Herding Cats: Developing a Uniform Approach to Achieving Energy Efficiency in High-Rise Multifamily Buildings for EPA's ENERGY STAR® Program

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ABSTRACT

Energy efficiency issues for high-rise multifamily new construction are significantly different from those for low-rise multifamily projects. Divergence happens due to different code requirements for buildings over 3 stories, dissimilar influences on the choice of HVAC equipment, disparities due to scale of construction, and other factors. Although U.S. EPA has for a few years had a set of ENERGY STAR® criteria that could be applied to low-rise multifamily buildings, it struggled with trying to fit the same criteria to high-rise projects, or develop new ones specific to high-rise. Program designers and implementers from around the country offered to help in the effort based on their collective experience with programs that would eventually be dependent on the EPA guidelines if they wanted to be able to label high-rise multifamily (HRMF) buildings as "ENERGY STAR®." This paper first describes the collaborative process of the national Working Group that developed the proposals for EPA. It also presents the essence of the national Working Group's proposal and the rationale for its eventual composition. The proposal contained three paths to ENERGY STAR® labeling of HRMF buildings: a performance method based on ASHRAE/IESNA 90.1, a prescriptive path developed by the New Buildings Institute, and a means for deferring to state and local programs that assure at least an equivalent level of energy efficiency. The paper illustrates how this solution evolved from the disparate influences, interests and existing programs from all the various regions of the country.

Background/Introduction

In the summer of 2003 a series of events led to the formation of a national ad hoc Working Group that has worked over the past year to scope out the basic design of an ENERGY STAR® labeling program for new construction, high-rise[1] multifamily buildings. Over the first three months, the Working Group organized five separate sub-groups that met regularly by phone and produced drafts of sections of the initial draft report submitted to EPA for consideration and feedback. Ranging typically from 15 to 20 participants, the regular participants represented diverse program professionals from the Northeast, Midwest, California and the Northwest.

This paper describes the collaborative process of the national Working Group that developed proposals for EPA and also presents key components of the national Working Group's proposals. These should all be seen as parts of a "work in progress;" and tentative conclusions at

[1] "High-rise" is defined in building codes as four stories and higher, and that same designation is used here.

this point are subject to revision based upon the unfolding events that continue at the time of this paper.

This introduction and the following three major sections are primarily selected from drafts outlining the Working Group's ongoing research and some preliminary conclusions and recommendations. The initial work was submitted as a "draft" work in progress to EPA, submitted in this form in the hopes of receiving feedback from EPA that could inform the next stages of the group's work and its final proposal for this proposed enhancement to the national ENERGY STAR® effort.

The Need

The Working Group participants shared the belief that the need for a multifamily building ENERGY STAR® labeling program could not be overstated. From the outset, the participants agreed that the group's primary mission is to develop a unified national program. Since some programs are already running in some states, and new ones have been starting during the past year, the opportunity to coordinate programs is a real time issue, and it could become more difficult as time passes. It was generally agreed that it would be ideal for the program to involve an ENERGY STAR® label, but some in the group have expressed concerns that it may be necessary to create an independent label if the effort to assist EPA in adopting a national ENERGY STAR® label drags out too long or results in a labeling methodology that differs significantly from the Working Group's desired approach..

In the United States, there are more than six million housing units[2] in buildings of taller than three stories. They are commonly inhabited by citizens of lower income levels. The buildings involved are generally built to lower energy efficiency levels to start with in order to meet constrained construction budgets. In operation, they are typically under-capitalized and are far less likely to see energy improvements as they age. These buildings thus generate far larger negative impacts than needed on the residents, the owners and operators, all the systems and infrastructures supporting them in operation, and the environment through increased pollution. Providing real estate markets and prospective tenants with a reliable nationwide market indicator of superior energy performance would assist multifamily advocates, developers, and governmental bodies at all levels in their work to improve the energy efficiency of our multifamily buildings.

The volume and diversity of activity discovered by a survey the National Working Group performed, makes it clear that a nationwide program would provide valuable clarity. Since many participants operate in multiple states a standardized program becomes even more important.

The Working Group was formed with the express purpose of developing a proposal to EPA for a new ENERGY STAR® labeling program for high-rise multifamily buildings. The group decided to focus on new construction for this proposal, though from the outset there has been considerable interest in a proposed follow-on effort looking at ways to increase efficiency in existing multifamily buildings. The group organizers attempted to include stakeholders from around the country with expertise in a range of fields relevant to its task, and established committees in the following areas:

[2] RECS 1997

Technical Approach

The Technical Approach Committee was initially charged with the task of determining the criteria for the ENERGY STAR® label. The discussion of the committee initially focused on the approaches that are technically feasible and the tools that are available. It also examined the scope of the ENERGY STAR® criteria, particularly with regard to the inclusion of lighting and appliances. The committee suggested that there be two methods to certify compliance: a prescriptive and a modeling option. The committee has not determined the most appropriate requirement regarding appliances and lighting but described several options in the initial draft.

Testing and Verification

A key concern of the Working Group has been to establish a robust and verifiable standard that can be implemented in a cost-effective manner. The Testing and Verification Committee worked to identify a viable middle ground between extensive and expensive audit and commissioning procedures and a minimal self-reporting protocol. The committee assessed current ideas on tests and inspections needed and attempted to establish some priorities. They are seeking to determine which verification checks or tests might be deemed critical and also to identify the various measurement options above a bare minimum that might add the most value to a multifamily building ENERGY STAR® label.

Implementation

The Implementation Committee initially explored a number of options by which a new construction multifamily building ENERGY STAR® program might be delivered to designers, developers, and builders. The Committee scoped out the potential steps to delivering an ENERGY STAR® label to a multifamily high-rise building. They identified potential processes to certify individuals capable of modeling and verifying the energy use of multifamily buildings. They have also identified some of the capabilities necessary for implementing organizations and identified potential roles such local and regional organizations could play. On the national organizational oversight and coordination level, several entities already exist that appear to be well- positioned to provide implementation training and institutional support (BPI and RESNET, for example.)

Framework

Additionally, a Framework Committee was developed to take these initial concepts and address some of the broader issues of creating a nationally coherent and consistent labeling program. With materials developed from each of the committees and coordinated by the Framework Committee, the Working Group submitted an initial draft paper as a means of requesting feedback from EPA staff on the program concepts and direction. In addition to seeking response to the draft, the Working Group sought guidance from EPA on the potential role that EPA and others could play in such a high rise multifamily labeling program, particularly in light of the efforts already underway in some states throughout the country.

The Proposed Approach

The balance of this paper describes the proposed approach on labeling multifamily buildings made to EPA as a results of the Working Group's deliberations.

Selecting ASHRAE 90.1 as a Baseline

Home Energy Rating System (HERS)-based programs for new single family construction suggest a model that could be used for multifamily buildings. In HERS, which is the basis for the ENERGY STAR® Labeled Homes program, the energy performance of the rated home is simulated and compared to the performance of a reference home. The reference home is determined by applying a widely recognized standard, the 1993 Model Energy Code (MEC93).

The Working Group suggested initially that the same basic model could be used for labeling of high-rise multifamily buildings. The reference standard against which the performance of these buildings would be measured would be the ASHRAE/IESNA Standard 90.1-1999: "Energy Standard for Buildings Except Low-Rise Residential Buildings" (hereafter, ASHRAE 90.1 or Standard 90.1).

The User's Manual for this standard states: "Standard 90.1 is a national consensus standard co-sponsored by the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) and the Illuminating Engineers Society of North America (IESNA) As a product of consensus and by virtue of the participants in this consensus process, Standard 90.1 represents the collective views of the manufacturing, design, and construction communities for an appropriate set of minimum requirements for energy-efficient design and construction. Participants in the development and review of the Standard included, among others: professional, technical, and trade organizations; environmental organizations; equipment manufacturers; utility companies; code officials; and design professionals. " (ASHRAE, 1999) This standard, in either the 1989 or 1999 versions, is also the basis for the energy performance provisions of building codes in 39 states (BCAP 2004).

ASHRAE 90.1 addresses all systems and components of a building that either use energy directly or affect energy use. As such, the standard specifies performance criteria for components of the envelope (or enclosure system), HVAC, DHW, Lighting, electrical power, and motors. The performance criteria vary according to climatic criteria including heating degree-day, cooling degree-day, design heating and cooling conditions, and others.

ASHRAE 90.1 addresses building systems and components at a greater level of detail than MEC93. For example, it explicitly sets performance standards for the individual components of mechanical conditioning systems (pumps, fans, controls, etc.) whereas these performance characteristics are digested to a single performance indicator for MEC93-based assessment.

ASHRAE 90.1 offers three modes of compliance. There is the prescriptive path, the envelope trade-off method (allowing trade-offs among different components of the building enclosure system), and the Energy Cost Budget (ECB) method. In addition to these three paths to compliance there are general and mandatory requirements that must be met in all cases. The ECB method is analogous to the HERS analysis procedure in that the proposed design is modeled using an energy simulation tool and then the performance of this model is compared to that of a baseline building (termed the Budget Design Case in the standard) that is defined as being minimally compliant with the reference standard. In the ECB method, compliance is established

by demonstrating that the proposed design performs as well or better than the baseline building defined by minimum prescriptive compliance. The ECB method can be used to provide a measure of improvement beyond the baseline standard. In fact, the US Green Building Council has adopted the ECB method for determining credits under the energy performance section of its LEED™ (Leadership in Energy and Environmental Design) rating system[3].

There are several fundamental differences between the ASHRAE 90.1 ECB method and the HERS protocols. Generally these differences make the ECB more appropriate to larger buildings and, perhaps more importantly, provide greater flexibility to incorporate expanded energy performance goals. For example, the ECB, as the name suggests, makes a comparison based upon energy costs. This allows market utility rates to serve as surrogate measures for total source energy. Also, because of the utility rate structures generally applied to larger buildings – including, for example, time-of-use-, block-, and demand charges – the method has a built in mechanism to encourage peak load reduction. Because lighting is an end use directly measured by the ECB comparison, energy efficient lighting will directly benefit the measured energy performance. In addition, lighting will affect the performance comparison in proportion to its significance among end-uses for the particular building; among the several regulated end uses, none is given special weight relative to the others beyond the proportion of energy cost that the end-use represents. Because the thermodynamic contribution of energy uses such as appliances to cooling loads can be explicitly represented in the ECB method simulations, the beneficial effect of energy efficient appliances in reducing cooling loads can be represented in a performance comparison.

It follows from the flexibility of the ECB in representing a variety of building systems and operations, that it is also fairly complex. In fact, the ability to understand and apply the ASHRAE 90.1 ECB well would certainly require specialized training[4]. However, the flexibility of the ECB method to address a wide variety of building situations also makes it an excellent tool for designing prescriptive packages (similar to the ENERGY STAR® "Builder Option Packages" used for single family homes) for various climates and building types that represent a defined performance threshold relative to the baseline.

Of course, the ASHRAE 90.1 Standard and the ECB method are not without drawbacks. In practice, the achievement of ASHRAE 90.1 performance goals may be less than robust due to the fact that few of its provisions are reinforced by field verification requirements. For example, ASHRAE 90.1 does not include a performance standard for infiltration control, which may (or may not) be significant in different types of buildings. Also, the ECB method does not provide for adjusting infiltration loads between the proposed design and Budget Design Case.

The standing and widespread recognition of ASHRAE 90.1 as an energy standard suggests its adoption as the basis for a national multifamily energy efficiency labeling program.

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[3] There are two modifications to the ECB method imposed by the LEED Energy Modeling Protocol (EMP). These establish bounding comfort parameters that the proposed design must satisfy and affect the baseline modeling of cooling plants for systems smaller than 150 tons. The U.S. General Services Administration as well as other federal, state, and municipal agencies has adopted the LEED certification criteria as a required attainment for new construction projects. The USGBC website (www.usgbc.org) offers updated information on the market penetration of the LEED rating system.

[4] This is not to say that this ability does not already exist among individuals in the energy efficiency community.

ENERGY STAR Criteria for High-rise Multifamily Buildings

The Technical Approach Committee recommended initially that the ENERGY STAR criteria for high-rise multifamily buildings be set at 30% better than ASHRAE 90.1-1999 or 15% above code, whichever is more stringent. This threshold is deemed appropriate for the following reasons:

- Consistency with the current ENERGY STAR® Homes Program. To earn the ENERGY STAR® label, a home must be at least 30% more energy-efficient than the 1993 Model Energy Code (MEC) or 15% more efficient than the state energy code, whichever is more stringent. Consistency between the two programs will avoid confusion in the marketplace and allow for broader program participation, particularly amongst stakeholders who work with both single family and multifamily housing stock.
- Based on the committee's collective experience working with multifamily building projects, an efficiency level of 30% better than 90.1 requires the design and construction teams to make a strong commitment to improving the efficiency of the building but is certainly achievable. In fact, we have found that the project teams that are very committed to efficiency can achieve levels approaching 40% above ASHRAE 90.1.

A Prescriptive Path to ENERGY STAR®ENERGY STAR

The Advanced Buildings and the E-Benchmark noted above provide a possible model for a prescriptive path to qualifying a multifamily building under the proposed ENERGY STAR criteria. The E-Benchmark will provide designers, engineers, and contractors with information on how to deliver high-efficiency buildings to their clients. There are two key aspects of this project:

- The E-Benchmark provides a common framework, vernacular, and reference point for high performance buildings through performance-based goals.
- The Advanced Buildings education program that makes the E-Benchmark reference useful in the daily practice of designing and constructing buildings by showing designers how to use what tools when in the design and construction process.

For the ENERGY STAR® program for high-rise multifamily buildings, this approach offers the following advantages:

- Much of the criteria that apply to commercial buildings would also apply to high-rise multifamily construction.
- The criteria provide a reference for designers and a pattern to reaching high energy performance.
- The E-Benchmark references energy performance targets in the design phase. These references are consistent with the ENERGY STAR® Buildings program and while not required by the E-Benchmark, could be used by the ENERGY STAR® program to promote building performance.

- E-Benchmark includes specific testing criteria that promotes post-installation equipment inspection and performance testing to help assure that the buildings as designed deliver the savings anticipated by the ENERGY STAR® high-rise multifamily program.
- Software already exists (EnergyGauge-USA) that implements this whole-building approach by automatically implementing the ASHRAE-90.1 rules set. This reduces simulation cost and decreases errors and game playing associated with typical commercial simulation efforts.

Appliances and Lighting for ENERGY STAR Multifamily Buildings

Though the Technical Approach Committee did not reach consensus on a method for the inclusion of ENERGY STAR® appliances and lighting in the multifamily ENERGY STAR® criteria, it did consider a range of potential options. Overall, these options range from requiring all installed appliances and lighting to be ENERGY STAR® qualified to not fixing any requirement at this time beyond the lighting efficiency that would result from achieving 30% better energy performance than ASHRAE 90.1. A discussion of options follows:

There are currently no specific appliance and lighting requirements that a single-family home (or multifamily residential building of less than three stories) needs to satisfy in order to qualify to receive the ENERGY STAR® homes label. Requiring ENERGY STAR® appliances and lighting would therefore be inconsistent with the single-family approach. However, appliances and lighting can account for 20-35 percent of the energy use in a multifamily building and therefore should not be ignored. Moreover, standards have been proposed that add an appliances and lighting recognition to the HERS scoring system used for single-family homes. Lighting energy use is covered to some extent by ASHRAE 90.1, so even if ENERGY STAR® fixtures are not explicitly required, they could be a cost-effective measure to achieving 30% better than Standard 90.1. Plug loads (i.e., appliances) could be included for this program with some minor addenda to the ECB.

Initial discussions yielded three options for requiring ENERGY STAR® appliances and lighting[5].

1. Specify that some percentage of each category of appliances and lighting used in the building be ENERGY STAR® qualified where there is an appropriate ENERGY STAR® -qualified product available for the application.
2. Specify that the ENERGY STAR® building criteria (i.e., 30% above ASHRAE 90.1) be reduced (perhaps by 5-10%) if ENERGY STAR® appliances and lighting are used in all appropriate applications.
3. Address lighting and appliances only to the degree that they are already included in the modeling to achieve 30% better than the ASHRAE 90.1 standard.

[5] ENERGY STAR appliances that are considered include: refrigerators, dishwashers, ceiling, and ventilating fans, and clothes washers. ENERGY STAR lighting that is considered includes: compact fluorescent light bulbs; residential light fixtures including outdoor lighting and lighting with motion sensors; and exit signs.

The initial draft report suggested that these options and others would be considered by the overall Working Group in developing the final program proposal, once input is received from EPA on their view of the relative merits of these approaches.

Testing and Verification of Energy Performance

The Testing and Verification Committee compiled information on verification and testing procedures employed in energy performance labeling and recognition programs around the country. An appendix listing these procedures was provided in the draft report sent to EPA; these included those either employed in high-rise multifamily programs or that are procedures of low-rise residential programs deemed adaptable to a high-rise multifamily labeling program.

The list was intended to provide background information on testing and verification procedures employed in existing programs. It was not intended that all of the procedures listed would necessarily be required in a multifamily labeling and recognition program. In fact, the discussion to date among Working Group participants and the existing HERS model point to an approach that is less dependent on extensive testing. In the HERS low-rise analysis model the protocol defines conservative default assumptions that can be used in the absence of testing or inspection. The need for testing or verification of specific categories would be driven by two principles: 1) to take credit for better-than-default performance in that category, or 2) whenever a performance or product specification is required by modeling or given in a prescriptive package, testing and/or verification of that feature would be necessary.

Generally, the field-tested or directly observed input would better reflect the actual building than the default, thus providing a benefit to the performance rating. This provides for a trade off between the benefit to ratings (both score and veracity) and cost to perform the inspection or measurement. Specific implementations of the ECB or Prescriptive standard can then determine, based on the cost/benefit encountered in the particular market, which inspection and testing procedures merit inclusion in a particular program.

The group expected that examination of potential reference standards would yield further suggestions for inspection and testing procedures. The Working Group only recently had arrived at the consensus that ASHRAE 90.1 would be likely to be recommended as the basis by which targeted above-standard performance is measured. However, the list was deemed to be sufficient in general to accommodate application of the ECB modeling compliance method.

What was presented in the initial draft to EPA had begun to suggest what testing and verification measures could be performed and how these can be performed, but it did not yet attempt to assess the relative value and cost of each potential procedure.

Program Implementation

In order to deliver a national ENERGY STAR® for High-rise Multifamily Buildings Program, the Working Group agreed that an infrastructure of qualified, competent, and affordable individuals, businesses and organizations needs to be in place. The Implementation Committee examined a number of alternative approaches and organizations that could make up a national implementation infrastructure and arrived at a consensus-based solution.

The suggested approach for a national ENERGY STAR® for Multifamily Buildings Program in the initial draft proposal incorporated the following elements:

- Certified Multifamily Modelers and Verifiers.
- Multifamily Building Providers.
- National Multifamily Building Administrator.

Details on the proposed players and approach were also included in a separate appendix to the initial draft shared with EPA.

Benchmarking & High-Rise Residential Buildings

After the submission of the initial draft summarized above, members of the Working Group had a series of interactions with EPA representatives continuing the dialogue, while also meeting by phone every two to three weeks to provide updates on these interactions.

The Working Group concluded from the first interactions with representatives of EPA that the primary concerns for the EPA revolved around their preference for "benchmarking[6]" vs. computer modeling. EPA would prefer a uniform benchmark, developed through statistical manipulation of energy consumption data such as represented by their Commercial Buildings Energy Consumption Survey (CBECS) database. They stated that comparing a building through "benchmarking" to a statistically similar building is a more dependable measure of energy efficiency than comparing the same building to a hypothetical model of the same building using computer simulations.

The Working Group outlined reasons why the benchmarking approach is not suitable for high-rise residential buildings. Although the group did not presume that it was providing the EPA with any details that have not already been considered, it did submit to EPA the reasons it felt benchmarking is inappropriate for high-rise residential ENERGY STAR® criteria, including the following:

1. **Individual Meters**: since high-rise residential buildings are often individually metered, gaining access to the utility bills of all the tenants would be required to develop a benchmark. Laws in most states and regulations governing the utilities make it extremely difficult and very expensive to obtain complete or accurate billing data for all residential customers in such buildings.
2. **Tenant Turnover**: since tenants come and go on a continuous basis (average vacancy rates are ~6% across the country), obtaining and deciphering comparable information from a set of billing data would (a) be very difficult and (b) potentially introduce a large degree of inaccuracy.
3. **Variety of Metering Types**: some uses within high-rise residential buildings are centrally metered (e.g., central heating, water heating, common areas, and public hallways), while others are individually metered in some cases and centrally metered in others. The mix of possibilities would result in very few buildings having a viable comparable building or set of buildings for establishing a benchmark.
4. **Variety of Occupancies**: a high proportion of high-rise residential buildings are actually mixed use, with some of the HVAC and SHW/DHW functions combined or overlapping

[6] "Benchmarking" is commonly defined as the comparison of a building's actual energy consumption to an established target derived from the average, weather-adjusted energy consumption for that building type .

occupancies. Since the permutations of occupancy mixes are essentially infinite, creating a viable benchmark would be difficult to the point of economic impossibility.

5. **Variety of Residential Types**: besides the varieties in meter types (item 3), and the mix of residential versus nonresidential occupancies (item 4), even within residential occupancies there is a wide variety of building configurations and designs that would affect the ability to make a sensible decision about selecting the appropriate benchmark.
6. **Weather Variations**: while the benchmark baseline and target for a particular building might reflect "normal" (i.e., 30-year average) weather, billing data might represent a period of significant deviation from these "normal" parameters. Normalization for actual weather conditions during the billing data period would need to be applied for a fair comparison to the benchmark.
7. **Time Lag Between Project Completion and Certification**: because the benchmark approach requires a history of billing data, a project cannot be certified upon completion of construction. Where ENERGY STAR designation is tied to financial incentives from utility or other program, many projects – especially subsidized housing developments – rely on these incentives as part of the project financing. A delay in certification would thus represent a financial burden and significant barrier to participation.
8. **Factors Outside of Energy Efficiency Concerns Influence Energy Use**: the notion of comparing energy efficiency based upon energy bills is particularly questionable in the case of high-rise residential buildings. Even identical buildings would be expected to experience different energy use resulting from differences in how human beings use and interact with the building. Usage, then, becomes internal to the rating criteria in a benchmark approach based on energy use. Only a simulation-based approached allows for a comparison of all relevant energy performance criteria based in the hypothetical situation of "all other factors being equal."
9. **The Human Factor**: certainly, users of a building can meet or surpass energy use goals through conscientious habits. Even with normalization factors for hours of operation, activity type, etc., billing data can not distinguish efficient accommodation of high-intensity use, on the one hand, from inefficient accommodation of low-intensity use, on the other. While a benchmarking approach based on energy use might serve to reward residential buildings that house low-energy uses, it would not necessarily encourage efficient use of energy in serving the unique and particular uses, functions and situation of the building. And rewards to the developers of energy efficient buildings should not be based on the actions of the tenants.

While existing high-rise residential buildings MAY be appropriately served by a benchmarking approach, the metering problems notwithstanding, existing high-rise residential buildings had not been part of the National Working Groups initial agenda. The Working Group recognized the tremendous work represented by the development of the Commercial Buildings program and acknowledged that building upon this work to develop a nation-wide database of comparables suitable for high-rise residential buildings would be a monumental task.

In previous communications, EPA representatives had raised many specific and legitimate concerns about a modeling-based approach using a minimum energy efficiency standard baseline., but many in the Working Group believe that each of these concerns can be addressed effectively.

EPA Goals for the ENERGY STAR®ENERGY STAR Labeling Program for Buildings

In seeking to move forward in the dialogue with EPA, the Working Group then summarized for internal discussions its understanding of EPA's goals on this issue. These are summarized in outline fashion below.

ENERGY STAR Program in General

- Reduce greenhouse gas emissions
- Protection and enhancement of label integrity
- Consistency across program areas (avoid confusion in marketplace)

Multifamily Program

- Nationally applicable
- Recognition of superior energy performance
- Difficult to game without limiting the designer
- Consistent results with repeatable, stable baseline
- Accessible to broad marketplace
- Inclusion of appliances and lighting
- Maintain a good relationship with EPA's ENERGY STAR Homes Program Administration Partners

2004: The Dialogue Continues

Fixed Budgets

EPA staff have continued arguing for fixed budgets against which to compare the efficiency of buildings despite the Working Group's sentiments that modeling would be a more reasonable, consistent, workable and meaningful approach. EPA felt that fixed budgets would guarantee that only highly efficient buildings received the ENERGY STAR® label, but allowed that there would need to be some variables (e.g., climate and certain amenities that affect energy use). With a limited number variables and options for each variable, EPA imagined a finite number of fixed budgets that could be implemented in software based on building type, certain features and climate. The Working Group suggested that modeling should be used to determine the budgets, rather than a software-based look-up table. This would be easier both for program administrators and builders. EPA volunteered to develop a list describing which characteristics or typical model inputs would vary for determining the fixed budgets, and which would be fixed.

End Uses to Be Included

The Working Group then began a discussion of which energy end uses might be included in the energy budget calculation. EPA indicated that they would like the program to cover lighting and appliances. There was some debate over whether the entire plug load could or should be included and how this might be done with modeling. Another option would be to take

some items out of the modeling and have a prescriptive requirement (e.g., 75% ENERGY STAR® appliances and the ENERGY STAR® Advanced Lighting Package[7]). However, removing plug loads from the modeling affects the heating and cooling requirements.

Consumption Data

EPA is examining consumption data from DOE Energy Information Agency (EIA) for multifamily buildings to determine its applicability for determining energy cost budgets for multifamily buildings. They have located a database of national multifamily energy consumption data and are supplementing it with local data made available from Working Group participants. As of the writing of this paper, EPA is scrutinizing their data with Working Group input at critical junctures in order to determine whether it can work for establishing EPA's desired energy budget targets.

Modeling Ventilation & Infiltration

EPA has committed $25,000 for research on mechanical ventilation & infiltration. Apparently, modeling software has trouble with multi-level residential buildings (the "stack effect") and do not accurately reflect energy use of mechanical ventilation and infiltration (MV & I). They want to know how MV & I would be addressed in a program.

The group recognizes that the models do have trouble with MV & I, but note that this is a well-known fault of the software and so each modeler has ways to make adjustments. An incomplete accounting for MV & I could be one reason that modeling outputs typically don't match consumption numbers. However, what's important is the delta between two cases – the difference between the baseline and the proposed building – and modeling tools are quite good at predicting that. EPA, however, is not interested in the delta. They want predictable consumption numbers. This fundamental difference may be difficult to overcome.

The group acknowledged that modeling is imperfect right now. However, it might be possible to set aside some factors that cannot be modeled well. These factors could be netted out, whereby agreed upon defaults are used for both the baseline and proposal. As more data come in and modeling these tricky factors is better understood, they could be added in. There would be three kinds of variables: some would be fixed across both the baseline and proposal, others would vary across both, and a third category would be fixed for the baseline but could vary for the proposal. Such an approach would allow a program to move forward.

Several questions about the usefulness of the EIA data remain unanswered.

1. it is not clear whether there is sufficient geographic coverage, nor whether data could be normalized for states with higher codes;
2. since the EIA database is for existing buildings, a careful analysis will be needed to make sure the target or qualifying level of energy use is not too easy for new construction to meet (since presumably new buildings can be built to use much less energy than older buildings); and
3. the data needs to be parsed between low-rise residential buildings and high-rise buildings to identify differences between the two types.

[7] 50% ENERGY STAR light fixtures in high-use locations and outdoors, 25% ENERGY STAR fixtures elsewhere.

Additionally, the Working Group is interested in determining whether the level of detail included in the data will allow for normalization for various factors (climate, income levels, amenities). EPA asked that the group adivse on how to normalize the data for different building types.

Next Steps

FSEC Software

Several members of the Working Group are beta-testing the Florida Solar Energy Center's Energy Gauge building modeling software. This initial analysis has raised a few limitations in its current state (e.g., not very extensive library of equipment choices, difficulty of creating building assemblies). In brief, the model takes the inputs about a proposed building and compares it to a building that would have similar characteristics but, in terms of energy use, would just meet ASHRAE 90.1. Additional analysis is underway to determine the suitability of Energy Guage for use as the ENERGY STAR high-rise multifamily analysis tool.

Affirmation of Goals and Directions for Collaboration of the Working Group with EPA

The work of the National Working Group continues. The overall goal remains to create a set of criteria acceptable to all the active programs serving high-rise residential new construction, as well as being acceptable to EPA. The conference call meetings remain well attended, the most active members continue to contribute substantial in-kind efforts, and working group expectations remain high that this year-long collaboration will ultimately yield results consistent with the consensus goals of the group. The final version of this paper, as well as the Summer Study presentation, will provide an updated assessment of the future prospects for this critically important national initiative.

References

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