

Energy Efficient Lighting in ENERGY STAR® Homes: It Just Keeps Getting Better

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ABSTRACT

Gone is the twenty-dollar, what felt like forty-pound compact fluorescent lamp (CFL) and the humming and flickering, blue/green radiating, overhead fixture. Also gone are the days of builders refusing to install energy-efficient lighting in their new homes. Energy-efficient lighting technology has made enormous strides in pleasing the marketplace with attractive and dependable fluorescent lighting fixtures and bulbs, and ENERGY STAR builders are now happy to have them in their homes. This paper will explore the evolution of energy-efficient lighting technology and the strategies and incentives used by ENERGY STAR Home programs in Massachusetts, Rhode Island and New Hampshire to achieve a high penetration of energy-efficient lighting.

When ENERGY STAR-labeled hard-wired fixtures were introduced to the new construction market they lacked the style and sophistication builders were seeking. Affordable housing developers grabbed at the opportunity for rebates but were sometimes disappointed with light quality and reliability. Now high-quality and stylish fixtures are available and standards have evolved to improve reliability, light quality and durability.

Screw-base CFLs, once expensive and cumbersome, are now being installed in over 70% of the sockets in new certified ENERGY STAR Homes in Massachusetts, Rhode Island and New Hampshire under a direct install approach; almost 40,000 CFLs were installed in 2005. The success of the bulb program reflects the ease of installation and wide choice of bulbs. Energy-efficient lamps for recessed cans are now so similar in appearance to standard lamps that most people cannot tell them apart, and dimmable versions are helping fill a major market need.

Introduction

The ENERGY STAR Homes lighting program was implemented in Massachusetts and Rhode Island in 1999. One of the goals of the program for the year 2000 was to create a builder-friendly catalog of qualified ENERGY STAR hard-wired lighting fixtures that would allow the builder to easily select products for current projects and take advantage of the utility funded fixture rebates, which were substantial at that time—up to \$500 per housing unit. After the catalog was created and distributed, builders were not always pleased with the selection of the basic utilitarian-type fixtures and limited decorative fixtures, which were sometimes problematic after installation. Faulty ballasts, overheating, long lead times, lack of selection, flickering start-

ups and customer dissatisfaction were some of the issues that spurred the program to look at alternative energy-efficient lighting measures.

In early 2001 discussions about the evolution of the screw-base compact fluorescent bulb began. Builders were saying they did not want to install hard-wired CFL fixtures in their homes. Offering CFL bulbs was a way for builders to keep their selected incandescent fixtures and still make them energy efficient. Over the years, CFL bulbs had become smaller, more efficient, less expensive, and many had earned the ENERGY STAR label. Utility residential retrofit programs were installing CFLs in many homes and utility residential lighting programs were promoting awareness of CFLs, offering rebates on energy-efficient lighting products and subsidizing the pricing of many CFL products. Home improvement stores were starting to market CFLs heavily and they were selling.

The Joint Management Committee (JMC) decided to introduce a pilot program that would install CFL bulbs in existing incandescent fixtures in completed ENERGY STAR Homes.¹ Builders were more willing to allow CFLs into their homes because it does not require an electrician (and resulting high costs) to remove a CFL if the homeowner is dissatisfied. The pilot was successful and the Bulb Install Program continues to be a success, installing an increasing number of CFL bulbs each year. Also, home improvement stores continue to be a primary source of products for homeowners installing CFL bulbs and fixtures on their own. A recent survey of Massachusetts households found 59% of CFL purchasers and 43% of energy-efficient fixture purchasers buy these products at home improvement stores. (NMR 2006, 3)

This paper addresses the evolution of both fixture and bulb technologies, where the lighting market is headed and how the anticipated market transformation will find a place for both innovations. Barriers still exist with builder acceptance, product quality and perception. However, fluorescent lighting technology is more widely accepted by the market and the design community than ever before. Because of the existence of energy-efficiency programs and the ever increasing need for conservation measures, fluorescent lighting is not a latest trend but a permanent course of action in all types of building and renovation.

Laws, product standards and home energy rating systems are being rewritten to incorporate new and improved energy-efficient lighting technology. Beginning in 2005 the State of California Title 24 building standards mandate dedicated high-efficiency luminaires for almost all rooms in newly constructed or remodeled residential buildings. Independent research laboratories like Program for Evaluation and Analysis of Residential Lighting products (PEARL) and Pacific Northwest National Laboratories (PNNL) are testing both hard-wired fixtures and bulbs for ENERGY STAR criteria and product efficacy. The EPA's ENERGY STAR-standard has been revised to insure more efficient and better quality fixtures by instituting the following requirements among others (EPA 2003):

- Reduction of the color variance among rated fixtures
- Improvement in the lumen depreciation over the life of the lamp
- Implementation of accessible and replaceable ballasts

¹ Administration of the Massachusetts ENERGY STAR Homes Program is handled through the Joint Management Committee (JMC), a consortium of electric and gas utilities and energy service providers sponsoring the ENERGY STAR Homes program. JMC meetings are held monthly, led by the implementation contractor, and are attended by program implementers, evaluators, and non utility party consultants. Sponsoring utilities and energy efficiency service providers include: Bay State Gas, Berkshire Gas, Cape Light Compact, Keyspan Energy Delivery, Massachusetts Electric, Nantucket Electric, Narragansett Electric, New England Gas, NSTAR Electric, NSTAR Gas, Unitil, and Western Massachusetts Electric.

- Elimination of the less efficient magnetic ballasts and requirement of electronic ballasts for both interior and exterior fixtures other than HID

The Bulb Install Program

In an effort to gain additional electrical savings from the existing ENERGY STAR new homes program the Massachusetts JMC implemented and funded the Bulb Install Program in 2002. Installing as many as needed per home the JMC has tracked and continues to track the average number of bulbs installed per unit and the percentage of sockets fitted with CFLs. In 2002 the Bulb Install Program was introduced as a pilot in Massachusetts and by year end became a full scale program. It was expanded to include Rhode Island in 2003 and New Hampshire in 2005. By focusing on CFLs rather than hard-wired fixtures the Bulb Install Program reduced builder resistance to installing energy-efficient lighting and has been able to achieve a high penetration of CFLs in participating homes. To date, more than 85,000 CFLs have been installed in more than 4,600 homes through the program. The average number of CFLs installed in homes participating in the 2005 Bulb Install Program was 18.9. (In addition, an average of 7.9 ENERGY STAR hard-wired fixtures was installed in low income housing units taking advantage of rebates available for ENERGY STAR hard-wired fixtures.)

Only ENERGY STAR rated CFLs are chosen for the Bulb Program to ensure efficiency and customer satisfaction. Furthermore, the Program gives preference to bulbs that are tested by either PEARL or PNNL, two separate third party labs with different funding, and most of the bulbs installed through the Program are known for lasting longer than their projected life expectancy ratings. The cost difference between these tested bulbs and potentially lower quality bulbs is minimal—possibly 25 cents to \$1.00 for a higher quality, longer lasting bulb. The Program believes it is worthwhile to spend a little more for higher quality and longer life CFLs. Homeowner satisfaction with the CFLs installed through the program is high. Surveys in 2003 and 2004 of new ENERGY STAR home buyers in Massachusetts found homeowners remove very few ENERGY STAR hard-wired fixtures or CFLs: removal rates were 4% for hard-wired fixtures and 1% for CFLs in 2003, and 2% for hard-wired fixtures and 2% for CFLs in 2004. (NMR et al. 2005, 100)

ENERGY STAR Homes Project Coordinators who install the CFLs are awarded incentives of \$1 per unit installed, which has helped drive the program's success. In 2005 the program introduced a two year warranty on CFLs. End users simply call a toll free number for CFL replacement if they have any problem with the installed products. The call line is getting only one or two calls per month at the most. The goal is to transform the market and to maximize electrical savings by proving that using CFLs is both environmentally sound and cost effective as well as more convenient for the end user, with less frequent bulb changes and the added benefit of electrical savings.

With the addition last year of a dimmable reflector CFL, the opportunity for outfitting recessed down lighting was realized. CFLs continue to improve in light quality and brightness as well as proper fit in many of today's popular fixtures. Brad Steele, President of Energy Federation Inc. (EFI), a national wholesale supplier of energy-efficient and resource-conserving products and a key supplier of the Northeast region's efficient-lighting programs knows first hand about the growth in lighting technology and customer satisfaction. "Efficacies have improved about 10-12% in the past five years or so. Formerly it might be difficult to get a 15 watt bulb with 850 or so initial lumens into a ceiling or wall fixture with limited clearance/space,

and now there are 13-15 watt mini-spirals with 900-1,050 initial lumens. On the other end, one might fit a 23 watt CFL into a table lamp, getting 1,350 lumens (really 15%-20% less bright than a 100 watt incandescent). Now a 30 watt spiral is a better, easier fit, and will produce over 1,600 lumens after 12,000 hours of use! A recent Lighting Research Center (LRC) National Lighting Product Information Program (NLPIP) report, as well as some third party test results of CFL products EFI has received from manufacturers, shows that most CFLs not only are making their rated lifetimes (with 3 hour cycles) but are going well beyond those lifetimes, lasting 12,000, 15,000, and 18,000 hours, and in some cases, even 25,000 hours. The cost benefit ratios of bulbs costing dramatically less than they formerly did, and lasting perhaps longer on average than they were thought to last, should be making initiatives such as the JMC's one of great interest to energy efficiency programs and providers around the country." (Steele 2006)

Figure 1 shows how CFL bulbs have changed over time. The early bulb is one of the first commercial CFL bulbs sold by Westinghouse in 1981; the early bulbs claimed 40 to 50 lumens per watt. The current bulb is a 13 watt, 800 lumens (62 lumens per watt) mini twist by Feit Electric that replaces a 60 watt incandescent bulb.

Figure 1. Example of an Early and a Current CFL Bulb



Westinghouse Econ-Nova®

Feit Electric Mini Twist

Figure 2 is an example of marketing materials used to tell occupants of ENERGY STAR housing units participating in the Bulb Install Program about the energy-efficient lighting installed in their home.

Figure 2. Information Sheet for Occupants of Homes Participating in the Bulb Install Program

Energy STAR HOMES

LIGHT BULB GUIDE

Congratulations on your new ENERGY STAR® home!

To help lower your energy costs, ENERGY STAR compact fluorescent light bulbs (CFLs) have been installed in some of the light fixtures in your home.

These bulbs use approximately 1/3 as much electricity, last up to 10 times longer, and produce an equivalent amount of light as standard incandescent bulbs. ENERGY STAR rated bulbs were selected for use in your home because of their high quality, warm and pleasing light, and their performance guarantee. All without sacrificing aesthetics.

If you wish to order more ENERGY STAR bulbs, please call us at 877-516-1317. We fully guarantee the installed bulbs for two years.

ABOUT YOUR BULBS

- ENERGY STAR qualified bulbs are designed to have the same color temperature and comparable color rendering as regular incandescent light bulbs, while using only about 30% as much electricity.
- ENERGY STAR CFLs, like incandescent bulbs, come in a variety of wattages, shapes and sizes. We have selected a variety of the most appropriate high quality bulbs for your home's needs — for example, using reflectors in recessed or downlight fixtures.
- If you elect to move any of the installed CFLs from one fixture to another, be advised that **only dimmable CFLs should be used in fixtures controlled by dimming switches, and only three-way bulbs should be used in fixtures with three-way sockets.**
- Many CFLs can be used in outdoor fixtures as long as they are protected from moisture.
- The best use of ENERGY STAR compact fluorescent lights is in fixtures that are on several hours or more per day or those located in hard to reach places.

BULB GUARANTEE

We guarantee your satisfaction. If you are unhappy with any of the ENERGY STAR bulbs that have been installed in your home, or if any of them fail within two years, please call 877-516-1317. We will ship you a replacement product at no charge, and if necessary, make a visit to your home to ensure your satisfaction.

ENERGY STAR Homes • 800-628-8413 • www.energystarhomes.com

Source: JMC Marketing Material from Conservation Services Group

Overcoming Barriers

Although we are not all the way there, we have overcome many barriers. Builder resistance has been a factor from the beginning. Any new procedure is always hard to sell, even if it is free. Builders have feared callbacks from clients dissatisfied with the products, but with the addition of a hassle-free bulb replacement warranty homeowners and builders have become more receptive.

Of course every builder is different and some may never be swayed. At one end of the spectrum there are builders so enthusiastic and so committed to doing the right thing that they have installed energy-efficient lighting in their homes for years. Indian Hill Development in Worcester, Massachusetts is an example. They have consistently touted ENERGY STAR in all of their marketing materials and installed hard-wired ENERGY STAR fixtures in all of their homes. Even when the utility rebates for fixtures in single family homes were eliminated they continued to install ENERGY STAR fixtures. They are featured in a case study available on the ENERGY STAR website (EPA 2006). This is the true goal of market transformation—voluntary change without rebates.

At the other end of the spectrum, a large higher-end builder that consistently resisted installing any form of energy-efficient lighting for several years has recently agreed to install CFL bulbs in the fixtures they supply to the homeowner, namely recessed cans and exterior fixtures. Energy savings in their model homes, along with improved technology and the replacement warranty, were key factors in turning them around.

Custom builders tend to hire lighting designers who do not always encourage the use of energy-efficient technology, but gravitate towards latest trends and particular lamp types such as halogen and MR16s, what one Massachusetts lighting designer describes as “sparkle.” “The demand is just not there yet. Some customers are looking for a particular look and are not willing to compromise style for energy efficiency. The higher wattage lamps have come a long way and though the 13 watt CFL did not provide adequate illumination the higher 18 or 26 watt lamp does.” (Atherton 2006) Bulb technology has come a long way, but some gaps remain. Dimmable capability for reflector bulbs in recessed down lights has recently been addressed with some success, but there is room for further improvement. Certain types of fixtures that require smaller candelabra-base bulbs remain as unfitted sockets within the program. Most bulbs are adequate in the amount of light they provide compared to their incandescent equivalents. Although there is still a short waiting time for lamps to come to full brightness the improvement has been significant over the past couple of years and recently a new A lamp that has no delay was introduced.

Fixtures

A place still exists for energy-efficient hard-wired fixtures, especially in affordable housing where permanent efficiency measures are desired and utility sponsored rebates are still offered.² Also, new homes account for a significant share of all hard-wired lighting fixture sales;

² From 2000 through 2002 the Massachusetts and Rhode Island ENERGY STAR Homes Programs offered rebates of up to \$500 for hard-wired fixtures to all ENERGY STAR homes. As of 2003, only low income projects have been eligible for fixture rebates. From 2003 through 2005 rebates of \$50 per fixture, up to \$300 per unit in low income projects were available. In 2006 the rebate level was reduced to \$25 per fixture up to a maximum of \$150 per unit in low income projects.

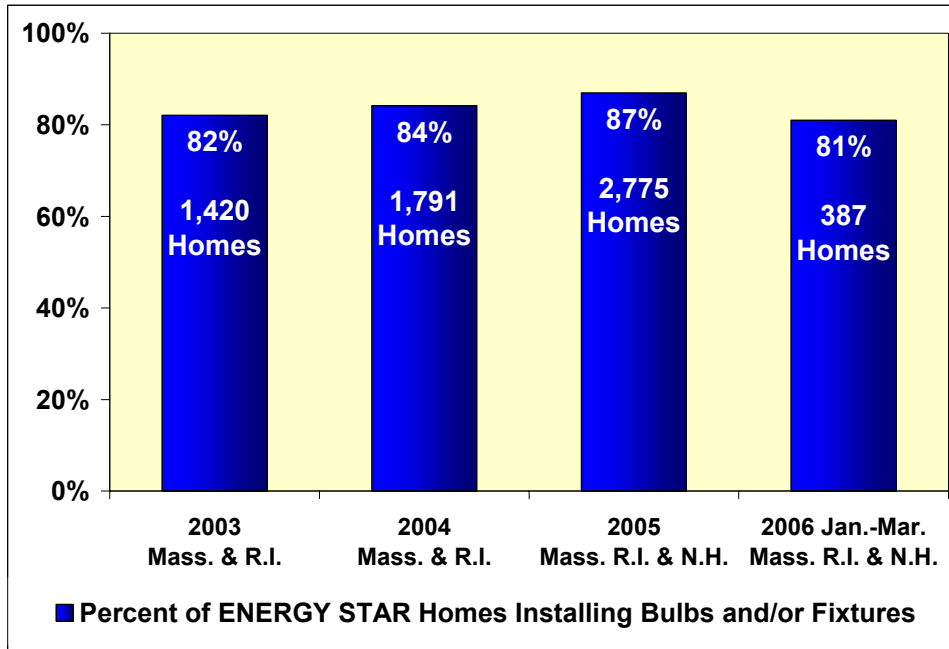
different studies estimate new homes account for 18% (ODC 1998) to over 33% (Ecos Consulting, 2002, 4) of all hard-wired fixture sales. A Massachusetts 2005 Baseline Study of new residential construction practices that included an inventory of lighting fixtures found the average new home has 41 lighting fixtures (NMR & Conant 2006, 55). Obviously, the potential for increasing the use of energy-efficient lighting fixtures in new construction is large. In the Vermont ENERGY STAR Home service an average of 10 energy-efficient fixtures per home were installed in 329 homes in 2003 and an average of 10.5 fixtures in 431 homes in 2004 (Faesy 2006). In 2005 California adopted Title 24 building standards, which require most of the hard-wired fixtures in newly constructed or remodeled residential projects to be high-efficiency luminaires: Screw-base CFLs are not allowed. The United States Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED) For Homes pilot certification program is awarding points in energy efficient lighting technology, with three points for installing the ENERGY STAR Advanced Lighting Package (ALP) and one point for installing CFLs in at least 80% of the light fixtures. Also, the Residential Energy Services Network (RESNET), the official standards-setting body for the national Home Energy Rating System (HERS) recognizes both hard-wired fluorescent fixtures and screw-based CFLs equally for increased HERS scores.

Achievements

The number of CFLs installed in completed ENERGY STAR homes has increased yearly since the inception of the pilot in 2002. To date over 85,000 CFLs have been installed in over 4,600 homes through the program in Massachusetts, Rhode Island and New Hampshire ENERGY STAR homes, with very few warranty calls recorded; one or two calls per month at most since the warranty was implemented. The most popular CFL type has been the one that most replicates a typical incandescent A lamp, followed by the mini spirals. Reflector lamps, both dimming and non-dimming, are gaining momentum. The increasing acceptance of CFL reflector lamps could have a dramatic effect on the market; kitchens are typically the highest energy consuming rooms in the home and commonly have recessed down lighting. Unfitted sockets in participating ENERGY STAR homes are a small percentage and usually reflect either candelabra-base bulbs, for which there is currently no ENERGY STAR qualified CFL alternative, or existing hard-wired fluorescent fixtures already installed by the builder or homeowner.

The number of CFL bulbs installed through the ENERGY STAR Home programs in Massachusetts, Rhode Island and New Hampshire has grown each year, from just under 11,000 in 2003 to almost 40,000 in 2005. As shown in Figure 3, since 2003 over 80% of ENERGY STAR-certified homes have installed ENERGY STAR CFL bulbs and/or hard-wired fixtures.

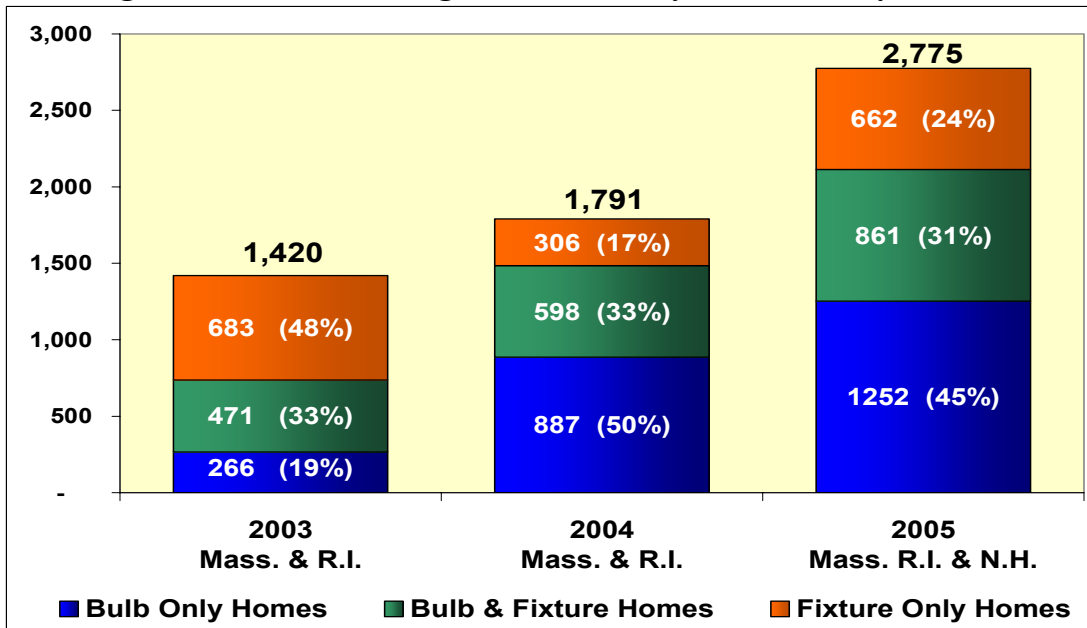
Figure 3. Percent of ENERGY STAR Homes Installing CFL Bulbs or Fixtures



Source: Conservation Services Group ENERGY STAR Home Program tracking data

The number of ENERGY STAR homes installing ENERGY STAR CFL lamps and/or hard-wired fixtures almost doubled from 2003 to 2005. As Figure 4 shows, in all three years roughly one-third of homes installing energy-efficient lighting installed a combination of ENERGY STAR CFL bulbs and hard-wired fixtures. During the same time period, the percentage of homes installing only CFL bulbs more than doubled while the percentage of homes installing only ENERGY STAR fixtures dropped by 50%.

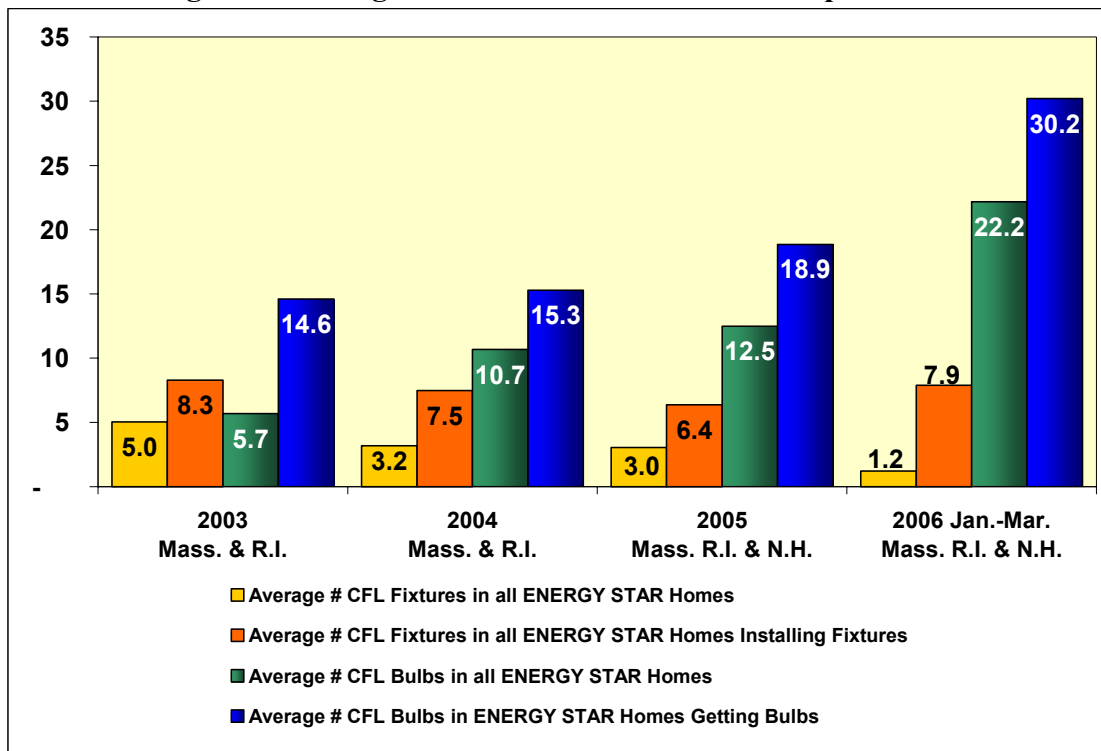
Figure 4. Homes Installing CFL Bulbs Only, Fixtures Only, or Both



Source: Conservation Services Group ENERGY STAR Home Program tracking data

Figure 5 shows the average number of ENERGY STAR CFL bulbs and hard-wired fixtures installed across all ENERGY STAR-certified homes, whether or not they installed CFLs or hard-wired fixtures through the ENERGY STAR Homes Program, and the average number installed in homes participating in the Bulb Install Program or taking advantage of available hard-wired fixture rebates. As shown, the average number of CFL bulbs installed in all ENERGY STAR-certified homes has increased from 5.7 in 2003 to 12.5 in 2005, and is 22.2 in the first quarter of 2006, while the average number of CFL bulbs installed in just the ENERGY STAR-certified homes participating in the Bulb Install Program has grown from 14.6 in 2003 to 18.9 in 2005 and is 30.2 in the first quarter of 2006. During this same period the average number of hard-wired CFL fixtures installed in all ENERGY STAR homes decreased from 5.0 fixtures in 2003 to 3.0 fixtures in 2005, while the average number in housing units taking advantage of program rebates for installing hard-wired fixtures fell from 8.3 in 2003 to 6.4 in 2005. All of these averages are much higher than found in the lighting inventory conducted as part of the Massachusetts 2005 Baseline Study of new residential construction practices and in a recent phone survey of 400 Massachusetts households conducted for the Massachusetts Residential ENERGY STAR Lighting Program.

Figure 5. Average Number of Products Installed per Home



Source: Conservation Services Group ENERGY STAR Home Program tracking data

The Massachusetts 2005 Baseline Study conducted on-site inspections of 144 recently completed non-ENERGY STAR homes throughout the state. The average number of qualifying fixtures in the 144 homes was 1.9 (NMR & Conant 2006, 55).³ Just over one-half of the new homes (51%) had qualifying fixtures and the average number of qualifying fixtures in these homes was 3.7 (NMR & Conant 2006, 55). A random digit dial telephone survey of 400 Massachusetts households conducted in December 2005 and January 2006 for the Massachusetts Residential ENERGY STAR Lighting Program found: “The average household in Massachusetts has approximately four CFLs in use; this translates into nearly seven CFLs in use in the homes where respondents actually report using the bulbs. In contrast, there is less than one [energy-saving] fixture installed in each household in Massachusetts, but an average of four energy-saving fixtures in use in the homes that currently have them.” (NMR 2006, 28)

In March 2005 the ENERGY STAR Home Program began tracking the number of sockets in each home participating in the Bulb Install Program in Massachusetts, Rhode Island and New Hampshire, the number of sockets that could not be fitted with CFLs and the reasons why CFLs could not be installed. From March 2005 through March 2006, almost three-fourths (74%) of all the sockets in ENERGY STAR homes agreeing to participate in the Bulb Install Program were fitted with CFLs: over 42,000 CFL bulbs were installed. The most common reason for not being able to fit the remaining 26% of sockets is that they were already energy-efficient hard-wired CFL fixtures: 50% of unfitted sockets or 13% of all sockets. This means 87% of all sockets in the ENERGY STAR homes participating in the Bulb Install Program are either hard-wired CFL fixtures or are fitted with CFL bulbs.

Reasons why the remaining 13% of all sockets were not, or could not, be fitted with CFL bulbs include homeowners or builders refusing to install CFLs in some sockets, sockets incompatible with CFL bulbs and non recessed can fixtures on dimmer switches.

Today’s Market

Lighting designers are coming around as technology improves. Most will agree that performance problems with early energy-efficient fluorescent lighting products earned them a bad reputation; but that improvements in both form and function have addressed these problems. “It’s time our industry addressed this misperception. State-of-the-art engineering means today’s fluorescent lighting is vastly more advanced and far more desirable than what was available only a decade ago.” (Blackman 2006) In speaking with one of the Massachusetts affordable home developers, she is quite pleased with the improved products. “They are more readily available, have better light quality, are flicker free, and are more attractive.” (Jones 2006) Better fixture style choices and more fashionable and sophisticated products have been and continue to be developed. Seagull Lighting has been a leader in offering ENERGY STAR fixtures and has a website dedicated solely to ENERGY STAR lighting products (www.energystarlights.com). Some of the other manufacturers now offering a selection of products meeting ENERGY STAR criteria include: Quoizel, Hubbardton Forge and Lightolier. Figure 6 shows examples of some of the new ENERGY STAR fixtures available.

³ Qualifying fixtures included fluorescent hard-wired (i.e. pin-based) lamps with ballast, fixtures fitted with screw-in CFLs and fixtures controlled by a photocell and motion sensor.

Figure 6. Examples of New ENERGY STAR Fixtures



Seagull Lighting

Lightolier

Hubbardton Forge

With the improvement in technology comes the added cost of manufacturing as is the case with the electronically ballasted fixtures now a requirement of the ENERGY STAR standard. In some cases this feature doubles the retail cost of a hard-wired fixture, making it unattainable for some affordable housing projects. Also, no one knows how readily available replacement pin base lamps for these fixtures will be when their long expected life comes to an end. If consumers are unable to find replacement pin based lamps, especially for expensive high-end fixtures, it seems reasonable to think they will shy away from purchasing additional hard-wired fixtures. Only time will tell whether or not consumers will consistently replace burned out CFL bulbs with new CFL bulbs, but with continually improving technologies and performance there is no reason to assume they will go back to incandescents.

Whether or not current regional programs call for dedicated hard-wired fixtures or replaceable screw-base bulbs, energy efficient lighting technology can only get better. Like cell phones, as technology evolves products get smaller and in the case of CFL bulbs reductions in size result in more convenient and aesthetically pleasing products. Builders can market both lighting products in model homes, where surveys have shown that viewers preferred energy-efficient technology over incandescent. Seeing is believing and the bottom line is energy savings with both technologies.

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