The higher the numerical value, the more favorable (i.e. the more economic productivity a building's tenants contribute to the economy per source energy that building consumes). Combining the recently released LL84 data with tenant datasets allows for an understanding of the relationship between energy consumed and the weighted economic productivity of the buildings' tenants. With this understanding, building efficiency can be redefined: economic contribution out per unit of energy in. Figure 2 shows a wide range of BEEC for commercial buildings, with the median BEEC of 1.2.

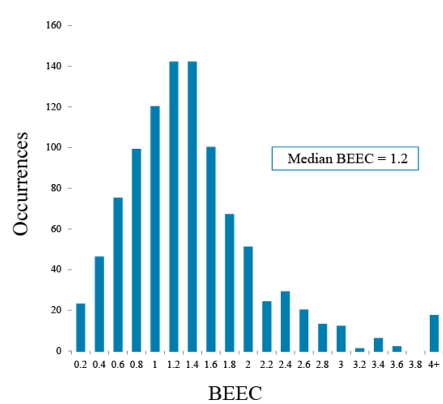

Figure 2. Histogram of Building Economic Energy Coefficient (BEEC)

CLARIFICATIONS

THE IMPORTANCE OF TRANSPARENCY

The mandatory benchmarking and public disclosure through LL84 made this study possible and was a catalyst for discussions about the economic and energy metrics in buildings.

WEATHER-NORMALIZED SOURCE EUI AS A DENOMINATOR

Site EUI is given in LL84, but is less encompassing than weather-normalized Source EUI, accounting for none of the transmission, delivery, and production losses that occur. The EnergyStar score is not applicable for several buildings in New York City and many high-profile buildings, such as OBP, do not have disclosed EnergyStar ratings.

BEEC IS NOT NORMALIZED BY OCCUPANT DENSITY

Building occupancy was included within the CTD, but it was acknowledged by the company that occupancy data was at a significantly lower level of accuracy than the tenant area data used in this study. There is also a general uncertainty by property owners in accurately accounting for population in commercial buildings due to frequent changes and inaccurate disclosure from tenants themselves.

OTHERS CLARIFICATIONS

- There has been no formal scrubbing of the data sets.
- Economic metrics were developed based on publically available GDP information, with tenant data directly from the third-party database.
- The data for BEII and BEEC has removed approximately five percent of outliers. Proposed future work would establish a representative sample set of ten to twenty commercial buildings in New York and provide more specific data review and tenant investigation.

DATA SETS AND REPRESENTATION

The original data set comprised all buildings greater than 50,000 sf, as required by LL84. Residential buildings were then removed, as not applicable to this study, as were the few buildings located in boroughs other than Manhattan, the study area. Many more were excluded because the properties, for multiple reasons, did not submit LL84 data.

BEII TO WEATHER-NORMALIZED SOURCE EUI

Figure 3 shows the relationship between BEII and Weather-normalized Source EUI. For the dataset studied, a loose correlation exists between the energy consumed in a building and the economic contribution of that building's tenants. This suggests that as buildings use more energy per square foot, they are increasing their economic contribution. In short, the energy being consumed is leveraged towards more economic benefit.

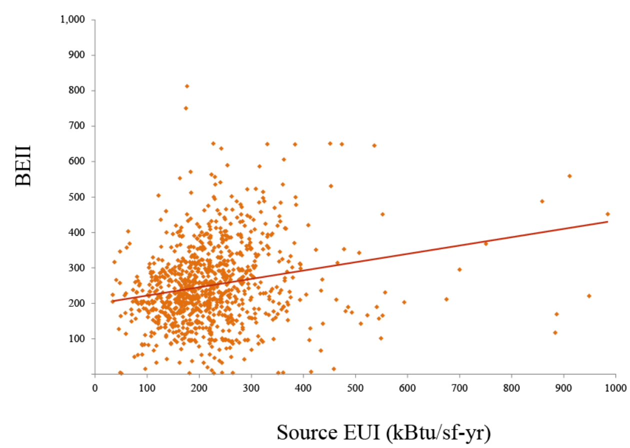

Figure 3. BEII to Source EUI.

BUILDING HEIGHT

How do the energy, economic and 'efficiency' metrics vary with building height? This question is particularly salient when considering tall buildings; as the highest floors tend to generate significantly more rental income than the majority of the building, a building with multiple floors fetching premiums – and as a result, leased by high-intensity tenants – might have further implications for the building energy economic output analysis. "Floors" was pulled from recently released data PLUTO data and will be used interchangeably with 'height' for this analysis.

Three graphs are shown below that analyze three separate metrics against building height in buildings: Source EUI in Figure 4, BEII in Figure 5, and BEEC in Figure 6.

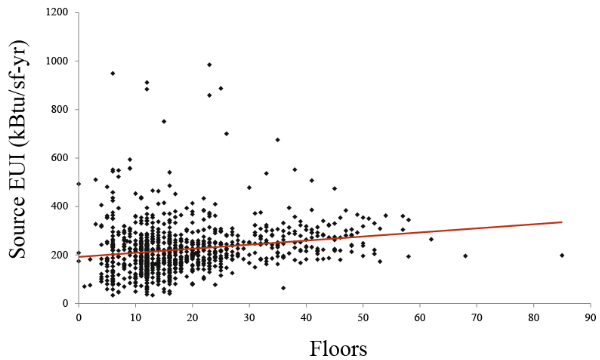

Figure 4. Source EUI v Floors

Figure 4 shows a graph for Weather-normalized Source EUI compared with building height. One would expect that taller buildings housing more 'intensive' tenants would generally have higher EUI scores. The trend line supports this, and although just slightly increasing, shows a direct relationship between height and energy intensity.

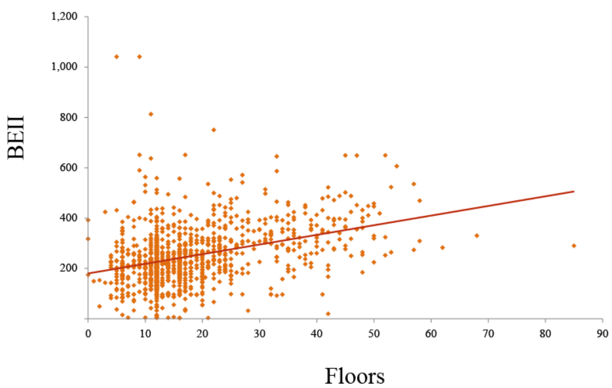

Figure 5. BEII v Floors

Figure 5 graphs BEII to building height. A trend line indicates the 'best fit' for median BEII to building height as increasing with building height. The upward trend supports developers' speculations that taller buildings tend to house tenants that provide greater economic contribution. Studies have shown taller buildings attract higher lease rates and house higher salaries on average, but the above graphs shows a direct relationship between building height and a building's tenants' economic output based on tenant type.

Do taller buildings offer more economic impact per source energy consumed for New York? If we accept the redefined term for building efficiency (by way of the BEEC metric), are taller buildings more efficient? Combining the 'economic' metric of BEII and the 'energy' metric of EUI, Figure 6 shows BEEC vs. building height. This trend line appears to show no direct relationship. This is expected, as both energy intensity and the economic contribution are greater for taller buildings.

The authors aim to gain more understanding on the relationship between densification (building height) and economics of these buildings. One way is to expand the database outside of Manhattan and understand BEEC trends of less dense areas than Manhattan. If taller buildings generate more economic contribution for every unit of energy they consume, than this would be a direct argument for densification, beyond the several traditional defenses today. Currently, this trend is not supporting this argument and the author's presuppositions about densification are not supported.

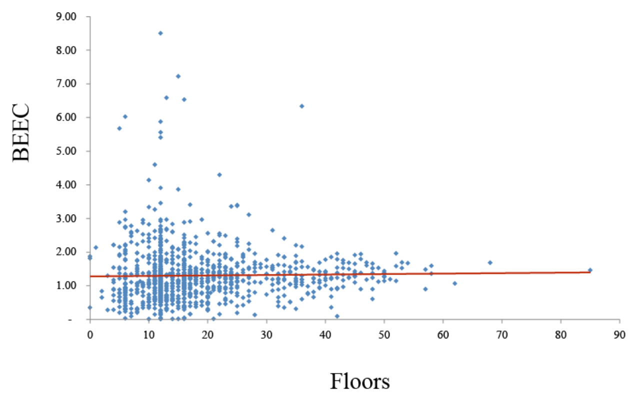

Figure 6. BEEC v Floors

AGE

One of the key trends that emerged from LL84 is that older buildings generally reported both lower EUI than their newer counterparts, as shown in Figure 7.

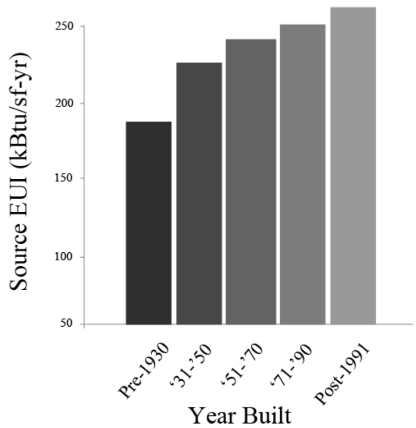

Figure 7. Median Source EUI by Age Group for Office Buildings from LL84 Report

Figure 8 shows the relationship between average BEII and age, using the same age groups as used in the LL84 report. One would expect that as buildings became newer, that their tenants would contribute more to economy than their older predecessors. However, this is not the case.

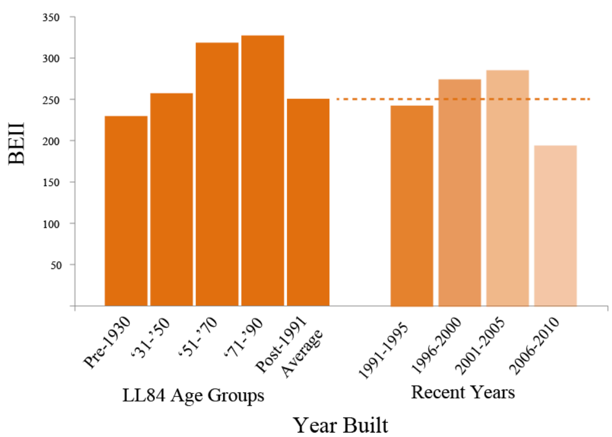

Figure 8. Average BEII v Age

The Figure breaks out the Age Groups that were included within the LL84 Report, as well as the more recent years to assess any trends within the last two decades. Although the data is not showing clear linear trends, overall, it is surprising to see that newer buildings (built between 2006-2010) are on average housing some of the least contributing tenant types within the city. Before clear conclusions can be drawn, the authors have proposed more in-depth analysis into the tenant composition of the buildings in this set.

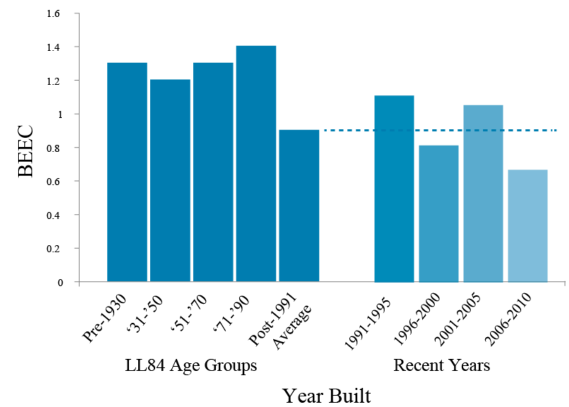

Figure 9. Average BEEC v Age

Similarly, the Average BEEC is trending well below historical averages for buildings built after 1991. This is also a surprising trend. Intuitively, one would have expected that newer buildings would have attracted higher-contributing tenants. This is due to the general increased energy intensity of newer buildings, and the findings from the BEII graphs in Figure 8. The general trends in this set suggest that newer buildings, especially those built after 2006, are less efficient than mid-century buildings.

LEED RATINGS

Although the information on LEED certified buildings in the dataset was limited, the authors graphed the relationship between both BEII and BEEC to LEED Ratings (NC and CS only), publically available from the USGBC.

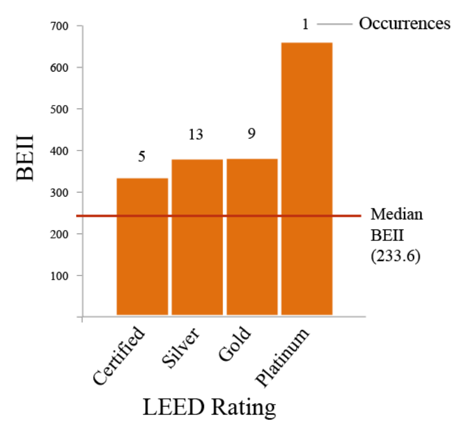

Figure 10. Average BEEI v LEED Rating

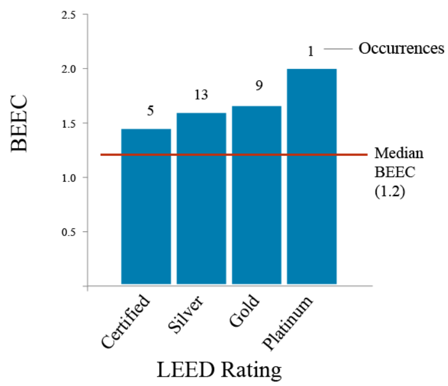

Figure 11. Average BEEC v LEED Rating

Although too small a set to be statistically relevant, the trends of the graphs are clear: that both the economic contribution and the efficiency of the buildings increase with increased LEED rating. The Platinum building is represented by One Bryant Park, which has, of late, been under extreme attack in the media because of its high energy intensity. It is also worthwhile to note that the average BEII and BEEC for all LEED buildings, and at every certification level, is significantly above the median values.

Despite the minimal occurrences of these buildings in the data set, one can begin to correlate that LEED building's tenant types contribute on average, more than non-LEED buildings; and overall, LEED buildings are more efficient than non-buildings. This would speak to the notion that LEED buildings in general attract an economically higher- contributing tenant type and the relationship between the BEII and Source EUI (BEEC) is more favorable.

CONCLUSIONS

Whether the BEEC can be used as more than a novel metric remains to be seen; this study was made possible by the availability of both the Local Law 84 data and a substantial, highly accurate commercial database of building tenants. Given the trend towards similar energy disclosure policies in other major cities, it will be possible to complete similar analysis for San Francisco, Philadelphia, and others in coming years. In the meantime, the results of this study can be used to spur a broader conversation about the relationship between economic and environmental impact, and how that relationship should influence the City's energy policies by providing a better understanding of the relationships between energy consumption and economic output.

Take for example, a high-intensity building for which no EnergyStar score can be calculated – a building which is undoubtedly more energy intense than the average commercial building but is contributing greatly to the city's economy.   If a local energy law of the future requires all buildings to achieve a minimum EnergyStar rating or limits their EUI, a high intensity building will be impacted differently than less intensive buildings. It is critical that in defining the direction of the City's growth, an energy policy does not accidentally provide a disincentive for high-intensity, economically high-contributing tenants and in doing so, drive owners and their tenants out of New York City to smaller markets.

In addition to identifying trends and relationships between economic output and energy consumption, parallel studies could assess densification arguments. It is challenging to make zoning arguments for higher densifications (increased floor area ratio) without understanding the balance between the economic impacts of the buildings and their environmental impact. One might conclude that on an environmental basis, the city has little to gain through zoning changes that would facilitate the replacement of Class B building stock with Class A.   However, this is clearly not the case: cities – and particularly high-density cities – are inherently lower impact than their suburban or rural counterparts.

Those taller buildings will bring with them far greater economic benefits than the older stock they are replacing. The relationship between these pieces – the economic contributions of the building's tenants and its energy consumption – is what this metric seeks to define. This paper presents the relevance of this metric; future work will be needed to provide more statistical analysis and an expanded dataset, including a focused analysis of small sample set of buildings, in which the authors can capture more accurate tenant use and energy information.

The authors have also begun to analyze building trends with respect to age and geographic location and have pulled data from the set on various trends in tenant types. These have not been presented here, but will be discussed during presentation materials at Greenbuild.

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