Code Calibration: Understanding what energy codes can really achieve

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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 - is conducted every three years on a very small sample of the building stock as a whole; however, no information is gathered that would allow this information to be related to energy codes.) In fact, the 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 to *actual* 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.

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