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Data Needs to Achieve High Performance Buildings
Written Testimony from Cathy Turner, New Buildings Institute

I. Summary of Oral Testimony: July 18, 2011

INTRODUCTION

New Buildings Institute (NBI) is a nonprofit organization working to improve the energy performance of commercial buildings. We work collaboratively with commercial building market players—governments, utilities, energy efficiency advocates and building professionals—to remove barriers to energy efficiency. Our activities include promoting advanced design practices, improved technologies, performance feedback mechanisms, and public policies and programs that improve energy efficiency.

NBI is a sponsor of this effort because of its critical importance to the core mission of our nonprofit organization. To achieve deep energy savings, all parties – policymakers, program managers, designers, owners, tenants, and the real estate community –must all have access to data that shows the strategies that are working and areas needing improvement.

As part of our research, we have compiled a substantial internal database of high performance buildings. That dataset is used in our analyses of the actual performance levels achieved and in the development of tools to better interpret energy use data. We have also participated actively in the DASH (Database for Analyzing Sustainable and High Performance Buildings) efforts over the past several years, working with a broad community of interested parties to identify the contents and structure of a national data repository.

This testimony summarizes the highest priority data needs that we see for the objective of dramatic progress toward very low energy buildings. We also include some suggestions for the process and structure of developing a data repository, based on our internal experience and that of the DASH effort. Fuller descriptions can be found in the referenced supporting document.

OBJECTIVES AND USES OF HIGH PERFORMANCE BUILDING DATA

We need timely feedback on the actual energy performance being achieved in today's buildings. This is critical to tracking the energy use progress leading to net-zero energy buildings, defining our pathway and interim goals to move forward. In particular, we must:

1. **Know the actual energy performance of buildings compliant with recent energy codes.**

   Initial baselines and subsequent calibration points of codes to energy performance are fundamental to effective energy code policies. While policymakers have set specific performance targets, most notably achieving net-zero energy use in buildings by 2030, there is no way to tell how much progress our building stock is making toward that goal. Current energy code practice is based on estimated energy use of a theoretical sample of buildings that meet *all* code requirements. This is not the same as using actual,

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measured building energy use as a basis for determining progress toward energy policy goals in buildings. (See additional information in the Supporting Materials appendix: Code Calibration: Understanding what energy codes can really achieve.)

2. Know the results that beyond-code programs are producing

High performance buildings, from voluntary programs such as state stretch codes or LEED, should be providing guidance for tomorrow's energy codes. However, a number of recent studies have demonstrated that various components of new buildings do not perform as well as intended. Stated savings are often based on modeled building performance, which assumes that all systems, components, and operation work as designed. In reality, such perfection is rarely attained, much less maintained.

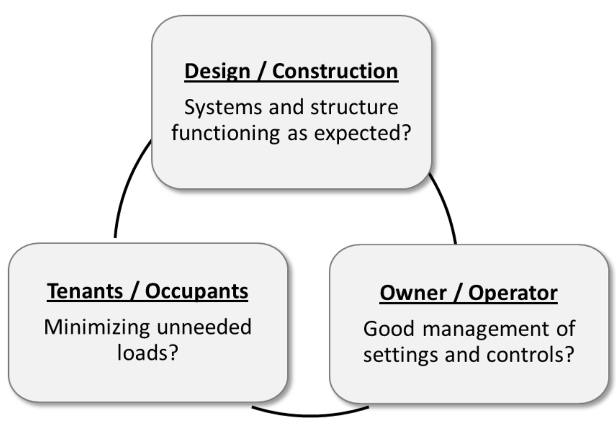
3. Provide the basis for benchmarking and interpreting energy use levels

a. Know building performance characteristics

A national repository of shared data should include important information on current building performance-related characteristics (relevant system types, ages, physical components, etc). That would enable extracting and communicating cross-cutting lessons from broad experience.

b. Separate whole building performance into the base building and occupant-driven components

For proper benchmarking, we must be able to split energy used by the tenants as a requirement of their basic business activity from energy used for conditioning and lighting the base building. Submetering plug loads and tenant energy use is important for tenant-specific feedback, which becomes essential as we move toward outcome-based codes and very low energy goals. At a minimum, tools for reasonably estimating that split are critical to benchmarking whole building energy, and a national data repository should contain the data needed to use such tools. (See for example: Using Measured Whole-Building Performance for Green Building Program Evaluation.)



4. Enable the transition to a forward-looking rating scale with a fixed baseline. This will support goals of:

- More meaningful tracking of performance levels over time. Many organizations and agencies have set aggressive performance improvement goals based on a year 2000 baseline. A national data collection strategy must support tracking progress toward policy goals on a consistent basis – not continuously changing the baseline by always looking at "% better than current code."

- Consistent benchmarking to identify progress as buildings move beyond the best 1% of all existing turn-of-the century building stock. In other words, we must be able to benchmark progress beyond a current Energy Star rating of 99.

The zero Energy Performance Index (zEPI) is one example of how such a rating scale could be implemented. A zEPI rating is the ratio of a building's energy use per square foot to the median for of similar buildings at the turn of the century (with similar climate and occupancy, and based largely on the 2003 CBECS). Thus, a rating of 100 reflects median turn of the century performance, and a rating of 0 denotes a net zero energy building. Codes, stretch codes, and high performance building program requirements could be specified in terms of a target zEPI level. This concept is consistent with Architecture 2030, the energy efficiency ratio calculated within the EPA ENERGY STAR program, ASHRAE Building EQ, and energy rating systems used in California and other states

With the support of a sound, regularly updated, national repository of performance data, realistic future goals and intermediate targets could be set on the basis of demonstrated performance levels achieved by the leaders in the current building stock.

GENERAL COMMENTS ON PROCESS AND ANTICIPATED DATA STRUCTURE

These comments are in the context of a usable national repository of data, to be fed by multiple information sources, maintained over time, and to be publicly accessible with appropriate protection of confidentiality.

5. **For each statement of desired data elements, clear definitions of expected users and objectives** will be essential.

    a. The intended use of information determines the amount and level of detail needed. Some objectives, such as accurately estimating the entire national energy use or the total savings achieved from a utility program, require rigorously sampled, statistically representative data. *However*, other goals, such as the support for local jurisdictions with disclosure ordinances or the move to forward-looking benchmarking, can be even better served with a more easily collected set of good, credible examples.

6. **Create a framework for efficient prioritization and staging**.

    a. Identify core data items needed for nearly all the desired uses, and provide consistent definitions to be used by all data contributors.

    b. Create a framework that supports adding deeper sets of information for specific purposes as definition and data become available.

    c. **Create synergies with local and state disclosure ordinances.**
    The jurisdictions that have adopted disclosure ordinances represent a potentially great data resource. No individual jurisdiction is in a position to collect national data from other jurisdictions.

7. **Use modern data technology to facilitate information gathering.**

   a. Anticipate ongoing updates, and possible multiple years of experience for a single building, as opposed to a periodic single survey

   b. As one example, consider an approach that could simplify the challenge of recording data for recent construction and renovation.

      i. **Capture building information at the time of a building permit**. Building data needed for calculating and benchmarking performance results should be readily available at this time: square footage, primary systems, and general occupancy characteristics.

      ii. **Establish a standardized protocol to accept data from utilities,** and

      iii. **Set up automatic uploads of utility data to the confidential central repository for these buildings**.

   Such an approach could be piloted in a single jurisdiction or utility program.

The best role of NIBS will emerge from the discussions begun today. Logical components could include defining and communicating the standards and definitions, hosting the repository, and spearheading the addition of information for targeted segments of the marketplace or types of information.

II. Supporting Material

Code Calibration: Understanding what energy codes can really achieve

Author: Mark Frankel, Technical Director, New Buildings Institute, July 2010

A key problem with current energy code practice is the difficulty in determining what level of performance the codes are delivering. While policymakers have set specific performance targets, most notably achieving net-zero energy use in buildings by 2030, there is no way to tell how much progress our building stock is making toward that goal. Current energy code practice is based on estimated energy use of a theoretical sample of buildings that meet *all* code requirements. This is not the same as using actual, measured building energy use as a basis for determining progress toward energy policy goals in buildings.

Estimates, also called "determinations," of how much energy codes save are almost always based on energy modeling simulations of how buildings built to code might perform. These estimates are never verified with actual data from the building stock. (U.S. EIA's Commercial Buildings Energy Consumption Survey - CBECS - has been conducted every four years on a very small sample of the building stock as a whole; however, no information is reported that would allow this performance information to be related to the applicable energy codes.) In fact, estimates of code outcome are almost universally optimistic. There are two basic reasons estimates of code building performance are inaccurate: 1) not everything in any given building works, and 2) buildings are not typically operated as anticipated by theoretical modeling programs.

A number of recent studies have demonstrated that various components of new buildings do not perform as well as intended. (Controls, economizers, lighting and daylighting systems, installed insulation, envelope air sealing; the list goes on…) But when building performance is modeled, the systems and components required by code are assumed to work as designed. This results in predictions which tend to underestimate actual building energy use by a relatively substantial percentage. For example, when modeling code building performance, it is typical to assume that the HVAC control system will implement night and weekend temperature setbacks to reduce energy use in unoccupied periods. However, it is very common for these setbacks to be missing or inaccurate, leading to substantially more actual energy use than an idealized 'modeled' building might use. Furthermore, while code may require a building to have setback capabilities, there is no mechanism in the code to require that they be implemented. In practice, over time control systems on most buildings tend to drift toward poorer performance (assuming they ever worked well in the first place). There are vast numbers of similar examples where real-world building operation does not live up to anticipated code performance. This is not the result of noncompliance; it is because the code does not address how buildings are used and maintained over time.

Not knowing how buildings built to code really perform represents a problem for increasing code stringency for two reasons: First, if we assume the code is already delivering low-energy-use buildings, then the savings associated with *additional* code stringency are reduced (each successive strategy saves a percentage of a smaller pie). By underestimating available savings, we alter the cost-benefit analysis of additional strategies, suggesting potential savings that are lower than actual relative to the cost of the strategy. Second, by assuming everything in the code works as intended, we forgo the opportunity to address known problems with these systems. Economizers are a good example. Economizers allow buildings to use outside air (instead of air conditioning) to cool buildings when warranted by outdoor conditions. They are required by code in many areas. However, studies have repeatedly shown that about 70% of economizers do not work as intended, thereby substantially increasing building energy use. But since the code assumes the economizers work, there is no mechanism in the code to recognize the long-term performance problem represented by their failure. Even though a clear strategy exists here to increase energy savings, the code does not recognize this possibility. This is just one example of how buildings that nominally meet code actually lag behind the energy performance anticipated by codes.

The solution to many of these problems is to calibrate energy codes and performance goals to *actual measured* building performance. By determining how buildings that are built to code are really performing, a wide range of new opportunities for code improvement becomes available. With actual performance data, strategies like building commissioning, effective maintenance, efficient occupant equipment (like computers and copiers), building metering and a range of other high-performance measures will become critical pieces of advanced code strategy. In addition, from a policy perspective we can better understand how effectively we are achieving the real and specific goals we have set for states and the nation to substantially reduce building-sector energy use. At a national level, there should be direction and funding to comprehensively address the lack of energy performance data for our nation's building infrastructure. Without this information, we will never answer the question: *Are we on track to meeting ambitious building energy performance goals?*

For further information including in-depth discussion of technical issues, real-world examples of barriers to energy savings and strategies to address them, see http://www.newbuildings.org/codes-policy.