Multifamily New Construction: Utility Program Leads the Way Toward Changing Building Practice and Energy Codes

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ABSTRACT

New construction of multifamily buildings in the Seattle area is becoming much more energy efficient. Two studies a decade apart reveal a 35% decline in energy use indexes (EUIs) among Built Smart program participants and a 45% decline among local-area baseline buildings. The findings point to ongoing transformation of the market place, led by a utility efficiency program that has touched most new projects in the past 15 years. Changes in standard practice have likely also been influenced by increased public awareness of energy efficiency, improved building designs and construction practices, and tighter building codes.

This paper describes the methods employed and empirical findings from two studies evaluating an evolving program that provides financial incentives to building developers to upgrade efficiency through building envelope specifications, efficient lighting fixtures, other equipment, and rigorous in-progress inspections. Evaluation methods included a review of billing and characteristics data for samples of participants and nonparticipants to form the basis for developing separate energy simulation models calibrated to utility billing records. Parameters from the nonparticipant model were substituted into the participant model to generate a baseline model.

Key findings show that, between 1994 and 2004, annual baseline EUIs declined from 13.26 to 7.36 kWh per square foot, while participant EUIs dropped from 10.26 to 6.66. This decline was demonstrated in all end uses: space heat, domestic hot water, lighting, and miscellaneous loads. While a welcome development, it also presents future challenges for the program to continue “pushing the envelope” of energy efficiency in multifamily new construction.

Introduction

This study arose out of uncertainty about the changing baseline for efficiency of multifamily new construction in the Puget Sound Area. Seattle City Light, through the Built Smart program, provides financial incentives to encourage multifamily building developers to upgrade the efficiency of their new buildings in the utility service area through “beat the code” specifications for design, construction, and equipment, as well as rigorous in-progress inspections that go beyond normal oversight by City building and energy code inspectors. Current estimates of energy savings from these measures are based on an impact evaluation completed in 1996 (Tachibana 1996). These estimates have been adjusted over time to reflect changes in the state energy code and standard practice. Nonetheless, Seattle City Light did not feel comfortable with these estimates, given the time that has elapsed since the original research was performed. As a result, a new program impact evaluation (Tachibana 2008) was conducted to measure the effect directly.

The purpose of this study was to update the baseline for estimating Building Smart energy savings, taking into consideration the effects of state energy code and standard practice since the period investigated in the 1996 impact evaluation. The study was also intended to discern energy savings associated specifically with rigorous in-progress inspections. This paper describes the methods employed and empirical findings from this impact study, and compares the results to those of the prior study, to evaluate an evolving program.

The Built Smart program (1997-present) and its predecessor, Long-term Super Good Cents (LTSGC, 1992-1997) have been "beat the code" programs designed to encourage builders of new multifamily residential dwellings with electric space heat to exceed provisions of the Washington State and Seattle Energy Codes (WSBCC 2002). The utility goal is to move the market toward more efficient construction practices.

LTSGC paid incentives to builders for specifications and measures that upgrade the efficiency of the building shell, thermostats, lighting, equipment and appliances such as fans, water heaters, refrigerators, and showerheads. Thermal envelope upgrades were based upon a prescriptive path of measures, or a computer analysis of heat loss and estimated savings per dwelling unit. Appliance upgrades were based upon efficiency ratings.

Built Smart has gone further to also incorporate referrals for water conservation and waste recycling measures, during both the construction and occupancy stages of each project. Built Smart provides builders with a simpler prescriptive path for energy efficiency compliance (SCL 2003). In 2001 a new Seattle Energy Code requirement for common-area lighting secured improvements in standard practice which the program previously acquired through incentives. In 2002 the Energy Code was again revised; the most significant and relevant change was an increase in wall insulation requirements. Once again, former program measures were secured in code requirements.

New program components implemented in 1999 include Built Smart–Affordable Housing and Built Smart–Lighting & Appliance Options. Affordable Housing provides specialized new-construction and rehabilitation incentives to builders/developers of low-income multifamily housing with electric space heat. Lighting & Appliance Options provide incentives for installing energy efficient lighting fixtures in common areas of multifamily buildings that are ineligible for Built Smart envelope measures; these include buildings with gas space heat or steel framing. High-rise steel-framed buildings are also offered incentives for qualifying models of appliances such as dishwashers and refrigerators, and for efficient ventilation fan systems.

Methodology

The study team investigated program energy impacts using typical energy program evaluation methods, including the review of program, billing, and characteristics data for a sample of participants, as well as a similar review for a sample of non-participants. These formed the basis for developing separate participant and non-participant energy simulation models, which were calibrated to utility billing records. First a calibrated prototype was developed for low-rise mixed-use multifamily Seattle City Light program participants (2002-2004), using energy simulation software. This prototype was used to determine the as-built energy consumption characteristics of new multifamily buildings that represent the majority of the population of recent program participants. Next a calibrated prototype was developed for non-participants, drawn from comparable buildings in the service are of an adjacent utility. This prototype was used to determine the as-built energy consumption characteristics of new multifamily buildings that represent the population of non-participants that were built at the same time as the participants. These non-participants are selected from the Puget Sound Energy (PSE) customer base in urbanized east King County (Seattle is located in the west of this county), where there is no multifamily new construction conservation program.

After this, parameters from the nonparticipant model were substituted into the participant model to generate a baseline model, to determine the baseline energy consumption characteristics of participants excluding the provisions of the Built Smart program. Finally, energy savings associated with the provisions of the Built Smart program were determined, computed as the difference between participant and baseline models under typical meteorological conditions and full occupancy. This process provided the best available estimate of the total program energy impacts. To the extent possible, the total savings were further broken down according to physical program measures and actions, including the rigorous inspection (building commissioning) provisions. Selected market actors were interviewed to inform the analysis, as well.

The Built Smart methodology was very similar to that used for the previous LTSGC study. Both studies created a baseline model by removing program features from a calibrated participant model. The Built Smart study also created a calibrated non-participant model. This was used to specify parameters to manipulate in the participant model to generate the baseline model. It also was examined in the attempt to identify building inspection impacts.

Sample Selection and Building Characteristics

The majority of electric-heat multifamily buildings newly constructed in Seattle today are mixed-use construction, having one or two concrete (retail or garage) lower floors, topped by three to five stories of stick-framed residences. To limit the scope of the study to the most prevalent type, town-homes and complexes of fewer than eight units, and buildings lacking a non-residential first floor, were not included as study candidates. These types are less common among electric-heat buildings and have different construction and energy-use characteristics. The sample frame also excluded high-rises and gas heated residences. From the sample frame, 13 participant buildings were selected, most of which had laundry facilities in the units.

It proved impossible to find eligible non-participant buildings in the City of Seattle, after extensive screening of building permits and cross-matching with program records; there were no program nonparticipants. Puget Sound Energy assisted with selecting mixed-use construction non-participants outside of Seattle. After an extensive screening process, 10 non-participant sites were located in the Cities of Bellevue and Kirkland, Washington.

Data collection included detailed participant and non-participant characteristics from program project files, design documents and blueprints available from municipal governments and, when necessary, drive-by observations or site visits at selected buildings. Key data included number of floors, type of wall construction and water heating for each building, as well as average conditioned floor and wall area and installed wattage for each housing-unit and common-area zone.

Electric Loads and Weather Data

Seattle City Light and Puget Sound Energy provided monthly or bimonthly electric billing records for all occupied housing units in the participant and non-participant samples, respectively. Supplemental electric load data was used to help inform the modeling effort, including hourly loads from similar buildings for constructing typical infiltration, internal load and thermostat set-point schedules (Tachibana 1996; SBW 1994). For non-participants, electric load data also included utility-supplied daily kWh totals and 15-minute kW interval data. After summarizing and cleaning these data, useful insights were obtained into day-types, variations in use between weekdays and weekends, and diurnal patterns of non-heat consumption. Also developed were average Energy Use Indices (EUIs) for participants and non-participants to serve as calibration targets during modeling.

Typical meteorological year (TMY) and actual weather data were assembled for the model calibration period (calendar year 2006) from the National Climatic Data Center weather station at SeaTac. These data were used in the energy simulation models.

Standard Practice and Energy Code Enforcement

An innovation in this study was to conduct telephone interviews to determine how builders install insulation and other related building envelope components, and how rigorously they achieve air sealing. A special emphasis was place on whether differences in the level of enforcement of the energy code between jurisdictions affects how builders install insulation and other related building envelope components. Market actors interviewed included general contractors, insulation subcontractors, and city building inspectors. Responses were compiled in a database, analyzed, and compared with building characteristics data and billing records to develop synthesized findings and recommendations regarding the impacts of program in-progress inspections.

Model Development and Analysis of Energy Savings

One fully calibrated participant prototype model was developed using eQUEST (DOE2) hourly energy simulation software. The prototype reflected the as-built conditions of the predominant participant building type, which included buildings containing primarily one- and two-bedroom housing units that had laundry facilities in the units. The prototype model characteristics were derived from program documentation that included as-built plan take-off data about floor and envelope areas, and construction and program participation features. Appliance, lighting, infiltration, and thermostat set-point schedules from prior research (SBW 1994) and the LTSGC prototype model (Tachibana 1996) were used at the starting point for model calibration.

Monthly energy use predicted by the model was compared to target values developed by aggregating actual 2006 billing data. The simulation was adjusted until the predicted whole building EUI was within 10% of the monthly target values and 5% of the annual target value. The as-built model was then modified to reflect measure participation levels for optional measures, and rerun under TMY weather conditions and full occupancy. The non-participant model was developed in a very similar way, with the additional step of incorporating summaries of daily and 15-minute kW data to adjust the model.

From the non-participant model, a list of inputs was compiled that are associated with the features of the Built Smart program. The modified as-built participant model simulation was then rerun, changing the inputs associated with the Built Smart features to the non-participant values for all envelope components and lighting power densities. This created a baseline model that simulated the performance of the participant model without the influence of the Built Smart program.

Energy savings were computed as the difference between participant and baseline models under TMY weather and full tenant occupancy conditions. The specific program measures evaluated for energy savings impact included: Option I (<12% glazing ratio) and Option II (12-15% glazing ratio) envelopes; common area, in-unit, and exterior lighting; hot water heaters; whole house fans; and the Built Smart program's enhanced envelope specification and inspection process

The two envelope measures were modeled by adjusting the participant models to include only the envelope differences. Energy savings were then estimated for the other measures by adjusting the Option I envelope model to include each measure sequentially, in a "rolling baseline" fashion. To estimate the nominal effect of non-envelope measures such as lighting and hot water heaters, hand calculations were performed to inform the models, as necessary.

Findings

Sample Characterization and Building Characteristics

Out of a list of 72 buildings that participated in the Built Smart umbrella of programs during 2003-2004, many were eliminated from the study sample because they were built under previous codes (21 buildings), they were not mixed-use construction, or insufficient metered billing data were available (22 buildings). The 13 participant projects selected from the pool of 29 mixed-use buildings consisted of seven residences with in-unit laundries and six with common area laundries. Across these projects, 81% of the residence units had in-unit laundries. These included several large complexes with over 160 units each.

To select non-participants, 93 buildings were identified that were constructed outside of Seattle in King County between 2002 and 2004; only part of this area is urban. Of these 72 were eliminated because they were not mixed-use construction. After further review of billing data and available documentation, a final sample of 10 projects was selected from the pool of 21 mixed-use buildings, all of which had in-unit laundries.

Nine of the sampled participant buildings had Option I envelopes (<12% glazing ratio) while four had Option II envelopes (12-15% glazing ratio). About a third of the participating buildings also incorporated efficient lighting and whole house fan measures into the Built Smart project. Nearly half of the participant buildings installed efficient water heaters.

The average sizes of participant and non-participant dwelling units were 777 and 825 square feet, respectively, based on an assessment of 673 participant units and 834 non-participant units. Component U-values for participants were uniformly lower (more efficient) than corresponding values for non-participants. Participant domestic hot water heaters were only slightly more efficient than non-participant heaters. Lighting measures among participants reduced interior lighting power densities significantly for participants, compared to energy code.

Energy Use Index and Program Energy Savings

Billing data revealed that for sampled participants the average energy use index (EUI) was 6.65 kWh per square foot annually, while for non-participants it was 7.64 kWh. Expressed in percentages, participants used 13% less energy on average than non-participants in 2006, unadjusted for any mitigating factors. After calibration of all models, the final estimate of typical annual consumption for the participant and baseline prototypes was 6.66 kWh and 7.36 kWh per square foot, respectively.

As expected, estimated annual energy usage is greater in the baseline case than it is for participants. The difference of 0.70 kWh per square foot represents overall annual gross savings of nearly 10% for program participants. Applied across all participants with in-unit laundries, the absolute average unit savings from the Built Smart program is 621 kWh per residential unit.

Table 1 below disaggregates these savings by individual measures. It is important to realize in this table that the reported results are normalized across all program participants in the sample, not just those affected by the particular measure. So, for example, Option II envelope savings appear much lower than Option I envelope savings, not because Option II envelopes are much less efficient than in Option I, but because Option II was found among a mere 7% of the sampled participants.

Table 1. Evaluated Measure Savings

Measure*	Annual EUI	Difference in EUI	Annual kWh Savings per Unit ***	% of Total Savings	% of Model Represented in Sample
Baseline	7.36				
Option I Envelope	7.13	0.22	200	31%	93%
Option II Envelope	7.12	0.01	11	2	7
In-unit Lighting	7.04	0.08	71	11	66
Common Area Lighting	6.69	0.35	313	51	59
Exterior Lighting	6.68	0.01	9	2	91
Domestic Hot Water Heaters	6.66	0.02	17	3	67
Whole House Fans **	6.66	0.00	0	0	62
Enhanced Inspections **	6.66	0.00	0	0	100%
ALL		0.70	621	100%	

EUI: Energy Use Index, in annual kWh per square foot.
* Savings from each measure are normalized across floor area for all in-unit laundry program participants, not just for measure-affected floor area
**Savings from these measures were found to be negligible and/or unquantifiable.
*** Savings per living unit are averaged across all in-unit laundry participants.

These results indicate that 64% of the gross savings from the Built Smart sample come from lighting measures. This is particularly notable since not all participants implemented lighting measures, as they were optional (envelope measures, by contrast, were mandatory under program rules). This also contrasts with the previous LTSCG results, which showed that lighting and envelope measure savings were nearly equal. Most of the savings for the Built Smart lighting measures are found in the common area lighting, since it is operated 24 hours per day.

Building Inspection Practices

To aid in study design and interpretation of study results, during the data collection phase telephone interviews were conducted with 12 individuals involved in the construction of multifamily buildings not participating in the Built Smart program. These market actors included two general contractors, four insulation subcontractors, and six building inspectors. The subset of insulation contractors interviewed represented a significant fraction of the pool of contractors in the area for this kind of work. The purpose of the interviews was to determine how builders install insulation and other related building envelope components, how rigorously they achieve air sealing, and how differences in the level of enforcement of the energy code between jurisdictions affects how builders install insulation and other related building envelope components. The consensus was that compliance with the insulation and air sealing requirements in the Washington State Energy Code is generally better in municipal jurisdictions and more lax in the unincorporated areas. It appears many of the municipalities in the Puget Sound area achieve a reasonable level of compliance with the code while a few, e.g., Bellevue and Seattle's Built Smart, appear to achieve a more rigorous standard for code compliance.

The non-participant buildings in the study sample were constructed in either the Bellevue or Kirkland jurisdictions. Based on the interviews, each jurisdiction appears to have different levels of thermal performance based on the integrity of insulation and air sealing practices. This might suggest that two non-participant models might have been appropriate—one for Bellevue, representing installation practices equivalent to Built Smart installation practices, and one for Kirkland representing non-participant Seattle buildings.

Quantitative analysis of the building data, however, did not offer any evidence that such a difference exists. The 2006 electric usage indexes (EUIs) for sampled buildings in Bellevue are about 9% higher than for Kirkland buildings, despite the suggestion during the interviews that Bellevue inspections are more rigorous. Differences, if any, in energy usage because of inspection-related envelope differences are masked by other, more significant differences in building geometry and glazing. In addition, the normal variation among inspectors and contractors, coupled with the relatively small sample sizes, may obscure the effect even further. The study team therefore concluded that developing separate non-participant models to capture the inspection effect would be fruitless.

Comparison Across the Decade: 1994 to 2004

Examining EUIs by end use provides another basis for comparing LTSGC impacts with those of Built Smart. Table 2 and Figure 1 show, in tabular and graphical form respectively, the EUI reductions attributable to each program. The LTSGC program yielded significant reductions in energy use of space heat and miscellaneous equipment (which includes interior lighting), reducing the average total EUI from 13.26 to 10.26 kWh per square foot annually, a 23% reduction. Evaluated annual savings from the LTSGC program for complexes with in-unit laundries were 1.43 and 1.57 kWh per square foot for Tier 1 shell measures and lighting add-on provisions, respectively, producing a total of 3.0 kWh per square foot in energy savings. The Built Smart program also reduced space heat and miscellaneous equipment consumption, but the magnitude of these changes is relatively small (annual savings of 0.68 kWh per square foot). The current estimate of Built Smart savings represents one-fourth (23%) of the savings estimate for LTSGC.

The fact that the Built Smart baseline EUI is well below the LTSGC efficient EUI likely illustrates how much more efficient current multifamily buildings have become compared to their predecessors a decade ago. Interestingly, the end use proportions for efficient LTSGC and Built Smart buildings remained nearly the same, although their overall magnitude has dropped. In both cases, space heating is about 12% of total usage, domestic hot water about 32%, miscellaneous equipment about 55%, and exterior lighting less than 1% of total usage. Built Smart lighting savings are 28% of LTSGC lighting savings.

The significant decrease in baseline EUI over the decade can be explained by several factors. The building envelope thermal integrity has improved because code changes and market transformation have altered standard practices in design and construction. Specifically, the following items helped reduce baseline energy use over the ten-year period.

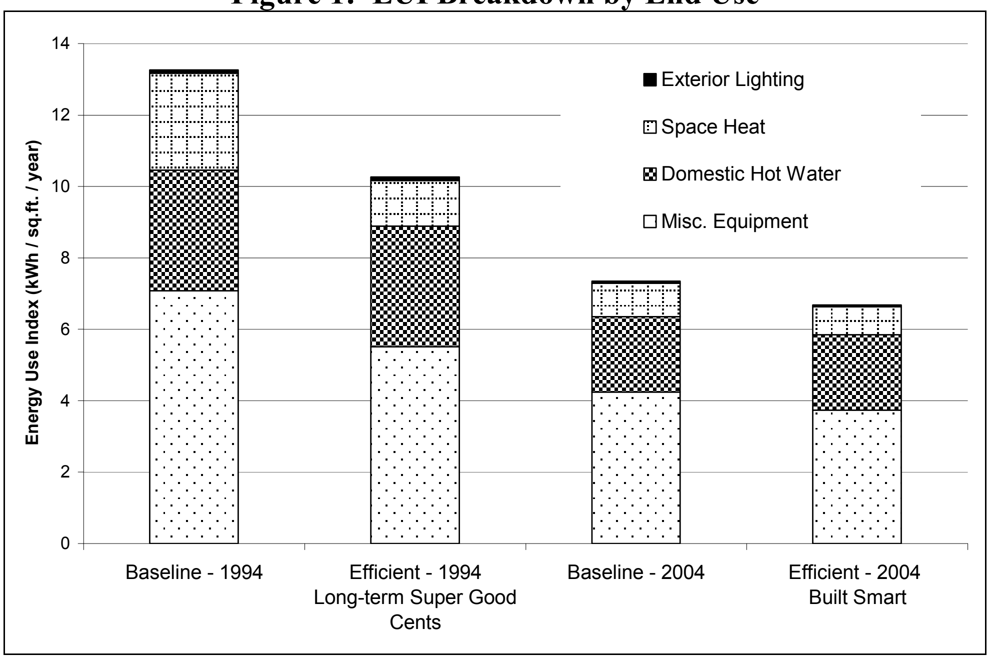
Table 2. EUI Breakdown by End Use

End Use	Long-term Super Good Cents (1996 Evaluation)				Built Smart (2007 Evaluation)			
	Baseline		Efficient		Baseline		Efficient	
	Annual EUI	% of Total	Annual EUI	% of Total	Annual EUI	% of Total	Annual EUI	% of Total
Space Heat	2.71	20.4	1.28	12.5	0.94	12.8	0.78	11.7
Domestic Hot Water	3.38	25.5	3.38	32.9	2.11	28.7	2.11	31.6
Misc. Equipment / Interior Ltg.*	7.08	53.4	5.51	53.7	4.24	57.7	3.74	55.9
Exterior Lighting	0.09	0.7	0.09	0.9	0.06	0.8	0.05	0.7
ALL	13.26	100.0	10.26	100.0	7.36	100.0	6.66	100.0

EUI: Energy Use Index, in annual kWh per square foot.

* Includes in-unit lighting as well as lighting in conditioned and unconditioned common areas.

Figure 1: EUI Breakdown by End Use



Window U-value. In 1994-1995, the baseline window U-value was observed to be 0.47, which did not even meet the code value of 0.45. In 2002-2004, baseline windows had a U-value of 0.36, which was better than the code requirement of 0.40. It is difficult to even find windows in today's Northwest regional market with a U-value as high as 0.40.

Air sealing. Since the 1994-1995 study, builders have significantly improved moisture and air sealing practices, primarily due to liability problems associated with moisture damage.

Domestic hot water. Hot water tank efficiency standards have increased over time also. Previously required energy efficiency factors were 0.86, instead of the more recent requirement of 0.91. Also, general improvements in the efficiency of dishwashers, clothes washers, and showerheads have reduced hot water demand.

Miscellaneous equipment. The efficiency of refrigerators has improved over the ten-year period, as well as for other equipment, such as computers. Use of efficient lighting, such as compact fluorescent lamps, has also increased during this time.

Exterior lighting. Common practice for exterior lighting fixture types and controls has improved to near the Built Smart program level over the ten-year period.

Other differences, such as in occupant behavior, may also be affecting EUIs, although it was not possible to discern these effects in the data collected for this evaluation study.

Discussion and Conclusions

New construction of multifamily buildings in the Seattle municipal area is becoming much more energy efficient. Between 1994 and 2004, energy use indexes (EUIs) declined significantly among both program participant and local area baseline buildings. The findings point to a large success in the ongoing transformation of the market place, led by a utility efficiency program that has touched most new Seattle projects in the past 15 years. Changes in standard practice have likely also been influenced by increased public awareness of energy efficiency, improved building designs and construction, and tighter energy codes.

Key findings show that, between 1994 (LTSCG) and 2004 (Built Smart), baseline EUIs declined from 13.26 to 7.36 kWh per square foot per year, while participant EUIs dropped from 10.26 to 6.66. This decline was demonstrated in all end uses: space heat, domestic hot water, lighting and miscellaneous loads. While a welcome development, it also presents future challenges for the program to continue “pushing the envelope” of energy efficiency in multifamily new construction. Seattle City Light plans to use the study findings to better estimate program impacts and make program revisions.

Based on the findings of this study, five key conclusions are offered.

Energy Savings from the 2004 Built Smart Program Were Lower than from the 1994 Long-Term Super Good Cents Program

Reduced electric usage of newer multifamily buildings, combined with program measures with less scope that yield smaller savings, led to Built Smart program impacts being much lower than those of its predecessor program. This reduction very likely indicates the success that Seattle City Light new construction programs have had in transforming the multifamily marketplace in the Seattle area, driving energy codes to more conserving levels. This success, ironically, may pose challenges for future Seattle programs of this type.

The evaluated average Built Smart baseline usage is 37% less that the baseline calculated a decade ago for the LTSGC program. While the overall Built Smart energy savings represents nearly 10% savings over current baseline, this value is much smaller than the LTSGC finding of 23% savings over the previous baseline. The end result is that the Built Smart annual savings of 0.70 kWh per square foot (621 kWh per unit) only is only 23% of the 3.0 kWh per square foot savings that LTSGC provided.

Both the reduced baseline usage and the smaller difference between participants and non-participants suggest that overall, multifamily new construction projects in the greater Seattle area are becoming much more energy efficient. We surmise that a combination of tighter building codes, improved building designs and construction practices, and increased public awareness of efficiency may have much to do with this welcome development. It is highly likely that programs such as LTSGC and Built Smart have been instrumental in effecting these improvements to the marketplace over the many years they have been in existence. Looking forward, Seattle City Light may consider additional measures to enhance the program portfolio of existing measures for multifamily new construction.

Interior Lighting Measures Yielded Most of the Program Savings for the 2004 Built Smart Program

Interior lighting measures yielded the preponderance of savings in the Built Smart sample, suggesting that a sustained program emphasis on these measures is warranted. Using the Washington State Energy Code as the baseline, savings from interior (in-unit and common area) lighting measures comprise nearly two-thirds of the gross savings from the Built Smart program. By comparison, just over half of gross savings came from lighting measures in the LTSGC program a decade earlier. This occurs even though not all Built Smart participants implemented lighting measures, since they were optional, while envelope measures were mandatory under program rules. Most of the savings for the lighting measures is found in the common area lighting, since it is operated 24 hours per day. Nonetheless, Built Smart lighting savings are only 28% of LTSGC lighting savings, due to more stringent current baseline conditions.

The high percentage of savings from lighting measures in the study sample, as well as the relatively ease with which they can be implemented, suggests that the program should continue to emphasize straightforward lighting measures. As with the low-rise mixed-use electrically-heated buildings included in this study, Built Smart is spurring on lighting efficiency improvements in other related building types, such as high-rise multifamily buildings with natural gas space heat.

The question remains, is the State Energy Code a good baseline for common areas? To confirm that lighting measures are cost-effective, Seattle City Light plans in future to perform additional work to verify actual baseline interior lighting conditions. Onsite visits of non-participant buildings from this study could determine whether the installed lighting falls short of code, meets code, or exceeds it. Such results would establish credible estimates of savings to expect in the future. These onsite visits could be extended to other non-participants, such as buildings currently under construction, as well as buildings that fell outside the scope of this study, such as high-rise steel-frame residences and town-homes. Assessing baseline conditions is particularly relevant, since the 2007 Seattle Energy Code calls for common-area lighting power densities of 0.8 watts per square foot. This more aggressive target is still higher than program participant densities, but will reduce the potential savings that the program will be able to acquire.

Exterior Lighting Measures Yielded Minimal Savings for the 2004 Built Smart Program

Exterior lighting measures yielded minimal savings, since standard practice appears to be at or near program thresholds. With average annual unit savings of 8 kWh per square foot, exterior lighting measures made up a negligible 2% of program savings. It appears that standard practice for this lighting—installing compact fluorescent lamps in fixtures with photocell control—is fast approaching program requirements, severely limiting opportunities for the program to achieve savings in this realm.

Since the 2002-2004 period from which the study sample was drawn, the Built Smart program has in fact been installing more common-area (as well as in-unit) lighting measures. As a result, estimates of current lighting impacts will need to be updated proportionately to obtain an estimate of current overall program impacts.

Energy Savings from the Built Smart Program's Inspection Process Were Negligible Compared to this Control Group

Energy savings from Built Smart's enhanced in-progress building inspections and commissioning appear to be negligible overall when compared to other jurisdictions with rigorous building department inspections. These savings remain potentially valid in concept, but it will require alternative approaches to ascertain their value.

Interview research for this study provided anecdotal evidence that different areas of the Puget Sound area may have different levels of envelope thermal performance based on the integrity of insulation and air sealing practices. For example, relevant construction practices may be more rigorous in Seattle and Bellevue, because of program and building inspector influences, respectively, than is the case in other municipalities. However, the quantitative analysis did not offer any evidence that such a difference exists between Seattle program participant buildings and non-participant buildings in Bellevue or Kirkland. It is possible that more significant differences, such as in building geometry and glazing, or between inspectors and contractors, are masking any inspection differences.

Alternative Approaches to Detect Program Inspection Impacts Are Needed

As it turns out, the major drawback of this study is that it did not settle the question of what impact is made by diligent beyond-code measure specification and inspection. The control group selected for this study happened to be drawn from a geographic area where, contrary to expectations at study design, the building departments take on more responsibility for energy code inspections than was anticipated based on experience in the City of Seattle. This fact did not become apparent until well into study execution. To truly settle the question, it will be necessary to range further afield to locate similar building types in jurisdictions where this is not the case. The issue remains important to the utility, because this feature has been a hallmark of the program, and a center-point of its value to participants. It is also of concern if the utility were to cease rigorous on-site inspections, and the building department did not take up the slack.

Seattle City Light has considered other options for future study to quantify or frame the question of the value and effects of enhanced inspections. One method might be an "inspect the inspector" approach, in which an impartial third party accompanied Built Smart staff, observed actual deficiencies, and based estimates of energy impacts on these observations. Such an approach, unfortunately, would likely be expensive and intrusive, and yield biased results. Another option might be to prove the hypothesis that enhanced inspections are cost-effective. This could be approached by first estimating the incremental cost to the program of these inspections, then assessing the minimum savings that inspections must provide to make the investment cost-effective. If the minimum savings seemed plausible given the evidence at hand, then one could conclude that inspections are cost-effective. A third, and perhaps the most direct and effective approach, would be to repeat this study with nonparticipants drawn from unincorporated areas of King County or Pierce County, where there are no multifamily new construction programs, and building departments that place little emphasis on State energy code enforcement. The difficulty would be to locate mixed-use construction in these localities. Discussions have ensued with other utilities in the Puget Sound area to collaborate on an investigation such as this, to determine the true baseline in the absence of any diligent measure specification and inspection process.

In order to project findings from this study for the current and future 2008 Built Smart program, several steps will be taken. Today's program generates project-specific savings calculations based on prior research and project characteristics. This method can be applied to the impact evaluation projects and comparisons drawn, to determine whether adjustments in the calculation methods are required. Today's program also provides increased levels of lighting measures, compared to the 2002-2004 study cohort, also requiring upward revisions to estimates. Also, the energy code has been updated for glazing and window U-values. With adjustments for these factors, study findings can be adjusted to estimate current program impacts and guide program revision. Analysis can also follow to optimize program cost-effectiveness.

It is hoped that, by addressing the conclusions from this evaluation, Seattle City Light can make appropriate program revisions to the evolving Built Smart program and continue "pushing the envelope" of energy efficiency in multifamily new construction.

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