A Performance Based ENERGY STAR® Homes Program: The Wisconsin ENERGY STAR Homes Perspective

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ABSTRACT

Over 13,000 certified homes during the past ten years are testament to the impact and influence Focus on Energy's Wisconsin ENERGY STAR® Home Program has made on the construction of new homes in the State of Wisconsin. Despite the impact that the current economic situation has had on construction, 23% of all Wisconsin homes built in 2009 were certified as Wisconsin ENERGY STAR Homes. The value that builders receive from the program is directly attributed to the required building performance standards. The Wisconsin ENERGY STAR Homes Program requires a higher level of performance for certification than the national ENERGY STAR Program. This is accomplished through attention to detail during the construction process, required measures, and following program standards and reference guidelines. While prescriptive measures are required, a home can only be certified after testing confirms the home meets the performance standard for building air tightness.

Over the program's history, the annual average leakage ratio (CFM50/square foot of building shell area) has steadily decreased at a rate of 0.0034 CFM50/sqft/year. Although the tightest homes remain in the 0.03 – 0.05 CFM50/sqft range, the distribution curve went from a normal distribution in the early years to a heavily skewed distribution with more homes approaching the range of the tightest homes in recent years.

This paper presents program information and statistics, trends of increasing annual performance of Wisconsin ENERGY STAR Homes, as well as a discussion on what drives the success of the performance standard.

Introduction

Focus on Energy's Wisconsin ENERGY STAR Homes Program is a voluntary program promoting building practices that address combustion safety, building durability, occupant comfort, indoor air quality, and energy efficiency. Over 13,000 homes certified to Program standards in the past ten years are testament to the impact and influence Wisconsin ENERGY STAR Homes Program has made on the construction of new homes in the State of Wisconsin. The cornerstone of the Program is the performance standard required of all certified homes. The main measure of performance is air tightness measured by the air leakage ratio. This paper details program information and statistics, trends of increasing annual performance of Wisconsin ENERGY STAR Homes associated with the steady decrease in the air leakage ratio. Also included is a discussion on what drives the success of the performance standard: customers, the builder's organization, and competition between builders.

Focus on Energy

Focus on Energy is Wisconsin's statewide program for energy efficiency and renewable energy, which was created in 1999 and expanded in 2005. The program is ratepayer funded, with investor-owned utilities being required to participate and municipal utilities and electric cooperatives having the option to participate or offer their own programs. The aim of the program is to increase Wisconsin's energy independence by helping residents and businesses implement efficiency and renewable energy projects that would not otherwise occur.

The Focus on Energy program serves:

- Residential customers, including single and multifamily buildings and homeowners as well as renters
- Businesses, including farms, industrial, commercial, school, and government facilities
- Cities and community groups that want to improve their sustainability

Focus on Energy's organizational structure involves a Program Administrator and several subcontractors utilized for implementation. The Wisconsin Public Service Commission provides oversight of the Program Administrator. More than 85,000 businesses and 1.3 million residents have participated in the program between 2001 to 2009. Focus on Energy has more than 3000 market provider partnerships statewide. By mid-2009, Wisconsin's residents and businesses were saving more than $268 million *annually* as a result of Focus on Energy programs.

Focus on Energy provides both technical and financial assistance. Technical assistance includes industry specific experience and access to unbiased industry professionals that identify opportunities and help quantify the benefits. Incentives include cash-back rewards on specific purchases, custom incentives, and cost-sharing on assessments and feasibility studies.

Wisconsin ENERGY STAR Homes

After beginning as a pilot in 1998, the Wisconsin ENERGY STAR Homes Program (Program) expanded to a statewide program in 2001. Since the inception of the Program, over 13,000 new homes have received certification. The Program's market penetration, Figure 1, reached 23% of Wisconsin's new home starts for the calendar year 2009. Figure 2 documents the historical trends of new home starts in the State of Wisconsin and the Program's certified homes since the inception of the Wisconsin ENERGY STAR Homes Program.

Success of the Wisconsin ENERGY STAR Homes Program is a result of many factors, the following are just a few:

- Wisconsin has a long tradition, extending back to the 1980s, of supporting residential energy efficiency programs as part of a balanced approach to managing the state's energy needs.
- The Wisconsin ENERGY STAR Homes Program is based on providing the Wisconsin residential building industry with reliable, relevant, and accurate information on proven energy efficiency and high performance building technology. Focus on Energy has accomplished this through trainings, conferences, marketing, and the development of a well-trained private Consultant (rater) infrastructure delivering certification services in Wisconsin.

- Wisconsin ENERGY STAR Home's standards for building tightness, combustion safety, mechanical ventilation, full height foundation wall insulation, and sealed sump pits in addition to the National ENERGY STAR platform address building issues of concern to the building community, buying public, and Focus on Energy's regulator (Wisconsin Public Service Commission). These additional standards, combined with a homeowner manual, have increased energy efficiency, reduced callbacks and strengthened the regional value and acceptance of the national ENERGY STAR label in Wisconsin's building market resulting in substantial gains in program growth and recognition.

The Wisconsin ENERGY STAR Homes Program has earned the confidence of Wisconsin's building industry and is often used as a resource for building science information by builders, trades contractors, supply houses, lumber dealers, building associations, and consumers statewide. All of this trust is premised on the fact that the Program promotes and requires sound building practices and techniques relevant to Wisconsin's climate, market, housing stock, and more importantly, are of value to our Builder Partners, Consultants, and homeowners.

Figure 1. Comparison of State Building Permits to Wisconsin ENERGY STAR Homes Certifications 2007-2009

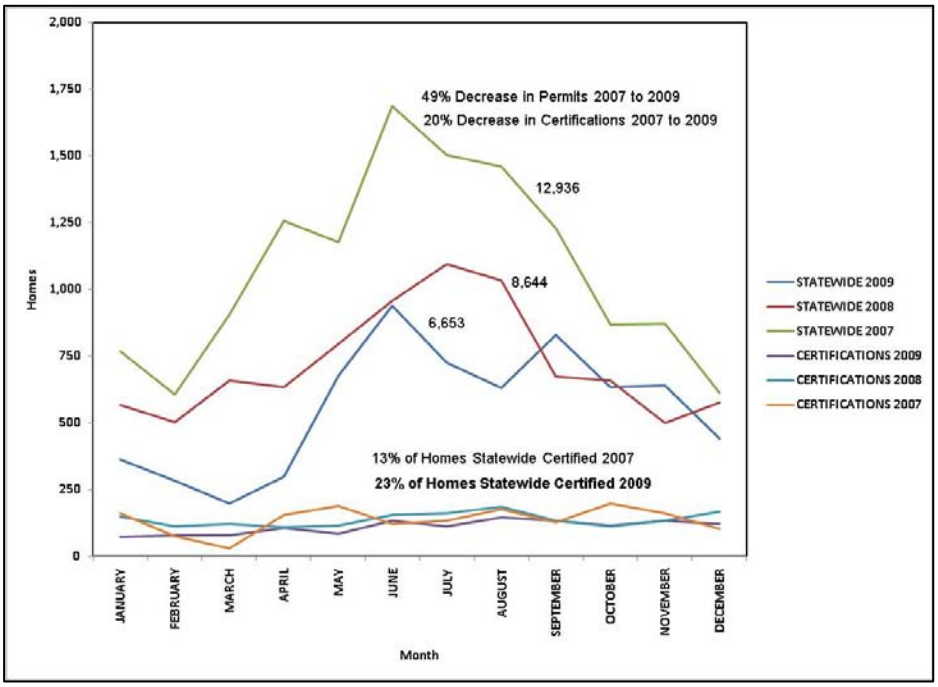
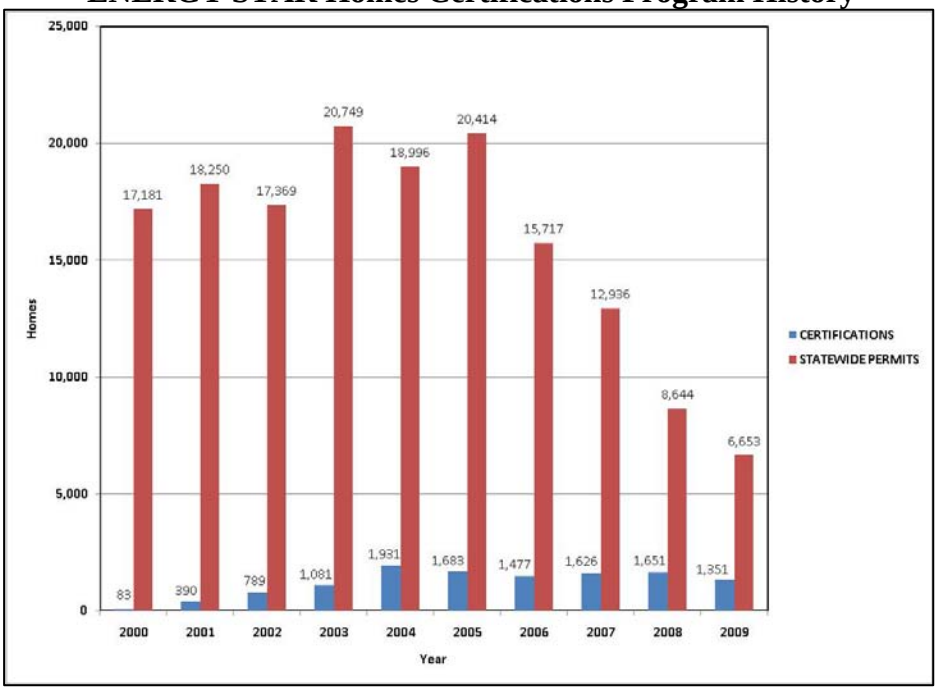


Figure 2. Comparison of State Building Permits to Wisconsin ENERGY STAR Homes Certifications Program History



Program Participants

The Wisconsin ENERGY STAR Homes Program is comprised of four participant groups: Builder Partners, Consultants, Customers/Homeowners, and Program Staff. Each of the groups has its own unique needs and requirements to participate in the Program. The Consultant (rater) model is unique as a program delivery model. As a Program, we must always remind ourselves that the Wisconsin ENERGY STAR Homes is a voluntary program that individuals and businesses must find value in otherwise there is no reason to participate.

Builder Partners

Builder Partners enter the Program through sponsorship by a Consultant. A goal of the Program is to make participation as simple as possible for a Builder Partner. The only time a Builder Partner is required to fill out Program paperwork is when they sign their market provider agreement. All fees for certification are negotiated between the Builder Partner and Consultant. The fees vary depending on the volume of new homes, travel distance, and number of site visits. It is important to note that the Wisconsin ENERGY STAR Homes Program certifies homes, not builders.

The number of Builder Partners that build one certified home per year has remained relatively constant at around 300 for the last six years, Figure 3. This constant level of builder participation in the program is interesting considering the fluctuations in certifications and the huge decline in building starts. Given the decrease in building activity while still maintaining Builder Partner numbers, it is no surprise that the average number of homes certified per Builder Partner has dropped by almost 2 homes per year since 2005, Figure 4.

Wisconsin home builders are predominately small businesses that build less than 10 custom homes per year. The Wisconsin market is not dominated by large production builders encountered in other states. The building activity of our Builder Partners reflects the composition of the Wisconsin builders as a whole. 87% of our Builder Partners build 5 or fewer certified homes per year, Figure 5. At the other end, only 14 Builder Partners built over 21 certified homes in 2009.

Consultants

Wisconsin ENERGY STAR Homes is based on a consultant model for program delivery. Consultants are independent businesses that offer energy efficiency services and home energy ratings. A common sentiment expressed by our Builder Partners is the value that they feel their Consultants bring to their building product. Over the last 5 years, the Program had between 40 and 50 Consultants per year, Figure 6. In 2009, more than half of the Consultants certified 10 or less homes per year and seven Consultants certified more than 60 homes, Figure 7.

Customers/Homeowners

A customer must decide if there is value in purchasing or building a Wisconsin ENERGY STAR Home. The value can only be communicated if the Builder Partner believes in and understands the Program.

Figure 3. Comparison of Wisconsin ENERGY STAR Homes Certifications to Number of Builder Partners

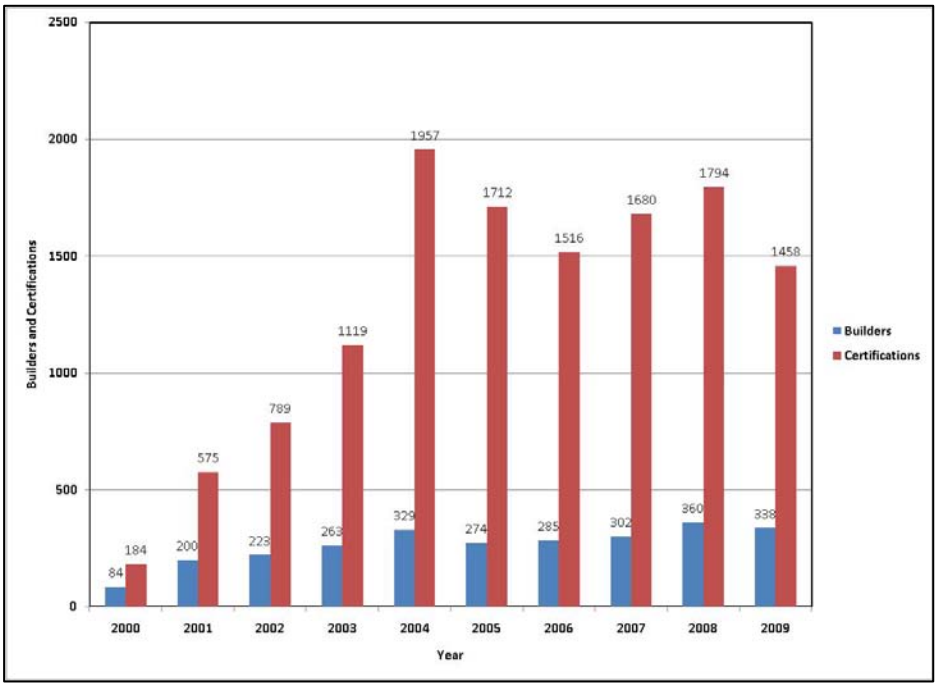


Figure 4. Comparison of Average Number of Wisconsin ENERGY STAR Homes Certifications per Builder Partner

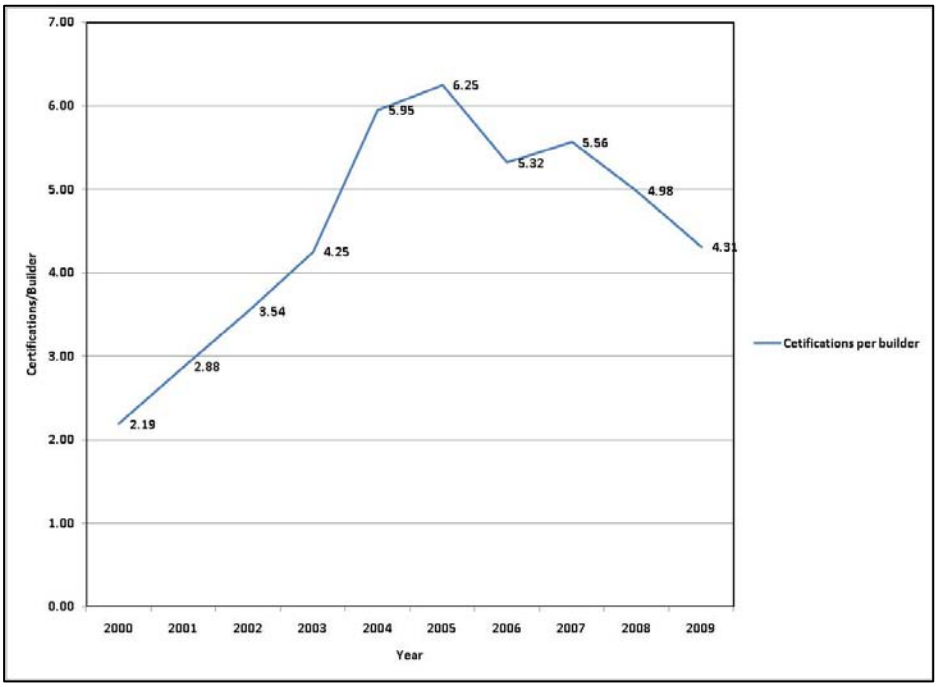


Figure 5. Comparison of Wisconsin ENERGY STAR Homes Certifications Levels to Number of Builder Partners 2009

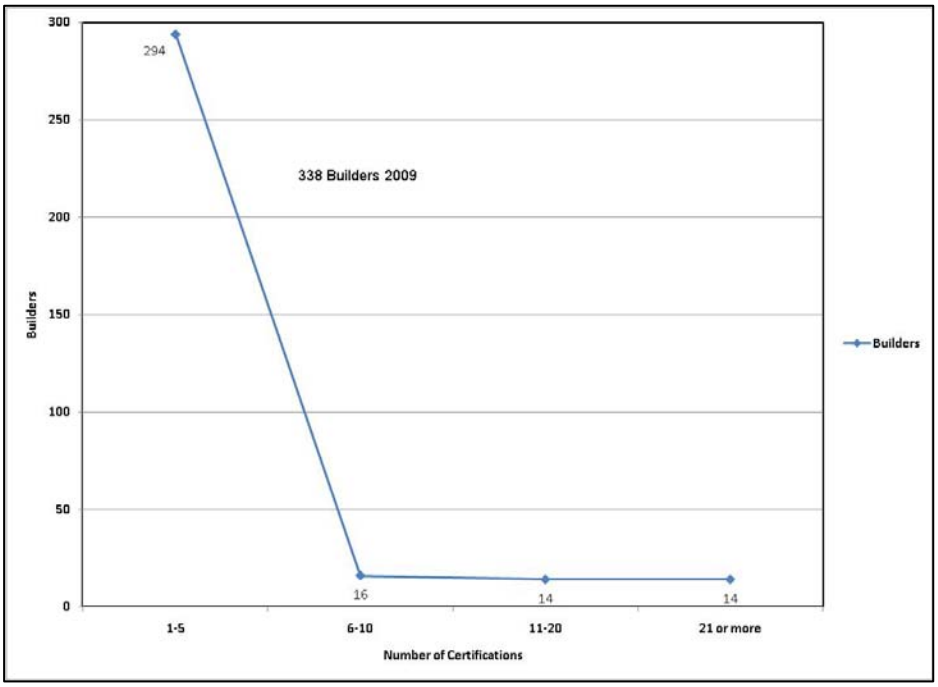


Figure 6. Consultant Numbers on an Annual Basis

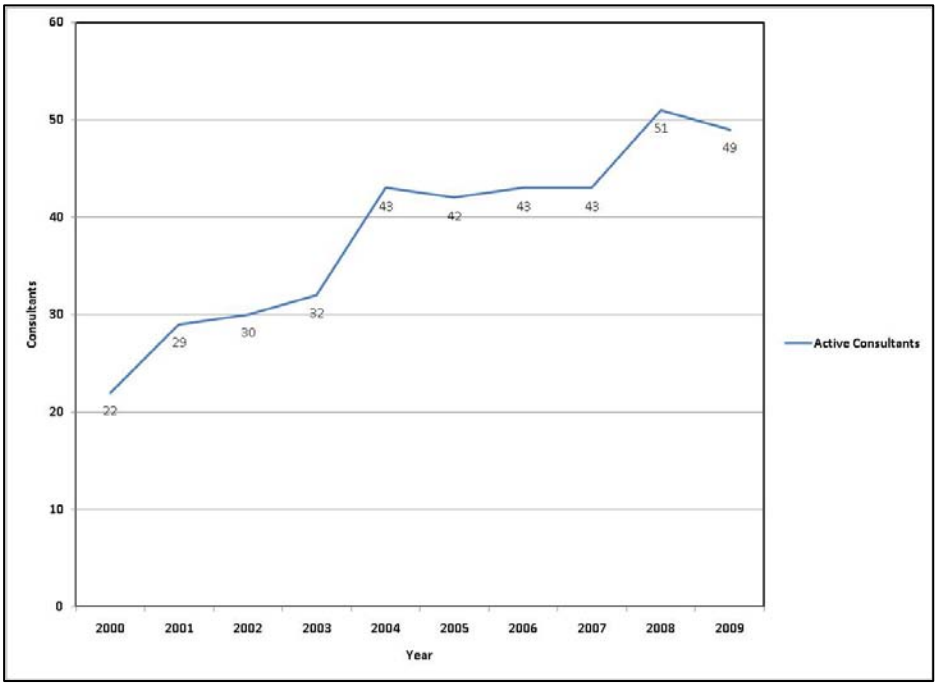
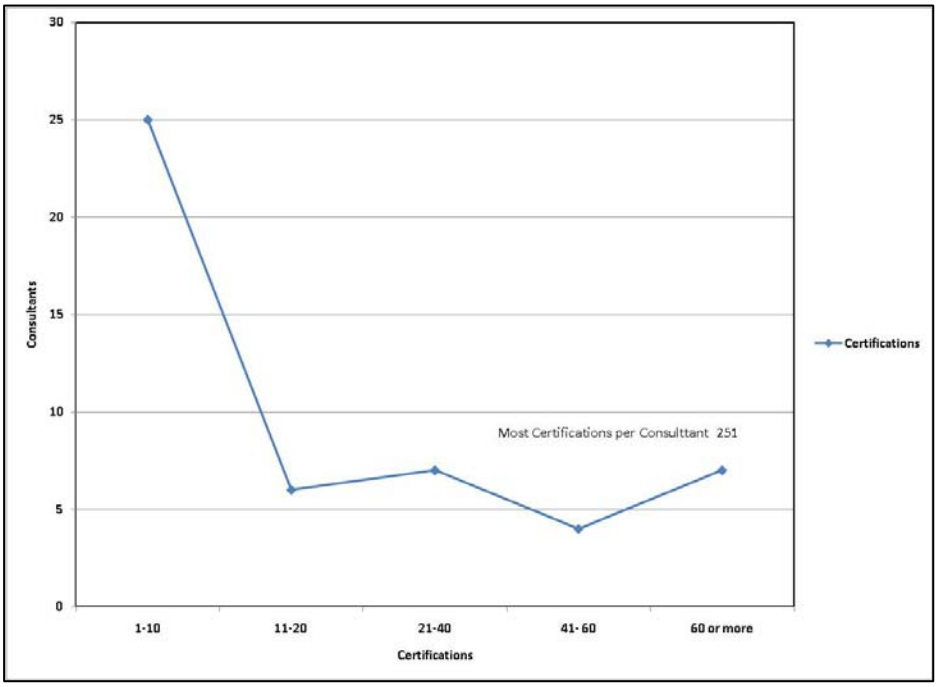


Figure 7. Comparison of Wisconsin ENERGY STAR Homes Certifications Levels to Number of Consultants 2009



Program Staff

The Program Staff is responsible for determining program delivery, training, and cash-back reward components of the Wisconsin ENERGY STAR Homes Program. For every certified

home, the Builder Partner receives $100. The Program is credited 100 therms towards annual energy savings goals for every home certified (Energy Center of Wisconsin 2000).

Program Implementation

Wisconsin ENERGY STAR Homes certification requires computer modeling, following Program Standards, and visiting the site. In addition, there are recommended Program Guidelines.

Program Standards

Wisconsin ENERGY STAR Homes require that all 10 Program Standards are met in order to achieve certification. The Standards address the four areas of building science and performance: air flow, indoor air quality, heat flow, and moisture flow.

- Standard 1A – Air tightness: Each home must meet the program air tightness requirement of equal to or less than a tested leakage ratio of 0.25 CFM at 50 Pascals per square foot of building shell area (CFM50/sqft).
- Standard 1AQ – Overall house ventilation: A mechanical ventilation system must be installed to provide whole-house ventilation compliant with both ASHRAE 62.2 and RESNET.
- Standard 1H – Full coverage foundation insulation: The entire foundation wall area must be insulated. The insulation can be exterior, interior, or a combination of exterior/interior.
- Standard 1M – Sealed sump pit: Any sump pit installed must have an airtight lid with all piping and electrical penetrations sealed.
- Standard 2AQ.1 – Spot ventilation for bathroom: In each bathroom either the exhaust fan ducted to the exterior or a centrally ducted ventilation system with an exhaust pick-up.
- Standard 2AQ.2 – Spot ventilation for electric kitchen range: Dedicated exhaust (such as a vented range hood or down-draft exhaust) ducted to the exterior unless centrally ducted ventilation system with an exhaust pick-up in the kitchen.
- Standard 2AQ.3 – Spot ventilation for gas kitchen range: Dedicated exhaust (such as a vented range hood or down-draft exhaust) ducted to the exterior.
- Standard 3AQ – Closed combustion, power-vented or direct-vented heating and water heating system: Any combustion equipment installed in the conditioned space must be power-vented, direct-vented, or closed combustion systems.
- Standard 4AQ – Gas and wood burning fireplaces: All gas fireplaces must be direct-vented technology and must include a sealed face with no openable doors. All wood burning fireplaces and stoves must be of closed combustion design, fitted with outdoor combustion air supply and have fully gasketed or mated machined surface doors.
- Standard 5AQ – Carbon monoxide detector: One carbon monoxide detector must be installed on each floor with a bedroom.

Program Guidelines

In addition to the Program Standards, there are 18 Program Guidelines. The guidelines are divided into three categories: building shell, lighting and appliances, and mechanicals.

Guidelines are recommendations for improving building performance beyond program requirements. Two examples of recommended Guidelines are:

- Building Shell Guideline 5 – Box sill and band joist surface areas should be insulated with "closed cell" spray foam in the amount needed based on thermal requirements for these areas. This would provide an air barrier/vapor retarder on the inside surface which will aid in air sealing while protecting the building materials from moisture damage.
- Mechanical Guideline 2 – Use multi-stage or modulating heating and air conditioning appliances whenever possible. Use air handlers with ECM blower motors to reduce electrical consumption.

Cash-Back Rewards are available for several of the Guidelines (for example installing windows meeting the ENERGY STAR criteria the builder receives $50).

Program Required Site Visits

Consultants with the Wisconsin ENERGY STAR Homes Program work with the Builder Partners and their trades contractors during the construction process to ensure Program Standards are followed for certification. For experienced program builders 2 site visits are required for certification while 3 site visits are required for new program builders (three or fewer certified homes). All homes receiving certification are tested; there is sampling. The three site visits are timed with the following three stages of construction:

- Site Visit 1 – The first visit by the Consultant occurs after rough framing is complete and the heating, plumbing, electrical, and duct systems are roughed-in. This visit must be completed prior to the installation of insulation and drywall. The Consultant and Builder Partner look for leakage areas between the conditioned space of the home and unconditioned space. This process ensures compliance with the national Thermal Bypass Checklist.
- Site Visit 2 – The second site visit occurs after insulation is installed but prior to drywall installation. The Consultant and Builder Partner look for areas where insulation will not achieve its rated R-value due to installation practices that produce gaps, voids, compressions, and misalignment with the air barrier. The consultant and builder review the continuity of the exterior weather barrier and interior vapor retarder, especially when the vapor retarder is also used as the primary air barrier.
- Site Visit 3 – This is the testing site visit after the home is finished. The Consultant and the Builder Partner complete a final on-site review of the home. A blower door test is conducted to quantify the air tightness of the building shell for compliance with Standard 1A. Any required duct testing will be completed while the blower door is set up. All ventilation equipment will be tested to verify compliance with Standards 1AQ and 2AQ.

Performance Measure

Wisconsin ENERGY STAR Homes has established a building tightness requirement which specifies the home must be tested to be at or below a leakage ratio of 0.25 CFM50/square foot of building shell area to meet Standard 1A. This measure is also known as the Minneapolis

Leakage Ratio. The ratio provides a normalized standard for measuring a building's leakage on a per unit area basis. An existing wood frame house might have a leakage ratio of 1.0 prior to air sealing and a ratio between 0.5 to 1.0 range after air sealing (The Energy Conservatory 2008).

As part of the certification process, the CFM50 measurements and shell areas are recorded in the Program's database. The Program has over 13,000 data points spanning 10 years to track trends in air tightness of the certified homes. On an annual basis, Figure 8 shows the trends of the leakage ratio. The overall shape of the annual curves move from a distribution heavily skewed to the right for the first years of the Program, more bell shaped for 2005 and 2006, and skewed to the left for 2008 and 2009. This trend in the distribution of the leakage ratios indicates that the Program certified homes are increasing in their air tightness and more are approaching the lower limit. In the Program's history 20 homes achieved the lower limit leakage ratio of between 0.03 and 0.04 CFM50/square foot with 7 of those homes in 2009. During the last 10 years 28 Homes achieved the next lowest interval 0.04 – 0.05 CFM50/square foot with 10 occurrences in 2009.

The average annual leakage ratio, Figure 9, show a steady decrease for the last 5 years. The first 5 years of the Program indicate fluctuations in the average annual leakage ratio. The fluctuations and tight grouping for the first five years might be explained by the lower number of certifications per year, slow adoption of the Program by builders, and a learning curve in how to make homes more air tight. A steady decrease in the annual leakage ratio is apparent in Figure 10. A linear regression of the annual leakage ratios indicates a .0034 CFM50/square foot reduction per year.

Drivers of Performance

Over the last ten years we have gathered documentation illustrating a steady decrease in the leakage ratio of Wisconsin ENERGY STAR Homes certified homes. Our Builder Partners and Consultants have identified three areas that have driven the increase in performance: customers, forces internal to the builder's company and forces external between builders. These categories are the summary of many conversations with the Program's Builder Partners and Consultants. The responses cut across the builder's volume or experience. Several builders mentioned all three categories, while others discussed the importance to their business of only one of the categories.

Our Builder Partners believe in the performance aspect of the homes they build because they see the difference in the final product firsthand, it differentiates their business from the competition, and helps with marketing to prospective customers.

Figure 8. Comparison of Leakage Ratios for Wisconsin ENERGY STAR Homes Certifications on an Annual Basis

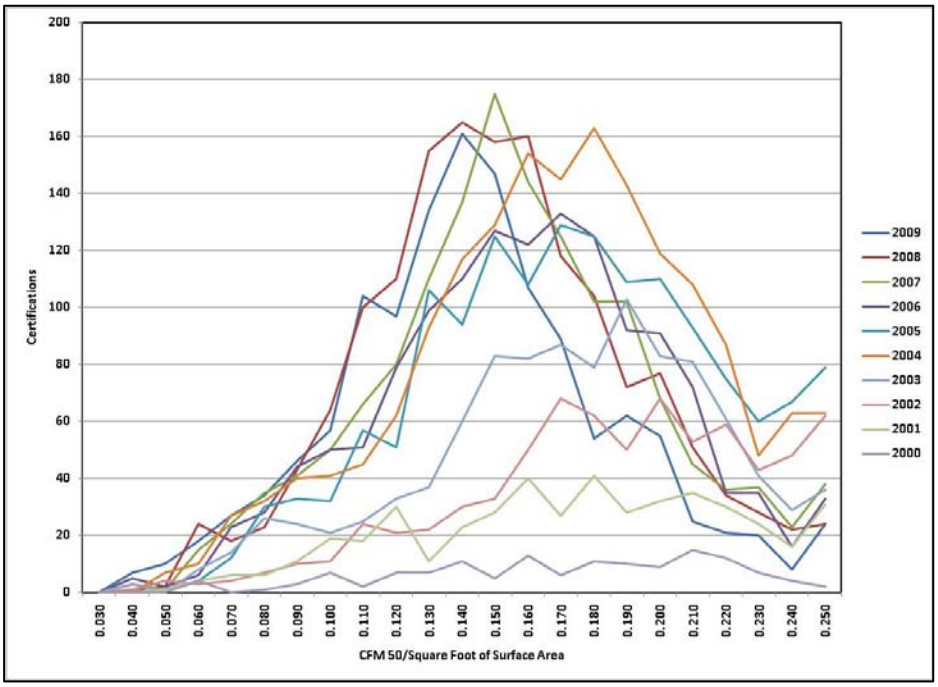


Figure 9. Comparison of Average Leakage Ratios for Wisconsin ENERGY STAR Homes Certifications on an Annual Basis

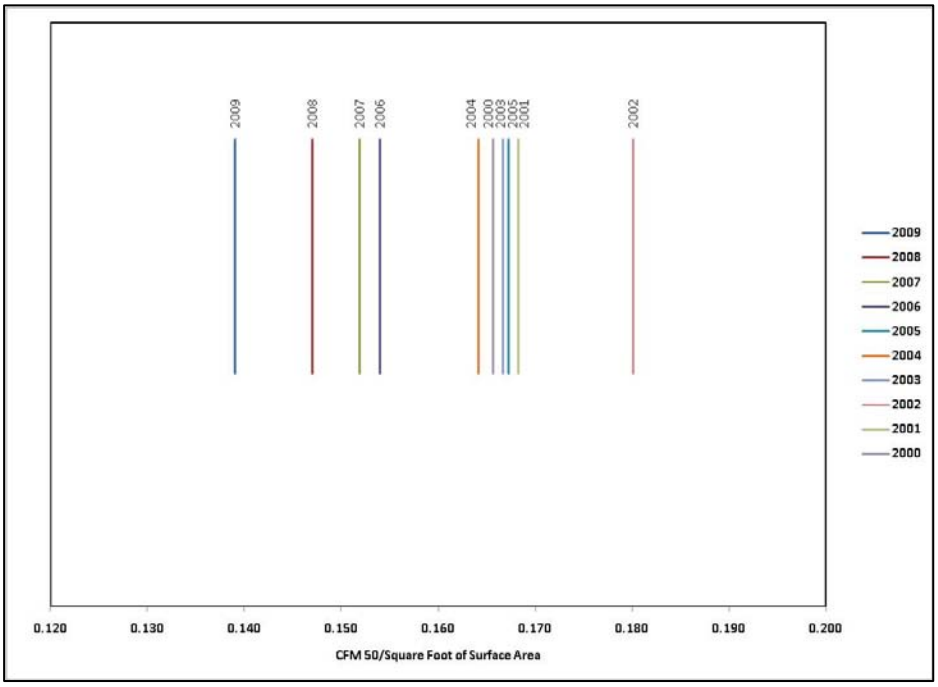
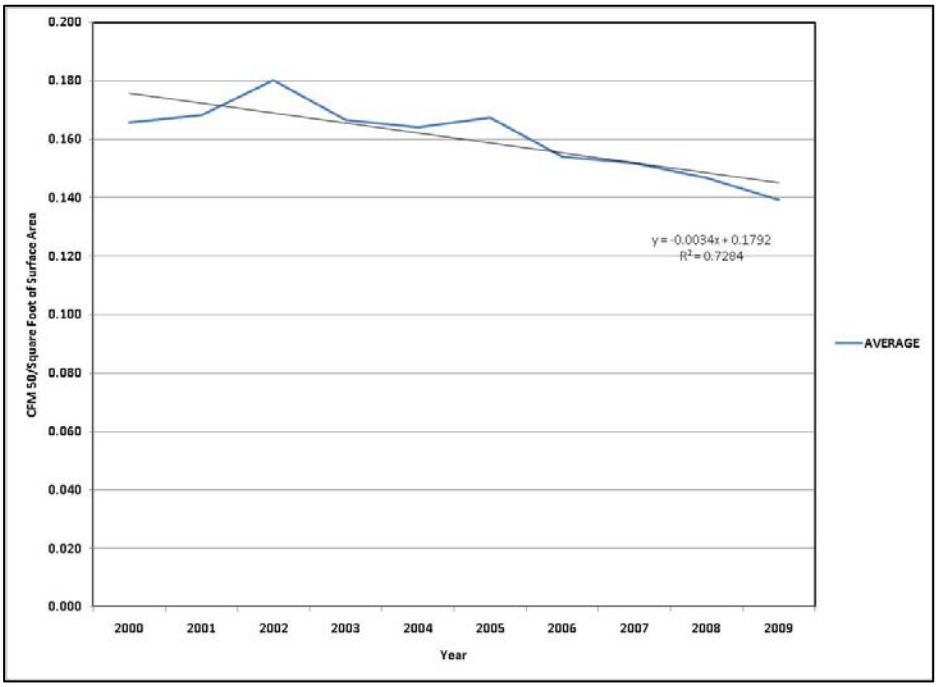


Figure 10. Comparison of Average Leakage Ratios for Wisconsin ENERGY STAR Homes Certifications on an Annual Basis and Linear Regression of the Decrease



Customer

One of the hallmarks of the Wisconsin ENERGY STAR Homes Program is the value that customers place on a certified home. A Builder Partner will explain to the potential homeowner that a certified home will provide the following features and benefits:

- Tested ventilation equipment for better control of indoor air quality and comfort
- Tested spot ventilation for managing moisture, odor and condensation
- Enhance combustion safety and building durability
- Lower energy bills

The builder will also explain that a home certified by the Wisconsin ENERGY STAR Home Program was designed, built, and tested for exceptional performance. A builder explains to a customer in easy to understand terms and concepts why performance is so important for Wisconsin ENERGY STAR Home certification. The basis of performance is air tightness and proper ventilation which is measurable. Having a high performance home will save the customer by decreasing their energy usage and therefore decreasing their monthly utility bill. Many of our Builder Partners provide to their customers a copy of the Consultant's report which includes the blower door results for air tightness. Several of Builder Partners arrange for the new homeowner to attend the Consultant's final site visit to see firsthand the actual testing process and results.

Internal - Builder's Company

Most Builder Partners report that their driver to a performance home is self improvement. Once a builder understands the principles behind a high performance home they strive for

continuous improvement and better results. An additional aspect of self improvement is maintaining the same building cost while increasing performance. Many Builder Partners report that the actual cost of materials and labor for certification is minimal compared to their prior building practices.

A Builder Partner who routinely builds homes that achieve the lowest leakage ratio reports that his three crew leads compete to see who can build the "tightest house." Competition is encouraged because the result is a high performance home.

External - Between Builders

Our Builder Partners are very competitive by their nature and by the homebuilding industry in which they work. On an annual basis in January, after entering all the previous year's certifications, we receive calls from half a dozen builders inquiring if they built the "tightest" home for the past year. For the past five years seven Builder Partners achieved the "Tightest Builder Award" for lowest CFM@50 and lowest leakage ratio. The builders that achieve this status use it for bragging rights with other Program Builder Partners. Also, they use their achievement as a marketing point when talking with potential customers that they build the "tightest home in Wisconsin."

Summary

The cornerstone of Focus on Energy's Wisconsin ENERGY STAR Homes Program is a practical and climate specific performance standard for new homes. Performance is measured by the air tightness of the home and its leakage ratio. With over 13,000 homes certified to Program standards in the past ten years a decrease of 0.0034 CFM50/square foot/year was observed. Our Builder Partners and Consultants have identified three areas that have driven the increase in performance: customers, forces internal to the builder's company and forces external between builders.

References

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