What Drives Energy Performance Scores: Benchmarking NYC High Rise Building Stock

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ABSTRACT

In the New York City commercial real estate market, large building operators have a dramatic impact on buildings' energy performance. With identical technology and systems in two different buildings with similar space uses, the efficiently operated building can run at 20-30% lower energy intensity. A recent initiative has assembled energy consumption benchmark data and other characteristics on a large sample of buildings owned or managed by leading New York area firms, which has provided a forum for sharing and discussing best practices toward continuous improvement in building energy performance.

A variety of lessons have been learned through the effort. Confidentiality of data is a real challenge, as is ensuring that all meters/energy use is captured for benchmarking. A variety of sometimes hard to detect changes, such as building occupancy patterns, vacancy of spaces, and addition of energy-intensive equipment, often have far greater impact on the energy performance than any energy-efficiency changes. Analysis of these drivers is important for understanding whether energy performance is improving or getting worse.

A valuable set of building performance data has been collected covering over 90 million square feet. Analysis of this data yields important insights into the impact of building operations, age, occupancy, equipment, and efficiency measures on overall energy consumption patterns. This paper will analyze the data and present the mix of buildings' physical and operational characteristics, their impact on energy consumption, and opportunities for further enhancements of energy performance across a range of larger commercial buildings in New York City.

Introduction

The energy benchmark data collection began in 2007 as part of a project is to promote the adoption and implementation of whole building energy performance improvements in the New York commercial buildings market. One component of the project was to establish a peer exchange network of operations staff from leading firms, and encourage energy benchmarking of commercial office properties and sharing results. The effort was begun by soliciting participation of industry “opinion leaders” who were willing to provide energy performance data on their buildings to kick off the New York benchmarking database.

The commercial buildings market is very complex, with a wide variety of important decision-making groups. Building owners and managers have a great impact on decisions about building energy use, though building occupants (often tenants in rental properties) and other entities may hinder or stimulate more interest in building energy performance improvement. Building operating staff also wield significant influence in how a building performs.

Using the benchmark data, the team hoped to build a peer exchange benchmarking forum. In the New York market, large building operators, generally led or supervised by the building "Chief Engineer" or Director of Engineering, have a dramatic impact on a building's energy performance. Anecdotal evidence suggests that in two different buildings with similar space uses and identical technology and systems, the efficiently operated building can run at 20-30% lower energy consumption (by energy intensity per square foot), with a resulting 10-30 point increase in the building's ENERGY STAR rating score.

The commercial buildings sector in New York State currently consumes about 74,000 GWh of electricity per year, using 460 trillion BTU of all fuels. The commercial buildings sector has seen a 3% increase in electricity consumption between 1994 and 2007 (NYSERDA 2009). The downstate/metro New York City stock of existing commercial buildings over 100,000 square feet, the principal target market for the proposed effort, accounts for almost 50% of this statewide total.

The New York City metro region contains more than 650 million square feet of office space, approximately 16.6% of the U.S. total, far in excess of the region's 6.6% share of the national population (Kelly 2002). In particular, the Manhattan Midtown and Downtown commercial districts comprise over 323 million square feet and 91 million square feet, respectively (Studley 2010). The peer exchange portions of this project (outlined below) specifically aim to reach that portion of the market by stimulating activity among perceived market leaders who can draw in participation by others who do not want to be left at a competitive disadvantage. The top five property managers in New York City manage over 134 million square feet; giving them the opportunity to match the performance of their more innovative peers is a significant motivator amidst the split incentives of rental real estate and may well outweigh the cost savings that might be achieved through a building performance initiative.

The project assembled energy consumption benchmark data and other characteristics on a sample of buildings owned or managed by several leading New York area owner/management firms, and became an informal network for sharing and discussing best practices toward continuous improvement in the building energy performance.

Methodology

The primary source of data for this study was energy billing data and physical building characteristics data derived from ENERGY STAR's Portfolio Manager. Portfolio Manager is a benchmarking tool that building owners and/or managers use to track the energy and water consumption of their buildings. With the cooperation of several major building owners and management companies, we were able to access the Portfolio Manager data for over 100 buildings in Manhattan, with floorspace totaling approximately 90 million square feet.

The physical characteristic data available through Portfolio Manager included square footage, year of construction, and fuel types used. Portfolio Manager also collects raw monthly energy billing data, by fuel. In order to use the billing data for energy comparisons among buildings, we normalized the data for each building. First, we normalized by billing cycle, so that the monthly data went through the end of each month. Next we converted all the fuel data to Btu's so that the total energy across all fuels could be compared. Finally, we divided total energy use by square footage, so that larger buildings would not be penalized for their correspondingly larger energy consumption. This resulted in a metric that could be compared across all buildings: energy use intensity (EUI).

Several data quality issues arose through this process. First, although the energy billing data was generally robust, the amount of data available varied by building. Some buildings had several years of data, while others had only a year (or in a couple of cases, even less) available. Because of the wide variations, we divided the data into two subsets. The smaller subset (Subset A) consists of several buildings from two building owner/managers, with comprehensive data. The larger dataset (Subset B) is made up of the remaining buildings. For many of the buildings in Subset B, the only data available is a year or so of energy billing data.

For Subset A we were able to do an annual rolling average EUI comparison over the span of several years. For Subset B, we calculated the average annual site and source EUI's for each building. Due to the varying degrees of completeness of the data, as many full years of data as were available for each building were included in calculating the averages (this varied from 1-9 years of data). In keeping with Portfolio Manager's requirement that any building to be benchmarked requires at least one full year of energy consumption history, data from several buildings were discarded because they had less than 12 months of consecutive data for all of their fuel sources.

As a result of the two approaches to the different subsets of data, the data quality differed for different buildings; Subset A allowed for more rigorous analysis, while Subset B provided the deepest dataset. A combination of the two approaches would have been ideal, but was not possible with the available data.

A second data quality issue revolved around the reported square footage of the buildings. While Portfolio Manager is clear about the definition of floor area to be used for benchmarking/normalization, the reality in the expensive NY real estate market is that obtaining consistent floor area data is challenging, as owners and brokers often inflate floor areas through industry agreed "loss factors," and these loss factors change over time, resulting in buildings having their "rentable floor area" grow as leases expire, even though there are no physical changes to the building structure.

The difficulty in understanding floor areas was highlighted in a story in NYC's principal business weekly newspaper: "Two years ago, a Japanese cosmetics company began talks to renew its lease for 14,500 square feet of office space on Manhattan's Third Avenue. Over the following eight months, the amount of space under negotiation grew first to 15,000 square feet and finally to 16,300 square feet... The tenant never moved, and the floor never changed." (Crain's NY Business 2006).

We found that comparing the reported square footage of the buildings among 3 different sources resulted in a large variance, thereby impacting the accuracy of the derived EUI's. The three sources we used were Portfolio Manager, MrOfficeSpace.com, and the New York City PLUTO database. The Portfolio Manager data is controlled by the building owner/manager, who is responsible for inputting the building size correctly to the best of their knowledge. MrOfficeSpace.com is an online database of larger New York City office buildings compiled by Yale Robbins, Inc, based on data supplied by owners and leasing agents. PLUTO (the "Primary Land Use Tax Lot Output") is a database of buildings at the tax lot level, compiled and regularly updated by the New York City Department of City Planning (2009). It includes the building area and type used for tax purposes.

For the purposes of this study, we used the data reported by the building owners in their Portfolio Manager inputs, because it was available for all buildings (whereas data for some buildings were unavailable through PLUTO and MrOfficeSpace.com). However, there is an inherent margin of error due to the potential inaccuracies of the square footage data.

Results

Different approaches to the analyses were used with different subsets of the building data, due to the wide variation in the completeness of the data points available. With Subset A, two building owners/management firms in particular were able to provide comprehensive, robust data for 16 buildings (totaling about 15 million square feet) via Portfolio Manager and interviews. For instance, most buildings in this smaller dataset had 5 years of energy use data available through Portfolio Manager, whereas for Subset B in many cases less than 2 years of data was collected. However, Subset B is important in that it contains a substantial cross-section of large office buildings in Manhattan, comprising nearly 100 million square feet of commercial real estate.

With Subset A, we were able to analyze the rolling average EUI over several years. The analysis is particularly robust because we were able to take annual total energy use in successive 3-month increments to accurately gauge the change in energy consumption over several years. During the analysis we reviewed and tracked both “site” and “source” EUI; *source energy* includes the energy consumed at the building itself—or the *site energy*—plus the energy used to generate, transmit and distribute the site energy. For this paper we chose to show all data as source EUIs, as that is the basis for the Portfolio Manager score. The source EUI is shown for both owners in Figures 1 & 2.

The trendline in Figures 1 & 2 is weighted by square footage, so it more accurately reflects the overall trend of energy consumption by the collection of buildings. Figure 3 shows all the buildings together on one chart: Owner/Manager 1 in red, Owner/Manager 2 in blue.

The comparison of the two owner/managers also draws attention to patterns such as the volatility of energy consumption by Owner/Manager 1 versus the relative stability of the energy consumption by Owner/Manager 2. Owner/Manager 1 manages several headquarters facilities for major financial services firms, some of which were sold or closed during the recent financial crisis (this is the reason why buildings A & C don’t have recent data -- they’re no longer managed by Owner/Manager 1). Because Owner/Manager 1’s financial services headquarters facilities include significant data centers, and in some cases, trading floor space, those buildings have notably higher EUIs than any buildings in Owner/Manager 2’s portfolio, which consists of more traditional high end office space (including corporate headquarters facilities, though not as data intensive).

Figure 1. Owner/Manager 1: Rolling Average Source EUI

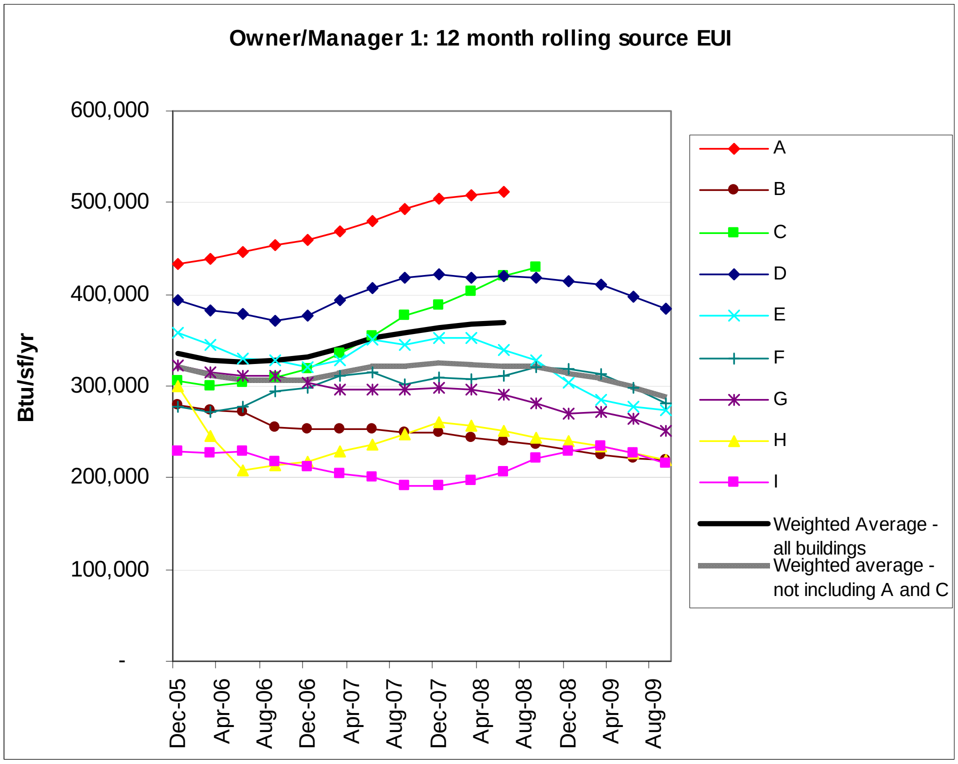


Figure 2. Owner/Manager 2: Rolling Average Source EUI

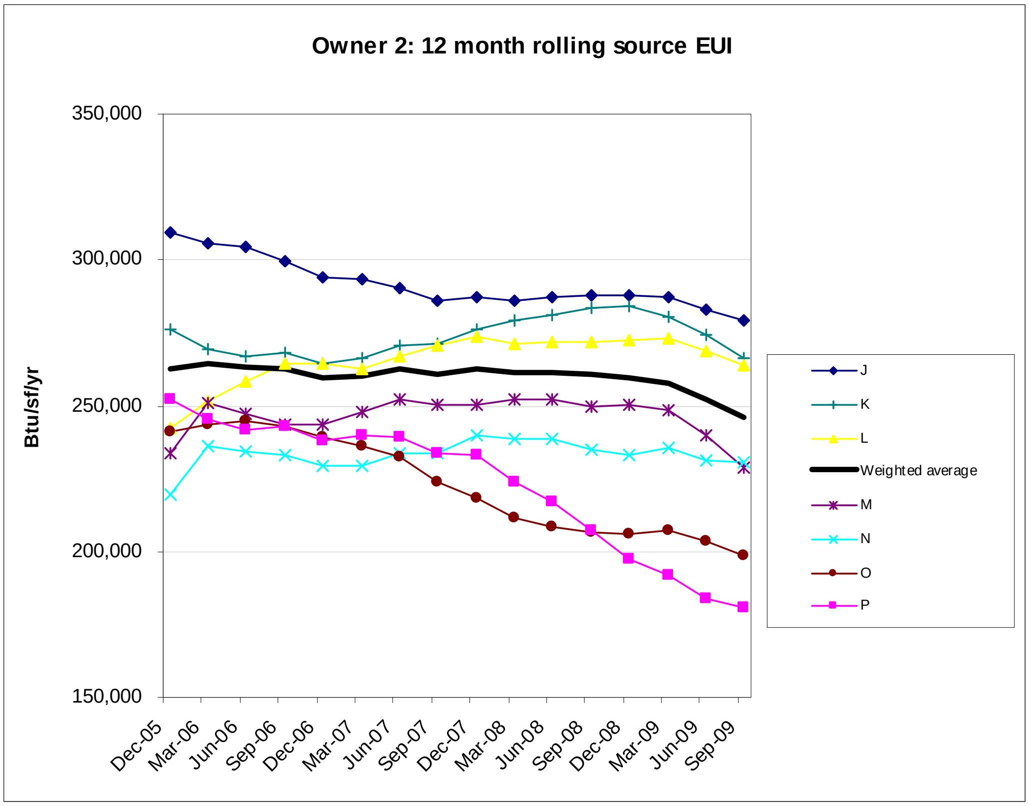
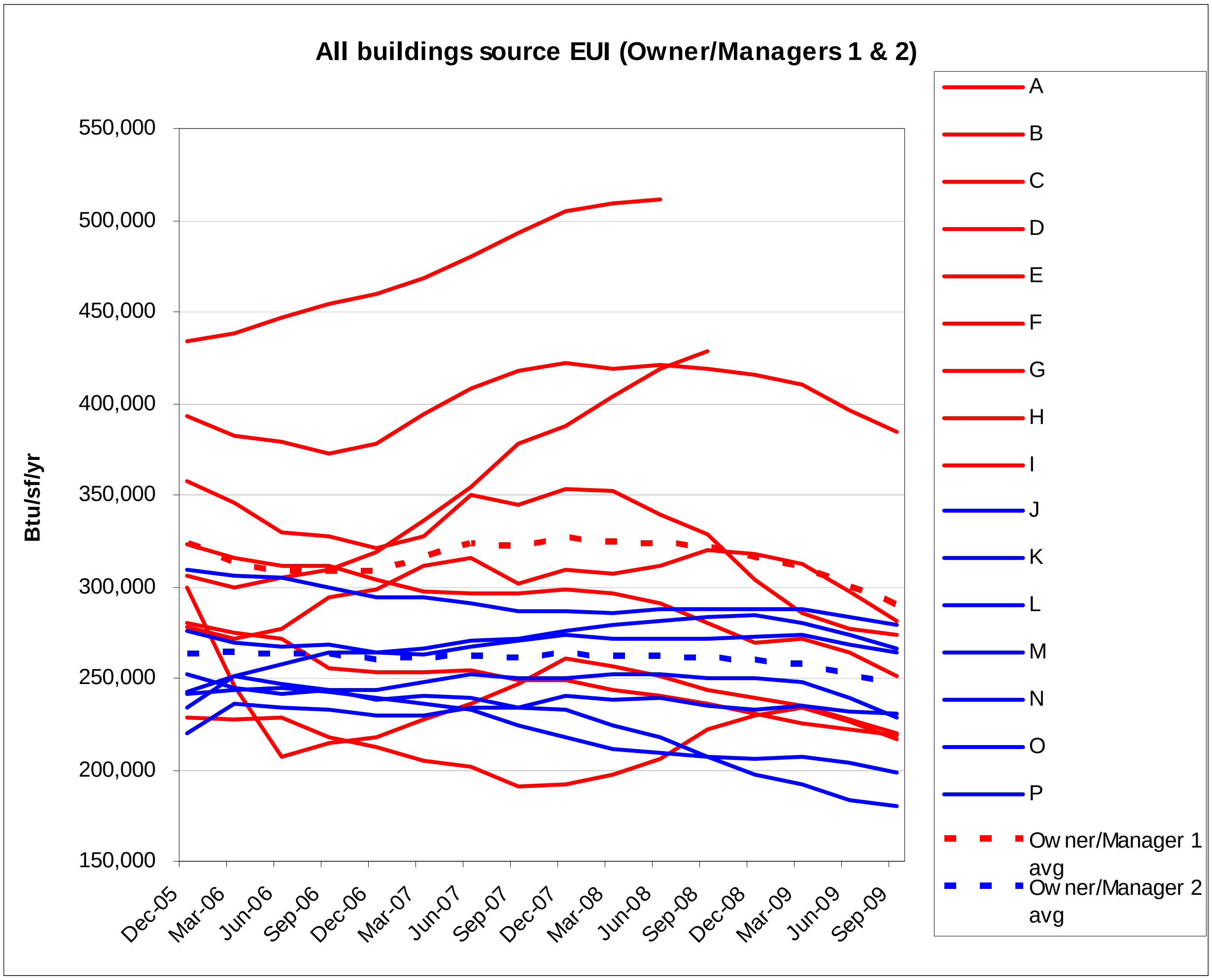
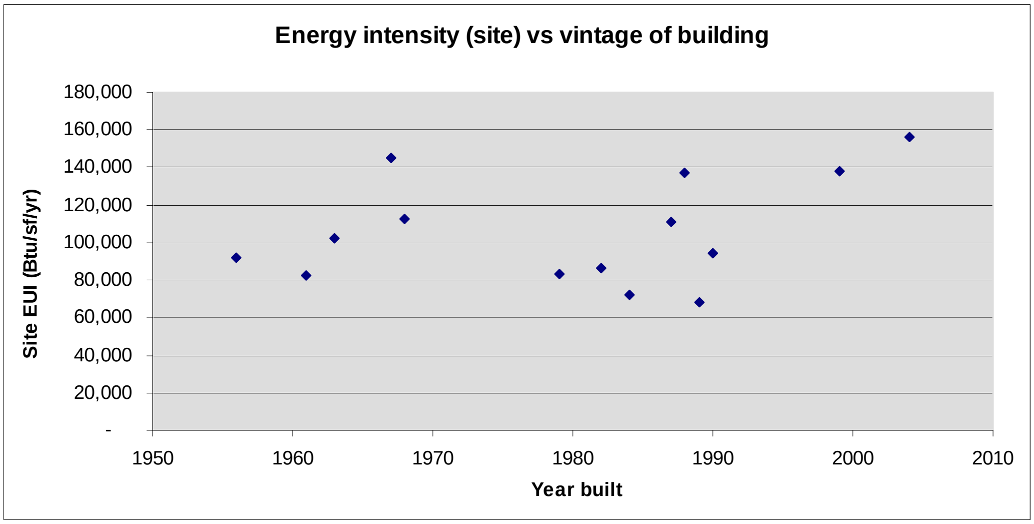


Figure 3. Rolling Average Source EUI for Both Owner/Managers



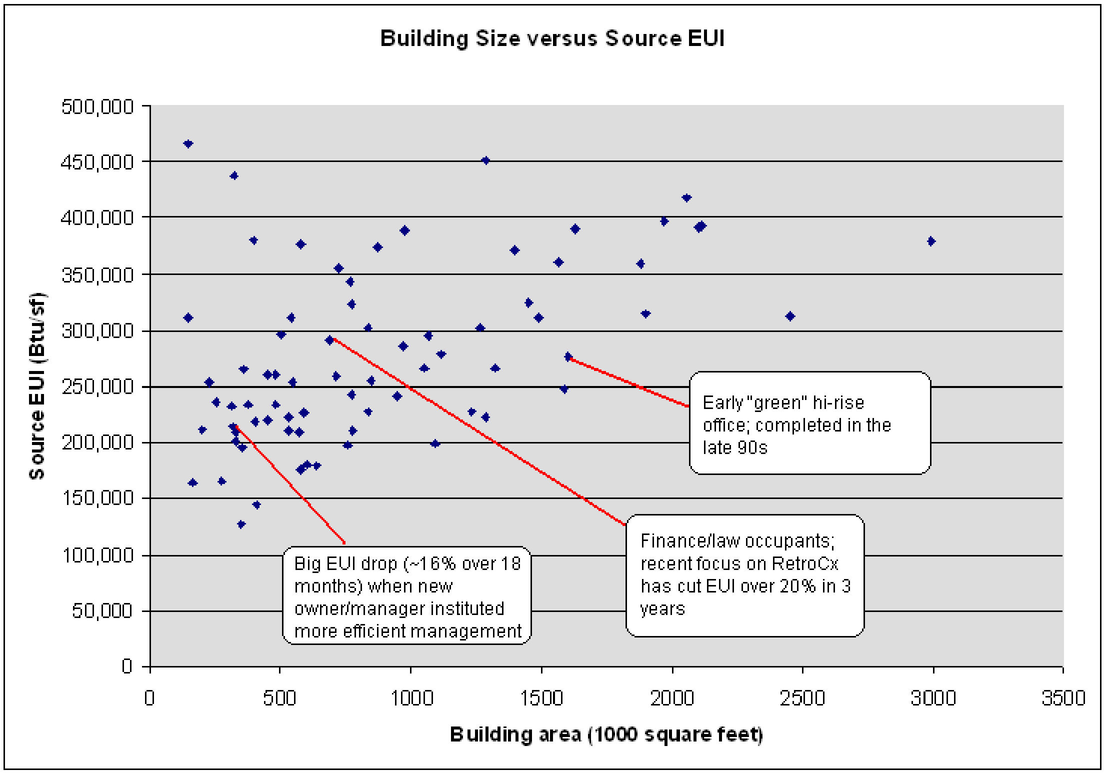
In addition to analyzing EUI over time for this dataset, we also assessed the contribution of other factors in determining EUI. This included the impacts of fenestration ratios, building vintage, and chiller fuel type. Figure 4 shows the impact of building vintage on site EUI. Unfortunately, this analysis, along with the others listed above, showed no statistically significant trend.

Figure 4. EUI versus Building Age



The larger dataset, Subset B, made up of over 100 buildings and over 90 million square feet of commercial real estate, gives a broader picture of energy consumption in large office buildings in Manhattan. Although there were some difficulties in cross-comparisons with the diversely reported data, we were able to look at the correlation between building size and EUI (see Figure 5). With the exception of several buildings, there is a distinct trend toward higher EUI as building size increases.

Figure 5. Building Size versus Source EUI



Discussion

Shortly after this project launched, New York City Mayor Michael Bloomberg announced his “PlaNYC 2030” initiative in April 2007, which promised to have significant activities aimed toward existing buildings in response to the first City emissions inventory showing that buildings represent 79% of City greenhouse gas emissions (PlaNYC 2007). As a result, building owners and managers became much more interested in benchmarking and data on more buildings than originally expected became available.

In December 2009, a mandatory benchmarking and disclosure bill was passed by the New York City Council, which will make benchmarking of all buildings in NYC over 50,000 square feet mandatory beginning in 2011, with public disclosure of the benchmarking results made available through the City Department of Finance website starting in 2012. Requiring periodic benchmarking and public disclosure of building energy performance can be a strong motivator to owners to measure and track that performance. The prospect of public disclosure of the energy performance has led some prominent owners of prime, high- performing (beyond average energy or environmental performance) buildings to understand current energy use and benchmark scores, and there are a few examples of substantial reductions in energy use in advance of any public disclosure. Unfortunately, these owners and their tenants are hesitant to discuss the reductions, as they perceive the less than great energy performance to be a sign of poor operational experience. Ongoing reductions will be easier to measure over time.

As can be seen in the results presented, there are very wide differences in EUI, often for buildings with very similar characteristics and tenants/usage. Teasing out the reasons for the differences was more challenging than anticipated, as it was very difficult to get the level of information on all of the buildings we’d hoped to have for a “CBECS” type of comparison based on specific characteristics. CBECS (the Commercial Buildings Energy Consumption Survey) is a comprehensive national survey of commercial buildings characteristics and energy consumption conducted by the Energy Information Adminstration (EIA). Gathering consistent data on the percentage of glass in the building envelope, chiller/AC system type, and other characteristics that seemed to be particularly relevant, was challenging, and for the buildings where data was available gave counterintuitive results. For example, initially it appeared that EUI vs. building vintage (year of construction) would have some correlation, and it does for some individual owner/managers, but when all of the data were lumped together the correlation fell apart.

What was very telling from the “longitudinal” data, where EUI was tracked on the rolling 12 month averages, were specific stories about different buildings. A few of these stories are:

- For owner/manager 1, three buildings (B, D & G) are principally occupied by a major financial services firm that had made public carbon reduction commitments. This occupant firm had never paid tremendous attention to energy cost savings before, as energy is such a small part of their “cost of doing business.” When the CEO and top management had made public commitments at high profile events (through the Carbon Disclosure Project), the Corporate Facilities executives needed to show real results, and track progress. The three highlighted buildings all went through a pilot retrocommissioning program, and quick payback projects were instigated during the last two years. Those three buildings have been the largest contributor to owner/manager 1 having dropped the weighted average source EUI by 11% from June 2008 to September 2009.

- Three buildings in Owner/Manager 2’s portfolio (buildings J, N and P) had more recent drops in their EUI, but this was more due to lower occupancy in those buildings as tenants moved out, as opposed to any efficiency improvement. That said, Owner/Manager 2’s portfolio operates at 15-25% less than other owners’ buildings that have similar types of tenants (principally law firms and publishing).
- Among the buildings in Owner/Manager 1’s portfolio, Building I stands out for maintaining the lowest EUI. From mid-2006 to late-2007, the building’s EUI dropped by approximately 16% in response to a greater emphasis on more efficient building management. In the spring of 2008, the project team interviewed the Building Engineer about the building’s energy performance and recent efforts to capture significant savings through improved O&M practices. It was clear from our discussions that the Engineer took the initiative to ferret out opportunities for energy savings and make the changes necessary to capture energy savings, in some cases implementing fixes to address idiosyncrasies in the design of the building and/or building systems. With the support of the owner/manager and his own desire to get his building to “run like a hot-rod,” the Engineer and his team reduced building energy use significantly without major capital outlays.

As described earlier, one of the issues with data quality was the conflicting data on building size. Table 1 illustrates the discrepancies in the square footage reported by 3 different sources. Even the smallest of these discrepancies is significant enough to make a substantial impact on EUI.

Table 1. Comparison of Building Floor Area from Different Sources

Building ID	*Building area (1000 SF)*						
	Portfolio Manager - Total area	MrOffice Space.com	PLUTO database	∆ from PM to MrOffice		∆ from PM to PLUTO	
				Sf	%	sf	%
1	1,286	1,221	1,175	111	9.5%	46	3.9%
2	1,626	1,346	1,028	598	58.1%	318	30.9%
3	315	282	268	47	17.4%	14	5.2%
4	309	289	268	40	15.0%	21	7.7%
5	714	700	628	86	13.7%	72	11.5%
6	683	580	561	122	21.7%	19	3.4%
7	1,392	1,225	1,141	251	22.0%	84	7.3%
8	971	1,056	1,040	(68)	-6.6%	16	1.6%
9	591	658	565	26	4.6%	93	16.5%
10	713	790	735	(22)	-3.0%	55	7.5%
11	377	425	380	(3)	-0.7%	45	11.8%
12	400	428	405	(5)	-1.3%	23	5.6%
13	1,600	1,724	1,643	(43)	-2.6%	124	7.5%

Findings

Confidentiality of data is a real challenge; owners are very uncomfortable about the prospect of having data on their particular buildings become public. The only way to publicly present most data is blind, in a big enough set that any particular building or owner is masked.

Being certain that all meters/energy use is captured for benchmarking is a challenge; in developing a "Best Practices in Benchmarking" case study for a training session of key partners, we assumed that since building G had been benchmarked by several reputable firms, the numbers were correct/complete. It was challenging to explain to the owner and others that the information was not correct, and was very time consuming trying to confirm the actual total electricity usage. Professional judgment about how deep to dig is key.

The prospect of mandatory benchmarking in NYC as a result of PlaNYC has raised the level of interest and awareness; the level of benchmarking activity and the resulting understanding of energy performance levels has grown exponentially since PlaNYC announcements. Even the prospect of mandatory requirements or new regulations has driven significantly more activity than ever before.

A variety of sometimes hard to detect changes, such as building occupancy patterns, vacancy of spaces even though rent is being paid, and addition of energy intensive equipment, may have far greater impact on the energy performance than any energy efficiency changes. Learning about these changes is very time consuming, but the information is important to understanding whether energy performance is improving or getting worse. Finding ways to improve data collection tools to better capture information on these kinds of changes as well as greater details on the full range of operational changes and maintenance tasks completed without undue commitments of time and resources would be very beneficial.

Building operating staff are a critical element in any effort to improve building energy performance. The chief operating engineer is responsible for implementing any changes to O&M practices and working with any new equipment installed; the operating staff also has the clearest picture of how the building is functioning for the building occupants. As such, operators can support or kill energy efficiency initiatives; finding, training, and retaining the right person with the right attitude and skills is critical. Efforts to develop "pride of ownership" among building operators through professional development opportunities, certifications, and awards/recognition can pay off. For example, a city-wide "Operator of the Year" award granted by the city and the real estate industry would provide recognition of the valuable role building operators play as professionals helping generate returns for their employers and reduce the environmental impact of building operations. Owner/managers could recognize leading operators within their portfolios as finalists for the city-wide award, creating additional opportunities for recognition and incentive for continuing education and improved job performance.

Conclusion

While benchmarking buildings and using the data to drive performance sounds simple, getting useful, reliable "apples to apples" comparison data is actually really challenging. While many owner/managers have practices that allow good comparison among their own properties, those internal best practices often don't translate well when trying to compare with other owner/managers. Development of consistent, required methods for calculating and documenting building floor area and requiring utility confirmation that data from all accounts at the property are included are to initial steps that would improve the quality and comparability of available data. Finding ways to incorporate information on other changes in building occupancy and usage that impact energy performance is also a challenge, but important to identifying and replicating best practices.

The growing interest in mandatory disclosure policies elevates and accelerates the need for effective tools for comparing performance. Disclosure can be an important "enabler" to other mandatory policies (and a key piece of any comprehensive policy package aimed toward existing buildings energy reduction). While the rationale for benchmarking and disclosure is strong, we have less clarity on evaluated results from the tools available to date.

References

Crain's NY Business. 2006. "**Landlords Stretch Square Footage**." May 15.

[EIA] U.S. Energy Information Administration. **Commercial Buildings Energy Consumption Survey.** http://www.eia.doe.gov/emeu/cbecs/

Kelly, Hugh F. 2002. **The New York Regional and Downtown Office Market: History and Prospects after 9/11**. Prepared for the Civic Alliance by Hugh F. Kelly, CRE, Hugh F. Kelly Real Estate Economics.

New York City Department of City Planning. 2009. **Bytes of the Big Apple**. http://www.nyc.gov/html/dcp/html/bytes/applbyte.shtml

NYSERDA. 2009. **Patterns & Trends: New York State Energy Profiles: 1993-2007**. January 2009.

PlaNYC. 2007. **Inventory of New York City Greenhouse Gas Emissions**.

Studley. 2010. **The Studley Report**. Studley Report, New York, 2010 1Q. www.studley.com