

What an Opportunity: Four New England States Conducting Residential New Construction Baseline Studies at the Same Time!

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ABSTRACT

Sponsors of the Massachusetts New Homes with ENERGY STAR[®] Homes Program decided to conduct a residential new construction (RNC) baseline study in 2011 in order to update the baseline home used in calculating energy savings. Three adjoining states then expressed interest in participating. The four states, all with RNC programs that include certifying ENERGY STAR homes, could potentially not only be conducting baseline studies at the same time, but collecting and reporting consistent data. The end result would be directly comparable residential new construction characteristics and practices for four states. What an opportunity!

As anyone who has worked on a RNC baseline study knows, there are many steps that need to be taken and decisions that need to be made prior to implementation. Is it possible to get multiple states, with different budgets and priorities, to agree on how to address these issues? A baseline team of program administrators and evaluation staff, energy efficiency consultants/advisors and implementation contractors was assembled to tackle these issues. The team began holding biweekly conference calls in September 2010. The challenge was to create an evaluation plan that would provide comparable information on core building characteristics while offering flexibility to meet individual state priorities and/or budget limitations.

This paper presents the final results of the planning process, addressing areas where reaching agreement was relatively easy and where long discussions were necessary. It also describes problems encountered recruiting homeowners and conducting on-site field inspections to date. Preliminary results will be included in the conference presentation.

Introduction

Background

Four states (Connecticut, Massachusetts, New Hampshire and Rhode Island) were interested in conducting a baseline study of residential new construction practices. Massachusetts's last baseline study had been conducted in 2005 (NMR and Conant 2006). Connecticut currently assumes that code is baseline, and believes that assumption is unrealistic. Rhode Island and New Hampshire have not previously conducted baseline studies.

All four states are interested in updating their baseline or User Defined Reference Homes (UDRH) used to calculate program savings. In addition, the sponsors of programs in states where the 2009 IECC Energy Code was implemented in 2010 are interested in assessing code compliance in the early stage of a new code cycle. The 2011 study results could serve as the baseline for measuring improvement in code compliance in later years.

Scope

The following are examples of the decisions that the baseline team needed to address to be prepared to conduct baseline studies in 2011:

- Whether or not to include homes that participated in RNC programs, including ENERGY STAR-qualified homes, in the sample of inspected homes
- Whether or not to include multi-family buildings and, if so, whether or not to address common areas in addition to residential units
- If multi-family buildings are included, whether to use one combined sample of single- and multi-family housing units or develop separate single- and multi-family samples
- How to address Massachusetts stretch code communities¹ in sampling and whether or not a different UDRH is needed for stretch code communities
- How to identify buildings permitted under the 2009 IECC Energy Code
- How to address building characteristics which are not easily identified in post construction inspections
- Whether or not to conduct HERS ratings
- How to define conditioned space
- Whether or not to include HVAC performance testing and, if so, on all or a sample of homes
- Whether or not to collect lighting and/or appliance data beyond what is required for HERS ratings
- Whether or not to collect information on renewables
- What incentive payment to offer homeowners who agree to an on-site inspection
- Whether or not to provide participating homeowners with a summary of their home's performance
- How to notify owners or occupants of any health or safety issues identified during inspections

The overall goal was to create an evaluation plan that would provide comparable information on core building characteristics while offering flexibility to meet individual state priorities and/or budget limitations.

Methodology

A baseline team of program administrators and evaluation staff, energy efficiency consultants/advisors and implementation contractors was assembled to tackle these issues. All team members were sent copies of three baseline studies to review: the 2005 Massachusetts (NMR & Conant 2006), 2008 Maine (VEIC, ERS & GDS 2008) and 2009 Vermont (NMR, RLW & Conant 2009) baseline studies. In addition to providing information on building characteristics, each of these studies includes unique comparisons of results by different home groupings. Examples are: ENERGY STAR versus non-ENERGY STAR homes, custom versus spec homes, and homes in different geographic areas or sponsor service territories. Some studies included a survey of homeowners with survey responses compared to what was found on site. Other differences include the level of detail provided and use of graphics. Together, these three studies provided team members with a picture of the range of reporting options.

¹ The Massachusetts 'Stretch' Energy Code" was developed to offer cities and towns the option of adopting a more aggressive energy code than the MA baseline energy code.

After an initial discussion of the issues to be addressed, team members were asked to fill out a form giving their initial thoughts on how they thought several issues should be addressed. The purpose of this exercise was to identify areas where team members would likely find it relatively easy to reach agreement and areas that would require more discussion. The results of this exercise showed that there was initial general agreement on several issues, including:

- Not to include ENERGY STAR-qualified homes in the sample of inspected homes
- Use RESNET definitions of conditioned space
- Include a single-family sampling plan that matches the percentage of on-site inspections conducted in each county to the percentage of state-level permits issued in that county
- Address multi-family housing, as multi-family units account for 37% to 66% of ENERGY STAR housing units certified in RNC programs in the individual states.

On-Site Inspection Options

A detailed list of on-site data collection options, including preliminary cost estimates for each option, was presented for discussion to provide potential study sponsors with a general idea of what the cost per on-site inspection would be under different scenarios. The list included the following options from which sponsors could choose:

- Use MA 2005 on-site data collection form
- Conduct HERS rating
- Conduct HVAC performance testing
- Provide Manual J assessment
- Provide REM/Rate compliance reports
- Conduct short on-site homeowner/occupant survey
- Collect hard-wired fixture lighting inventory by bulb type
- Collect basic renewable information
- Collect appliance model numbers
- Provide letter to homeowner on their home's performance
- Homeowner/occupant incentives

Multi-Family Housing

How to address multi-family housing became a much more complicated issue than anticipated. Background information was provided on multi-family housing permits, multi-family participation in the Massachusetts RNC Program, and differences in the characteristics of participating single-family homes and multi-family units. Views on how to address multi-family housing varied and generated a great deal of discussion. In general, team members initially supported:

- Separate single-family and multi-family housing samples
- Developing separate single-family and multi-family baseline homes
- Inspecting both buildings and units in multi-family buildings
- Collecting information on common areas

However, as discussion continued it became clear that interest in learning more about the multi-family housing market extended beyond data collection to create a separate baseline home for projects eligible to participate in the states' existing RNC programs. Very often, multi-family projects do not

clearly fit into traditional residential or commercial energy-efficiency programs. They may be one-story buildings or twenty-story high-rise condo or apartment buildings, they may be low income or luxury housing projects, they may be built under residential or commercial building code, units may be individually or mass metered, and parts of a building may be served under residential rates and parts under commercial rates. Many projects are a mix of residential and commercial space. Listed below are some of the issues and ideas raised by team members with respect to multi-family buildings:

- Expand the sample of multi-family on-site inspections to include not just buildings eligible for participation in the states' RNC programs or ENERGY STAR qualification, but all types of multi-family buildings.
- If buildings are served entirely, or partially, by commercial and industrial (C&I) programs it will be important to have C&I representation early on to provide input on what data the C&I program administrators want/need to ensure the desired data are collected.
- The program that would claim the savings associated with commercial space should pay for collecting data/information on commercial space.
- Sampling multi-family housing projects is more complicated. To ensure access to all areas of multi-family buildings requires recruiting building managers or talking with developers who are likely to be able to provide building plans.
- HERS ratings will not be appropriate for evaluating large multi-family buildings—a different data collection approach will be needed.
- Last year EPA approved buildings up to five-stories for ENERGY STAR certification if they were permitted as residential. It is important to have a clear understanding of what is eligible for ENERGY STAR qualification and what is not.
- Look less at what EPA says and more at what the housing industry does. A three-story building with central HVAC systems qualifies as residential for purposes of ENERGY STAR, but this configuration defies single-family energy efficiency program designs. How a building is configured needs to be a top consideration.
- What potential savings in multi-family buildings are being overlooked and what savings can be captured by RNC programs? If the savings cannot be captured in RNC programs (for example savings associated with central HVAC systems), maybe these buildings belong in a C&I multi-family program.
- Unique energy saving opportunities exist in multi-family buildings, specifically when above-code upgrades are incorporated into common area heating, cooling and lighting systems. An analysis of 18 projects participating in a 4-8 Story Multi-Family Pilot Program in Massachusetts revealed that 31% of total square footage was non-residential space; examples include community rooms, hallways, stairs and elevators, laundry rooms, exercise rooms, etc. Energy savings for these types of spaces cannot be captured with a HERS rating and will likely not be captured unless common areas are served by a C&I program. A majority of the pilot projects have a central, whole building boiler system with multiple commercial sized units and employ a central whole building cooling system that typically includes chillers, a technology that is not REM/Rate friendly.
- High-efficiency pumps, motors and drives are routinely used in multi-family whole building heating and cooling systems. However, the tracking of these components/systems are not part of a typical RNC baseline study or addressed in HERS ratings.
- EPA's ENERGY STAR Multi-family High-Rise Program will be introduced this year. Should the decision be made to offer the Multi-family High-Rise Program, which will not

use HERS ratings to verify compliance, the on-site inspections for a baseline study of these buildings would be different from what is being done for single-family homes.

- With the focus on buildings permitted under the 2009 IECC Energy Code, a very limited number of multi-family buildings permitted under the new code will likely be ready for inspection by mid-2011 because it takes longer for multi-family buildings to complete.

After much discussion, it was decided to defer studying multi-family housing until 2012. Clearly, interest in multi-family issues goes beyond basic baseline data collection to create a separate multi-family baseline home for projects eligible to participate in the states' existing RNC programs. Also, it is unlikely that many multi-family projects permitted under the 2009 IECC code will be completed and ready to be inspected in 2011. Finally, EPA's ENERGY STAR Multi-family High-Rise Program will be introduced this year, and should the states' programs decide to offer the Multi-Family High-Rise Program, which will not use HERS ratings to verify ENERGY STAR compliance, the on-site inspections of these buildings would be different from what is being done for single-family homes.

Single-Family Housing

Team members agreed early on to offer homeowners an incentive of \$150 dollars for allowing their home to be inspected and an additional \$50 for allowing performance testing of central air conditioning equipment. Team members also agreed that homeowners should be notified of any obvious health or safety issues identified during the on-site inspections. However, team members had different opinions on whether or not to provide information to homeowners about how their home performed. Some team members thought providing this type of information would be important to homeowners and would be an incentive to participate, while other team members did not want to provide this information because of liability concerns.

Single-Family Sampling

Sample sizes to achieve 90% confidence and 10% precision were estimated for each of the four states assuming that the coefficient of variation (CV) would be comparable to the 2008 Vermont Baseline study CV of 0.49 (NMR, RLW & Conant 2009, 2); this was considered to be a conservative assumption because it was higher than the 2005 Massachusetts Baseline study CV of 0.37². Under these assumptions, a sample of 64 homes would likely be sufficient to achieve the desired 90/10 precision in Connecticut, Massachusetts and New Hampshire and a sample of 59 homes in Rhode Island.

Team members agreed on a sampling plan for single-family homes, based on Census permit data, that matches the percentage of on-site inspections conducted in a county to the percentage of state level permits issued in that county, with no more than two homes inspected in any one town to ensure broad geographic representation and avoid oversampling in any one socioeconomic area.

In addition, sponsors of the Massachusetts and Connecticut studies set targets for the percentages of custom and spec homes inspected. Based on experience from previous baseline studies, owners of custom homes are much more likely to agree to having their home inspected (NMR & Conant 2006). Owners of custom homes, who are more involved than buyers of spec/development homes in design and construction decisions, tend to be more interested in participating in a study that will provide them feedback on how their homes compare to other new homes. Although a large number of custom homes participate in RNC programs, the majority of homes are spec built, including individual spec-built homes, detached homes in developments and attached single-family housing projects. Therefore, to ensure custom homes are not over represented in the baseline samples, Connecticut established a goal of

² Coefficients of variation were calculated, not included in the 2005 Massachusetts Baseline Study report.

having not more than 40% and Massachusetts not more than 26% of inspected homes be custom homes.

Recruiting Single-Family Homes

Team members agreed early on that homes for the baseline study should be recruited through homeowners, not builders. Based on experience conducting other baseline studies, recruiting homes through builders is likely to result in a biased sample because only builders who are building to at least code are likely to agree to have their homes inspected. Team members also agreed early on that the most efficient way of identifying the population of occupied newly constructed homes is to have the electric utilities provide lists of new permanent service requests that include addresses and contact information.

Two options for recruiting homeowners were discussed: 1) recruiting directly from the list of new permanent service requests, and 2) conducting a phone survey of owners of newly constructed homes and recruiting as many homeowners as possible from survey respondents. One advantage of recruiting from survey respondents is that it supports a comparison of what owners say about their homes in the survey to what is found on site in the final baseline report. However, it is likely that some additional homeowners, who will not have participated in the phone survey, will need to be recruited to reach the targeted number of sampled homes. These additional recruited homeowners could be asked to complete the full phone survey either by phone or at the time of the on-site inspection.

Budget Proposals

Once team members were fully informed on and had discussed what information could be collected during the on-site inspections, how to recruit homeowners, and reporting options, representatives for each state were sent checklists of all available options to fill out and return. Using the checklist responses, detailed budget proposals were developed for each state and sent out for review.

Final Decisions

After reviewing budget proposals, three states decided to conduct single-family baseline studies in 2011: the Connecticut study will include inspection of 70 homes, Massachusetts 100 homes and Rhode Island 40 homes.³ The Massachusetts and Rhode Island studies will target homes built to meet 2009 IECC code requirements (Massachusetts and Rhode Island adopted the 2009 IECC code in 2010; Connecticut did not). Massachusetts will also conduct a home buyer survey. New Hampshire decided not to conduct a baseline study in 2011, but will be conducting a home buyer survey. The Massachusetts and New Hampshire home buyer surveys will each survey 100 owners of newly constructed ENERGY STAR homes and 100 owners of newly constructed non-ENERGY STAR homes.

In summary, the single-family baseline studies will:

- Use a single-family sampling plan that matches the percentage of on-site inspections conducted in a county to the percentage of state level permits issued in that county.
- Conduct HERS ratings on each home.
- HERS ratings will include code compliance reports and collection of information on renewables.
- Use RESNET conditioned space definitions

³ While offering less precision, Rhode Island sponsors determined a 40 home sample was adequate for their needs. If the CV for the Rhode Island study is 0.37, which was the final CV for the 2005 Massachusetts Baseline Study, the estimated sample size to achieve 90% confidence and 10% precision is 35 homes.

- Include HVAC performance testing
- Include Manual J assessments
- Capture ECM furnace fan information
- Individual study sponsors in each state will have the option to send letters to participating homeowners describing how their home performed.

Implementation

Recruiting Homes

Identifying Massachusetts and Rhode Island homes permitted and built to meet the new 2009 IECC code turned out to be a time-intensive process. Identifying and recruiting a sufficient number of spec-built homes to meet sponsors' targeted mix of custom and spec-built homes inspected was particularly challenging.

The first step was to clean the lists of new permanent residential electric service requests provided by the utilities to remove multi-family projects and single-family homes still listed under the builder name. The next step was to call town building departments to find out if the homes on the cleaned new service request list were permitted to be built to meet 2009 IECC code. Building department cooperation varied; some departments provided information over the phone, others required that someone come in person to get the information or wanted a written request for information. In addition, some departments were unable to report when the permit for the home was applied for; this is an important date because 2009 IECC became mandatory in both Massachusetts and Rhode Island as of July 1, 2010; all permits applied for from July 1, 2010 on should be built to meet 2009 IECC code requirements. If the permit application date was not available, it was assumed that permits are typically issued within a month of the application and that homes with permits issued August 1, 2010 or later were permitted under 2009 IECC. Connecticut did not adopt 2009 IECC in 2010, so all single-family homes on the list of new permanent service requests that had owner information were considered eligible to participate in the baseline study on-site inspections.

Owners of eligible homes are being sent letters describing the objectives of the study, what would be involved in the on-site inspection if they are called and agree to participate, and the \$150 incentive they would receive the day the inspection was conducted. The letter also includes a list of contacts, including phone numbers and email addresses, for each sponsor that homeowners can contact if they have any questions. Letters going to homeowners in Massachusetts also explain that they may be called and asked to complete a 15 to 20 minute phone survey addressing what home buyers look for in a new home and the information sources they use; at the end of the survey these homeowners are asked if they are interested in having their home inspected.

End of June Status

Letters have been mailed to eligible homeowners in Connecticut and Massachusetts and the Massachusetts home buyer survey is underway. Homeowners in both Connecticut and Massachusetts are being recruited for the on-site inspections and a few inspections have been conducted. Letters will be mailed to Rhode Island homeowners in mid-July and on-site inspections are planned to begin in late July.

Looking ahead, by the time this paper is presented, we will have more to say about any problems incurred related to the on-site inspections, as well as data cleaning and analysis, and be able to provide preliminary findings on building characteristics in Connecticut and Massachusetts.

Conclusions

The team approach for planning the baseline studies, combined with starting the discussions several months before decisions needed to be made, worked. The team was relatively large and included members with expertise and experience in many different areas, which guaranteed a variety of opinions and ideas would be expressed. Limiting the agendas for the bi-weekly calls to one or two topics ensured ample time for team members to fully discuss and debate the pros and cons of different options.

Assumptions can be dangerous. It turned out to be much more difficult and time consuming than expected to identify homes permitted under the 2009 IECC building code in Massachusetts and Rhode Island, especially owner occupied spec-built homes. This is likely to be the case at the beginning of any new code cycle. Cooperation from building departments was inconsistent and in many cases required evaluator staff to travel to the building department office to collect information in person.

Recommendations

Recommendations for planning and budgeting baseline studies, and identifying eligible participants for the on-site surveys are:

- Start planning early and include all interested parties in the process.
- If plans require getting access to information from outside sources, spend some time up front learning exactly what will be involved and how much time it will likely take before developing budgets.

References

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