Toward a Future Model Energy Code for Existing and Historic Buildings

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ABSTRACT

Advancements in the energy efficiency standards of building codes have made great strides in improving the energy efficiency of buildings. However, as energy codes become more stringent and more widely applied, they can pose serious obstacles to achieving deep energy savings in existing buildings. Therefore, if we are to look to buildings for significant reduction in our total energy consumption, we will need a regulatory framework that can significantly improve the energy efficiency of existing buildings.

Prescriptive codes are not as well suited to the constraints presented by existing conditions as they are to the relative design freedom afforded by new construction. The greater flexibility afforded by alternate modeled performance compliance paths are not as valuable to existing buildings with their higher cost of model production as they are to new designs. As proxies for actual performance, both of these can miss the efficiency strengths of existing buildings and the particulars of specific and idiosyncratic conditions that affect actual performance outcomes.

This creates the need for an additional, alternate compliance path that can not only more ably address the realities of existing buildings but also do more to produce greater energy savings in existing buildings. An outcome-based compliance path would possess both of these characteristics. It would bypass the obstacles presented by both prescriptive and modeled performance compliance paths through focusing on outcomes. It also presents a way to advance code triggers that does not intensify those obstacles and goes farther than compliance triggers that are tied to construction events do.

Executive Summary

By most estimates, buildings account for 40%-50% of the energy consumed in the United States. In an average year, new construction and major renovations only account for 1-3% of the total building stock. As such, existing buildings necessarily compose the majority of the energy consumption and carbon emissions that are due to buildings. Advancements in energy codes have made great strides in advancing the energy efficiency of new buildings and substantial renovations. However, the energy efficient building of the previous generation is the average building of this generation, and the inefficient building of the next generation. Therefore, if we are to look to buildings for significant reductions in both energy consumption and carbon emissions, we need an energy code framework that can effectively produce deep energy savings in existing buildings, that will apply to a larger scope of existing buildings, and that will reinforce and enable other mechanisms that can foster energy efficiency in existing buildings.

However, these goals could face significant obstacles moving forward within current energy code frameworks.

Currently, the dominant energy code framework is prescriptive, component-based. While this approach to energy codes has many advantages and has had much success, it also presents many obstacles for existing buildings in a future of more stringent and more widely applied energy codes. As we move to a future of energy codes that do more to generate energy savings in existing buildings, there is the very real risk that these prescriptively-based codes could become a threat to existing buildings. Without the flexibility for owners and designers to select the most effective and cost effective energy efficiency solutions for their existing buildings, more stringent and more widely applied prescriptive energy codes could require changes that are costly, less effective than other measures that might be available, detrimental to architectural character, or outright physically impossible.

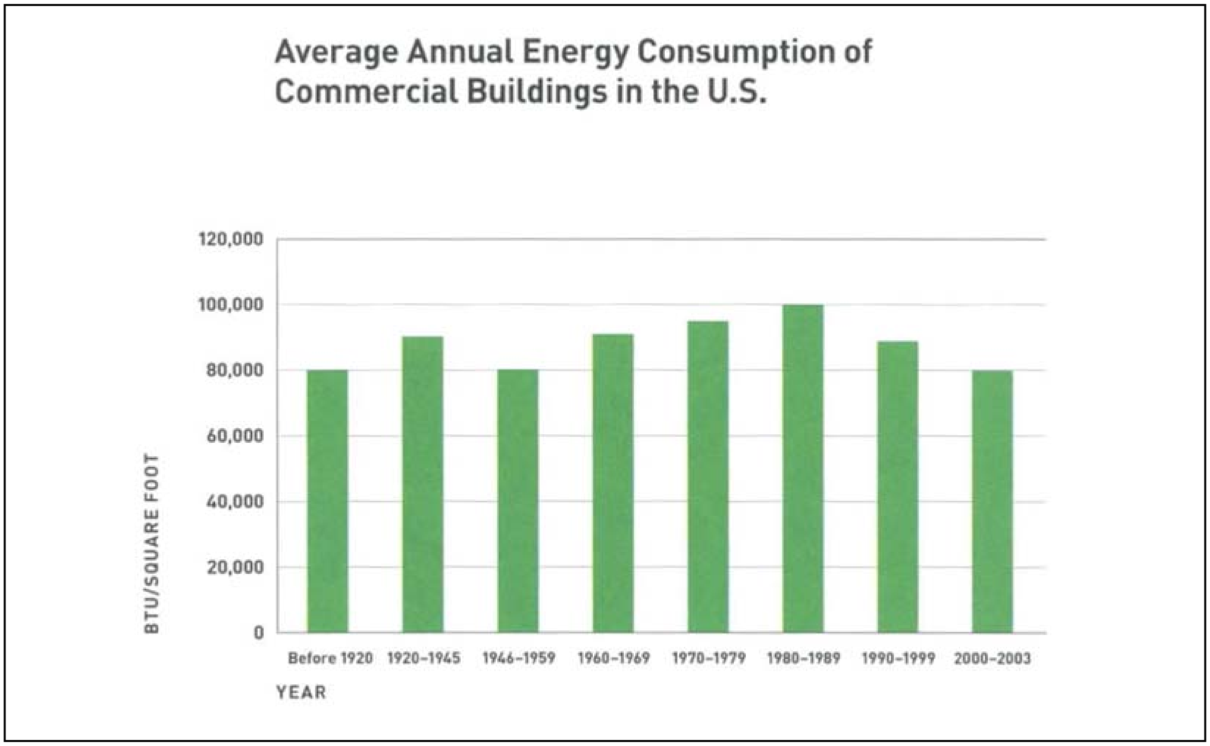
Therefore, there is a need for an alternate compliance path that can move beyond prescriptive, component-based compliance to a compliance path that is based on actual performance. This represents a significant shift in the way that codes are formulated and enforced. Therefore, it should not be seen as a replacement for existing compliance paths, but rather a complement, much as alternate modeled performance paths have not replaced traditional prescriptive paths. Foundational elements of an outcome-based compliance path can be introduced into current code frameworks, and reach codes and hybrid codes can introduce the new path gradually. However, this next generation compliance path will require foundational elements such as benchmarking, performance disclosure and the creation of a performance metric to be created first if it is to be functional and credible. The obstacles to provide truly deep energy savings in existing buildings with existing energy codes creates an urgency to begin the work and to begin to introduce those elements into current code frameworks now.

The Case for Existing Buildings

As 'green' issues and sustainability have become more and more prominent, it has become clear that historic and other existing buildings present opportunities for sustainability. Avoided building material consumption, the preservation of green space, urban density, the reuse of infrastructure, and keeping existing buildings out of the waste stream are the most obvious ways that the continued use and re-use of existing buildings is a sustainable practice. Some of the greenest buildings are some of the ones that have already been built.

However, existing buildings are often viewed as energy hogs, and as such an obstacle to the goals of sustainability. This is certainly true of many existing buildings, especially those built in eras of relatively cheap energy such as the 1960s or especially high use of glass cladding such as the 1980s. But data from the U.S. Energy Information Agency indicates that for pre-1940s and especially pre-1920s buildings, this is often not the case (Figure 1). Many of the energy approaches that are the hallmarks of some of the "greenest" modern buildings are actually a rediscovery of approaches that were often common in pre-war buildings. Passive strategies to assist or completely provide cooling, ventilation and lighting, shading and operable window coverings, climate and site responsive siting and massing, the arrangement of interior spaces, window-to-wall ratios balanced to best meet the competing demands of daylighting and thermal insulation are all features that can help make some of these older existing buildings perform as well or better than even new energy efficient construction.

Figure 1. Energy Use in Commercial Buildings by Vintage.



Source: Urban Land Institute. 2008

Therefore, as we try to get greater and greater energy savings out of our building stock, the challenge is to formulate an energy code that can respond differently to different existing buildings. Rather than a code that would require the same approach for all buildings regardless of its effectiveness for that specific building, we need an energy code flexible enough to allow owners, designers and operators to choose the most effective approach to achieve our efficiency goals.

As energy and energy-related concerns such as CO_2 emissions become more and more to the value and desirability of buildings, inefficient buildings will become less and less desirable. Therefore, if an existing building cannot be competitive in terms of energy performance, it will be in greater risk of the downward spiral of neglect and disinvestment that leads to demolition and replacement. If energy codes can be used as a mechanism to improve the energy efficiency of existing buildings, they can actually be a great mechanism to foster the reuse of existing buildings, thereby claiming all of the other sustainability benefits that come with the re-use of existing buildings.

The National Energy Code Landscape

In the United States there is currently no nation-wide building energy code. Instead, there is a patchwork of codes, standards and voluntary programs set at the national, state and local levels.[1] For most of the country, code requirements are set at the state level, with some of these states also allowing local jurisdictions to pass local variations that are more stringent or

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[1] The US Department of Energy offers a good primmer on this landscape in "Understanding Building Energy Codes and Standards" (http://www.energycodes.gov/implement/pdfs/codes101.pdf).

locality-appropriate. However, some states have no statewide energy code at all and local jurisdictions are the only source of energy code requirements. Perhaps astoundingly, this leaves some places with no building energy code at all.

Whether at the state of local level, most jurisdictions do not craft their own codes, but rather adopt or adapt model codes or standards created and maintained by others. Although there is no national energy code, there are national model codes that jurisdictions can adapt and/or adopt. The International Energy Conservation Code (IECC) is a national model energy code for both residential and commercial buildings with climate-specific variations developed by the International Code Council which many state and local jurisdictions adopt, either whole or in part, as their energy code. ASHRAE 90.1 is a national standard for commercial buildings developed by the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE), also with climate-specific variations. Both of these follow a schedule of updates, and jurisdictions don't always adopt the latest revision, which only adds to the nationwide diversity in energy codes.[2] In fact, although both have more current versions available, IECC 2006 and ASHRAE 90.1-2004 are still the most common bases for energy codes in the US.

A handful of jurisdictions stand out for their more advanced and more stringent codes. Foremost among these is the State of California. Instead of adopting or adapting ASHRAE 90.1 or the IECC, the California Energy Commission develops and maintains its own energy code—known as Title 24—with California-specific climate zones even more specific than the national climate zones. The 2008 version of Title 24 went into effect in January of 2010 and is estimated to be about 15% more stringent than the 2007 iteration of ASHRAE 90.1 on average (Architecture 2030 2008). Massachusetts stands out in a different way. It has a state-developed code, but in May of 2009 adopted a new stretch commercial energy code based on Core Performance—an advanced protocol designed by the New Buildings Institute—that provides about 30% savings beyond performance levels achieved by ASHRAE 90.1-2004 and IECC 2006. The stretch code is a code that local jurisdictions in Massachusetts, such as cities, can adopt if they want more stringent energy standards. Seattle stands out as an example of a city with a more stringent code. Washington already has one of the more advanced energy codes in the country, but the city has mandated that the city's energy code exceed ASHRAE 90.1-2004 by 20%.

Although there is diversity in the nationwide landscape of codes, all codes currently in effect share one element in common: they are all ultimately based on a set of prescriptive requirements for building components. All of these codes, including the proposed updates to IECC and ASHRAE 90.1 are a combination of individual prescriptive requirements: levels of insulation, U-factors for windows, efficiency ratings for HVAC equipment, etc.

Many codes allow for an alternate compliance path based on modeled performance. An approved piece of software is used to model a proposed design and compare it to a baseline reference model that consists of the same building specified so that it would meet all of the prescriptive requirements of the code. If the energy consumption of the model of the proposed design is less than the energy consumption of the reference model, then the design complies with the code. The modeled performance path allows designers to step away from the prescriptive minimums when it is advantageous for the building design. They can trade off lesser levels than required by the prescriptive requirements by adding an equal level of energy performance elsewhere in the building.

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[2] See http://www.energycodes.gov/implement/state_codes/index.stm for a visual map of the status of state energy codes.

California's alternate performance path stands out for its sophistication and the maturity of the industry of energy modelers that has sprung up to support it. ASHRAE 90.1 contains a modeling provision called Appendix G and the IECC allows ASHRAE's modeled performance methodology as an alternate compliance path. Alternate compliance paths based on modeling are typically considered "performance" paths since they set a level of performance that the design must meet instead of a laundry list of building component requirements. However, these paths are still ultimately prescriptively based because the performance level is established by a building that meets the prescriptive standards.

Recent Code Developments

The American Clean Energy and Security Act of 2009—also known as the Waxman-Markey bill—is legislation that requires an immediate 30% improvement over a baseline established by the dominant versions of IECC and ASHRAE 90.1 and a 50% improvement over the same baseline by 2015.

Currently, the IECC is in the public comment phase of adoption of a joint proposal by the New Buildings Institute, the American Institute of Architects and the US Department of Energy to update the IECC for 2012 based on NBI's Core Performance, which would improve this model code for commercial buildings by an average of about 25% over the 2006 version.[3] Likewise, ASHRAE is currently updating 90.1 for 2010 with the goal of being 30% more stringent than the current 2007 edition. Both ASHRAE and the ICC are also offering "green" codes/standards. The ICC's new International Green Construction Code is still in the development phase and is being designed to be at least 30% more efficient than IECC 2006 and to be available ahead of IECC 2012. ASHRAE/USGBC/IESNA Standard 189.1 has been released and is designed to be 30% more efficient than 90.1-2004.[4]

Obstacles to a Future of Deep Energy Savings for Existing Buildings

There are two ways to increase the impact of energy codes: increase the scope and stringency of the code requirements themselves, and broaden the scope of circumstances in which those requirements must be met. As we move to a future of energy codes that are certainly more stringent and will likely be more broadly applied, the continued use of current prescriptive frameworks could present several obstacles for widespread, optimally cost-effective and architecturally appropriate energy efficiency retrofits of existing buildings. The following section will explore the obstacles that exist now, and the new obstacles that might emerge.

Triggers

Not all buildings are required to meet the standards set in energy codes. Generally, the energy code is tied to construction events or changes in occupancy which 'trigger' compliance requirements. New buildings are thus almost universally required to comply fully with the prevailing energy code. This naturally gives the requirements of energy codes a focus on new buildings and substantial renovations.

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[3] According to preliminary modeling done by the New Buildings Institute.

[4] The DOE analysis shows that about 1/3 of these savings come from the integration of renewable energy in projects.

This construction focus means that energy codes have a much more limited impact on existing buildings. Just as there is diversity in the national landscape of energy codes themselves, there is some diversity in the thresholds that trigger compliance for those codes. For most basic projects in most jurisdictions, the scope of code compliance is determined by the scope of the construction project. For example, in project to replace an HVAC unit, the new unit must comply with the energy code, or in a project to replace windows, the windows must comply with the energy code. As projects become more extensive, the scope of compliance can extend beyond the scope of the project. Most jurisdictions have a requirement that a whole building must comply with the whole energy code once the scope of the project meets a certain threshold. This threshold can be based on the absolute cost of a project, a certain percentage of square footage affected, or a certain ratio of project cost to building value. Regardless of threshold tests, the triggers for code compliance are typically still tied to construction events.[5] So an existing building that undergoes no construction events will also face no requirements to meet the requirements of energy codes.

Advancing code triggers is one way to use the energy code to create more energy savings in existing buildings. There are two ways to advance triggers that stand out: the scope of code compliance required by existing triggers can be expanded and the set of compliance triggers can be extended beyond construction events. Broadening the scope of compliance required by current triggers can be employed for both partial and full compliance triggers. To build on an example of partial code compliance requirements above, HVAC equipment replacements could make the entire HVAC system subject to code compliance: duct leakage, controls, etc. For envelope upgrades, the entire building envelop could be subject to code compliance by any number of threshold events: fenestration replacements, roof replacements, percentage of scope of an envelope project, etc. And for full code compliance, the threshold can simply be lowered. If full code compliance is currently triggered at a scope of 50% alteration of the building, that threshold could be reduced to 40%, 30%, even 20%. Another way to advance triggers is by expanding trigger events beyond construction. Non-construction events such as sale, refinance or lease could be used to trigger partial or complete code compliance. Partial or complete code compliance could be triggered on a periodic basis, such as every five years or every ten years. As the benchmarking of buildings becomes more widely utilized and even required,[6] performance levels could become a trigger for partial or full energy code compliance. Non-construction triggers are not foreign to building codes. Life safety issues are often triggered by non-construction events such as lease, sale or deficiencies in the building.

Advancing triggers are a two-edged sword for existing buildings. On the one hand, more frequent triggering of full or partial energy code compliance will improve the energy efficiency of more existing buildings. On the other hand, the obstacles presented by prescriptive requirements that are difficult, cost-ineffective or impossible for existing buildings to meet will only be multiplied by advancing triggers. Expanding the scope of compliance requirements beyond the scope of the construction project itself increases the cost of the construction project. In essence, advancing triggers magnify both the strengths and weakness of any energy code.

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[5] Even in the case of change of occupancy since change of occupancy almost always necessitates adaptation of the building and therefore construction activity.

[6] Seattle, New York, and Washington DC have all adopted legislation requiring some form of building energy use disclosure.

Prescriptive Requirements

Until now, code revisions have followed a pattern of ever more stringent prescriptive standards. This has been a very successful approach to energy codes. It has offered a predictable, easily understood and relatively inexpensive way for the owner and designer to achieve code compliance while also providing clearly defined building elements for code officials and inspectors to inspect and verify. It has also offered a fairly clear way to advance the code. In addition to advancing code triggers, requirements for building elements can be tightened and the scope of requirements can be expanded. For obvious reasons, this approach to energy codes is well suited to new construction. Even if prescriptive codes were to expand beyond building elements to design elements,[7] the design freedom of new construction could accommodate those requirements. However, this is not the case with existing buildings where building elements and design elements are already determined. This creates both a significant missed opportunity for improving the energy performance of existing buildings and a set of code compliance obstacles for existing buildings in a future of advancing codes.

In existing buildings, fundamental buildings elements are already established. The mechanical and lighting systems are already in operation. The windows are already installed. Some construction types are inherently incapable of achieving very low levels of infiltration. The envelope is already built. Wall cavities may not be able to accommodate high insulation levels, retrofit of existing cavities can be costly, and expanding cavities is destructive, costly and reduces occupiable space, adding insulation can create moisture problems. Ceilings can face some of the same challenges where the insulation is not placed above the roof deck. Orientation is fixed. Window-to-wall ratios cannot be changed without significant alteration to the building and its character-defining elements. S labs and foundations simply cannot be retrofitted with exterior insulation. As we move to a future of prescriptive codes with greater scope, this could become a serious issue for existing buildings. Existing buildings could become unable or effectively unable to meet any prescriptive requirements that apply to fixed building elements such as those mentioned above. A simple solution to such a problem would be to create a conditional exception for existing buildings, but this has serious drawbacks as well. It would add further complexity to the code—when one of the strengths of prescriptive codes is their relative simplicity—without also adding energy savings potential. Exceptions for existing buildings would also miss the opportunity to improve the efficiency of those buildings.

Predictive Modeling as a Code Alternative

Most energy codes provide an alternative pathway to code compliance based on computer modeled performance. The greatest benefit of this approach is that it provides flexibility to owners and designers. Prescriptive requirements that might interfere with design features can be substituted for equivalent energy efficiency elsewhere. More cost effective efficiency measures can be substituted for less cost-effective measures. Energy efficiency measures that are more common and understood in the local market can be substituted for less familiar measures. In modeled compliance paths, a modeler models the proposed design and a reference design. Typically, the reference design is the proposed design with all of the prescriptive requirements of

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[7] Such as window-to-wall ratio, building proportions, orientation, etc. Many codes are already moving into this area. For example, California's Title 24 and the IECC contain window-to-wall ratio limits.

the code. If the performance of proposed model exceeds the performance of the reference model, the proposed design complies with the energy code.

The increased flexibility of a modeled performance compliance path can be a great benefit for existing buildings. However, there are also obstacles to the use of modeling for existing buildings. Foremost is cost. Modeling is dependent on having information about building elements. For new construction, the designer is selecting the building elements and so this information is readily available. For existing buildings, this information will likely have to be acquired through research. Few buildings have complete documentation of existing conditions and "as-built" documents don't always capture subsequent changes. For most existing buildings the information needed to model the building must be obtained through on-site investigation. This additional labor increases the cost of modeling for existing buildings. Additionally, for many existing buildings, this information can be especially difficult to acquire, raising that additional cost even more. Enclosed walls, roofs and foundations can make it difficult to discern insulation levels or construction methods and estimate values for these building elements. This is especially an issue for older existing buildings that are more likely to contain construction techniques that have passed out of common contemporary use. Efficiency information on older equipment can be unavailable, and older equipment might not be identifiable at all. Even if identification of building elements and equipment can be made, condition can be difficult to ascertain: insulation can settle or degrade, sealants can fail, default insulation values may not be accurate for aged materials or materials produced with the production methods of another age.

Code compliance modeling software in use today is generally good with the building features that it does model. However, most compliance software does not directly model many passive design approaches—such as natural ventilation, daylighting, thermal mass etc.—which can be fundamental to the performance of some existing buildings. When the software does account for passive approaches, they usually do not directly model them, but instead use factors to adjust the model. So in the case of daylighting with integrated controls, code compliance modeling software does not model the lighting performance based on the control strategy and available daylight, it simply reduces the lighting power densities in a daylit zone by a set factor. These factors are understandably conservative and so can often undervalue the impact of the approach. Additionally, rules for what can be counted as part of the daylit zone are also conservative and there is no control for the quality or effectiveness of the daylighting design.[8] There are other programs designed specifically to model the actual performance of passive systems, natural ventilation and daylighting, but until the compliance softwares do the same, passive strategies will be undervalued in code compliance.

Energy Code Performance Metrics

Another challenge presented by conventional code frameworks to achieving better energy performance across our entire building stock is the lack of consistent, absolute metrics for comparing different codes (and their versions) to each other, different buildings to each other, and both buildings and codes to zero net energy goals.

Beyond code energy efficiency performance is typically denoted by stating that the building exceeds the code by some percentage. However, this does not provide a way to

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[8] The draft version of the IgCC includes a more comprehensive method for calculating daylit area based on more advanced method called "Total Daylight Potential."

compare buildings that were built under different codes or under different versions of the same code. Even within the same vintage of the same code, this metric is limited. Since the baseline for compliance is that individual building modeled as if it met the prescriptive minimums, no two buildings will be compared to the same baseline.

Other approaches used to tackle energy performance of buildings (LEED, Living Building Challenge, Portfolio Manager) use different scoring systems and so make it difficult to compare prescriptive, modeled and measured performance for the same building, and make it difficult to understand how buildings perform relative to each other and with regard to "net zero" goals. EPA's Portfolio Manager tool, which measures actual energy usage, assigns commercial buildings an Energy Intensity Usage (EUI) metric and an Energy Star score on a scale of 1 to 100 (where higher is better) according to their percentile ranking against an underlying database (CBECS) of buildings of similar size and use, adjusted for climate. For example a building that receives a Portfolio Manager score of 80 has a measured energy efficiency that is better than 80% of the buildings in its cohort of similar buildings. AHRAE's "Energy Quotient" is a 100-0 scale (with zero being zero net energy and 100 being the median building for that building type) and accompanying A-G scale.

Actual energy scales such as EUI have a couple of weaknesses. EUI does not provide for a way to make an "apples to apples" comparison between different building types and buildings in different climate zones which all have inherently use energy in different intensities. Another weakness is that it does not account for occupancy density or schedule. It effectively penalizes buildings that more efficiently use each square foot of area. Relative energy scales such as ASHRAE's EQ and EPA's Energy Star score can mathematically normalize for these kinds of diversities. However, they do not represent actual energy consumption and so require a calculation to move between these scores and actual performance information.

This issue extends beyond the energy code itself. The lack of a universal performance metric makes it difficult to compare the performance of different buildings. This in turn prevents market forces from being able to meaningfully value energy efficiency. By embedding this kind of metric in the code, it gains the kind of universality and credibility that the market desires in its metrics.

A New Compliance Path to Achieve Deep Savings in Existing Buildings

The previous section discussed the obstacles in current prescriptive code frameworks to meeting the goal of a future energy code that can effectively produce deep energy savings in existing buildings. While many of these obstacles could be removed through additions and alterations to existing frameworks, not all of them can be. This suggests that there is a need for a new path to energy code compliance that can allow existing buildings to circumvent those obstacles while still ensuring the energy efficiency that is the goal of energy codes. Current compliance paths have many strengths and advantages, so this new framework should not be a replacement for existing codes, but rather an additional, alternate compliance path within existing code structures.

Ultimately, the goal of energy codes is to set standards that will ensure certain levels of actual energy performance for buildings. Within this context, prescriptive requirements and performance modeling are really proxies for actual building energy outcomes. Here existing buildings have one significant asset lacking in new construction: existing buildings have a history of actual performance. For existing buildings, actual energy performance is already known and can be evaluated not just through performance proxies, but also through actual monitored energy performance outcomes. Combined with the obstacles laid out above, this makes existing buildings especially well suited to an alternate compliance path based on performance outcomes. The performance history of an individual existing building could be used to establish a baseline from which to require an improvement, or the history of a broad selection of buildings could be used to establish absolute performance goals for both existing and new buildings. Either way, energy performance can be assured, with a certainty greater than the performance proxies offered by existing prescriptive and performance compliance paths, while the obstacles of existing prescriptive and performance compliance paths can be avoided.

Benchmarking

Existing buildings do have an energy performance history; however that data needs to be collected and needs context in order to be useful. Therefore benchmarking plays a vital role in establishing an outcome-based compliance path in energy codes. In an outcome-based performance path that requires a certain percent improvement in energy performance, the old energy performance needs to be known. In an outcome-based performance path based on absolute performance goals, sufficient data about building performance needs to be known in order to establish those goals.

In this regard, we are not starting from scratch. CBECS (Commercial Building Energy Consumption Survey) is one significant repository of building performance data. While CBECS contains a wealth of performance data, it is not perfect. It is only updated every three to four years, and the last public update was for 2003. Additionally, while the data is statistically significant on a nationwide basis for many building types, the sample is not robust enough to dig down to regional and sub-regional levels for all building types. Finally, CBECS contains only commercial buildings and does not contain information for all buildings types; multi-family housing is one significant gap. In order to introduce any kind of outcome-based compliance path into energy codes, there is a need for much broader benchmarking data. Disclosure requirements such as those already adopted in Seattle, New York, and Washington DC, the optional disclosure requirements of the IgCC, and those being considered in many other jurisdictions could quickly provide the kind of comprehensive data needed if they become widespread.

Outcome-based energy codes are not the only driving factor behind more and better benchmarking. There is a need for performance data that can be used to validate and improve the assumptions used in energy modeling software. There is a need for performance data to serve as the underpinnings of any kind of labeling system that would rate the energy performance of buildings. There is a need for performance data to inform the real estate market in valuing energy performance in property values and rental rates. There is a need for performance data for building operators to be able to evaluate the performance of their buildings and diagnose problems and opportunities for improvement. And there is a need for performance data to validate the effectiveness of existing energy codes.

A Universal Metric for Energy Performance

A universal metric for energy performance would remove the various problems that come from the "moving baseline" of existing codes. Although a universal metric is not strictly necessary for the adoption of an outcome-based compliance path, it would simplify the process and provide many ancillary benefits. The ability to clearly designate performance goals for outcome-based compliance is only part of it. At the policy level, a universal metric can be used to plot a path of continuous improvement with zero net energy as the ultimate goal. Historically, each new version of a code has been compared to the previous vintage. With this metric, a 25% improvement over a previous version of the code would provide continuously smaller savings. A universal metric would allow code officials to set absolute performance goals for each vintage to make and set a timeframe to reach ZNE that is appropriate for that jurisdiction. Similarly, with benchmarking for an entire building stock, this metric would allow jurisdictions to evaluate how their entire building stocks are performing and set goals to move not just code levels, but the entire building stock forward. It would make it easy introduced new energy code triggers based on performance.

Beyond the energy code itself; a universal performance metric could have even more profound impacts. Foremost among these is that it would allow the performance of different buildings to be compared. This information could foster energy efficiency in multiple ways. In the real estate market, potential buyers and tenants would get a better idea about the real costs of operating a building or space. With this information, energy efficiency can be valued in the market and the market can provide motivation to improve energy performance. In the realm of utility efficiency incentives, this information can be used to target incentive programs. The worst performing buildings could be identified for a more concerted effort. The information could be used in other policy “carrot” and “stick” mechanisms. The worst performing buildings can be assessed special “energy hog” penalties or offered special incentives to improve performance.

All of these would be beneficial for existing buildings. Existing buildings with good performance could spared the “inefficient old building” stigma while existing buildings with poor performance could be targeted for constructive improvement. With performance as the goal, owners and designers could choose the most effective solutions to improve performance rather than the solutions required by a prescriptive code.

Conclusion

Existing energy code frameworks have been very successful in saving energy in buildings. However, this paper has laid out how as we make energy codes more and more stringent and more and more widely applicable, these frameworks present many obstacles to achieving deep energy savings in existing buildings. Prescriptive codes are not as well suited to the constraints presented by existing conditions in existing buildings as they are to the relative design freedom afforded by new construction. As code triggers become more aggressive, this will only become more pronounced. The greater flexibility afforded by alternate modeled performance compliance paths are not as valuable to existing buildings with their higher cost of model production as they are to new designs. As proxies for actual performance, both of these can miss the efficiency strengths of existing buildings and the particulars of specific and idiosyncratic conditions that affect actual performance outcomes. And the dominance of construction events as triggers in energy codes limits the impact that they can have on buildings that are already built.

This creates the need for an additional, alternate compliance path that can not only more ably address the realities of existing buildings but also do more to produce greater energy savings in existing buildings. An outcome-based compliance path would possess both of these characteristics. It would bypass the obstacles presented by both prescriptive and modeled performance compliance paths through focusing on outcomes. It also presents a way to advance code triggers that does not intensify those obstacles.

This solution is not without barriers. Introducing an outcome-based compliance path to existing energy codes will require not only foundational development work, but will also require a fundamental shift in the way that buildings comply with energy codes and receive their Certificates of Occupancy. Outcome-based codes will require much more pervasive benchmarking in order to determine credible performance targets for a broad selection of building types and to determine performance histories of individual buildings. Perhaps more profoundly, code compliance will have to shift from something that occurs before building occupancy begins to something that occurs after building occupancy occurs. This is a fundamental shift in the way that building officials interact with buildings. While it also presents the opportunity to simplify the verification of energy code compliance—a building either performs or it doesn't, there are not building components to check, no models to verify—it is still a fundamental change and carries the challenges of all policy change.

For these reasons, there is the need to begin to take those foundational steps now. Benchmarking needs to be more pervasive now so that when we need to determine required outcomes, we will have the data. Associated building monitoring needs to become more widespread so that performance histories are available when it comes to evaluating the performance of existing buildings. More sophisticated jurisdictions need to begin to experiment with post-occupancy code compliance now so that the frameworks and methods will be mature when they are needed on a wide scale. For these reasons, there is an urgency to begin to act now. Existing energy code frameworks may only pose a limited danger to the use and re-use of existing buildings, but more stringent and more widely applied energy codes will only increases that danger. If the next generation compliance path, outcome-based energy codes is going to be ready before then, then we must begin to act now.

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