How's that for Performance? Changes in New Construction Practices Over Time

Zack Tyler, NMR Group, Westford, VT
Tony Larson, National Grid, Waltham, MA
Bob Wirtshafter, Wirtshafter Associates, Chatham, MA

ABSTRACT

The residential new construction market changes with every new code cycle, making it particularly challenging to evaluate the impact of residential new construction programs. This paper presents the findings from a series of studies assessing the baseline characteristics of new single-family homes in Massachusetts. Three studies, completed between 2011 and 2016, were conducted to assess statewide code compliance and to provide updated baseline inputs for the state's Residential New Construction (RNC) program savings calculations. These studies covered the implementation of three separate energy code cycles, and a more rigorous, performance-based energy code.

The studies found that building practices do improve after code changes are enacted, but that these improvements vary by measure. The studies also found that improvements take place over the course of a code cycle, suggesting that some combination of market forces, program incentives and support activities, and code enforcement are at play. This creates a big challenge for evaluators seeking to parse out the contributions of program intervention and enhanced code compliance efforts.

These baseline studies make it possible to understand how changes in building codes affect the efficiency of new homes. The studies show that the Massachusetts RNC program has consistently increased program requirements in step with code improvements so that the difference in efficiency between program and non-program construction practices has not changed substantially over time. This paper offers lessons to inform other RNC programs about what they may be able to expect in terms of baseline changes when undergoing a code change.

Introduction and Background

The stringency of residential new construction (RNC) building codes has consistently increased over the past decade with respect to energy efficiency. These changes not only impact the baseline market conditions, they also influence the structure of programs that seek to promote high efficiency building practices.

In Massachusetts, the energy code has undergone four separate iterations of the base energy code since 2008. Over that time, the state has adopted and enforced the following versions of the International Energy Conservation Code (IECC):

- 2006 IECC (10/17/08 through 6/30/10)
- 2009 IECC (7/1/10 through 6/30/14)
- 2012 IECC (7/1/14 through 12/31/16)
- 2015 IECC (1/1/17 to present)

In addition, certain Massachusetts municipalities have adopted what is known as the “stretch code,” a performance-based energy code that requires increased efficiency over the base energy code.[1] The stretch code has been adopted over time, with some municipalities beginning to enforce the requirements in 2010 and others just beginning to enforce the requirements in 2017.[2] Until 2017, stretch code homes were required to meet the mandatory provisions of the 2009 IECC and achieve a Home Energy Rating System (HERS) score that ensures construction practices are approximately 20% more efficient than the base code. A summary of the code requirements across these code versions can be found in Table 1.

The Massachusetts Program Administrators (PAs) are invested in two separate efforts to claim savings in the RNC market:

- The RNC program, which promotes high efficiency building practices above the code requirements; and
- The Code Compliance Support Initiative (CCSI), which seeks to enhance compliance with the energy code.

The RNC program has been in place for many years, while the CCSI is a relatively new program that began offering trainings late in 2014.

The Massachusetts PAs have periodically measured the baseline efficiency of new homes throughout the state to assess statewide compliance levels for the CCSI and to measure a baseline against which the RNC program can calculate savings. The RNC program has consistently offered performance-based incentives for program homes. Specifically, the program offers varying incentives depending on how efficient program homes are compared to non-program baseline homes. This design allows the program to achieve efficiencies in the new construction market that would be unlikely in the absence of the program.

Study Sample and Timeline

Between 2011 and 2017, the Massachusetts PAs and the Energy Efficiency Advisory Council (EEAC) conducted three baseline studies of the single-family RNC market in Massachusetts. These studies measured the efficiency of single-family non-program homes that were built under four different energy codes and included five separate samples. Specifically, the studies looked at homes built at various stages of the code under the following energy code cycles:

- 50 homes built at the end of the 2006 IECC (NMR Group et al. 2012a)
- 100 homes built at the beginning of the 2009 IECC (NMR Group et al. 2012b)
- 50 homes built at the end of the 2009 IECC (NMR Group and Conant 2016)
- 50 homes built under the optional and performance-based stretch code (NMR Group and Conant 2016)
- 50 homes built at the beginning of the 2012 IECC (NMR Group and Conant 2016)

Figure 1 presents a timeline that details the year the sampled homes were completed, the starting point for the PAs’ CCSI efforts, and the start date of code enforcement for each code cycle.

[1] Details on the stretch code requirements considered in these studies can be found here: http://www.mass.gov/eopss/docs/dps/8th-edition/115-appendices.pdf

[2] Details on the municipalities that have adopted the stretch code and when the stretch code began being enforced can be found here: http://www.mass.gov/eea/docs/doer/green-communities/grant-program/stretch-code-towns-adoption-by-community-map-and-list.pdf

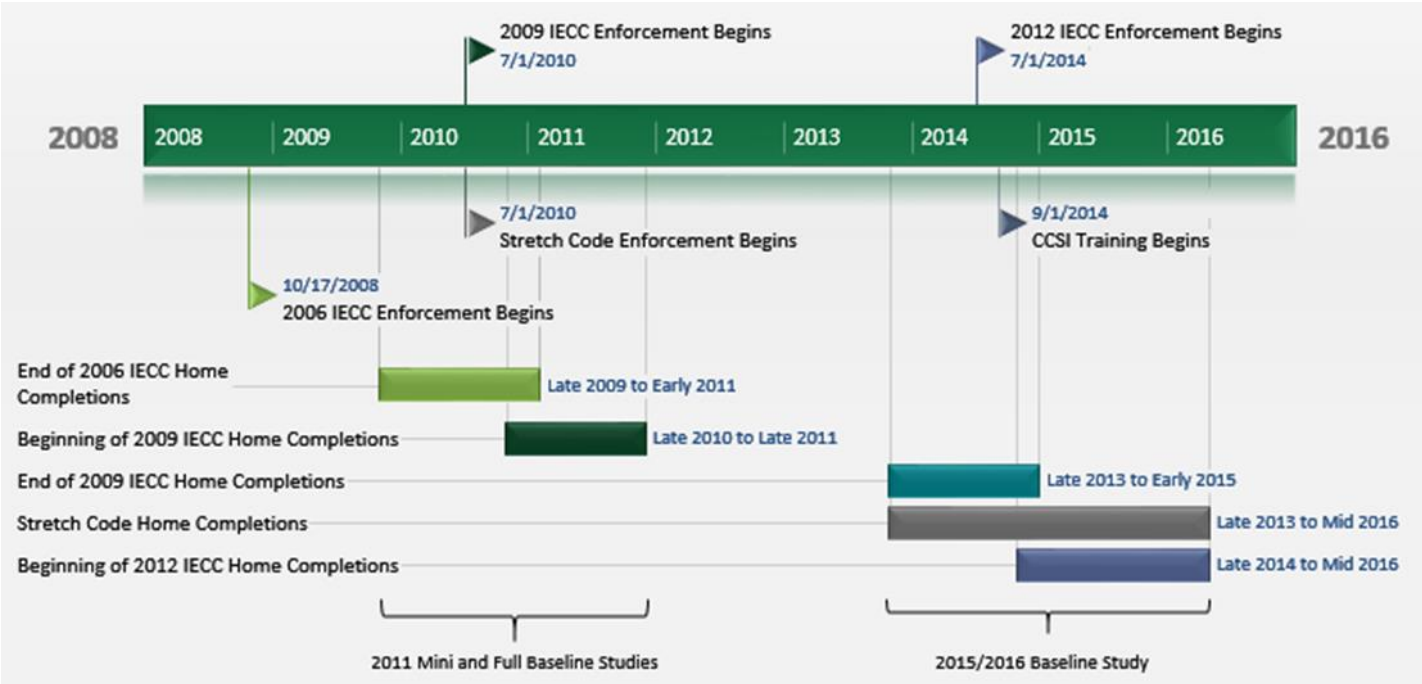

Figure 1. Timeline of baseline study on-site inspections

In addition to non-program homes, the studies leveraged program energy models to determine how program homes compare to non-program homes in terms of relative efficiency. Program homes from the 2011 program year and the 2015 program year were used in various studies. The 2011 program files were compared to homes built at the beginning of the 2009 IECC, while the 2015 program homes were compared to homes built at the beginning of the 2012 IECC and homes built under the stretch code.

Methodology

The baseline study inspections took place at newly constructed homes that were built under the aforementioned energy codes. The evaluation team visited building departments across the state of Massachusetts to verify when homes were permitted and determine which code they were built under. The inspections focused on homes that did not participate in the RNC program.[3]

The evaluation team recruited at the homeowner level and inspected completed and occupied homes. Recruiting at the homeowner level presents limitations, particularly with regard to observing insulation details in slabs, enclosed walls, and ceilings. That said, this approach avoids the potential bias toward efficient homes that may be introduced when recruiting builders. The bias results when builders who believe their homes are energy efficient are more likely than other builders to participate in a study that requires a third-party inspection (Nexus Market Research et al. 2004). Because most homeowners are not familiar with the energy code or the construction of their home, we believe homeowner recruitment minimizes the bias toward more energy-efficient homes.

[3] Recruiting non-participant stretch code homes was especially challenging as the penetration rate of stretch code homes in the program is estimated to be 77%. This is significantly higher than the penetration rate for non-stretch code homes (estimated to be 24%).

Each of the homes included in these studies was inspected by a certified HERS rater. The evaluation team collected all of the data necessary to complete full HERS ratings and populated detailed energy models. This included comprehensive data collection for the building shell (e.g., wall and ceiling insulation), mechanical equipment, lighting, appliances, and diagnostic testing for air and duct leakage. The evaluation team relied on the following key data sources as part of our on-site data collection procedures:

- **On-site visual verification of the actual building component.** Actual observations in the field are our first and most important source of data. When direct access to the component was not possible, we examined around the component to gather whatever information we could. For example, when trying to determine exterior wall insulation, we might have removed an electrical outlet cover and probed to determine the presence and level of insulation.
- **On-site visual verification of a similar component.** Once we exhausted opportunities to examine the actual component, we used similar locations to inform our assessment. For example, we might have found that there was visible, accessible above-grade wall insulation in an attic knee wall or walkout basement that we might have used to inform our assessment of the enclosed wall cavities.
- **Building department documentation.** To improve the accuracy of our data collection, we supplemented the methods above with documentation available at most building departments. The evaluation team used a combination of in-person visits, phone calls, and email exchanges with building departments to review all energy-related compliance documentation associated with most homes.

Comparison of Key Code Requirements

To understand the code compliance results presented in this report, it is important to understand how key requirements vary by code. As shown in Table 1, the key differences between the 2006 IECC and the 2009 IECC are found in the wall insulation, air infiltration, duct leakage, duct insulation, and lighting requirements. The 2012 IECC has increased requirements over the 2009 IECC for ceiling insulation, fenestration U-factor, air infiltration, duct leakage, and lighting. As previously mentioned, the stretch code is a performance-based code that is based on the 2009 IECC.

Table 1. Comparison of key code requirements across codes

Measure	2006 IECC requirement	2009 IECC requirement	2012 IECC requirement	Stretch code requirement
Code Timing	10/17/08 through 6/30/10	7/1/10 through 6/30/14	7/1/14 through 12/31/16	7/1/10 to present
Wall insulation	R-19 or R-13+5 (U-.060)	R-20 or R-13+5 (U-.057)	R-20 or R-13+5 (U-.057)	No requirement*
Ceiling insulation	R-38 (U-.030)	R-38 (U-.030)	R-49 (U-.026)	No requirement*
Floor R-value	R-30 (U-.033)	R-30 (U-.033)	R-30 (U-.033)	No requirement*
Foundation wall R-value	R-10/13 (U-.059)	R-10/13 (U-.059)	R-15/19 (U-.050)	No requirement*
Slab R-value	R-10, 2ft	R-10, 2ft	R-10, 2ft	No requirement*
Fenestration U-factor	U-0.35	U-0.35	U-0.32	No requirement*
Air infiltration	Requires air sealing, but there is no testing option. Compliance is assessed through visual inspection.	Requires air sealing. Compliance is assessed through visual inspection or air infiltration testing (7 ACH50)	Requires air sealing. Compliance is assessed via air infiltration testing (3 ACH50)	Requires air sealing. Compliance is assessed through visual inspection or air infiltration testing (7 ACH50)
Duct leakage	Requires duct sealing, but there is no testing option. Compliance is assessed through visual inspection.	Requires duct sealing, which is assessed through duct leakage testing (8 CFM25/100 ft^2 leakage to the outside)	Requires duct sealing, which is assessed through duct leakage testing (4 CFM25/100 ft2 of total leakage)	Requires duct sealing, which is assessed through duct leakage testing (8 CFM25/100 ft^2 leakage to the outside)
Duct insulation	Supply and return ducts insulation to a minimum of R-8. Ducts in floor trusses shall be insulated to R-6.	Supply ducts in attics shall be insulated to a minimum of R-8. All other ducts shall be insulated to a minimum of R-6.	Supply ducts in attics shall be insulated to a minimum of R-8. All other ducts shall be insulated to a minimum of R-6.	No requirement*
Lighting	n/a	50% high efficacy lamps in permanently installed fixtures	75% high efficacy lamps in permanently installed fixtures	No requirement*

*The stretch code requires that homes comply with the mandatory requirements of the 2009 IECC and have a HERS score of 70 (for homes < 3,000 ft^2) or 65 (for homes ≥ 3,000 ft^2). These measures are not associated with mandatory requirements.

Non-Program Changes Over Time

In order to assess the influence of codes on the efficiency of new construction practices, this paper first examines homes that did not participate in the RNC program. The RNC program requires that builders exceed measured baseline practices and, as a result, the efficiency of program homes is linked to the change in non-program practices over time. Non-program homes are influenced by changes in code requirements. Therefore, program homes are indirectly influenced by those same code changes.

This section details changes in efficiency over time for a whole-house building efficiency metric (HERS scores) and for key efficiency measures that have undergone a significant change in code requirements between the 2006 IECC and the 2012 IECC. It focuses on changes in air leakage, duct leakage, and ceiling insulation. The various baseline studies referenced in this report provide additional details on other key measures.

HERS Score

The HERS Index, created by the Residential Energy Services Network (RESNET), is a metric that measures a home's energy efficiency. The index is based on a scale that ranges from below zero to well over 100. A score of zero represents a net zero energy home, while a score of 100 represents a home built to the 2004/2006 IECC requirements. RESNET indicates that every one point on the HERS index represents a 1% change in energy efficiency. For example, a home with a HERS score of 150 would be considered 50% less efficient than a home built to the 2004/2006 IECC requirements (a HERS score of 100); a home with a score of 50 would be considered 50% more efficient.

Table 2 presents a comparison of HERS scores across the non-program homes built under each of the code cycles considered in this paper. Within this table and tables that follow, superscript letters of the alphabet indicate a significant difference between two samples. For example, Table *2* shows a significant difference between the end of the 2006 IECC and the beginning of the 2009 IECC, as indicated by a superscript 'a.' Similarly, the end of the 2009 IECC is significantly different from the stretch code as indicated by a superscript 'c.' As shown, the HERS scores of non-program homes have consistently fallen (i.e., homes have increased in terms of efficiency) over the course of the 2009 IECC cycle and as codes have changed. Stretch code homes, which were required to achieve a HERS score of 65 or 70 depending on the size of the home, display the lowest average HERS score (66).

Table 2. HERS score comparison of non-program homes

HERS Score	End of 2006 IECC	Beginning of 2009 IECC	End of 2009 IECC	Beginning of 2012 IECC	Stretch Code
Sample Size	*50*	*100*	*50*	*50*	*46*
Average HERS Score	83^{a}	$79^{a,b}$	$73^{b,c}$	69	66^{c}

[a,b,c] Significantly different at the 90% confidence level.

Air Leakage

Table 3 presents a comparison of air leakage levels across the various non-participant groups. Air leakage is measured in air changes per hour at 50 Pascals (ACH50). The 2006 IECC did not include a specific air leakage testing requirement, though it did require air sealing. The 2009 IECC includes an optional testing requirement of 7 ACH50, while the 2012 IECC includes a mandatory requirement of 3 ACH50. The stretch code requires air leakage testing, though there is no specific leakage level required by the code.[4]

As shown, air leakage levels have decreased over time. The focus on an air leakage testing option that accompanied the 2009 IECC appears to have led to a change in practices among builders, as

[4] Testing is required because the stretch code requires a HERS score; to develop a HERS score specific air leakage levels are necessary. The stretch code does not specify a prescriptive level that is required, instead the home must meet a specific HERS score requirement. One way to work towards a lower HERS score is to lower air leakage levels.

homes built at the beginning of the 2009 IECC have significantly lower leakage levels than those built at the end of the 2006 IECC. Interestingly, this is a practice that did not change much over the course of the 2009 IECC—perhaps because initial levels were already well below the code requirement of 7 ACH50. The 2012 IECC resulted in substantial changes in the energy code requirement, moving from an optional requirement of 7 ACH50 under the 2009 IECC to a mandatory requirement of 3 ACH50 under the 2012 IECC. This again resulted in a significant change in air leakage levels from the end of one code cycle to the beginning of another. Stretch code homes, which are required to use a HERS rater and conduct performance testing, show very efficient air leakage levels that are comparable to homes built at the beginning of the 2012 IECC.

Table 3. Air leakage comparison of non-program homes

Air Leakage	End of 2006 IECC	Beginning of 2009 IECC	End of 2009 IECC	Beginning of 2012 IECC	Stretch Code
Code Requirement	n/a	7 ACH50		3 ACH50	7 ACH50
Sample Size	*50*	*73*	*50*	*98*	*46*
Average Air Leakage (ACH50)	5.8[a]	4.8[a]	4.7[b,c]	3.5[b]	3.7[c]

[a,b,c] Significantly different at the 90% confidence level.

Duct Leakage

Table *4* presents a comparison of duct leakage levels (duct leakage to the outside) for the various non-program home samples. Duct leakage levels have drastically improved over time. Testing was not required as part of the 2006 IECC and homes built at the end of the 2006 IECC have the least efficient leakage results by far (17.2 CFM25/100 ft^2). Beginning with the 2009 IECC, duct leakage testing became a mandatory requirement, with a specification that duct leakage to the outside not exceed 8 CFM25/100 ft^2. As Table 4 shows, this had a profound impact on the duct leakage levels in non-program homes. Homes built at the beginning of the 2009 IECC have significantly lower leakage levels than homes built at the end of the 2006 IECC. While the homes built at the beginning of the 2009 IECC were still largely non-compliant, the impact of the mandatory testing requirement certainly influenced the efficiency of these homes. It appears that the market became more comfortable with the duct leakage testing requirements over the course of the code cycle, as the homes built at the end of the 2009 IECC had significantly lower leakage levels than those built at the beginning of the code cycle. The 2012 IECC increased duct leakage requirements even further, moving from requiring that homes meet a threshold for leakage to the outside to a total leakage requirement. These requirements again had a significant impact on the efficiency of these homes compared to the end of the previous code cycle. As with the previous measures, stretch code homes display efficient characteristics in line with homes built under the 2012 IECC. This is likely due to the fact that these homes must meet a performance-based whole-house requirement, and that diagnostic testing is needed to meet the HERS score requirement of the stretch code. While the stretch code does not specify a maximum duct leakage level, it is easier to meet the whole house HERS score requirement if duct leakage levels are low.

Table 4. Duct leakage to the outside comparison of non-program homes

Duct Leakage to the Outside	End of 2006 IECC	Beginning of 2009 IECC	End of 2009 IECC	Beginning of 2012 IECC	Stretch Code
Code Requirement	n/a	8 CFM25/100 ft^2 LTO		n/a*	8 CFM25/100 ft^2 LTO
Sample Size	*40*	*69*	*47*	*98*	*43*
Duct Leakage to the Outside (CFM25/100 ft^2)	17.2[a]	12.4[a,b]	6.5[b,c,d]	3.9[c]	4.1[d]

[a,b,c,d] Significantly different at the 90% confidence level.

*No leakage to outside requirement. The 2012 IECC requires duct leakage levels of 4 CFM25/100 ft^2 of total duct leakage

Ceiling Insulation

Table 5 presents a comparison of the flat attic R-values for non-program homes from the various code groups. The prescriptive code requirement for flat attic insulation is R-38 under the 2006 IECC, the 2009 IECC, and the stretch code. The 2012 IECC increased the prescriptive code requirement to R-49. As the table shows, there was improvement over time from the end of the 2006 IECC to the end of the 2009 IECC. As was the case with duct leakage, this improvement is likely due to market actors becoming more comfortable with the code requirements and perhaps to code officials increasing their enforcement of the requirement. The increase in the R-value requirement under the 2012 IECC clearly had an impact on the efficiency of homes. While the average R-value is below the code requirement of R-49, the homes built at the beginning of the 2012 IECC have significantly higher average R-values than homes built at the end of the 2009 IECC or homes built under the stretch code.

Table 5. Flat attic insulation R-value of non-program homes

Ceiling Insulation	End of 2006 IECC	Beginning of 2009 IECC	End of 2009 IECC	Beginning of 2012 IECC	Stretch Code
Code Requirement	R-38	R-38		R-49	n/a*
Sample Size	*50*	*97*	*49*	*48*	*41*
Flat Attic R-Value	32[a]	36.8[a]	38.7[b]	43.3[b,c]	37.6[c]

[a,b,c] Significantly different at the 90% confidence level.

*The stretch code does not have a prescriptive ceiling insulation R-value requirement.

Comparison of Program and Non-Program Homes

As previously mentioned, the Massachusetts RNC program has consistently required that program homes achieve a certain level of efficiency relative to the non-program baseline. Most recently the program provided a tiered incentive package for program homes achieving 15%, 30%, or 45% improvement over the 2014 non-program baseline home.[5] Below we compare the efficiencies of program homes to the non-program baseline homes in order to assess the effectiveness of the

[5] The 2014 baseline was a modified version of the baseline that was produced as part of the 2011 baseline study, which looked at homes built at the beginning of the 2009 IECC.

Massachusetts RNC program requirements. Specifically, we compare the 2011 program homes to homes built at the beginning of the 2009 IECC cycle, and we compare the 2015 program homes to a combination of homes built at the beginning of the 2012 IECC and homes built under the stretch code. The 2012 IECC and stretch code non-program homes are merged for this comparison, as the 2015 RNC program included a mix of homes built under the 2012 IECC and homes built under the stretch code.

Table 6 presents the comparison of program homes and non-program homes for each of the measures outlined in the previous section of this paper. Detailed comparisons for other measures can be found in the baseline studies that are referenced in this paper. Below is a list of key findings based on these comparisons.

- **HERS Scores:** The program has consistently maintained significantly lower HERS scores than non-program homes. In 2011, the average HERS score for program homes was 16 points lower than the average score for non-program homes (63 vs. 79). In 2015, the gap between program homes and non-program homes fell to 13-points (55 vs. 68).
- **Air Leakage:** Program homes in both 2011 and 2015 maintained significantly lower air leakage levels than their non-program counterparts. In 2011, program homes had average leakage levels that were .9 ACH50 lower than non-program homes. In 2015, the difference between program and non-program homes fell to .7 ACH50.
- **Duct Leakage:** In 2011, program homes had average levels of duct leakage to the outside that were 9.1 CFM25/100 ft^2 lower than non-program homes. In 2015, the difference between program homes and non-program homes was only 1.3 CFM25/100 ft^2. While 2015 programs homes still show a significantly lower leakage rate than non-program homes, the gap between the two populations has become much smaller.
- **Ceiling Insulation:** In 2011, program homes were significantly more efficient than non-program homes in terms of ceiling insulation R-value and U-factor. The U-factor accounts for the rated R-value of insulation, the thermal properties of framing and other construction materials in the ceiling assembly, and the quality of insulation installation. In 2015, program homes did not have significantly higher ceiling insulation R-values, but they did have significantly lower (more efficient) U-factors. The U-factor gap between program homes and non-program homes fell between 2011 and 2015. In 2011, the difference between these samples was a U-factor of .014 and in 2015 it was .003.

Table 6. Comparison of program and non-program home efficiencies

Measure	Program Year 2011		Program Year 2015	
	Non-Program (Beginning of 2009 IECC)	2011 Program Homes	Non-Program (Beginning of 2012 IECC/Stretch Code)	2015 Program Homes
Average HERS Score	79[a]	63[a]	68[b]	55[b]
Air Leakage (ACH50)	4.8[a]	3.9[a]	3.6[b]	2.9[b]
Duct Leakage to the Outside (CFM25/100 ft^2)	12.4[a]	3.3[a]	3.9[b]	2.6[b]
Ceiling Insulation R-value	36.8[a]	40.6[a]	40.7	41.0
Ceiling Insulation U-Factor	0.044[a]	0.030[a]	0.030[b]	0.027[b]

[a,b] Significantly different at the 90% confidence level.

Over time, program homes have maintained significantly more efficient construction practices in comparison to non-program homes. The gap in efficiency between program homes and non-program homes has decreased slightly from 2011 to 2015. As previously mentioned, the HERS index is a measurement of whole house efficiency. Each one point change in the index represents a 1% change in building efficiency. Based on the HERS index, program homes were 16% more efficient than non-program homes in 2011, and 13% more efficient in 2015. The closing gap between program and non-program homes could be attributable to the increased efficiency of non-program homes, which is directly linked to changes in code requirements. As codes continue to increase in stringency, it will be increasingly difficult to maintain a large efficiency gap between program homes and non-program homes.

While program homes increasingly include significantly more efficient construction practices than non-program homes, the savings available to the PAs are shrinking. The reduction in baseline consumption of non-program homes leads to a reduction in net savings available to the PAs, even with program homes maintaining a significant efficiency gap over non-program homes. Using the HERS scores as a reference, we know that program homes were 16% more efficient than non-program homes in 2011, and 13% more efficient in 2015. We also know that the non-program baseline has increased in efficiency, leading to reduced consumption. These two factors together result in decreased savings for the PAs. For example, let's assume non-program homes in 2011 had an average baseline consumption of 150 MMBtu and in 2015 that consumption dropped to 100 MMBtu. Based on the HERS scores, we can assume that the savings for the program would have been 24 MMBtu in 2011 (a 16% change in MMBtu consumption) and 13 MMBtu in 2015 (a 13% change in MMBtu consumption). This shows that the increased efficiency of non-program homes has a two-pronged effect on program savings: a reduction of total savings available and a reduction in the efficiency gap between program and non-program homes.

Conclusions

The evaluation team's results highlight several key findings related to the impact of code changes on RNC baseline conditions and the impact of these changes on the efficiency of RNC program homes.

- The overall efficiency of RNC non-program homes, as measured by the HERS index, has increased with each code change.
- This paper shows a large increase in the efficiency of non-program homes over the course of the 2009 IECC. Homes built at the end of the code cycle displayed significantly lower HERS scores than homes built at the beginning of the code cycle. A recent study by NMR Group (2014) determined that spillover from the Massachusetts RNC program was responsible for a large portion of this improvement.
- Performance testing requirements for air and duct leakage have led to significant increases in efficiency among non-program homes. This is highlighted by the comparison of homes built at the end of the 2009 IECC and homes built at the beginning of the 2012 IECC. In addition, stretch code homes display the most efficient average HERS score of all non-program homes. These homes are subject to performance testing requirements.
- The Massachusetts RNC program has managed to maintain a significant efficiency gap between program homes and non-program homes over time, though the size of the gap appears to be decreasing slightly. By measuring the non-program baseline and tying program requirements to it, the Massachusetts PAs have driven program homes to maintain significantly higher energy efficient construction practices than non-program homes, even in the face of an evolving new construction market with enhanced energy code requirements.
- The increasing baseline efficiency of non-program homes is leading to reduced savings opportunities for the PAs, even though program homes have maintained a significant efficiency gap over non-program homes. The combination of a reduced baseline consumption and an efficiency gap that is shrinking slightly results in reduced net savings potential for the RNC program. This will be something to monitor for RNC programs in the future.

These results should be helpful to other states that anticipate code updates and a shifting RNC market baseline. While this paper focuses on a few key measures, code impacts often vary from cycle to cycle. It is imperative to understand what measures change from one code cycle to another, and the relative size of those changes. As shown in Massachusetts, these changes can have a significant impact on both the non-program baseline and the subsequent efficiency of program homes.

Determining savings attributable to the Massachusetts RNC program and the CCSI will be challenging given the interconnected nature of program participants and non-participants. Each of these markets is impacted by evolving codes, increased compliance enforcement, and the inclusion of performance-based code requirements. Attributing above-code practices and compliance improvements to the programs, while accounting for spillover, Naturally Occurring Market Adoption (NOMAD), and avoiding double counting, will be challenging in a constantly evolving RNC market.

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