Responding to Increasingly Stringent Energy Codes: Xcel Energy's Preliminary Strategy

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ABSTRACT

The ASHRAE 90.1 Energy Standard for Buildings has been gradually increasing energy-efficiency requirements since its inception in 1989. The most recent standard ASHRAE 90.1-2010, which is expected to be widely adopted in the U.S. by 2013, reduces energy consumption by an average of 18% relative to the previous 2007 version (DOE 2011). This more stringent energy standard will significantly reduce energy savings from existing new construction demand-side management (DSM) programs, but opens up opportunities for utilities to provide new strategies such as energy code support programs. Utility DSM programs must evolve to maintain cost-effectiveness and value for rate-payers.

This paper provides insight into the implications of the higher efficiency requirements of ASHRAE 90.1-2010 on building design and existing new construction DSM programs. We discuss strategies for DSM programs, including some approaches that Xcel Energy is considering to help mitigate the impacts of reduced energy savings from the higher code level with a focus on emerging energy-efficient technologies and a codes and standards program.

Background

Utility-funded, energy-efficient building programs for new construction generally reference the local energy code as the baseline above which savings are incentivized. About half of the states in the U.S. have adopted the 2009 International Energy Conservation Code (IECC) or ASHRAE 90.1-2007 Standard for Commercial Buildings (Online Code Environment & Advocacy Network 2012); the 2009 IECC allows for compliance using ASHRAE 90.1-2007.

As jurisdictions adopt more stringent energy codes, such as the 2012 version of the IECC, the cost-effectiveness of new construction DSM programs must be re-evaluated to ensure value for rate-payers. The 2012 version of the IECC references ASHRAE 90.1-2010, which reduces energy consumption by 18% relative to ASHRAE 90.1-2007 (DOE 2011) as shown in Table 1. To help explain Table 1, the site energy-use intensity (EUI) column can be interpreted as an equivalent increase in the baseline used for a new construction utility program. Of the 16 building prototypes modeled by the Department of Energy (DOE), the savings in whole building use range from approximately 5% to 27% based on site EUI. According to the model, the highest quartile savings are predicted for the secondary school, stand-alone retail, hospital, and primary school. The lowest quartile savings occur in the fast food restaurant, small hotel, and both types of apartment buildings.

Table 1. DOE Modeled Building Types under ASHRAE 90.1-2010
Estimated Percent Energy Savings with 2010 Edition - by Building Type

Building Type	Building Prototype	Building Type Floor Area Weight %	Percent Savings in Whole Building Energy-Use Intensity (%)		
			Site EUI	Source EUI	ECI
Office…………	Small Office………………….	5.61	16.1	16.4	16.4
	Medium Office………………	6.05	22.1	24.4	24.4
	Large Office………………….	3.33	22.3	21.5	21.5
Retail…………	Stand-Alone Retail…………..	15.25	26.1	24.7	24.7
	Strip Mall……………………	5.67	16.8	18.9	18.9
Education……..	Primary School………………	4.99	24.2	20.8	20.8
	Secondary School…………..	10.36	26.7	23.3	23.2
Healthcare…….	Outpatient Healthcare……..	4.37	22.6	22.2	22.2
	Hospital……………………..	3.45	24.5	20.1	20.1
Lodging……….	Small Hotel…………………	1.72	5.9	7.7	7.7
	Large Hotel…………………	4.95	11.0	10.5	10.5
Warehouse…….	Non-Refrigerated Warehouse	16.72	20.7	23.1	23.1
Food Service…..	Fast Food Restaurant……….	0.59	5.1	8.6	8.6
	Sit-Down Restaurant……….	0.66	13.8	19.3	19.4
Apartment……..	Mid-Rise Apartment……….	7.32	6.8	4.4	4.4
	High-Rise Apartment……….	8.97	7.2	4.5	4.5
National………..	……………………………..	100	18.5	18.2	18.2

(Source: DOE 2011)

To achieve 18% savings relative to the 2007 version, ASHRAE 90.1-2010 strives to incorporate the most cost-effective efficiency measures. Table 2 lists the measures that account for major savings in ASHRAE 90.1-2010 compared to the 2007 version (DOE 2011).

Table 2. Energy-Efficiency Measures Resulting in Savings
ASHRAE 90.1-2010 from 90.1-2007

Cool roofs in hot climates	Receptacle control requirements added
Lighting power allowances lowered	Energy-recovery ventilation expanded
Lighting power allowances in retail lowered	Chiller efficiency
Lighting power densities applied to alterations	VAV fan control on single zone systems
Occupancy sensors expanded	Demand-control ventilation
Daylighting controls under skylights	Supply air reset
Daylighting controls in side-lighted spaces	Economizer use expanded
Skylights and daylighting	Outdoor air damper requirements expanded
Commissioning of daylighting controls	Data center efficiency requirements
Exterior lighting illuminance levels lowered	
Exterior lighting controls expanded	

(Source: DOE 2011)

Our experience with the Business New Construction Energy Design Assistance (EDA) Program offered by Xcel Energy in Colorado is that these measures, with the exception of daylighting controls and receptacle controls, are common to projects demonstrating 15% to 20% savings relative to ASHRAE 90.1-2007. Currently, projects in Xcel Energy's EDA Program must show at least 15% electricity demand savings and 15% natural gas savings to qualify to receive design assistance and earn a rebate. In transitioning to 90.1-2010, these measures will largely be required in buildings just to meet the standard; to achieve savings for a DSM new construction program, additional measures will need to be implemented.

While Xcel Energy's EDA Program requirements and goals are stated in terms of electricity demand, energy, and natural gas savings, compliance with ASHRAE 90.1 is measured in terms of energy cost. DOE uses site and source energy in kBtu to assess improvement in energy standards. In evaluating the influence of the higher energy standards on utility new construction programs, it is important for stakeholders to distinguish between these metrics. For example, projects in Xcel Energy's EDA Program often demonstrate a greater percentage electric demand savings than energy cost savings, electricity savings, and natural gas savings. Of the efficiency measures listed in Table 2, lighting design, daylighting controls, chiller efficiency, and data center efficiency have the greatest potential to reduce electricity demand, whereas the other measures primarily reduce energy consumption. Understanding the differences between these metrics is important because, as energy codes become more stringent, the disparity between metrics can become amplified. This can create unintended consequences such as flawed decision making for a customer and suboptimal design solutions for a building.

Energy Design Assistance Projects and ASHRAE 90.1-2010

What will Xcel Energy's EDA Program look like with ASHRAE 90.1-2010 as the baseline? Will the program demonstrate high enough energy savings to be cost-effective?[1] This will depend on whether projects can cost-effectively demonstrate energy savings beyond ASHRAE 90.1-2010 and provide value to rate-payers.

To begin to answer these questions, we selected a sample of current EDA projects in Colorado to evaluate the potential energy savings relative to the 2010 standard (Table 3). The four projects are representative of typical EDA building projects by type and size, and they all used 90.1-2007 as the baseline. The four projects each achieved somewhat higher energy savings than most EDA projects, but savings were not exceptional. Efficiency measures implemented were generally cost-effective for the building owner, with payback periods of less than 10 years. The savings for these projects relative to ASHRAE 90.1-2010 were estimated using the average savings predicted from DOE's Final Notice of Determination (2011)—for the office, primary school, and hospital, the 90.1-2010 baseline uses 18% less than the 90.1-2007 baseline; for the multifamily building, the baseline uses 8% less than the 90.1-2007 baseline.

As previously mentioned, rebates are paid through Xcel Energy's EDA Program if electricity demand and natural gas savings are at least 15% above a baseline relative to ASHRAE 90.1-2007. As shown in Table 3, the office building has 33% demand savings relative to 90.1-2007 and 18% demand savings relative to 90.1-2010. However, natural gas savings are less than 15% relative to both versions of the code. The hospital is the only building that does not meet the 15% demand savings with the 2010 version. This suggests that, while current building designs in the existing program are achieving some savings relative to the newer standard, other cost-effective efficiency measures (relative to 90.1-2010) and new program opportunities will need to be considered to meet the utility EDA Program's 15% savings threshold.

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[1] In Colorado, Xcel Energy measures the cost-effectiveness of a program based on a modified Total Resource Cost Test (TRC) calculation. TRC is the ratio of the value of the energy and capacity saved to the cost of a demand-side management program, including both the participants' and utility's costs. A TRC greater than 1.0 is considered cost-effective.

Table 3. EDA Project Savings Relative to ASHRAE 90.1-2007 and 2010

	Office		Primary School		Hospital		Multifamily	
	270,000 SF (+150,000 SF garage)		74,400 SF		295,000 SF		112,300 SF (+27,000 SF garage)	
ASHRAE 90.1 Version	2007	2010	2007	2010	2007	2010	2007	2010
Electricity Energy Savings (kWh/yr)	729,000	289,600	449,000	261,000	1,456,000	160,000	296,000	225,700
% Electricity Energy Savings	30%	14%	43%	30%	20%	2%	34%	28%
Demand Savings (Peak kW)	340	154	180	118	381	77	120	100
% Demand Savings	33%	18%	55%	45%	23%	5%	49%	45%
Natural Gas Savings (Therms/yr)	3,600	0	7,100	5,638	27,700	0	7,400	4,400
% Natural Gas Savings	10%	0%	86%	82%	13%	0%	19%	13%

Table 4 shows the estimated percentage reduction in electricity energy, demand, and natural gas savings using the ASHRAE 90.1-2010 baseline compared to the ASHRAE 90.1-2007 baseline. These percentages reflect the reduction in savings that the utility could claim through the EDA Program. In the case of the office, electricity savings drop by 60%. Instead of claiming 729,000 kWh of savings using the current code, Xcel Energy would only claim 289,600 kWh. The demand savings drop by 55% and there are no natural gas savings using the 2010 standard for the office.

While the savings are greatly reduced, it should be noted that the incremental measure costs will be much lower since they are relative to the higher ASHRAE 90.1-2010 baseline. The implications of these measure costs as well as energy savings will need to be factored into future EDA Program analysis.

Table 4. Reduction in Energy Savings Claimed by Utility Using ASHRAE 90.1-2010 from 90.1-2007

	Office	Primary School	Hospital	Multifamily
Electricity	**60%**	**42%**	**89%**	**24%**
Electric Demand	**55%**	**34%**	**80%**	**17%**
Natural Gas	**100%**	**21%**	**100%**	**41%**

Table 4 note: Analysis assumed reduction for electricity, demand, and natural gas savings equals the DOE Final Notice of Determination (2011). This assumption may not be correct for electricity demand. For example, the percent demand savings are greater than electricity savings for most projects in the EDA Program. Further analysis is needed to accurately assess the energy savings of EDA projects using ASHRAE 90.1-2010.

Because the cost-effectiveness of programs and projects is important to Xcel Energy and rate-payers, we conducted a cost-effective utility review in terms of total resource cost of the four EDA projects relative to the 90.1-2010 standard. This review showed an estimated decrease in cost-effectiveness of 65% for the office building, 97% for the hospital, and a 60 to 66% range for the primary school and multifamily building.

The analyses presented above—showing a reduction in energy savings and cost-effectiveness to the utility—further emphasizes the need for utilities to pursue new technologies and strategies to continue to move energy efficiency into the marketplace.

Rethinking Design and Program Concepts for Energy Efficiency in New Construction

What else can utilities' new construction demand-side management programs do to continue to provide value to the rate-payer as baselines become more stringent? The good news is that many potential opportunities are available to utilities to provide additional energy-efficiency support.[2] While Xcel Energy is exploring many opportunities, two options that are most directly related to the new construction programs that Xcel is currently acting on are 1) identifying emerging technology through product development for inclusion in DSM programs and 2) a codes and standards market transformation program. These strategies are discussed below.

Emerging Technology

Adopting higher code requirements can have a positive impact on driving innovation for new products. While new products are often initially sold at high margins, greater supplies of new products drive costs down.

One example of this is lighting design. Table 5 compares the lighting power allowances for different spaces in the last three versions of ASHRAE 90.1. Projects participating in the EDA Program that demonstrate greater than 20% savings relative to 90.1-2007 typically have lower lighting power densities than the maximum values allowed in 90.1-2010. For example, design teams consistently achieve less than 0.8 W/SF in open offices through more efficient fixture layouts and higher efficacy fixtures while meeting lighting level requirements. This suggests that achieving lighting power densities that are lower than 90.1-2010 is cost-effective for building owners with currently available technology; this was not the case 10 years ago.

Table 5. ASHRAE 90.1 Lighting Power Allowances

	ASHRAE 90.1-2004 Lighting Power Allowance, W/SF	ASHRAE 90.1-2007 Lighting Power Allowance, W/SF	ASHRAE 90.1-2010 Lighting Power Allowance, W/SF
Office	1.1	1.1	0.98
Conference	1.3	1.3	1.23
Classroom	1.4	1.4	1.24

Along with lighting design, lighting technology is evolving quickly. LED products are now available that have a higher efficacy than some fluorescent lighting. The cost of LED

[2] Some potential opportunities include addressing behavior changes in building users; smart grids and end-use metering; demand-response controls; communicating thermostats; stretch codes beyond the current ASHRAE requirements for green communities; and financing mechanisms, such as on-bill financing.

lighting is also coming down as technology advances and demand increases. The same is true for lighting controls; however ASHRAE 90.1-2010 requires lighting and daylighting controls, so the potential to claim associated energy savings is limited.

In most commercial building applications in Colorado, increasing wall and roof insulation levels above the energy code is often not a cost-effective strategy. There can be synergetic relationships between increasing insulation levels and decreasing heating, ventilation, and air conditioning (HVAC) system requirements, but in general the associated energy savings are somewhat limited and the potential demand savings are even less.

Innovations in glazing and window technology are emerging. All glass manufacturers offer a range of products that can be tuned by orientation to manage solar gain, optimize daylighting, and perform better than required by code. And on the horizon are dynamic windows—electrochromic, thermochromic, and photochromic.

From an HVAC viewpoint, we are seeing projects with a goal of 30% or more savings move away from conventional variable air-volume systems to zonal systems with dedicated outdoor air systems, such as variable refrigerant flow systems, chilled beam, and distributed heat pumps coupled to geoexchange loops. Based on Xcel Energy's current utility rates in Colorado, these alternative HVAC systems have a 10 to 20 year simple payback. Installed costs appear to be coming down for variable refrigerant flow systems as well.

Many emerging technologies make it possible to achieve significant energy savings; however, first cost is clearly an issue. Can a utility rebate these measures at a level at which the owner will buy in? The timing and level of rebates is another area requiring further exploration to arrive at a new construction program that is cost-effective and can transform the market.

Codes and Standards Market Transformation Support Program

In addition to incorporating new technologies and innovative strategies with high energy savings, another potential opportunity for bolstering energy efficiency in new construction is through codes and standards (C&S) market transformation support,[3] which Xcel Energy is piloting in Colorado.

In general, C&S programs aim to support the continuous transformation of markets and new technologies for the long-term by creating a continuous improvement cycle, including greater economies of scale for energy-efficiency adoption in the marketplace. These programs can include a variety of efforts from training and technical support to advocacy on code compliance and adoption.

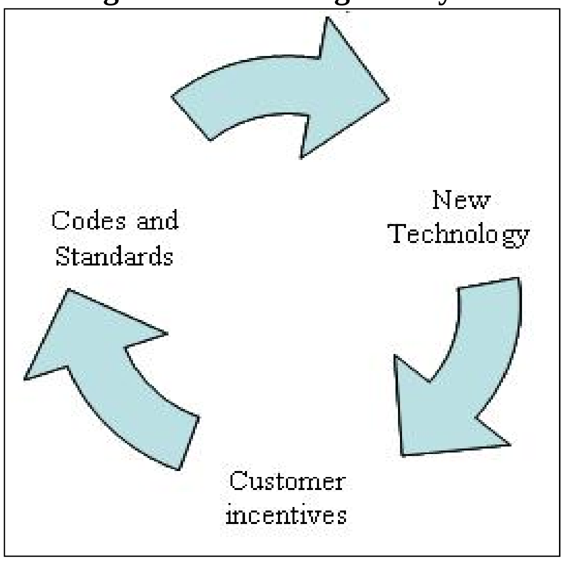
C&S programs are described as being able to pick up where traditional DSM utility rebate programs—designed to achieve more immediate energy and demand savings—may leave off. In turn, traditional rebate programs often identify technologies that may be ripe for code adoption and can help develop the marketplace. *(See DSM program cycle in Figure 1).* Since new construction programs are designed to exceed current codes, they can serve as useful "test-

[3] Xcel Energy in Colorado defines market transformation as marketing strategies that result in a permanent decrease in energy usage by inducing changes either in the product supply chain or in the behavior of the end-user. These structural and behavioral changes in the marketplace often result in an increased or earlier adoption of energy-efficient technologies and energy-efficient practices that remain even after the program stimulus is removed. (Source: DSM Plan, 2012/13)

beds" to inform the development of future code and equipment standards by demonstrating the extent to which the current code can or cannot be exceeded, highlighting the more cost-effective measures and identifying problem areas for implementation.

On the flip side, the above potential benefits come with challenges. A C&S program decreases or displaces existing rebate program savings, does not easily fit into existing program structure, requires an initial investment in program creation, and is complex and costly in terms of measuring and verifying energy savings. It may also be difficult to obtain regulatory and public approval, especially for claiming savings (Cooper, 2011).

Figure 1. DSM Program Cycle



Source: Xcel Energy 2012

Figure 1 note: Codes and standards can be thought of as the third segment in a circular model for energy efficiency: 1) new technology enters the marketplace, 2) incentivized customers buy technology and change behavior, and 3) supporting of codes perpetuates the process beyond rebates.

The California investor-owned utilities (IOUs) have been offering a C&S program since the early 2000s and were authorized by the California Public Utilities Commission to claim rate-payer earnings starting in 2006. The California IOU C&S program is evidencing cost-effective successes and enabling the state to accelerate the adoption of more stringent building energy codes and/or to increase code compliance (PG&E Company). California's C&S program acts to influence standards and code-setting to strengthen energy-efficiency regulations. In addition, it strives to improve compliance with existing codes and standards, and works with local governments to develop ordinances that exceed statewide minimum code requirements. Studies are developed focusing on energy-efficiency improvements for promising design practices and technologies and presented to standards- and code-setting bodies at both the state and federal level, such as the California Energy Commission and ASHRAE Standard 90.1. To additionally leverage their research, support activities, and influence, the California IOUs are also partnering with national advocacy groups and other key stakeholders.

Several other states and regions—Arizona, Massachusetts, Minnesota, and the Pacific Northwest, and the Northeast—are also in some stage of researching or integrating codes and standards into utility energy-efficiency program portfolios. The opportunity for energy savings from C&S programs is purported to be large, yet, to date, only California gives utilities credit toward their efficiency goals for such energy savings. From 2006-2009, the California investor-owned utilities claimed 678 GWh of electricity savings and 123 MW of peak demand reductions, which represent about 9% of the overall energy-efficiency portfolio for the utilities. The savings were also delivered cost effectively from the utility perspective, which can have the added benefit of reducing the overall program portfolio cost per kWh/kW saved.

Xcel Energy is currently piloting a Building Code Support Market Transformation Program in Colorado working with the local building community and jurisdictions to adopt and/or improve compliance to IECC 2009/2012 (Xcel Energy 2012). This program could be especially effective in Colorado where it is the responsibility of local, rather than state, government to enact and enforce building codes, presenting a challenge to coordinate and manage compliance and code levels.

The pilot will rely on the DOE Building Energy Codes Program (BECP) framework and protocol as the basis for verification and evaluation procedures. BECP provides guidance on measuring compliance with building energy codes as well as suggestions for improving building energy code compliance (BECP). The pilot plans to answer many questions, including can Xcel Energy cost effectively quantify additional energy savings to support a full C&S program? Can a C&S program be effectively integrated with the portfolio of DSM programs and be an avenue to continue to incentivize energy efficiency in new construction?

As results from Xcel Energy and other state/jurisdiction C&S efforts becomes available over the next year or two, we will be able to better determine the best avenues for DSM and new construction programs for the future.

Conclusion

This paper shows that energy savings associated with utility new construction programs decrease significantly with the ASHRAE 90.1-2010 standard as the baseline for comparison. We also have shown that there are innovative opportunities for utilities to increase energy savings through various avenues to help move energy efficiency into the marketplace. Like many utilities, Xcel Energy has had success in cost effectively meeting increasing energy-savings goals by offering a comprehensive portfolio of electric and natural gas DSM programs. With increasing code level adoption and increasing goals, utilities are exploring new opportunities, such as promoting emerging technology and implementing a codes and standards program. Yet questions remain. How much can new technologies offset the reduction in utility-claimed energy savings from the implementation of ASHRAE 90.1-2010? Will traditional new construction DSM programs end up in a new role of support for C&S programs? Are these opportunities the long-term solution for getting higher DSM savings?

To answer these questions and ensure continued success for utilities in meeting or exceeding goals and providing innovative strategies to increase energy efficiency, utilities need to further investigate the implications of evolving energy codes on their new construction programs and explore new approaches. Innovative approaches can positively affect changes in the DSM marketplace and play an important role in transforming markets and attitudes to be more energy efficient and demand responsive.

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