nbi new buildings institute

# Energy Performance of LEED for New Construction Buildings

***Frequently Asked Questions about the study***

This document addresses several questions frequently raised regarding the way in which LEED data was summarized in the March 2008 report, "Energy Performance of LEED for New Construction Buildings."

Even with 121 participating buildings, data volume can be insufficient for perfect comparisons when subdivided among multiple variables, particularly with variability in individual performance results and with limitations of comparable data from CBECS. NBI made general choices in how to present LEED data throughout the study that considered simplicity of explanation, consistency of presentation, and credibility of results. Consult the full study report for further information.

**I read an article by Henry Gifford that questioned the overall study results and, in particular, the conclusion that LEED buildings are saving energy compared to CBECS. Was that an accurate analysis?**

We welcome further observations and analyses of the study data by others, but Mr. Gifford's conclusions were largely based on a comparison of the mean energy performance of all LEED buildings in the study with the published CBECS mean of all commercial building stock. While this may seem a reasonable approach on the surface, it actually biases and masks key results.

The NBI study broke results into two groups: "High Use" (e.g. supermarkets and laboratories) and "Medium Use" buildings (e.g. offices, libraries, schools). Combining these two very different groups into a single average does not provide a meaningful result and complicates further attempts at comparison. The questions below provide more detail on this and other benchmarking issues.

**Did the focus on LEED buildings with medium energy level activities skew the comparison to CBECS averages for all building types?**

The high energy activity buildings in the study, such as labs, datacenters, and supermarkets, have average EUIs about four times the level of the medium energy activity buildings, and most of their energy use is driven by the activities of the businesses in the building, as opposed to the basic building heating, cooling, and lighting systems. The 100 medium energy activity buildings form a much more coherent data set for analysis; combining the two masks, rather than reveals, information.

A few specific observations may further clarify that point.

- High Use buildings are in the study data in a greater percent than in the CBECS data. For example, 8% of the LEED buildings in the study are laboratories. In CBECS, labs are included as part of the general "Other" category, and *all* other buildings constitute less than 2% of the total.

- The study notes that the industry does not appear to know enough about how energy is used in the High Use buildings to analyze them effectively. Some could well be very efficient facilities, using the most efficient energy-intensive equipment available to accomplish their purposes. We simply can't tell from the data.

More study is clearly needed to support better design and benchmarking of these High Use facilities, but averaging their results with Medium Use buildings will not accomplish those objectives.

The overall published CBECS averages include *both* very low energy activity buildings (vacant space, self-storage warehouses, etc) and high energy activities, neither of which are represented in the study's medium energy activity group. Thus neither the comparison of LEED Medium Use buildings to all CBECS buildings nor of all LEED buildings to CBECS is perfect.

The study does show that the median energy use for *all* LEED buildings in the study was 69 kBtu/square foot, 24% below the 91 kBtu/square foot for all CBECS buildings. But the more compelling and informative comparisons are for individual building activity types, in cases where both datasets have comparable definitions and sufficient data.

For example, LEED offices, the largest group in the study, had a median EUI 33% lower than average CBECS offices. Other building types showed LEED EUIs ranging from 12% below to 51% below CBECS.

**Did the study's use of medians to represent the average skew the comparison with CBECS, which reports averages using means?**

The median is a common statistical indicator of the average that is particularly appropriate for highly variable data sets. In statistical terminology, it provides more robust results than the mean, less distorted by extreme results. The median was used for all of the LEED building averages in the study for this reason. It is true that the published averages for CBECS buildings are based on means, and the comparison of LEED median to CBECS mean is one of the sources of imprecision in the results. When future studies provide a larger data set and a

better understanding of the primary drivers of performance variation, more precise comparisons will be possible.

**Why were LEED buildings compared to CBECS buildings of all ages, rather than just new construction?**

The comparison to all vintages of construction was chosen because of the lack of any strong pattern of CBECS EUI by vintage. The most recent vintage category for the latest CBECS data includes buildings constructed in 2000 through 2002, with energy use shown for the full year 2003. While the EUI for that most recent vintage was lower than the average for all vintages, there were too few observations in that subgroup for good subdivisions by type or other characteristics. We considered using comparisons to CBECS for 1990 and later construction, as summarized in DOE's Building Energy Data Book. Those more recent construction averages are usually close to the all-vintages averages.

There is a clear need for better benchmarking tools for new high performance construction. Limitations of using CBECS for this purpose include the delay in data becoming available, the relatively thin sampling of the newest construction, and the lack of desirable supporting characteristics to better determine the drivers of variations. Future data-gathering efforts may address some of these limitations. The ENERGY STAR ratings included in the study provide a much better normalized benchmark when available. However, those ratings are available only for certain building types, and could not be calculated for half of the buildings in the study.

**Why weren't comparisons done within building size ranges?**

It is true that LEED buildings are on average much larger than CBECS. When we looked at office buildings, the most common single type in the study, by size, we still saw LEED EUIs less than CBECS in each range. On average, when weighted according to the LEED study size distribution, the LEED office results were 28% below CBECS. The largest difference, 42% below, was for buildings under 25,000 square feet. The smallest difference, 21% below, was for buildings 25,000 – 100,000 square feet.

**Were comparisons skewed because the LEED building participants were all volunteers, rather than a statistically random sample?**

There is no way to know what the measured post-occupancy experience was from the LEED projects that did not provide data. However, examination of the general characteristics of responders, such as size, type, and region, did not reveal material differences from characteristics of the full LEED set.

Further, our sense from the recruiting process, in which all LEED-NC certified buildings were invited to participate, is that the non-responders and partial responders were primarily from two groups: those where contact information was out of date and those that simply could not easily provide the required 12 months of energy bills, often because the building was not even individually metered. It isn't clear that there is any inherent bias in those selection factors. There *is* a clear and definite need for more readily available and meaningful performance feedback in the future, at both the individual building and program evaluation level. Use of modern metering and reporting technologies, and strengthening of data requirements for LEED participation will be important in addressing these needs.

**Why is there such a wide range of performance among LEED buildings?**

The wide range of individual results, for every subdivision of the dataset and every metric used, is an important finding of the study. This result may not be surprising in relation to the even wider spread of individual results seen in the CBECS' national building stock surveys, but it does reveal a strong need for better understanding of the true drivers of energy use: to dramatically improve the individual building models used in life cycle cost analysis and to provide more accurate and meaningful benchmarks for individual building results.

You can find the full study on NBI's website. Further comments and recommendations are welcome for interpreting the results of the initial data and for improving measured performance feedback in the future.