No More Easy Refills: the Move from Prescriptions to Performance-Based Codes

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ABSTRACT

The last two decades have seen a tremendous increase in the stringency of California's building energy efficiency code, Title 24 Part 6. Along with these changes, the complexity of the code has increased dramatically, as different design options for building envelope, heating, ventilating and air conditioning (HVAC) and lighting systems have become available under prescriptive compliance paths. Meanwhile, the performance compliance approach, often perceived as a way to trade off efficiency measures or efficiency levels of different components or building systems, is reaching its natural asymptote: most design best practices, such as daylighting controls, demand-based reset of chilled water supply temperature, and cool roofs, are already required by code. There is little left to trade off. Without major advances in technology, the cost effectiveness criteria that are prerequisites to updating California's Building Energy Efficiency Standards become increasingly difficult to meet over time.

All of these factors highlight the need for an energy code that is a true indicator of whole building performance. Yet the question remains: how can an efficiency level be mandated for a broad class of buildings with different design requirements, while maintaining fairness? This paper looks upon advances with both the energy code and compliance tools to illustrate potential paths forward, which both incentivize high performance design, while maintaining a reasonable standard for compliance.

Prescriptive vs. Performance: Separate and Not Quite Equal

Since their inception in 1978, California's Title 24 Building Energy Efficiency Standards (CEC 2015) have paved the way for energy efficiency in both commercial and residential buildings. Energy demand in California has steadily increased over the last four decades, but energy consumption per capita has remained nearly flat. At their origin, the Standards were simple to understand and to enforce: an energy use intensity (EUI) target was set for buildings of a certain type. In 1974, the Warren-Alquist Act established the California Energy Commission, in part to designate an impartial body to develop load forecasts. This regulation also established a framework to ensure that new efficiency measures would be cost-effective over their useful life, to both serve the building end user and accommodate industry constraints. Over time, prescriptive standards, which specify a list of required building features and their respective minimum efficiency levels, have gained prominence. Model codes such as ANSI/ASHRAE/IES Standard 90.1 (ASHRAE 90.1) and the International Energy Conservation Code (IECC) have followed a similar pattern (ASHRAE 2013, ICC 2015). While the prescriptive approach has many benefits, including relative ease of enforcement, it has become not a building energy efficiency code but rather a building component efficiency code. Industry practices and product availability can inhibit code revisions by effectively allowing the lowest performing class of products to comply. With lighting, for instance, energy code cannot mandate a new class of lighting products such as LED lighting until the market has reached a certain level of maturity in adoption rates and availability of products.

The Title 24 prescriptive standards are often constructed so as not to eliminate entire classes of products that perform similar functions as other prescriptively allowed products. Historically, standards have been developed to ensure cost effectiveness and availability of multiple product options meeting prescriptive requirements. Some manufacturers of products that do not comply with new prescriptive standards may feel that their products are effectively excluded from the market, despite the fact that their products are allowed under the performance approach.

Yet here is the rub: in California, a significant portion of new commercial buildings are designed with the performance approach, a comparison of a simulated abstraction of the proposed building to a custom baseline building, which is a code-minimum version of the proposed design. In Title 24, the performance baseline is designed to mimic the performance of a building that meets minimum prescriptive requirements. But which set of requirements? A small packaged rooftop direct expansion unit, a variable refrigerant flow (VRF) system with a dedicated outside air system (DOAS), and water-cooled chiller all meet minimum prescriptive requirements, but the energy code is not structured to ensure that different system types have equivalent performance. A high-mass building with minimal insulation may perform more or less efficiently than a steel-framed building with extra insulation, depending upon the extent to which the high-mass design is coupled with passive strategies.

Compounding this problem is the well-known fact that the prescriptive standards do not and cannot fully define the energy performance of a commercial building. Design specifications, such as fan static pressure and pump head, are building-specific and are not regulated. Also, component efficiency regulations do not always factor in the interdependence of equipment, such as tower selection for a water-cooled chiller. Historically, the solution to address this issue is to define a baseline component efficiency that is "neutral," or equal to the proposed design. While this maintains some fairness, it does little to promote the concept of a visible building performance benchmark, and claims of 20 percent better than code begin to lose their meaning. A transparent benchmark is important for building designers in setting performance targets, and for policy makers in evaluating incremental improvements in building codes as a whole between cycles. Periodic revisions to Title 24 and ASHRAE 90.1, and the fact that building energy efficiency regulations do not address whole building energy use, add to the confusion as to what beyond-code means. Using a common building performance rating scale is one solution to this problem (Eley et al. 2011). A performance rating scale can use either statistical building survey data of energy consumption, or previous code cycle efficiency levels to establish a reference point for energy comparison. With this type of scale, comparison of the efficiency levels of buildings for both energy efficiency code and beyond code programs becomes more transparent. ASHRAE 90.1-2013 Addendum *bm* uses a form of this concept and establishes a baseline approach based on ASHRAE Standard 90.1-2004.

The uneven building efficiency levels in the prescriptive standards can be demonstrated through a simple example. A medium office building prototype was modeled in the Title 24 compliance software, CBECC-Com, to compare the energy performance of different building types that minimally comply with the Title 24 Standards. Table 1 shows how predicted building energy performance can vary relative to the performance baseline, even among alternatives that each meets prescriptive requirements. The substitution of the baseline packaged variable air volume units with single zone systems for a three-story office building prototype increases HVAC time-dependent valuation (TDV) energy use by 12.2%, primarily because of the use of constant-volume fans[1]. Changes in window-wall ratio (WWR) to 20% and 40% from the base case of 33% changes TDV energy use by -5.2% and 2.8%, respectively. Yet all four buildings comply with prescriptive requirements. It may not be feasible to eliminate a custom baseline and specify a fixed EUI target for code compliance, but the Title 24 prescriptive code does not currently define a clear energy performance level for a given building type.

Table 1. Medium Office, Prescriptively-Compliant Buildings (Title 24-2013)

Case	Site Elec (kWh)	Site Gas (therm)	Site Energy kBtu/sf	TDV Energy kTDV/sf	% Change kTDV/sf
Base	128.0	3146	14.0	94.9	--
PSZ	162.8	2476	15.0	106.5	12.2%
20% WWR	122.8	2943	13.3	90.0	-5.2%
40% WWR	131.1	3250	14.4	97.6	2.8%

Federal preemption laws establish HVAC component efficiency levels that prohibit the adoption of state regulations with higher efficiency levels than federal minimum. This also prevents the establishment of a single performance baseline that exceeds federal minimums (Chase, McHugh and Eilert 2012). Approximately 64% of California commercial building electricity consumption and 70% of California commercial gas consumption are affected by federal efficiency requirements (Itron 2015). Besides HVAC systems, the major regulated building efficiency components in the Standards are building envelope, interior lighting, and exterior lighting. In California, increases in stringency for building envelope components require justification that the change does not increase life-cycle costs. Products with a mature segment and limited horizons for advances in technology, such as insulation, tend to follow a “J curve” pattern (Figure 1). However, we are gradually reaching the point of diminishing returns for most building envelope measures. Each of these challenges directs policymakers towards policy solutions that offer flexibility through creative design solutions and a systems approach.

In a technical feasibility study for zero net energy buildings, a typical medium office building was modeled with a discrete package of measures to achieve 49% energy savings beyond ASHRAE 90.1-2010, with the balance offset by solar photovoltaic panels (Arup 2012). Of these measures, a large reduction in lighting power, a reduction in plug load levels to 0.5 watts per square foot, the addition of nighttime plug load controls and reduction of exterior lighting power accounted for 34% of the 49% improvement. This highlights the need to address plug loads and other unregulated loads to achieve net zero. Also, due to federal preemption constraints and current Title 24 code requirements, an effective way to increase HVAC efficiency requirements in code may be to introduce compliance options for new and innovative HVAC systems. While specific HVAC system types cannot be mandated by code, their use can be promoted by incorporating compliance options and by providing a fair relative estimate of energy performance. To truly move toward low-energy and zero energy buildings, code updates must move beyond lighting to address HVAC energy use and unregulated plug loads.

[1] Time-dependent valuation (TDV) energy is an energy metric used for evaluating energy efficiency measures for inclusion in Title 24 and for the performance compliance approach. It incorporates both source energy effects and time-of-use effects.

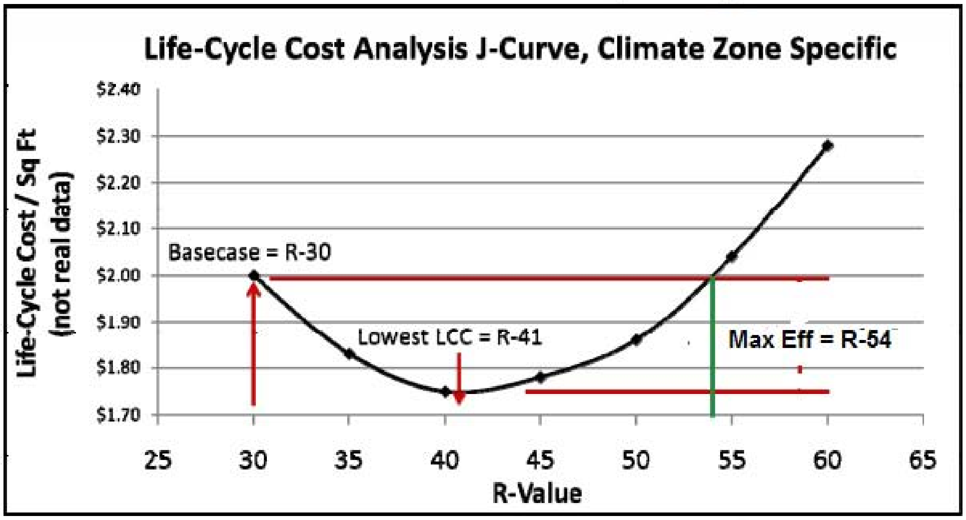

Figure 1. "J Curve" pattern of life-cycle costs (LCC). In this hypothetical example, a minimum LCC is achieved with an insulation level of R-41, but the required level can be set as high as R-54 without increasing LCC.

The performance compliance approach, which uses a whole building simulation to compare the energy efficiency of a proposed design to a baseline, is often used for both code compliance and beyond-code evaluations, such as the U.S. Green Building Council's Leadership in Energy and Environmental Design® (LEED) green building program and California's Savings by Design incentive program. In California, Title 24's performance approach makes accommodations for designs that do not meet all prescriptive requirements, such as the WWR limit, fenestration solar heat gain requirements, and others. However, Title 24 has evolved to the extent that there is little left to trade off: most design best practices, such as daylight controls and rigid continuous insulation for walls, are already required by either mandatory or prescriptive code. Through product substitution (gradual phase-out of products such as linear fluorescent in favor of LED lighting), an increase in scope (extending the prescriptive requirements to cover additional processes, such as commercial refrigeration and data centers) and an increase in extent (verification of energy performance during occupancy, beyond permit), Title 24 can make large advances toward low energy and zero net energy designed and operated buildings. While these ambitious goals are within sight, some steps must be taken today to address common myths and misconceptions people have about today's building code.

To Move Toward Net Zero, Let's Get Static

Despite the increasing trend toward the performance compliance approach and the use of a whole building simulation, prescriptive standards still have a practical role in industry. Even if product substitutions are allowed in the performance method, with equal or better performance, many assert that designers will use the prescriptive template as a guide for choosing products, and those that don't comply prescriptively are effectively eliminated as a code compliance option. Many see green building codes as a potential way to give the building industry foresight as to what may be required in future code cycles. A quick review of common misconceptions on the use of prescriptive and performance compliance paths can indicate how code development officials can work with industry to achieve meaningful progress.

Common Energy Code Myths

While programs abound on how to comply with standards, how to interpret standards and how to use compliance software, there are pervasive misconceptions as to the role and extent of the different approaches. Some common misconceptions include:

Myth: All prescriptive requirements and options must be available the same way in the performance code. The reality is that the performance compliance approach often incorporates building features directly into a model. A simple example of this is the relative solar heat gain coefficient (RSHGC) requirement in Title 24. This is the solar heat gain coefficient of the window, adjusted by an overhang factor, if one is present. In the performance approach, the solar heat gain coefficient and geometry of the overhang can be modeled directly by the simulation program; therefore inputting the RSHGC values directly is not part of the performance specification. Other prescriptive options, such as the complete building method for lighting compliance, are not necessary in the performance, since a lighting power density must be specified for all modeled spaces.

Another example of how the performance approach differs from the prescriptive approach is with HVAC system comparisons with the performance baseline. Both Title 24 and ASHRAE 90.1 have developed an HVAC system map to define a baseline system type that is a "standard of care" or common practice for a few basic building characteristics, such as conditioned floor area, number of floors, and occupancy. For the performance compliance approach, the system map is a step toward defining a baseline system type for a broad class of buildings. In this sense, a "fixed baseline" or static baseline is one where the baseline efficiency parameters that are part of the building-design are independent of the proposed building attributes. In this case, the independent system map baseline sets a common mark for comparison with code, regardless of which HVAC system is selected. A disadvantage of a fixed baseline is that there may be "winners and losers" – that is, some buildings may have specific design constraints that lead to an unfavorable comparison against a baseline.

Myth: The prescriptive compliance path is less flexible than the performance compliance path. In many ways in the Title 24 Standards, this is not the case. The prescriptive compliance approach allows for three different lighting compliance methods: the complete building method, which applies a single baseline lighting power density limit to the entire building, the area category method, where each space is allotted a lighting power budget, and the tailored method, which provides special allowances for retail and other spaces that have lighting needs associated with that space function, such as floor and display case lighting. The prescriptive HVAC requirements allow a choice between several types of HVAC systems, from unducted packaged vertical air conditioners or heat pumps, to water-cooled chillers. Similarly, requirements for building envelope components are tailored toward the component type: mass walls, wood-framed walls and steel-framed walls each have separate requirements. The Title 24 prescriptive requirements have some flexibility but cannot accommodate all building designs. There may only be one or two unmet prescriptive requirements that cause designers to opt for the performance compliance approach. In contrast, although the performance baseline is custom for each building design, it is intended to provide a stable performance target that is largely independent of design decisions.

Myth: The prescriptive compliance path fully defines energy-using components of a building. Some engineers and analysts believe that everything specified in the performance approach ruleset must be derived from a rule in the mandatory and prescriptive sections of the Standards. This is not possible, because the prescriptive standards do not define required performance of all energy-consuming equipment in the building, even when excluding unregulated process loads. For example, small to medium fan systems have no prescribed fan power limits – prescriptive rules only apply to fan systems with a total design horsepower (HP) of 25 HP or greater for Title 24, or greater than 5 HP for the IECC. This is likely because some parameters, such as fan static pressure and pump head, are dependent on the building design. Other building component efficiency parameters are defined, but insufficiently for the performance approach. Equipment ratings of energy efficiency ratio and integrated energy efficiency ratio cannot adequately define equipment performance over a range of part-load conditions. The prescriptive requirement for a minimum skylight area leads to an indeterminate problem when the proposed building does not have any skylights (Rosenberg et al. 2015).

Static Electricity and Friction

Recent attempts to create a static baseline have met some resistance from the design community. Those who see performance code as effectively equivalent to prescriptive rules, rather than a derivative of them, complain that a feature that meets prescriptive requirements is penalized in the performance code. Common complaints include the use of a gas baseline for heating and baselines that significantly penalize packaged rooftop units, in some cases. The implied criticism is that the static baseline results in a perceived loss of equity, despite the fact that the performance method itself is an alternative to prescriptive compliance. Some detractors believe that fairness is sacrificed in the move toward simplicity. The tax code analogy roughly applies: a set of regulations so complex that they are difficult to enforce and possible to circumvent, versus a code so simple that its enforcement is easily achieved, but can never achieve perfect fairness in accommodating the unique circumstances of individual buildings. Despite these obstacles, Addendum bm to ASHRAE 90.1-2013 has been successful in establishing a baseline performance benchmark that is relatively independent of the proposed building and stable over time (Rosenberg et. al. 2015).

There are indeed cases where a static baseline is difficult to achieve. A few examples of building attributes that are normally held constant between a baseline and a proposed building design include:

- Location-Specific Parameters. Building location and climate zone of the baseline are set to match the proposed building.
- Building Geometry. The building geometry of the baseline normally matches the proposed. Possible changes are to limit window area by building type.
- Attributes with Non-Energy Benefits. Some building attributes, such as construction type, have non-energy benefits and design requirements, including structural design and fire ratings. Others, such as illuminance level, are function-specific.
- Operational Settings. Occupant densities, HVAC schedules, heating and cooling setpoints
- Process Requirements. Processes not covered under a performance standard, such as commercial refrigeration or data center server use, are typically treated as neutral. Smaller add-ons, such as an extra pressure drop allowance for unusual filtration requirements, are often included in the baseline (also known as the standard design).

A simple example illustrates the difficulty in making a baseline more static. The nonresidential building envelope section of the Title 24 Building Energy Efficiency Standards has prescriptive requirements for fenestration. Requirements for fixed windows are slightly different than requirements for operable windows, as the Standards are developed by comparing life-cycle costs of like types. However, for the performance approach, a decision was made to assume a performance baseline equivalent to a fixed window, regardless of the proposed design window type, since that is standard practice. After the review process, it was decided to rescind this rule, and make the baseline window type match the proposed building window type. While one could make an argument for including window type as a design parameter (particularly because it has non-energy benefits), must every prescriptive option, exception, and footnote be included in the performance ruleset? Or should we strive toward a ruleset that creates a static benchmark that is independent of the proposed building?

These and other design issues make it difficult not only to use a fixed EUI benchmark, but even to use a static baseline. Recently, efforts have been made in Title 24 to define a more static baseline in the performance compliance approach. Building attributes such as fan static pressure and design head for chilled water and condenser water loops have been added. Since limits for these building attributes have not been defined in the Title 24 Standards, it becomes difficult to add them to the performance approach. However, to address whole building energy use, it is necessary to fully define building attributes that affect performance, and Title 24 prescriptive requirements are incomplete in this regard.

Performance Targets: Removing the Baseline

Energy codes and model codes have incorporated the concept of a custom performance baseline for many code cycles. During the 2013 Title 24 development cycle, Architectural Energy Corporation (now NORESCO) conducted a conceptual study (2011) to explore the feasibility of a fixed EUI baseline for commercial buildings. The authors classified building attributes as one of three types:

1. proposed design features for which a product may receive “credit” or “penalty” above or below code requirements,
2. prescribed design features that are fixed by compliance software, such as occupancy, schedules and setpoints, and
3. building-specific features not dictated by code, such as building geometry and number of floors.

The study focused on this third class of features outside of code requirements to determine their effect on building EUI for a medium office building prototype. While effects were examined separately in different California climates, results here are shown for California climate zone 3, which encompasses San Francisco and Oakland, to illustrate results in greater detail. Table 2 shows that most building geometry characteristics have relatively low impact on building EUI. The receptacle load, which is outside the regulatory scope of Title 24, has a large impact on the predicted energy performance, as does the WWR.

Table 2. Sensitivity of Medium Office EUI to Non-Energy Design Parameters

Parameter	Input Variations	Low Value	High Value
Building footprint aspect ratio	1.5:1, 3:1, 5:1	-0.60%	+0.60%
Building floors	2, 3, 4	+3.66%	-1.85%
Floor-floor ceiling height	12’, 13’, 14’	+0.11%	-0.12%
Window-wall ratio	40%, 20%	See Figure 2	See Figure 2
Building orientation	0 deg, 90 deg	-0.22%	+0.22%
Receptacle loads	+/- 50%	+33.4%	-33.5%

Percentage variation in modeled building energy use intensity (EUI) from the base case.

For a California climate that includes San Francisco and Oakland, the effect of the building floor area was studied in greater detail. For small buildings, Figure 2 shows that modification of WWR has a moderate but significant impact on EUI for small buildings, yet has only a small impact for larger buildings. The building floor area has a large impact on the building EUI. Other non-energy design attributes, such as building aspect ratio and building orientation, have a relatively small effect on EUI. Equipment power density (EPD), which is not a regulated load by Title 24, has a significant impact on EUI.

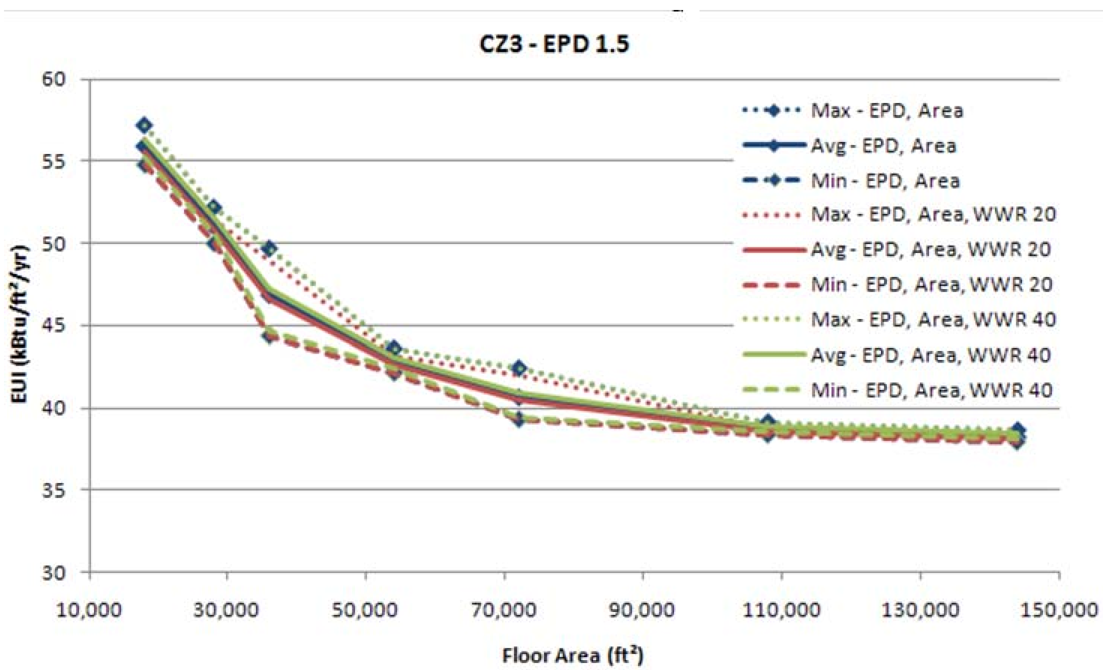

Figure 2. Medium Office Energy Use Intensity, Variation with Floor Area. *Source*: NORESCO

These results suggest that, despite all the inherent difficulties, an EUI performance target is a possibility when adjusted for key non-energy attributes. Building industry professionals cite inherent modeling inaccuracies in building simulation programs used for compliance and the subsequent need for a relative baseline for comparison. This investigation showed that with building efficiency attributes such as lighting power, insulation levels and HVAC efficiency held constant at code-minimum levels, non-energy attributes other than floor area had relatively little impact on the building's predicted EUI level. Actual energy performance in terms of EUI of buildings will always differ from predicted performance, due to operational factors outside of the designer's control. While an EUI benchmark may not be suitable for energy code, the study suggests that performance targets for specific types and sizes of buildings could inform code development in a more "top-down" fashion.

From Beyond Code to High Performance

A Tale of Two Rulesets

At the heart of a whole-building performance code option is a ruleset. The ruleset defines which building component performance metrics can be used to receive "compliance credit" for outperforming code and which receive a "compliance penalty" for underperforming. Rulesets are often applied for several purposes, including code compliance, green building programs, incentive programs and building asset ratings. Each purpose will have a slightly different rule set and consequently a different baseline performance benchmark. Typically, rulesets designed for beyond-code and incentive programs have carried far fewer constraints than code compliance programs. Since their focus is on rewarding high-performance designs, there are far fewer rules constraining how a building can be modeled. For example, the Performance Rating Method in ASHRAE 90.1 has a performance baseline that is more independent of the proposed building than the Energy Cost Budget method (Rosenberg et al. 2015). With the Title 24 Standards, the focus historically has been to prevent "gaming" the system and over time, an overwhelming number of rules have been developed to achieve this goal. One of the problems with a ruleset focused on eliminating all loopholes is that the building modeled for compliance does not closely represent the proposed building. For Title 24 compliance, equipment and occupancy schedules, plug loads and space set points are prescribed by the compliance ruleset. While this has a number of benefits, it places an additional layer of abstraction from real world building performance.

Aligning Code Minimum with High Performance

Achieving high-performance buildings has become increasingly difficult using the prescriptive compliance approach. As has been shown, this approach leads to an uneven level of building energy performance across similar classes of buildings, and code development becomes difficult, because a one-size-fits-all approach does not work well in building design. If only one of the prescriptive requirements in the Standards cannot be met, the performance approach must be used. Prescriptive packages could be used to complement current compliance options, by providing for common tradeoffs and providing allowance for multiple HVAC designs.

A preliminary concept of prescriptive packages have recently been introduced in the 2015 IECC and described in policy roadmap papers (Rosenberg 2015). The IECC code compliance option requires that the building design include one of several high performance design elements: higher HVAC system efficiency, either a reduced interior lighting power, enhanced lighting controls, onsite renewable energy, a DOAS, or, for some building types, high-efficiency service water heating. The City of Seattle has also looked to prescriptive packages in its recent regulations. A potential negative aspect of prescriptive approaches is that they can be seen to limit design flexibility. If, for example, a specific HVAC system type is omitted from the package options, then that system becomes much less likely to be included in projects. Further research and analysis must be pursued to develop a prescriptive package framework that provides engineers and architects similar flexibility in design choices to what they have available today.

One possible application of prescriptive packages is to tailor prescriptive packages for specific building types. Then, recommendations can address common design variations that apply to specific buildings, and code improvements could become more relevant. This approach allows for additional stringency by including building measures that are more appropriate for the as-designed building. Packages of measures customized by building type would avoid problems such as prescriptively requiring wall insulation on a data center building with very high internal loads, or stringent cool roof requirements on a warehouse building with comparatively low internal loads and consequently lower cooling needs.

To maintain fairness, alternate prescriptive packages should essentially have energy equivalence to the “primary” prescriptive package. Under this code development approach, the primary package is first developed with a set of measures and shown to be cost-effective (the set of measures does not increase building life-cycle cost). This primary package could include additional measures or tradeoffs beyond the prescriptive Standards. Then, one or more alternate packages can be developed with different combinations of efficiency measures, such as lighting or HVAC efficiency measures, or a different HVAC system type, that achieve the same or lower building energy use (in California, a time dependent valuation of energy) as the primary package. If one set of measures is cost effective, it should not be necessary to demonstrate cost effectiveness for the other ones. This approach gives code officials opportunities to specify alternate efficiency measures, such as VRF equipment or electrochromic glazing, to help promote their use in industry.

In California, the Title 24 performance approach is often used for small buildings, simply because there are one or two prescriptive requirements that can’t be met. These building-specific packages would be especially useful for small or simple buildings that have typically fewer design variations, or building types with more limited budgets. Figure 3 shows how the majority of the building stock for common building types has a floor area less than 25,000 square feet. If the vast majority of these types of buildings used a prescriptive package to comply, building officials could then focus their limited resources on more complex and higher energy-consuming buildings.

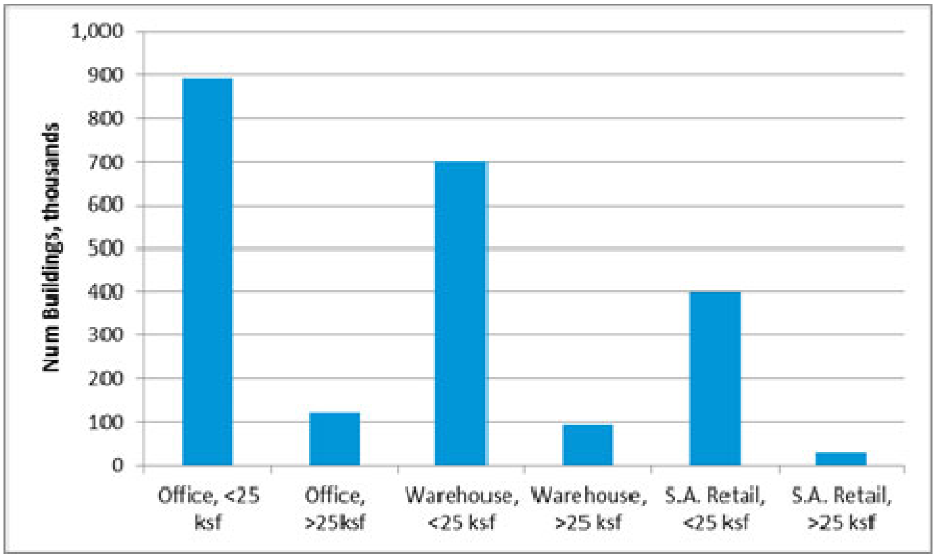

Figure 3. Distribution of building stock from 2012 CBECS Database for office, warehouse and standalone retail buildings. *Source*: EIA 2015.

Action is also needed to loosen current restrictions on modeling high-performance buildings for compliance. With compliance constraints in Title 24, it is possible that a building that qualifies for beyond-code programs may not even comply with the Standards. One example of a building design that fares poorly under Title 24 performance rules is a high mass building coupled with a night purge and pre-cooling. This is because the code does not permit the user the flexibility to specify custom setpoints or off-hours cooling strategies for this design. Yet in practice, this design has good potential at reducing peak cooling loads and maintaining comfort, even in hot, dry conditions in inland California.

Performance rulesets should accommodate alternate conditioning strategies, such as passive or mixed mode designs, to assess their potential benefits. Such additions will require considering not only dry-bulb temperatures relative to a setpoint, but also comfort-based metrics of operative temperature, something simulation tools are already positioned to do. Radiant-based cooling systems will also require shifts in thinking to incorporate the use of suitable metrics. While performance rulesets are based on an assumption of forced-air cooling systems, the code compliance tools must evolve. Technologies for HVAC and lighting, and the development of simulation algorithms, far outpace policymakers' ability to develop and validate energy modeling rules for the Title 24 performance compliance approach. Providing easier paths for new technologies to comply with the Standards would speed the rate of market adoption.

Conclusions and Recommendations

In summary, while policymakers are geared for the long journey toward zero net energy commercial buildings as code, there are first a few hurdles we must cross. Consider these recommendations to transform energy efficiency codes to promote high-performance designs.

Provide industry with clear, consistent explanations of the scope and the intent of prescriptive and performance codes. Prescriptive codes still serve useful purposes: they provide designers with packages of components to meet the Standards, which are especially useful for small buildings and alterations of existing buildings. Prescriptive packages for green building programs can act as a forecast for both designers and equipment manufacturers as to what may lie ahead. Regulators should consider limiting the use of performance codes in smaller buildings (for example, below 25,000 square feet conditioned floor space) to free up resources for review and design of more complicated and energy-intensive buildings. Providing prescriptive package options tailored to a specific building type may further promote the use of the prescriptive option for small buildings.

Revamp the performance code, so that it can apply to both code compliance and green building programs. For compliance, the performance method can be an instrument to identify standard and best practice, and provide feedback on the prescriptive approach. Others have suggested the need to remove low-performing systems from the code (Hewitt, Frankel and Cohen 2010). As federal preemption prevents policymakers from mandating equipment efficiencies beyond-code, it is difficult to remove them entirely. A review of end use intensity of commercial buildings shows that approximately 70% of the entire commercial building consumption is affected by federal preemption to some extent (Chase, McHugh, and Eilert 2012). Rather than restrict the use of systems in energy code, more emphasis can be placed on improving and vetting modeling tools to spur the adoption of innovative technologies and design approaches. As has been shown, progressive performance approaches provide less rigid guidance on the specification of the proposed building and a clear, stable baseline. This baseline can be fixed for a given code cycle, or fixed at a point in time to provide a stable benchmark (Rosenberg et al. 2015).

Develop a set of prescriptive packages that provide clear direction to the building community on requirements and enable designers to more easily weigh the impacts of their design choices. For the Title 24 Standards, prescriptive package measures should be tailored to specific building types, to maintain their relevance. They should also incorporate HVAC efficiency levels beyond federal minimums, and where feasible, incorporate alternate system selections, such as VRF systems or water-source heat pumps. The prescriptive packages should be encouraged as a compliance option for smaller buildings, which typically have fewer design considerations and smaller budgets than larger, more complex buildings. The code development process itself will also be improved, since code improvement targets between cycles can serve an end goal when developing integrated packages of measures.

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