# Codes and Standards: A Path to Affordable Amenity and Customer Satisfaction

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**ABSTRACT**

Insufficient attention paid to amenity and comfort has led to low retention of some energy efficiency measures. For example, the compact fluorescent lamp, the icon of cost-effective energy efficiency, is also despised by many due to some lamps having poor color characteristics (e.g. high color temperature and low color rendering index) and other features that do not make it a good substitute for incandescent lamps for many applications. However efficiency is not always associated with poor amenity; earlier studies cited in this paper have documented a number of technologies where efficiency improvements not only saved energy but were also followed by improved features and amenity. Amenity and comfort suffer from similar split incentives between purchasers and users as has been the case for energy efficiency and we propose that energy efficiency standards can be an effective tool for overcoming split incentives for both energy and amenity. The cost of amenity can be reduced through the commoditizing effect of codes and standards. Success in these areas has been linked to increased customer satisfaction with the sponsoring utility. This paper provides examples of both successful and unsuccessful efforts to include product amenity requirements for 10 products in energy efficiency programs and energy codes.

## Introduction

Efficiency has been characterized as "doing more with less." Reduction of energy consumption without maintaining the desired end use amenity is more accurately considered conservation rather than efficiency and has been characterized as making buildings "too hot in the summer and too cold in the winter." (Conlon 1981) Efforts to conserve energy by reducing amenity are not only unpopular, but these efforts can result in consumer and political backlash against conservation and by association, energy efficiency. Utilities and other entities that operate energy efficiency programs can increase customer satisfaction with their operation of the program when the advice given provides cost-effective energy savings and does not result in a loss of product quality or reliability.

This paper hopes to fully repudiate the "hair shirt" connotation to conservation/efficiency and identify the many ways that energy efficiency standards stimulate innovation in increasing amenity while reducing energy consumption. At the end of a recent public hearing at the California Energy Commission (during which the CEC adopted quality and performance requirements for LED lamps), Commissioner Karen Douglas summed up the issue: "If you really

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want to drive very high levels of adoption of a product, make it a better product. Make it a better product than the one that you're hoping people will move away from. Because if it's a better product, people will want it."[5]

In this paper we provide examples where energy efficiency requirements in energy codes were accompanied by improvements in the usefulness or the quality of the product. We also recount the history of efficiency measures where amenity was not preserved and how this limited the uptake of the measure and generated resistance to these efficiency standards. Amenity and comfort suffer from similar split incentives between users and purchasers as has been the case for energy efficiency. The purchaser (builder, landlord etc.) may not have an incentive to provide either energy efficiency or quality when they neither pay the energy bill nor suffer the degraded amenity of low quality products. Building codes and appliance standards have been effective policy tools for resolving split incentives for energy efficiency, and occasionally these standards have been used to improve or maintain amenity.

As efficiency codes are often the exit strategy of a broad based market transformation program of product evaluation, demonstration projects and incentive programs, this paper describes the process of maintaining or improving amenity of energy consuming products as part of market transformation programs including energy codes. This process includes:

- Identifying primary and secondary forms of benefits provided by the product.
- Quantifying amenity: presence of features or use of test methods.
- Specifying minimum and in some cases premium levels of amenity

When adopted into codes these quality attributes become the commodity product and competitive pressures and economies of scale help reduce costs.

## Identifying Primary and Secondary Benefits of Products

The primary benefits of a particular product are usually pretty straight forward. The primary benefit of an air conditioner is to cool a space to a given temperature and the primary benefit of a light bulb is to provide light. The metrics of performance for these primary benefits are relatively well understood (Btus of cooling for air conditioners and lumens for light bulbs). The energy efficiency metrics are in terms of Btu/W (EER or SEER) for air conditioners and lumens per Watt (luminous efficacy) for light bulbs.

Sometimes benefits of a product have multiple metrics because the product does multiple things. As an example for washing machines one might think that the primary metrics would be water usage and energy usage per load. Besides the embedded energy in water for treatment and pumping etc., energy is used to heat water using in washing machines. But a washing machine does more than wash clothes – it also extracts water in the spin cycle which in turn impacts the amount of energy used by the dryer. In the clothes washer "Integrated Modified Energy Factor" metric, DOE takes into account the remaining moisture content in clothes that are leaving the machine upon the completion of the wash cycle, even though the actual energy savings will be realized by the clothes dryer by having to use less energy in drying clothes. In other words, the rated efficiency of the clothes washer is tied to how it impacts the clothes dryer, such that a

[5] Commissioner Karen Douglas Transcript of the 01/27/16 Business Meeting Page 125 http://docketpublic.energy.ca.gov/PublicDocuments/16-BUSMTG-01/TN210174_20160205T104106_Transcript_of_the_012716_Business_Meeting.pdf

clothes washer that leaves higher remaining moisture content in the finished load (which in turn requires more energy by the dryer to fully dry the load) is considered less efficient.

The secondary benefits are not always so easy to identify and quantify. An air conditioner is not very comfortable if it is blowing cold air directly on the occupant; as a result room air conditioners often have the feature of the user being able to redirect the flow of air in the direction they choose. An air conditioner with a noisy fan is annoying; thus, some air conditioners have a sone or decibel rating.

Other forms of secondary amenity that are less apparent are those that make sure that the operation of equipment does not degrade the operation of other equipment. Examples include the Federal Communication Commission (FCC) Radio Frequency Interference (RFI) requirements in Part 15 of Title 47 of the Code of Federal Regulations. If an appliance causes static on nearby TVs, radios, or mobile phones this would be a loss of consumer amenity to other devices used nearby.

In addition, there are a number of cases where amenity is increased directly in response to the efficiency measure. An example is the occupancy sensor in the laundry room: one can walk into a laundry room with arms full and the lights come on without having to operate a light switch.

When considering secondary benefits of light sources, one can consider the history of compact fluorescent lamps (CFLs) and the desired amenities that were not initially provided, such as:

- Color - early CFLs developed a reputation for having poor quality of light. Consumers in several studies described them as having harsh, cold, or “unfriendly” light. This may have been a result of the color appearance not matching expectations – lights often appeared bluish, pinkish, or greenish. These reactions were likely also a result of the decreased color rendering properties of fluorescent sources – CFLs did not accurately render skin tones and colors of other objects.
- Color consistency – CFLs often had inconsistent color appearance such that some lamps would not match the color of other lamps in the same room initially or over time.
- Flicker – visible flicker (modulation of light output) can be highly distracting. Consumers also reported experiencing headaches under fluorescent lamps, which can result from visible flicker or imperceptible flicker.
- Lifespan – many CFLs did not live up to their long life claims, particularly when installed in a recessed or enclosed fixture.
- Start time – some consumers noticed a delay after flipping the switch before CFLs would turn on.
- Run-up time – CFLs were notorious for taking several minutes to “warm up” to full light output.
- Dimmability – CFLs were not only non-dimmable, but when placed on a dimmer, many would experience an immediate failure/burnout.
- Toxicity – CFLs contains mercury – a toxic material that is hazardous if the lamp is broken, and creates disposal issues.

The CFL market share was extremely slow to increase in the 1990s and early 2000s, and most believed it was a result of their high prices. Indeed, when prices dropped below about $5 in the mid 2000’s, sales finally began to increase, and market share hit about 25% in 2007. As prices continued to decline to about $2, it appeared CFLs were poised to finally take over the general service lighting market. However, over the next three years, CFL market share stayed relatively stagnant at around 20-30%, as shown in Figure 1. Even today, 7 years later, CFL market share has continued to hover between 30-40%. In retrospect, price had not been the only thing holding CFLs back – the many shortcomings of CFLs prevented them from achieving mass adoption.

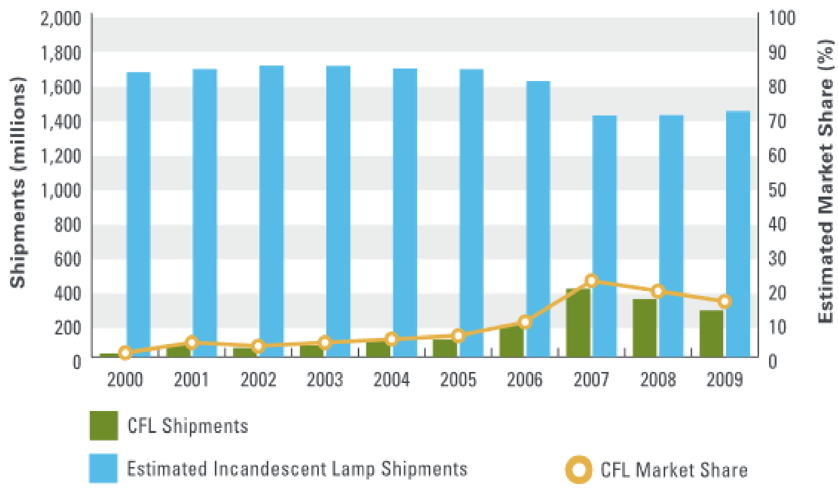

Figure 1. CFL & Incandescent Shipment and CFL Market Share since 2000. (USDOE 2010)

Insufficient amenity provided by high efficiency technologies can stymie their adoption or implementation in energy codes. Section 321 of Energy Independence and Security Act of 2007 (EISA 2007), required increases in general service lamp efficacy in two phases. The first phase, which took effect gradually between 2012-2014, required incandescent lamps to increase their efficacy by around 30%, effectively requiring a shift to halogen incandescent lamps. Opponents pushed back by inaccurately claiming the first phase would require consumers to shift to CFLs (with all of the performance concerns described above). One of the outcomes of this backlash was the BULB (Better Use of Light Bulbs) Act which would have repealed the lighting requirements of EISA 2007. When it was publicized that the new legislation would only require halogen lighting with none of the amenity problems listed above and that the lighting industry supported the changes, support of the BULB Act collapsed.

The second phase of the lighting requirements in EISA 2007, which will take effect nationally in 2020 and in California in 2018, will require that general service lamps have a minimum efficacy of 45 lumens/Watt. This phase *will* effectively eliminate general service halogen lamps and require a shift to high efficacy products like CFLs and LEDs. The savings associated with the general service lamp regulations are around 102,000 GWh/yr, or equivalent to the output of 33 medium sized (500 MW) power plants! (NRDC 2011) The huge energy savings associated with the regulation would be at risk if the replacement lamp technology does not provide comparable levels of lighting quality and consumer backlash results in Congress overturning this regulation before 2020 or the California legislature overturning California's early adoption in 2018. Significant efforts are underway to prevent this from happening in California and are described below.

## Quantifying amenity: presence of features or use of test methods

Some amenities are discrete – they are either are present or not. Examples for refrigerators include: a self-defrost cycle, an ice maker etc. Other amenities are continuous. For example light bulbs have a continuous scale of color fidelity called the Color Rendering Index (CRI) which predicts how accurately a light source will render the colors of objects, relative to the reference light source. For these types of performance metrics an unambiguous test method is needed. As an example, for something as simple as quantifying noise level of a product one has to define how far away the measurement should be taken and in what direction. Does one choose the highest measurement or average the measurements taken at different angles? These kinds of questions are specified in test methods. An example is the Environmental Protection Agency's (EPA) ENERGY STAR test specifications contained in its "Program Requirements Product Specification for Lamps Version 1.0: Noise," Recommended Practice (August 2013):

The sources of test methods can be those that are developed by technical societies such the American Society of Hearing Refrigerating and Air-Conditioning Engineers (ASHRAE) or the Illuminating Engineering Society (IES) or by industry associations such as the American Heating and Refrigeration Institute (AHRI) or the National Electrical Manufacturers Association (NEMA).

Other test methods have started out as a voluntary standard often as a basis to be included in an efficiency program; examples include ENERGY STAR (EPA) and WaterSense. These voluntary programs recognized that the program would have an enhanced uptake if their certification could be branded as identifying reliable, high quality energy efficient products.

Though many of the test methods specified in state or federal government regulations reference the test methods from the other entities described above, sometimes the test methods are developed by these government entities when no other acceptable method exists. A recent example is the flicker test method that is included in Joint Appendix 10 to California's Title 24, Part 6 building energy efficiency standards. Requirements for "low flicker operation" had been in the Title 24 standards for over 20 years and were updated in the 2008 version to accommodate high frequency flicker associated with dimming control of LEDs. The definition of low flicker operation was very specific: flicker shall be "no greater than 30 percent amplitude modulation for frequencies less than 200 Hz." However when manufacturers asked how to show compliance, past guidance suggested that an observer look for visible flicker. To fill this gap, the California IOU Codes & Standards program worked with the California Lighting Technology Center to develop a test method based on concepts in IEEE PAR 1789 as well as making use of an equipment configuration developed by PNNL in their investigation of flicker.

## Energy Standards Can Lead to Increased Amenity at Lower Cost

As shown in Figure 2, the last 70 years have seen significant changes in the volume, energy consumption and real (inflation adjusted) price of refrigerators. Energy consumption of refrigerators was increasing year upon year, reflecting increasing capacity and increasing capabilities (e.g. auto-defrost, icemakers). In 1987 the first California appliance standard went into effect and this resulted in significant reductions in electrical consumption even though storage volumes were still increasing. Mauer et. al. (2013) identified that since 1987 real (inflation adjusted) prices have dropped 35%, while energy consumption has decreased by 50% and adjusted volume has increased.

While refrigerators were becoming more efficient, this had corresponding impacts on cost and amenity. With improved insulation and temperature control, compressors could be smaller, less costly and quieter. Food quality improved due to smaller temperature excursions.

Energy efficiency regulations both decrease and increase market choices. The decrease in market choices is obvious; one can no longer sell products that use more energy. Initially this reduces the number of products on the market and minimally compliant equipment must compete on price. This helps drive costs down on the new commodity product. With fewer component choices, there are greater volumes of the higher efficiency components, whether it is high R-value foams or electronically commutated motors, and these changes impact the costs of the finished product. However these competitive pressures also drive manufactures to innovate; first to find less costly ways to hit the target efficiency, but also to deliver the next premium product.

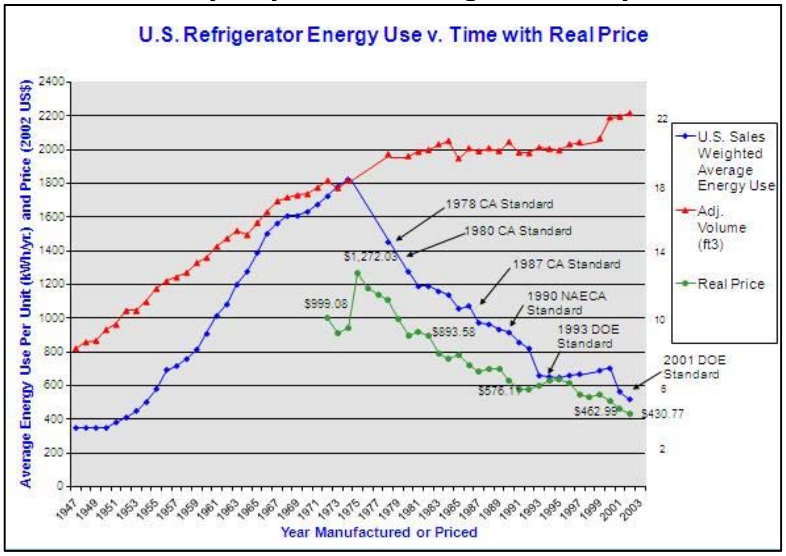


Figure 2. Refrigerator Energy Use, Volume, and Retail Price from 1987 – 2003 (Delforge 2010)

In this way, energy efficiency regulations also increase market choice. There may be little incentive to provide higher efficiency equipment without efficiency regulations. With so many appliances in the home, energy is essentially invisible; the consumer can rarely distinguish which appliance is giving them a high utility bill. With energy regulation comes certified testing, energy rating and energy labeling in addition to minimum standards. As a result, the consumer is given more knowledge on how much energy the appliance uses and this provides an opportunity for competition and differentiation in terms of energy efficiency.

Some efficiency standards also result in ratings for various forms of amenity. Examples include: sone (sound) rating of fans, lighting quality of lamps, flush performance for toilets (MaP rating), skylight diffusion (haze), and other metrics that require minimum levels of amenity and require labels on products so they can be differentiated and compete based on amenity.

## Impact of Energy Codes or Energy Ratings on Amenity

### Serendipity - Amenity as a By-product of Energy Codes.

As described above for refrigerators, energy efficiency requirements may have a side benefit without being specifically required. The following energy efficiency measures have amenity benefits by the nature of their construction for saving energy.

**Double Glazed Low-e, Low SHGC Windows.** In some cases, double glazed windows will reduce their sound transmission, especially if the glazing layers are of different thicknesses (they absorb different frequencies of sound) and even more if one or more of the glazing layers are laminated. The thermal and solar transmittance of windows have a direct impact on human comfort – even when the room air temperature is identical. The Center for the Built Environment (2006) has identified how glass properties impact comfort. They found that the primary impacts of glass selection are: long wave radiant heat exchange between the human body and the window and diffuse solar radiation transmitted through the window (direct beam solar radiation is so uncomfortable under all but the coolest indoor conditions that people will move or take some action to reduce direct beam radiation). People sitting near windows in a conditioned space could be comfortable under a significantly wider set of exterior temperature conditions with double low-e glass than single paned glass; it could be 22°F degrees cooler outside and still have similar levels of comfort inside with double low-e windows. Similarly for a low-e window with a low

SHGC (solar heat gain coefficient), the summer comfort index is approximately half that of a single glazed clear window. In other words, the same summer time comfort can be achieved by sitting next to windows with a double low-e, low SHGC window with twice as much solar gain impinging on it as compared to a single glazed clear window.

**Variable Speed Pool pumps**. In 2004, the CA IOUs (California Investor Owned Utilities) proposed and supported the adoption of the first-in-the-nation appliance standards for pool pump motors in California. Included in these initial standards was a requirement that all residential filtration motors greater than one total horsepower (THP) be able to operate at two or more speeds starting in 2008. In 2005 one manufacturer developed and introduced the variable speed/ variable flow pump which introduced flow control to the residential pool market. While initially significantly more expensive than minimally compliant two-speed pumps, variable speed pumps soon out-performed the two-speed products and have since captured a significant majority market in this product category. Today, not only do variable speed pool pumps use less energy, but they have built-in freeze protection and safety features to prevent suction related drownings, are fully programmable with built in time-clocks and can be wireless controlled from a smart phone. Another feature that pool owners widely admire about these products is that they are so much quieter due to their permanent magnet motors (as compared to induction motors) and their ability to run as low as a ¼ speed. In fact manufacturers often highlight this attribute in advertising their pool pumps claiming that the variable speed pumps create roughly one third fewer decibels than single-speed pool pumps. Historically, pool pumps have been notoriously noisy, leading homeowners to run them during the day when they are either awake or gone from the home. Because these products are so much quieter, variable speed pumps offer significant flexibility with regards to their operation schedule. Where, in the past, a single-speed pump may have been scheduled to run during the peak demand hours during the day to avoid noise issues, a modern variable speed pump can run quietly through the night (off-peak), with no impact to the homeowner. This flexibility further enables the opportunity to take advantage of utility time-of-use rates, saving consumers even more.

### Amenity Directly Addressed

**LED quality standards.** Starting in 2011, the CA IOUs began development of an array of proposals that will require improved levels of quality and performance from the next generation of high efficacy lighting, to avoid a repeat of the CFL market roll-out and stagnation. These proposals were adopted into the next update of the California building energy standards (Title 24) in 2015[6] and into the California appliance standards (Title 20) in early 2016.[7] The building code requirements and test methods, which are contained in Joint Appendices 8 (JA8) and 10 (JA10) will require most lighting in all residential new construction, effective January 2017, to be high efficacy (45 lumens/Watt – a level that cannot be met by incandescent or halogen sources), but also to meet a list of performance criteria designed to prevent consumer dissatisfaction including: high color rendering, long life (including elevated temperature testing for products in recessed or enclosed applications), dimmability, reduced flicker, fast start time, incandescent-like color temperature, low noise, and others. The appliance standards adopted in Title 20 will take effect in January 2018, and will apply to LED lamps sold anywhere in the state.

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[6] http://www.energy.ca.gov/title24/2016standards/

[7] http://docketpublic.energy.ca.gov/PublicDocuments/15-AAER-06/TN207218_20160107T132138_Notice_and_Revised_15Day_Language.pdf

The Title 20 requirements also include a number of performance and quality requirements. Together, these two standards have set a high bar for LED performance to ensure that the next generation of energy efficient lighting delivers a high level of amenity, along with the promise of energy savings.

**Bi-level occupancy sensing**. Parking lots and parking garages spend most of their time being unoccupied especially after business hours. Many building owners are afraid to turn off their lighting at night as they might be sued for creating a hazard in regards to tripping and falling or perceived safety of the lot. Though the trip and fall hazard associated with sufficient lighting can be eliminated via on/off motion control, walking towards completely black zones creates a perceived (and perhaps actual) risk that someone is lurking in the shadows. As required in the Title 24 and ASHRAE 90.1 standards, with bi-level motion control of parking lot lighting, one can see beyond the zone of their activity. In addition, motion control of security lighting provides enhanced security as compared to static outdoor light sources. With motion controlled lighting, police traveling by the site can identify areas where movement is taking place where there shouldn't be. In discussions with one energy and security manager, acts of school vandalism decreased after adding motion sensing to exterior lighting.[8]

**High cut-off outdoor lighting**. Designing outdoor lighting so that it places light where it is needed seems like an obvious method of reducing lighting energy consumption. Since the 2005 version of the California Title 24 building efficiency standards, the amount of stray light leaving outdoor lighting luminaires above certain vertical angles has been limited. In addition to saving energy, this reduces the amount of "visual trespass" of light from parking lots into the rest of the outdoor environment and into neighboring buildings. It also reduces sources of glare for drivers and pedestrians.

**Diffusing skylights.** Both ASHRAE 90.1 and Title 24 prescriptively require a minimum amount of skylight area in large spaces with tall ceilings that are directly below a roof. Diffusing skylights are required as they spread the light relatively uniformly which is needed to displace electric lighting. In addition to reducing glare for performing the visual task, diffusion also prevents the creation of hot spots which can cause thermal discomfort and in grocery stores can reduce product quality (freeze/thaw cycles for frozen food and wilting for fresh food).

**Demand responsive thermostats.** Since the 2008 version of Title 24, California has required demand responsive thermostats for commercial single zone air conditioners and "global temperature adjustment" capability in energy management systems controlling air conditioning with direct digital control (DDC) to the zone. Both of these controls provide the capability to reset the thermostat in receipt of a demand control signal. This approach is different than traditional approaches towards load control of air conditioners. In the past, air conditioners were cycled on an open loop basis – the control dispatchers had no idea what the temperature conditions were inside the spaces served by these duty cycled air conditioners. Some spaces with greater levels of insulation and greater thermal capacitance were minimally affected and perhaps could have been curtailed more; however other spaces were seeing large temperature excursions with unhappy occupants with the risk of losing that air conditioner's participation in next year's program. In contrast occupant controlled smart thermostats (DR thermostats) limit the amount of temperature excursion to more closely track the trade-off between demand response and occupant comfort.

**Ventilation fan sone rating.** Research conducted on recently built homes in California found that relatively high levels of formaldehyde are found in almost all new homes and that

[8] Personal communication, Stu Reeve, Poudre School District.

people rarely open their windows (CEC 2009). As a result, the 2008 California Title 24 standards not only require that homes comply with the ASHRAE 62.2 air quality standard but in addition the California standard does not recognize operable windows as a method for providing ventilation to meet the standard. As a result, a fan powered outdoor air ventilation system is required. The ASHRAE standard requires either higher volume fans running intermittently with a sound rating of no greater than 3 sones or a lower volume fan running continuously with a sound rating of no greater than one sone. The purpose of these sound ratings is to retain the amenity of quietness so occupants do not disable the exhaust fan.

### Is Federally Covered Equipment Preempted from State Amenity Requirements?

One consideration for state energy standards that can impact the effectiveness and the duration of adopted requirements is the issue of federal preemption. Generally speaking, unless there is a specific carve out (exemption) identified by legislation, states cannot implement or enforce energy efficiency standards that are different from the federal standards that exist for a given product. Even if a state adopts standards for a product that is not yet covered by federal standards, if the Department of Energy later adopts federal standards for the product, the new federal standards preempt the existing state standards on the effective date of the federal standards. The current preemption provision states that federal standards *"supersede any State regulation insofar as such State regulation … requires disclosure of information with respect to the energy use, energy efficiency, or water use of any covered product other than information required"* by the federal standard (42 U.S. Code § 6297 - Effect on other law). However, since many amenity standards do not require the disclosure of information related to *"energy use, energy efficiency, or water use"* of a product, many of the state standards related to amenity may not be subject to federal preemption. For example, state requirements related to color rendering, flicker, or noise for LED light bulbs may not be at risk of federal preemption because they do not require the disclosure of information related to energy or energy efficiency of the product.

## Utility Customer Satisfaction and Codes and Standards

Since energy codes by design impact the status quo, some industries may be upset that their relative position in the market has changed depending upon how well they respond to changing factors including energy codes. In addition, newly regulated products have the added expense of testing, and in some cases, product redesign. Even though the changes to codes are ultimately the decisions of local, state or federal governments, utility codes and standards programs provide technical and market data that influence these policy decisions and this is occasionally not welcomed by some participants in energy code proceedings. However is the dissatisfaction by a few manufacturers overwhelmed by the benefits to many utility ratepayers? Do the significant energy savings and amenity benefits accruing to all ratepayers result in a net increase in consumer satisfaction towards utilities that advocate in the codes arena on their behalf?

Customer satisfaction continues to be an increasingly important metric for utilities. The J.D. Power and Associates customer satisfaction ratings are the most common measuring stick for utilities and the results are heavily scrutinized. For many utilities, customer satisfaction scores are tied to compensation for senior leadership, company managers, and employees. Utilities with high customer satisfaction scores are often more successful during rate cases. Specifically, results from studies conducted by J.D. Power and Standard and Poor's have shown

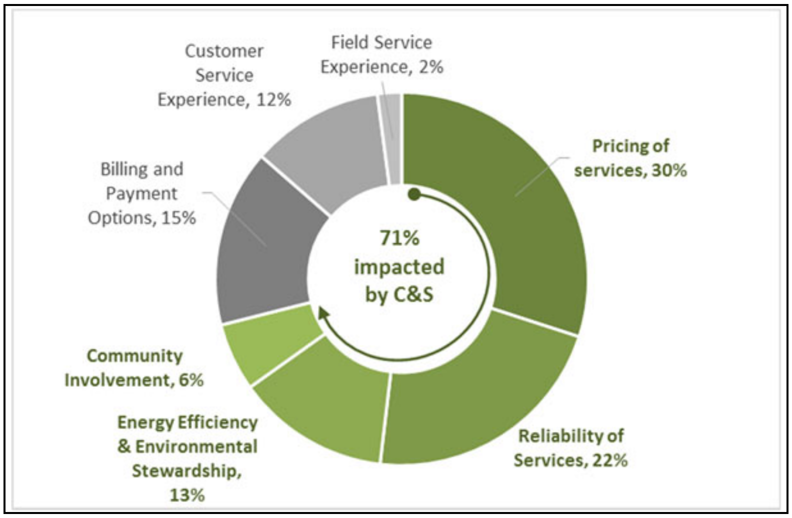


Figure 3. Utility customer satisfaction determinants[9]

that "on average, a 10-point increase in customer satisfaction, based on the 1,000-point index scale utilized by J.D. Power and Associates, is associated with a 0.04% increase in return on equity (ROE). More notable is the finding of a 0.5% increase in ROE among utilities in the top quartile of customer satisfaction one year prior to a rate case, compared with utilities in the bottom quartile of customer satisfaction during the same time frame. This 0.5% increase applied to an equity base of $1 billion equates to $5 million in annualized increase in earnings available to shareholders." (J.D. Power and Associates 2012). Further, utilities are increasingly sensitive to keeping their customers satisfied in an environment where those customers are gaining more interest and options regarding the source, usage, and cost of their energy.

Customer satisfaction can be influenced by a number of factors. Successful codes and standards activities can likely impact and increase customer satisfaction associated with a majority of these factors. For example, Figure 3 shows that 71% of the relative "importance index" scale could be directly or indirectly impacted by codes and standards activities. Pricing and reliability of services have generally been the top two determinants of customer satisfaction, and in this case account for 52% to the total. With respect to "pricing of services," we presume that this includes more than just the rate but also—and perhaps most importantly—the total energy bill that the customer sees each month. In that respect, successful codes and standards can lower monthly energy bills. The California Codes and Standards program has been very effective at reducing energy costs. As shown in Figure 4, by 2016 the California statewide codes and standards program generates half of the electricity savings and over a quarter of the gas savings necessary to achieve the goals of the statewide energy efficiency portfolio while expending only 2% of the portfolio budget. The California Codes and Standards

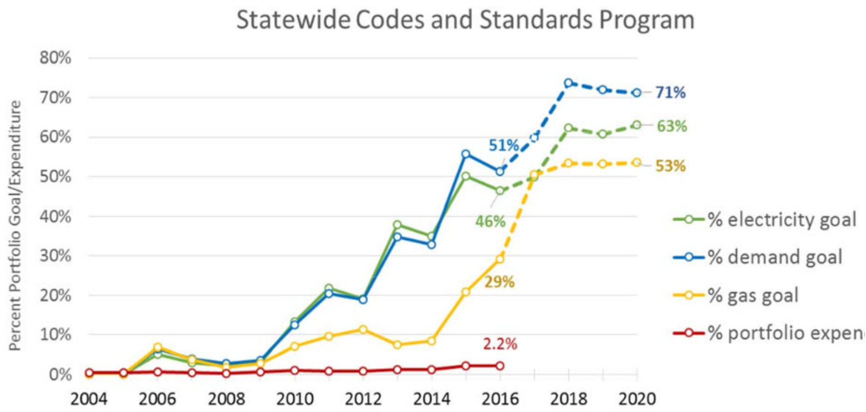


Figure 4. California codes and standards: percent of energy savings goals and percent of energy efficiency portfolio budget.[10]

[9] Percentages indicate the relative "Importance Index" impacting customer satisfaction for residential, small business, and medium business customers. Source: Internal PG&E e-mail.
[10] Slide 3. "Portfolio Perspective" (CA IOU C&S 2016)

program activities are estimated to have reduced consumers' annual bills by $400/yr in new homes and by $100/yr in existing homes.[11] This benefit is equitable as it applies to all Californians.

With respect to reliability, codes and standards can play an important role as states approach their various goals for energy efficiency, renewable generation, energy storage, greenhouse gas reductions, and zero net energy (ZNE) buildings. Within this context, grid operators are looking for new mechanisms to manage supply and demand to maintain grid reliability. Utility codes and standards programs can support design specifications for Integrated Distributed Energy Resources (IDER) such as energy-using products, PV modules, inverters, batteries, etc. to ensure product safety, reliability, and interoperability across the entire industry, regardless of the product manufacturer. Design specifications typically focus on safety and reliability, but some metric of energy performance is usually included (Hauenstein et al. 2016).

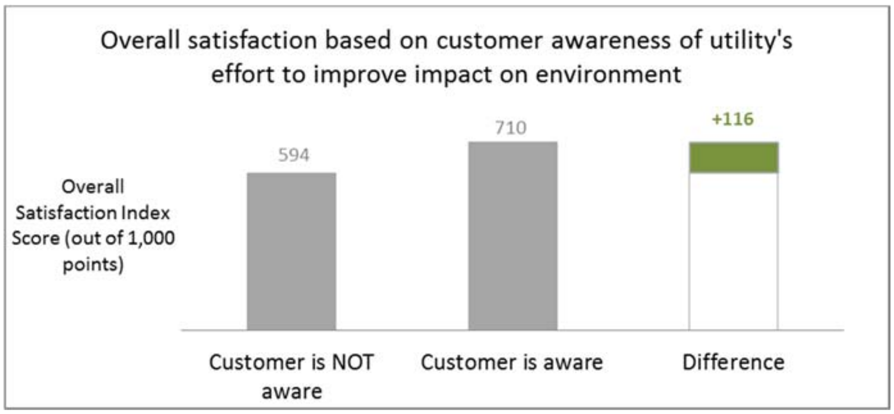


Figure 5. Overall customer satisfaction based on customer's awareness of utility's effort to improve its impact on the environment (J.D. Power and Associates 2009)

Two additional determinants—"energy efficiency & environmental stewardship" and "community involvement"—fall with the J.D. Power's broader category of "corporate citizenship." While generally smaller factors compared to price and reliability, they are often more "controllable" from a utility's perspective. And Figure 5 shows that overall customer satisfaction significantly increases when customers are aware of their utilities effort to improve their impact on the environment. According to J.D. Power research, satisfaction scores increased 116 index points (out of a 1,000 point scale) with this customer awareness. Assuming that each 10-point increase results in a 0.04% increase in ROE (as discussed above), a 116-point increase would yield a 0.46% increase in ROE.

One connection that is less known and tested is how utility customers would connect their utility's role in developing codes and standards to the broader theme of a utility's "effort to improve its impact on the environment." Based on our experience in utility codes and standards industry, we think that few customers are aware of their utility's role in developing and supporting codes and standards (if indeed the utility is doing so). However, research by the Consumer Federation of America indicates that a large majority of Americans (72%) support the government setting minimum energy efficiency standards for appliances, with strong support from 28%. This support increased by 10% on average when the respondent was generally aware of the existence of government-mandate efficiency standards (see Figure 6). Thus, we posit that customer satisfaction scores could significantly increase for a fair amount of utility customers if they knew more about their utility's role in codes and standards and the resulting positive impacts on the environment, energy costs, and reliability. This effect would likely be amplified if

[11] Ibid. Slide 4. "Bill Reductions from C&S Impacts"

customers also knew about the impacts that codes and standards can have on amenity and their utilities' efforts ensure that improved amenity is a focus of codes and standards initiatives. We recommend that utilities explore this connection further by utilizing focus groups to test different messaging strategies and then roll out that messaging to targeted user groups.

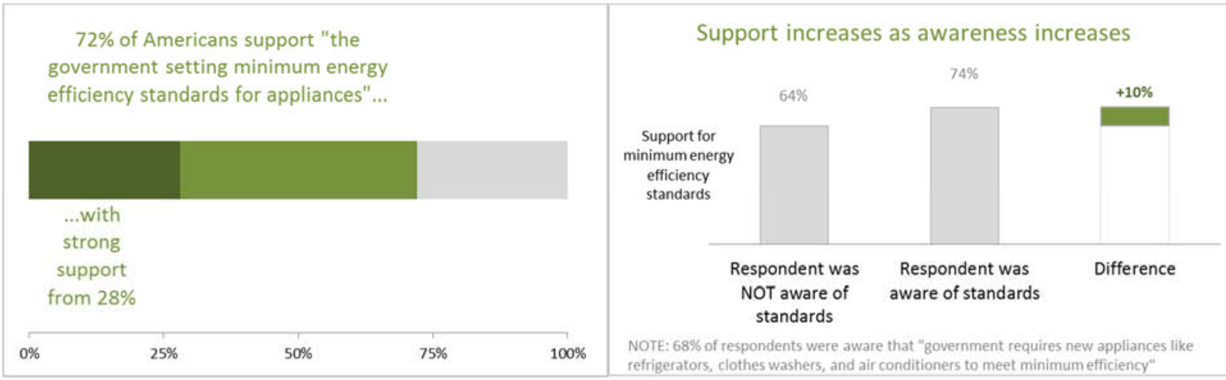


Figure 6. Public attitudes toward energy efficiency and appliance efficiency standards (CFA 2011)

## Conclusions

Building codes and appliance efficiency standards can advance the public good by saving energy but also by assuring that the desired end-use (amenity) is achieved in addition to minimizing energy consumption. The tools used for specifying and regulating energy efficiency can also be applied to other amenities of building and appliances including: defining and quantifying amenity, developing testing protocols, and specifying minimum levels of performance and amenity. Similar to the history of cost reductions associated with economies of scale for mandated efficiency measures, mandated amenity features can also enjoy cost reductions associated with commoditization.

Ignoring the importance of the amenity of a building or product can undermine efficiency goals. If amenity is compromised by an efficiency standard, there may be enough consumer backlash that the efficiency standard is overturned or that consumers "vote with their feet" and bypass the efficiency requirement. Either outcome reduces the potential energy savings as compared to a standard that maintains amenity while minimizing energy consumption.

Codes and standards that reduce energy consumption *and* quantify or ensure enhanced amenity provide great value for the public. Research on public attitudes towards energy and the environment suggests that informing ratepayers of utility sponsored codes and standards activities on their behalf, and the impact this has on their utility bills and on the global environment, may increase their satisfaction with the participating energy utility. We recommend that utilities with effective codes and standards programs test different messaging strategies with focus groups and then roll out effective messaging to targeted users.

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