The energy performance of green buildings: there's good news, and bad news

Newsham, G. R.

Publisher's version / Version de l'éditeur:

Canadian Consulting Engineer Magazine, 50, 7, pp. 19-21, 2010-01-01

The energy performance of green buildings: there's good news, and bad news

NRCC-52653

Newsham, G.R.

January 2010

A version of this document is published in / Une version de ce document se trouve dans:
Canadian Consulting Engineer Magazine, 50, (7), pp. 19-21

ENERGY

Green Buildings & Energy:

good news, and bad

An analysis of the actual energy usage of 100 occupied LEED buildings showed some unsettling results.

By Guy R. Newsham, Ph.D.
National Research Council Canada, Institute for Research in Construction (NRC-IRC)

Numerous countries have developed green building rating systems, and many organizations have committed to a future portfolio of green-certified buildings. All rating systems for green buildings use a scheme that allots credits for design features deemed to improve sustainability. The credits are for reductions in energy use, improvements in indoor environment quality, and other measures. To date, many of these rating systems have been based on expected performance at design time. Many green-rated buildings have now been occupied, and it is reasonable to ask: are these buildings living up to expectations?

This article focuses on energy performance. A major effort to collect appropriate data was undertaken by the New Buildings Institute, under contract to the US Green Buildings Council. These organizations generously shared their data with the National Research Council's Institute for Research in Construction (NRC-IRC) for the analysis presented in this article. Our analysis focused on 100 LEED-certified commercial and institutional buildings in North America (the vast majority in the US) which provided one full year of measured post-occupancy energy use data.

Total energy use intensity (EUI) for each building was derived by summing the purchased energy from all fuel types. This result was compared to the EUI of buildings in the U.S. national building stock, derived from the 5,000+ buildings in the 2003 Commercial Building Energy Consumption Survey (CBECS) database, and to initial baseline and design models in LEED submittals.

Our findings

Our analysis shows that, on average, LEED buildings used 18-39% less energy per floor area than their conventional counterparts. However, about one-third of individual LEED buildings used more energy than their conventional counterparts. Further, the measured energy performance of LEED

buildings had little correlation with the certification level of the building, or the number of energy credits achieved by the building at design time.

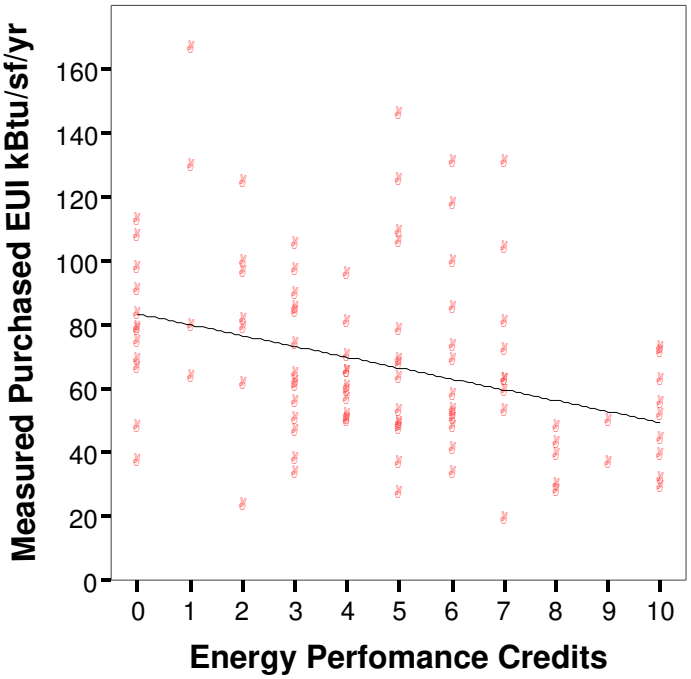
The method

To make for the fairest comparison possible between green and conventional buildings we paired each LEED building with a single matched CBECS building. The CBECS matched building was chosen to be as similar as possible in terms of activity type, size, age, and climate zone. We did the matching in many different ways, varying the strictness of the matching criteria. We conducted analyses for all building types and for offices alone (35 of the 100 buildings).

No matter what was the basis for comparison, the results showed that LEED buildings used statistically significantly less energy per floor area than CBECS buildings: average savings were in the range 18-39%, depending on the parameters of the comparison. However, despite these average savings, 28-35% of individual LEED buildings used more energy per floor area than their individually matched CBECS counterpart.

We then tested whether measured EUI, and measured % energy saved compared to the modelled baseline, varied by LEED certification level. Here we found no effects. This might seem surprising, but remember that a given certification level is achieved by accumulating credits for many different sustainable practices beyond energy performance. Therefore, in the next stage in our analysis we looked at these same two variables versus the number of LEED energy credits received (up to 10) at design time. We only found one statistically significant relationship: measured EUI did decrease with increasing energy credits across all buildings. This effect is shown graphically in Figure 1; this is a weak relationship, with much scatter in the data. Further, the effects for EUI for offices only, and for measured % savings relative to the modelled baseline for all buildings, were not statistically significant.

Finally, we looked at whether LEED buildings that had received credits for additional commissioning and measurement and verification had better energy performance. We found no effect.



Above: measured EUI vs. energy credits achieved, for all LEED-certified buildings in the sample.

What does it all mean?

Overall, it appears that LEED buildings do save energy, and that a general program of building green can be expected to reduce energy use by upwards of 20%. However, about one-third of LEED buildings are actually using more energy than their conventional counterparts. This may be a problem for the owner/operators of these buildings, who are not realizing the energy performance that they presumably expected. Further, the energy-related credits that people are striving for seem to have little relation to measured energy performance. These factors might raise questions for the credibility of green building rating systems, which could jeopardize the overall societal benefits.

It is important to recognize that these conclusions are drawn from a dataset with many limitations. We had a relatively small sample size of LEED buildings in their early years of operation. Building owners and operators participated voluntarily, and it is possible that those who thought they exhibited better performance would be more likely to participate. In addition, there were inevitably a host of on-the-ground design and operational issues affecting energy use that were not recorded in the dataset. Further, LEED-certified buildings tend to have a higher proportion of owner-operators, particularly public-sector ownership, which may also have systematic feature differences compared to the general population of buildings. In addition, even the newer CBECS

buildings were, on average, a couple of years older than the LEED sample, it is possible that newer conventional buildings will have better energy performance due to general improvements in building design and operation. For all these reasons, we recommend that these findings should be considered as preliminary, and that the analyses should be repeated when longer data histories from a larger representative sample of green buildings are available.

Despite these concerns, this is the best data to-date with which to explore whether green buildings are delivering on energy savings. The good news and bad news is likely no surprise to green building advocates. There are some things in green building performance that need to be improved, and in this context research such as this is simply a necessary part of evolving the green building process from "good" to "better".

The results do highlight the importance of investigating the post-occupancy performance of buildings. NRC-IRC has begun a new project to look at the indoor environment quality in green buildings, in addition to energy performance. In the longer-term, it may be wise for all green building certification systems to require not only sustainable design intent, but also demonstrated sustainable performance after the building is built and operating.

x *author blurb/footnote*

Guy Newsham, Ph.D is a senior research officer at the NRC Institute for Research in Construction, Ottawa. E-mail guy.newsham@nrc-cnrc gc.ca

This article was derived from a more detailed scientific paper published in the journal Energy and Buildings. See that article and more information about NRC/IRC green buildings research, at: http://www.nrc-cnrc.gc.ca/eng/projects/irc/post-occupancy.html.

x pull quote

"We looked at whether LEED buildings that had received credits for additional commissioning and measurement and verification had better energy performance. We found no effect."