
# Overall Report
# Vermont Residential New Construction Study

## Final Report
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**Submitted to:**

**Vermont Department of Public Service**

**Submitted by:**

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# Executive Summary

The overall objective of the combined studies covered in this report is to provide the Vermont Department of Public Service (DPS) with residential new construction market assessments and baselines to help identify opportunities for increased energy efficiency in Vermont. This report summarizes the combined findings of a phone survey of 296 homeowners, on-site audits conducted at 106 recently constructed homes across Vermont, and in-depth interviews with 25 builders, nine HVAC contractors and ten insulation contractors.

On-site data collection covered building envelope characteristics, heating and cooling equipment, water heating equipment, heating and cooling system ducts, appliances, and lighting. Blower door and duct blaster tests were conducted in homes where the homeowners agreed to the testing. In addition, homeowners completed a short questionnaire at the time of the audit that included exploring their satisfaction with the thermal comfort of their home and things about their home they would like to or would consider changing.

Participating homes were recruited by RLW staff from homeowners who participated in the telephone survey of 296 owners of newly constructed homes and who said they would be willing to have their home audited. When volunteers from the telephone survey did not provide enough homes in some of the geographically targeted (GT) regions, lists of new residential electric service requests provided by Efficiency Vermont (EVT) and Burlington Electric Department (BED) were used to supplement the survey respondents—these lists yielded eight on-site audits.

Potential bias is a concern in any sample based on voluntary participation. There are many factors that may influence a homeowner's willingness to have their home audited or a builder or subcontractor to agree to being interviewed. There is no clear indication of bias in the samples of surveyed homeowners, audited homes, or interviewed builders. (See Section 2—Potential Sample Bias Addressed for a detailed analysis of potential bias issues.)

All findings in this report are presented at the state level unless otherwise noted. All statistical significant differences are reported at the 90% confidence level. At the 90% confidence level, the homeowner survey provides a sampling error of 4.7% for the state. For the on-site audits, the relative precision is ± 7.8% for state level results. The DPS requested state level information on newly constructed single-family homes located in Vermont plus detailed information for four separate geographic regions. The four geographic regions are three geographically targeted (GT) regions (Northern Chittenden, St. Albans, and Newport/Derby) plus the city of Burlington. Because homes in the GT regions were over sampled, in order to estimate the statewide results we weight the results from the GT regions and the remainder of Vermont by the percent they represent of all new homes in Vermont. (See Section 1.2—Weighting and Precision for more information on how weighting was applied.)

## Results Show Improvement

The energy efficiency of new homes has improved since the last baseline study was conducted in 2002. The sampling approaches for the 2002 and 2008 studies are very similar, which suggests comparing the findings from the two studies presents a realistic picture of changes in

construction practices. The 2002 study used a nested sampling approach, similar to the 2008 study, where potential participants were asked to participate in an on-site audit after completing a telephone survey.[1] It is not clear how comparable the findings of the 1995 study are to either the 2002 or 2008 studies. As described in the 1995 study:

> "As a result of the long time lag between the data collection and this report [1995 baseline study], key information regarding the sampling process was lost. While it is clear that the utilities intended to survey a random sample of new homes, the documentation available in 1998 (three years following the data collection) was inadequate to demonstrate that procedures for random sampling were followed."[2]

Table ES 1 on the next page shows the results of the 1995, 2002 and 2008 Vermont new residential construction baseline studies. As shown, the percentages of homes meeting or exceeding RBES code requirements for wall, ceiling and foundation wall insulation in the current study are all higher than in previous studies. More homes have double pane Low-E or better windows, envelope leakage is lower, and heating systems are more efficient. A higher percentage of homes have CFL bulbs, and the average number of CFL bulbs per home is higher. The percentage of dishwashers that are ENERGY STAR is almost double what it was in 2002. The percentages of refrigerators and clothes washers that are ENERGY STAR are only slightly higher than in 2002. (Please note that throughout this report the percentages of ENERGY STAR appliances reported are likely conservative estimates.[3]) One thing that has not improved is that some homes are still installing tankless coil water heating. (See Appendix B—1995, 2002 and 2008 Baseline Studies for detailed tables comparing study findings.)

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[1] *Vermont Residential New Construction 2002: Baseline Construction Practices, Code Compliance, and Energy Efficiency.* Prepared by West Hill Energy & Computing, Inc. for The Vermont Department of Public Service. January 2, 2003.

[2] *Report on the 1995 Vermont Residential New Construction Baseline Data.* Prepared by West Hill Energy and Computing for The Vermont Department of Public Service. October 21, 1999. (page 2)

[3] Auditors recorded the ENERGY STAR status and model numbers for appliances during the on-site audits; the ENERGY STAR status of these models was validated at http://www.energystar.gov/index.cfm?c=appliances.pr_appliances, the ENERGY STAR website. Model numbers have a variety of configurations (due to differing colors, features, etc) and an exact match is required to positively identify a model as ENERGY STAR. In addition, model numbers are not always visible on appliances; for these units, we relied on the auditor's original designation of ENERGY STAR status. For these reasons, the percent of ENERGY STAR units reported is likely a conservative estimate, particularly when compared to the prior study that measured the ENERGY STAR percentage using only those units with known models numbers.

**Table ES 1: Comparison of 1995, 2002 and 2008 Results**

| Feature | Vermont 1995 Baseline (n=151)* | Vermont 2002 Baseline (n=158)* | Vermont 2008 Baseline (n=106)* |
|---|---|---|---|
| **Flat Ceiling Insulation Meets or Exceeds Code Requirements (R-38)** | 62% | 68% | **74%** |
| **Sloped/Cathedral Ceiling Insulation Meets or Exceeds Code Requirements (R-30)** | 65% | 64% | **80%** |
| **Conditioned/Ambient Wall Insulation Meets or Exceeds Code Requirements (R-19)** | n/a | 90% | **95%** |
| **Below Grade Basement Wall Insulation Meets or Exceeds Code Requirements (R-10)** | 48% | 62% | **73%** |
| **Percent Glazing Area Double Pane Low-E or Better** | 70% | 80% | **94%** |
| **Average Percent Glazing Area (window to wall ratio)** | n/a | 14% | **13%** |
| **Average Natural Air Changes Per Hour (ACHnat)** | 0.45 | 0.31 | **0.28** |
| **Average AFUE of Central Heating System** | n/a | 85.0 | **87.8** |
| **Percent of Homes with Tankless Coil Water Heating** | 32% | 3% | 5% |
| **Percent of Homes with CFL Bulbs** | ≈33% | 47% | **81%** |
| **Average Number of CFL Bulbs per Home** | n/a | 3.0 | **14.2** |
| **Percent ENERGY STAR Refrigerators** | n/a | 27% | **30%** |
| **Percent ENERGY STAR Dishwashers** | n/a | 36% | **69%** |
| **Percent ENERGY STAR Clothes washers** | n/a | 47% | **48%** |

*The numbers of homes are the total number of homes in the study. Not all homes have all features; therefore, the numbers of homes with specific features vary. (Sample sizes for the 2002 study range from 113 homes with sloped ceilings to 158 homes with wall and CFL data; sample sizes for the 2008 study range from 55 homes with sloped ceilings to 125 refrigerators; sample sizes for the 1995 study are not known for all individual features.)

## Room for Further Improvement

Looking at study results from a different perspective shows opportunities for further improving the energy efficiency of new home construction in Vermont. Table ES 2: Areas with Room for ImprovementTable ES 2 on the next page, presents combined targeted region, remainder of Vermont, and state level results. Table ES 2 shows that, at the state level, 26% of homes with flat ceilings have less than R-38 insulation, 20% of homes with cathedral ceilings have less than R-30 insulation, 17% of homes have no foundation wall insulation and an additional 15% of homes have foundation wall insulation that does not meet RBES code requirements, almost one-half of the homes with slabs do not meet RBES code insulation requirements, and one-third of tested homes have envelope leakage exceeding 0.35 natural air changes per hour (ACHnat). Almost one-fifth (19%) of homes do not have any CFL bulbs installed and, based on this study's likely conservative estimates of ENERGY STAR appliance penetrations, there is ample room to increase the penetration of ENERGY STAR appliances in new homes. In most cases there is little difference between targeted region and remainder of Vermont results. This is not surprising. Program staff verified that the Vermont ENERGY STAR Homes Program (VESH) has not

conducted any special marketing in the geographically targeted regions and that the incentives available in the targeted regions are the same as in the rest of the state.

**Table ES 2: Areas with Room for Improvement**

| Areas with Room For Improvement | Targeted Regions (n=34)* | Remainder of Vermont (n=60)* | State Weighted Data (n=106)* |
|---|---|---|---|
| **Flat Ceiling Insulation Fails to Meet Code (R-38)** | 24% | 27% | 26% |
| **Sloped/Cathedral Ceiling Insulation Fails to Meet Code (R-30)** | 20% | 20% | 20% |
| **No Foundation Wall Insulation** | 9% | 19% | 17% |
| **Average Foundation Wall Insulation Below Code (R-10 or R-19)** | 15% | 15% | 15% |
| **Slab Insulation Fails to Meet Code (R-10)** | 57% | 43% | 46% |
| **Air Infiltration—ACHnat Greater than 0.35** | **10%**** | **39%**** | 33% |
| **Percent of Homes with No Screw-in or Pin-based CFL Bulbs** | 15% | 20% | 19% |
| **Percent Non-ENERGY STAR Refrigerators** | 67% | 71% | 70% |
| **Percent Non- ENERGY STAR Dishwashers** | 34% | 29% | 31% |
| **Percent Non-ENERGY STAR Clothes washers** | 57% | 50% | 52% |

*The numbers of homes are the total number of homes in the study. Not all homes have all features; therefore, the numbers of homes with specific features vary. (Sample sizes for the combined GT regions range from 15 homes with sloped ceilings to 45 refrigerators; sample sizes for the remainder of Vermont range from 40 homes with sloped ceilings to 80 refrigerators; sample sizes for the state range from 55 homes with sloped ceilings to 125 refrigerators.)

**Significantly different at the 90% confidence level.

## ENERGY STAR and Non-ENERGY STAR Homes Compared

The VESH Program has been in place for several years. As of May 2009, EVT's website lists over 300 builders and developers who have built at least one ENERGY STAR-certified home since May 1997 and have collectively built more than 6,000 ENERGY STAR-certified homes in Vermont.[4] Assuming the VESH Program has been successful in encouraging builders to build more energy-efficient homes and providing the training and support they need to build ENERGY STAR-certified homes, we would expect to see measurable differences between ENERGY STAR and non-ENERGY STAR homes. Table ES 3 on the following page shows that the audited ENERGY STAR homes do tend to be more energy efficient and incorporate more energy-efficient materials than the audited non-ENERGY STAR homes, and that the differences in most cases are significant at the 90% confidence level.

Compared to non-ENERGY STAR homes, ENERGY STAR homes have higher average levels of wall and ceiling insulation, are more likely to have something other than fiberglass batt

[4] http://www.efficiencyvermont.com/stella/filelib/VESH%20Builders%20List.pdf

insulation, and more likely to have foundation walls insulated to RBES code requirements. ENERGY STAR homes have, on average, more energy-efficient windows, lower air infiltration measured in both ACHnat and total CFM50 leakage, and higher AFUE heating systems. ENERGY STAR homes are also much more likely to have programmable thermostats. These differences between ENERGY STAR and non-ENERGY STAR homes suggest that EVT has been successful in helping participating builders build more energy-efficient homes. Rising energy costs together with the currently depressed, and thus more competitive, new single-family housing market[5] may present a good opportunity for Vermont to reach out to builders who want to learn how to increase their competitiveness by incorporating cost-effective, energy-efficient construction practices.

**Table ES 3: ENERGY STAR and Non-ENERGY STAR Homes**

| Areas Where ENERGY STAR Homes are More Efficient than Non-ENERGY STAR Homes | Non-ENERGY STAR Homes (n=76)* | ENERGY STAR Homes (n=30)* |
|---|---|---|
| Average Conditioned/Ambient Wall Insulation R-value | R-20** | R-25** |
| Non-Fiberglass Batt Wall Insulation | 20%** | 47%** |
| Average Flat Ceiling Insulation R-value | R-36** | R-44** |
| Non-Fiberglass Batt Flat Ceiling Insulation | 52%** | 89%** |
| Average Cathedral ceiling Insulation R-value | R-32** | R-40** |
| Non-Fiberglass Batt Cathedral Ceiling Insulation | 53% | 80% |
| All Foundation Walls Insulated to Code | 68% | 75% |
| Average Window U-value | U-0.35** | U-0.33** |
| Air Infiltration—Average ACHnat | 0.29** | 0.23** |
| Air Infiltration—Total CFM50 | 1,702** | 1,212** |
| Average Heating System AFUE | 87.1** | 89.9** |
| Average Gas Boiler AFUE | 87.8 | 89.5 |
| Have Programmable Thermostat | 25%** | 50%** |

*The numbers of homes are the total number of homes in the study. Not all homes have all features; therefore, the numbers of homes with specific features vary. (Sample sizes for non-ENERGY STAR homes range from 32 homes with gas boilers to 76 homes with wall insulation data; sample sizes for ENERGY STAR homes range from 15 homes with sloped ceilings to 30 homes with wall insulation data information.)

**Significantly different at the 90% confidence level.

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It is important to note that some of the audited non-ENERGY STAR homes are very energy-efficient. Several non-ENERGY STAR homes have SIPS wall construction and one has triple pane Low-E with argon windows; seven of the eight highest efficiency gas boilers (AFUES of 95.0 or higher) are in non-ENERGY STAR homes. Also, some ENERGY STAR builders do not

[5] The number of single-family permits issued in Vermont in 2007 was 24% lower than in 2006, and permits issued in the first six months of 2008 were down 36% from the same period in 2007. http://www.census.gov/const/www/C40/table2.html

have all their homes certified; in some cases they leave it up to the homeowner to decide whether or not to seek ENERGY STAR certification. Interviewed ENERGY STAR builders say they build the same home whether or not the homeowner decides to have it certified.

## Builder Interview Findings

The 25 interviewed builders are a diverse group serving diverse markets. There are builders who built one or two homes in 2007 and builders who built 14 or 15 homes. There are modular and stick-built-home builders, custom- and spec-home builders, ENERGY STAR and non-ENERGY STAR builders, builders who serve the first-time homebuyer market and builders who serve the multi-million dollar custom and vacation home market. Some builders sub all their work out and/or hire part-time help as needed; some have full-time staff. Some builders do no advertising except maybe a sign on their truck—all their business comes from word-of-mouth—while other builders have sophisticated websites.

EVT was able to verify that 19 of the 20 interviewed builders who said that they have built ENERGY STAR homes have completed at least one home that met all the requirements for certification through either the VESH or EPA ENERGY STAR Homes programs. EVT also verified that 33% of the 123 homes built by interviewed builders in 2007 are ENERGY STAR qualified. This percentage of ENERGY STAR homes may seem high, but EPA reports the penetration of single-family ENERGY STAR homes in Vermont was 27% in 2007 and 33% in 2008.[6]

**Audited Homes Built by Interviewed Builders vs. Non-interviewed Builders.** A comparison of the 26 audited homes built by 19 interviewed builders to the 80 audited homes built by non-interviewed builders shows that the overall efficiency of the homes is not that different . Homes built by interviewed builders have a significantly higher average wall insulation R-value; differences in ceiling insulation levels, below grade foundation wall insulation levels, and the percentage of homes exceeding RBES code requirements for ceiling and foundation wall insulation levels are not statistically significant. Differences in natural air changes per hour (ACHnat), the percentages of homes with ENERGY STAR windows, and the percentage of gas boilers, oil boilers, and gas furnaces that are ENERGY STAR are not significant. Differences in the average number of CFLs installed per home and the proportion of total bulbs that are CFLs are not significant. (See Section 2.4—Builder Sample for more detail.) This suggests that the sample of interviewed builders is not severely biased toward better-than-average builders.

**Differences Between Sub-groups of Builders.** An assessment of differences between interviewed builders grouped by the number or type of homes they built in 2007, the price and size of homes they built, their experience building ENERGY STAR homes, how they market energy efficiency, and their concentration on new residential construction showed some statistically significant differences. However, the sample sizes are small and, in most cases, the characteristics of the individual builders in any one sub-group category vary considerably. For example, builders of one or two homes in 2007 include builders with from one to 18 employees

[6] http://www.energystar.gov/index.cfm?fuseaction=qhmi.showHomesMarketIndex

and with from 10% to 100% of their residential work in new construction; some built only custom homes, some built only spec homes, and one built both spec and custom homes; the homes they built ranged from less than 2,000 square feet to over 5,000 square feet and were priced from $230,000 to $3,000,000. Therefore, we believe the results are not particularly useful for program planning purposes and provide little insight on how to target unique builder groups. With a larger sample it would be possible to separate builders into sub-groups that include more than just three or four builders with several common characteristics, for example small high-end custom-home builders or large spec-home builders.

**Builder Training.** Most builders who say they have had energy-related training (10 out of 16) mention EVT-based training; another six builders have worked with EVT to successfully build ENERGY STAR homes. Builders clearly listen to, respect, and value the advice and support EVT provides. Several builders mentioned at some point in the interview that builders who are not familiar with, or not having their homes certified through, the VESH Program will need to know what ENERGY STAR builders are doing and telling their clients if they [builders not currently building ENERGY STAR homes] want to remain competitive. This suggests that many builders not currently participating in EVT programs may soon, if not already, be hungry for information and training that will enable them to effectively compete for clients demanding energy-efficient homes. EVT is clearly in a position to offer appropriate training opportunities to builders at all levels of energy-efficiency awareness.

**Home Buyer Interest in Energy Efficiency.** Builders say the biggest obstacle to getting customers to choose energy-efficient options is cost. Builders report homebuyers are showing increased interest in energy efficiency, but do not tend to specifically specify or request ENERGY STAR-labeled materials or equipment. Also, builders report energy efficiency is still not a top priority for many new-home buyers; the average of builder estimates of the percentage of homebuyers asking about heating and cooling cost is 55% (median is 50%) and of homebuyers asking about energy efficiency is 58% (median is 60%).

**ENERGY STAR Builders.** The 19 verified ENERGY STAR builders interviewed had just over one-half (55%) of the 91 homes they built in 2007 certified. Just over one-half of the builders who say they build ENERGY STAR homes (11 builders) say they always put the ENERGY STAR label on their certified homes. This suggests that homebuyers, in general, are not yet demanding ENERGY STAR homes because it seems reasonable to think that if home buyers were demanding ENERGY STAR homes then builders would be putting the ENERGY STAR label on all their qualified homes.

Nine of the 20 builders who say they build ENERGY STAR homes say it cost more to build an ENERGY STAR home, but only one builder says he charges more for an ENERGY STAR home. The most frequently cited advantage of building ENERGY STAR homes is lower operating cost, followed closely by improved marketability. Other advantages cited by more than one builder are building a better home, environmental benefits, energy efficiency, and a more comfortable home. Eight interviewed builders think there are disadvantages to building ENERGY STAR homes. Four builders say additional cost is a disadvantage. Other disadvantages cited by individual builders include certain design limitations, the hassle, schedule delays, and additional effort. One builder says, “People get the perception you are an expensive builder—it is not going into our pocket, but into their house.”

**Builders Marketing ENERGY STAR Homes.** Most custom-home builders (13 of 17) who say they build ENERGY STAR homes say they always encourage their clients to build to ENERGY STAR standards, but the final decision about whether or not to seek certification through the VESH Program is up to the client. Some builders say they tell their clients they can have their finished home tested and certified if they want. With the introduction of the TBC as a requirement for certification, builders can no longer do this because certification requires a pre-drywall inspection. Also, many builders talk about building "5 Star ENERGY STAR homes." However, 5 Star and ENERGY STAR requirements are no longer consistent. We understand EVT is working to break the link between 5 Star and ENERGY STAR homes in program marketing and, based on the builder interviews, this will be a challenge because builders seem to fixate on the number of stars their homes earn.

Over one-fourth of new single-family homes in Vermont are ENERGY STAR certified. If, as some builders say, they build all their homes the same way but only have them ENERGY STAR certified if the homebuyer requests it, the actual penetration of homes built to, or very close to, ENERGY STAR standards may be much higher.

**Impact on Builders Outside the Program.** Over one-half of the builders who say they build ENERGY STAR homes (12 builders) think the program is having an effect on builders outside the program. These builders say that customers are asking questions and that some are requesting ENERGY STAR homes, which means that builders not currently building ENERGY STAR homes need to know about ENERGY STAR-home requirements to be able to answer their clients' questions and meet their needs. ENERGY STAR materials, equipment, and building supplies are widely available and marketed, more builders and subcontractors are offering high-efficiency insulation options, and energy awareness is rising. One builder sees the VESH Program as a resource for builders to turn to as customers ask for more energy-efficient houses.

**Non-ENERGY STAR Builders.** Only one of the five interviewed builders who say they have not built an ENERGY STAR home is not familiar with the VESH Program. Non-ENERGY STAR builders who are aware of the VESH Program say they learned about it from EVT and literature. All five builders say they would be interested in building an ENERGY STAR home, especially if a home buyer requested an ENERGY STAR home.

**Interest in Building Beyond ENERGY STAR.** Almost all interviewed builders (92%) say they are interested in at least one of the following: solar options, green building, net-zero energy homes. Most interviewed builders (72%) say they currently incorporate at least some green building practices in their homes and six builders are now either building a green home or considering building one. One builder is working with a customer who wants a net-zero energy home. Builders say homebuyers express interest in green building and solar options, but mostly at the concept level—they do not have specific product requests. Over one-half of custom-home builders say their clients ask about solar water heating (57%) and/or PV panels (52%), although few homebuyers, at this point, decide to install them; no builders mentioned The Vermont Solar and Small Wind Incentive Program.[7]

[7] Vermont's Solar and Small Wind Incentive Program, initiated in June 2003, provides funding for new solar water heating, solar electric (photovoltaic) and wind energy system installations. Currently in its third round of funding

There is clearly a sizeable market of both builders and consumers ready and willing to build homes that exceed current ENERGY STAR requirements if they can find a way to do it cost effectively. Some builders are personally very interested in building more energy-efficient and green homes, and some builders say they need to get up to speed on energy-efficiency and green building because their clients know more than they do. It appears anything EVT can do to show builders how to build more energy-efficient and green homes cost effectively, perhaps using case studies and/or testimonials, would be of interest to both builders and homebuyers.

**Electric Savings—Lighting.** ENERGY STAR lighting is a key source of electric savings. Builders provide mixed views on customer interest in and satisfaction with CFL fixtures and bulbs. However, all but one interviewed builder say they install CFL fixtures in at least some of their homes and 20 of the 25 interviewed builders say they install screw-in CFL bulbs in at least some of their homes. Several builders say they have seen a big increase recently in homebuyers wanting ENERGY STAR lighting, but builders also say getting some of their clients to install ENERGY STAR lighting remains an obstacle—especially high-end custom-home clients. It seems clear that the VESH Program requirement that all certified homes have four CFL fixtures installed in non-low-use locations, and offering additional rebates for installing CFL bulbs has encouraged more builders to install more of these products. Given that builders and consumers are gaining experience with CFL lighting and appear to be becoming more comfortable with its performance, it may be more a matter of time than anything else to get more builders to install more CFL lighting and more homebuyers to specify ENERGY STAR lighting.

**Electric Savings—Central Air Conditioning.** Getting builders who install central air conditioning to install more efficient systems and perform the testing necessary to ensure the systems operate properly is another potential source of electric savings. Few new homes in Vermont have central air conditioning, but many of the homes that do are high-end custom homes. Owners of high-end custom homes are much more likely to install what their architect or builder recommends because cost is not as much of an issue for them as it is for buyers of starter or moderately priced homes. Many builders do not work directly with an architect, and almost all custom-home builders say they [the builders] play a key role in specifying HVAC equipment. However, most builders also say they rely on their HVAC contractor to size and recommend equipment. Therefore, it seems important to work with both builders and HVAC contractors to encourage the installation of properly sized and tested high-efficiency air conditioning. HVAC contractors need to know that a builder is at least somewhat aware of the benefits of installing properly sized and tested high-efficiency equipment, not just the lowest cost option, before they are likely to bid high-efficiency equipment including performance testing. HVAC contractors should be encouraged to submit alternate bids—one for standard equipment and one for high-efficiency, tested equipment—to builders not yet requesting high-efficiency equipment.

**Current Building Practices.** Interviewed builders are building energy-efficient homes—none of the interviewed builders could be categorized as building inefficient homes. They all use efficient framing practices, over one-half say they always exceed the RBES R-19 requirement for

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($980,000), the program is available to single- and multi-family residences, businesses, farms, schools, and local & state governments.
Source: http://www.dsireusa.org/library/includes/GenericIncentive.cfm?Incentive_Code=VT17F&currentpageid=3

wall insulation, almost one-third say they use spray foam to insulate walls, almost two-thirds say they always exceed the RBES R-38 requirement for flat ceiling insulation, and they all say they install ENERGY STAR windows. (Three builders say they install windows with U-values below 0.30 and two additional builders mention using triple-pane windows.) Most interviewed builders (22 of 25) say they always install ENERGY STAR boilers, several builders are installing high-efficiency condensing wall-hung gas boilers, and four builders installed ground source heat pumps last year. Nine builders have received the $2,000 federal tax credit for some of their homes (42 homes total), and another builder was submitting six homes. Although, as mentioned earlier, builders agreeing to be interviewed are likely to use better-than-average building practices, it appears there are many Vermont builders who are capable of building well beyond minimum ENERGY STAR standards, some who do not currently participate in the VESH Program, and who are receptive to trying new things.

## Homeowner Survey Findings

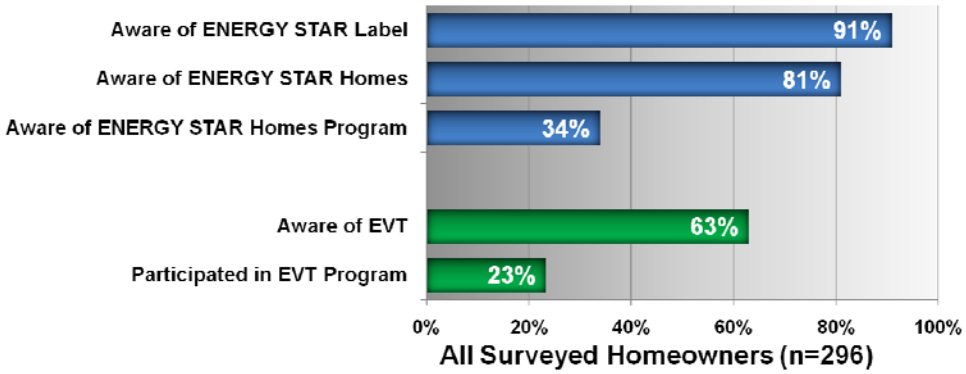
Overall, a majority of the 296 surveyed homeowners (58%) either purchased land or already owned land and worked with an architect or builder to build their new home. Another 12% of respondents built their home themselves; this may seem high, but is consistent with U.S. Census Bureau data reports showing 11% of new single family homes completed in 2007 in the Northeast are owner-built homes.[8]

When buying or building their new homes, most of the homeowners considered the quality of construction (96%), the lowering of energy bills (95%), the levels of insulation (94%), and the efficiency levels of the windows (93%) to be very important factors. Forty-two percent of respondents strongly agree or agree that all new homes are energy efficient. Most respondents (61%) "strongly agree" with the statement "My home is energy efficient," and another 36% "agree."

[8] http://www.census.gov/const/www/charindex.html#singlecomplete (Northeast includes the following states: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New Jersey, New York and Pennsylvania.)

**ENERGY STAR and EVT Awareness.** Figure ES 1 shows that awareness of the ENERGY STAR label and awareness of EVT are high among surveyed Vermont homeowners, but that only about one-third (34%) of all surveyed homeowners say that they are aware of the VESH Program and only about one-fourth (23%) say that they have participated in an EVT Program.

**Figure ES 1: ENERGY STAR and EVT Awareness**




**ENERGY STAR Awareness.** Awareness of the ENERGY STAR label is high; 91% of surveyed homeowners said that they had seen or heard of the label prior to the survey (unaided recognition); this compares to 58% unaided recognition nationally in 2007 and near 80% in markets where utilities use the ENERGY STAR label to promote energy efficiency.[9] Most homeowners (81%) also said that they had heard of or seen a newly constructed home referred to as an ENERGY STAR home. Of homeowners aware of ENERGY STAR homes, 71% report that they were aware before they started shopping for or planning a new home. However, fewer than one-half (42%) of homeowners who said that they are aware of ENERGY STAR homes (34% of all homeowners) said that they are aware of the VESH Program.

**EVT Awareness.** Almost two-thirds (63%) of all surveyed homeowners are aware of EVT, but only slightly more than one-third (38%) of homeowners aware of EVT (23% of all homeowners) say that they have participated in an EVT program; these percentages are likely low because some EVT programs, such as the CFL markdowns, are transparent to the customer. More than one-third (38%) of homeowners who say that they participated in an EVT program (9% of all homeowners) say that they participated in the Compact Fluorescent Lights (CFL) rebate program.

**ENERGY STAR Homes**. Comparing what homeowners said about the ENERGY STAR status of their homes to EVT records shows that 24 of 34 surveyed homeowners (71%) who think they have an ENERGY STAR home do have an ENERGY STAR home, 2 of 38 surveyed homeowners (5%) who think their home is not ENERGY STAR do have an ENERGY STAR home, and 4 of 26 homeowners (15%) who do not know if they have an ENERGY STAR home or who did not answer the question do have an ENERGY STAR home.

[9] http://www.cee1.org/eval/2007_ES_survey_rep.pdf

**Who Specified Home Components.** Two-thirds or more of surveyed homeowners report that they selected their own clothes washer (96%), room air conditioner (90%), freezer (89%), refrigerator (88%), dishwasher (84%), and hard-wired lighting fixtures (67%); about one-half selected their central air conditioning (56%), heating system (53%), windows (52%), and water heater (49%). More than one-third, but fewer than one-half, of surveyed homeowners report that they selected their own level of insulation (43%), type of insulation (42%), and framing (41%).

About two-third of homeowners believe that their refrigerators, dishwashers, freezers and clothes washers are ENERGY STAR qualified. About one-half think their water heaters are ENERGY STAR qualified, but at the time of the survey water heaters did not have ENERGY STAR ratings. Homeowners who believe that their appliances are energy efficient most often cite energy efficiency or energy savings as the reason why they selected the model they purchased, but fewer than five percent mention the ENERGY STAR label.

**Home Offices.** Overall, 24% of surveyed homeowners have a home office and most (81%) are used for less than 30 hours per week. This is virtually identical to what was found in existing homes; 24% of existing homes have offices and 80% are used less than 30 hours per week.

**Lighting—CFLs.** Overall, 94% of surveyed home owners have unaided recognition of CFLs and nearly all (99%) have aided recognition. Almost one-half of homeowners aware of CFLs report that CFL bulbs were installed in their home before they moved in, and nearly 60% say that they have installed CFL bulbs since they moved in. Nearly three-quarters of homeowners who believe that CFLs are installed in their home report that they have six or more CFLs installed. Fewer than one-half of all homeowners with CFLs installed in their home report that they have purchased CFLs with an instant rebate coupon.

Most homeowners who report that CFLs are installed in their home (82%) are satisfied with their bulbs, with 32% very satisfied and 50% satisfied. Homeowners not satisfied with their CFL bulbs were most likely to be dissatisfied by the color of the light (39%), the lack of light (32%), the delay in the light coming on (22%), or the overall quality of light (21%). Homeowners who have not installed any CFLs are most likely to have not installed them for reasons related to light quality(6%), delay in the light coming on (6%), brightness (5%), color (3%), appearance (3%), or fit (3%); 25% simply say that they do not know why they have not installed CFLs.

**Lighting—Fixtures.** One-third of homeowners report that all the fixtures in their homes were included in the purchase price, with no options. Almost one-fourth (21%) of homeowners report that the fixtures were included in the purchase price and they could choose any fixture. Overall, only 38% of homeowners report having ENERGY STAR CFL fixtures installed in their home; 47% believe that they do not have them installed, and another 15% do not know.

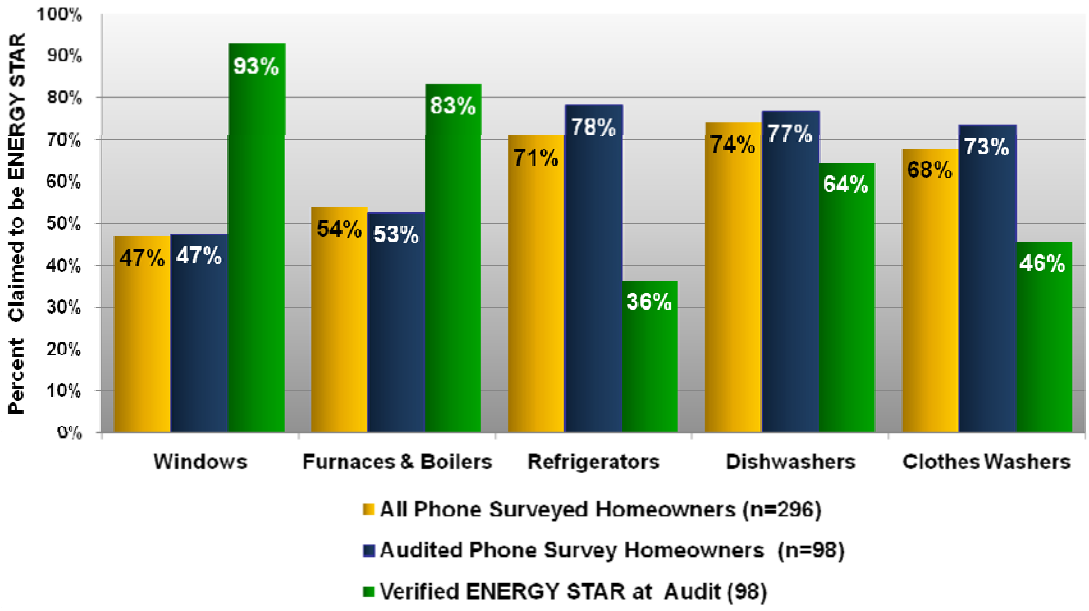
## Survey and On-site Findings Compared

In general, homeowners appear to have a fairly good sense of how energy efficient their homes are. The homes of owners whose homes were inspected, and whose owners think that, in general, all new homes are energy efficient, have less energy-efficient characteristics than homes whose owners do not think all new homes are energy efficient. Homes of the owners who said they "strongly agreed" with the statement "My new home is energy efficient" have more energy-

efficient characteristics than the homes of owners who said they "agreed." Similarly, homes whose owners rated the energy efficiency of their homes as a nine or ten (on a zero to ten scale) have more energy-efficient characteristics than homes whose owners gave their homes a rating of six, seven or eight; no homeowners gave a rating below six. Also, the homes of owners who are not satisfied with the thermal comfort of their homes are less energy efficient than other homes.

**Perceived vs. Actual Awareness of ENERGY STAR Components.** Homeowners are not a reliable source of information on the ENERGY STAR status of components in their homes. Figure ES 2 shows the percentages of all surveyed homeowners saying that the windows, furnaces/boilers, and appliances in their homes are ENERGY STAR qualified, the percentages of surveyed homeowners whose homes were audited saying these components of their homes are ENERGY STAR qualified, and the percentages of audited homes where auditors verified that these components are ENERGY STAR qualified. As shown, the percentages of all surveyed homeowners and those whose homes were inspected saying specific components in their home are ENERGY STAR qualified are very similar. However, on-site audit findings show much higher percentages of ENERGY STAR-qualified windows and furnaces/boilers, much lower percentages of ENERGY STAR-qualified refrigerators and clothes washers, and a somewhat lower percentage of ENERGY STAR-qualified dishwashers. (Note that study estimates of ENERGY STAR appliance percentages are likely conservative.)

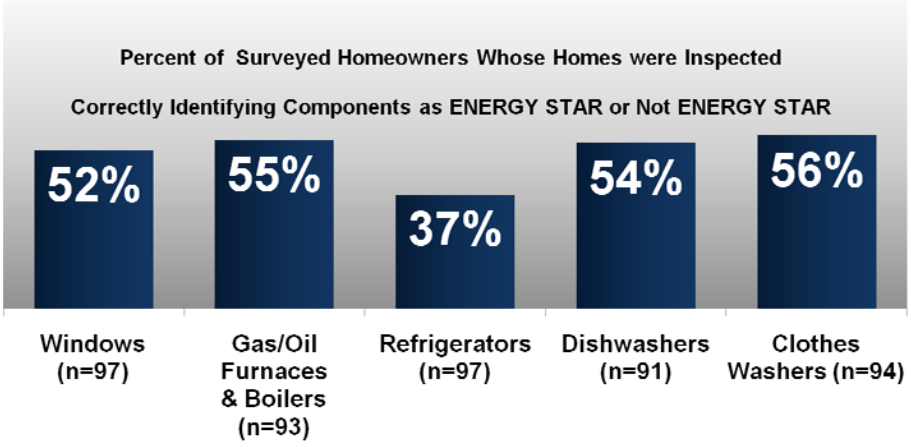
**Figure ES 2: Perceived vs. Actual ENERGY STAR Penetrations**




Comparing how individual homeowners described the energy efficiency of various components in their home to what auditors found during the on-site audit, many homeowners described ENERGY STAR-qualified components as not ENERGY STAR qualified or described non-ENERGY STAR-qualified components as ENERGY STAR qualified. Figure ES 3 shows the percentage of owners of audited homes correctly identifying the ENERGY STAR status of the windows, gas and oil heating systems, and appliances in their homes. As shown, just over half of homeowners accurately described the ENERGY STAR status of their windows, heating

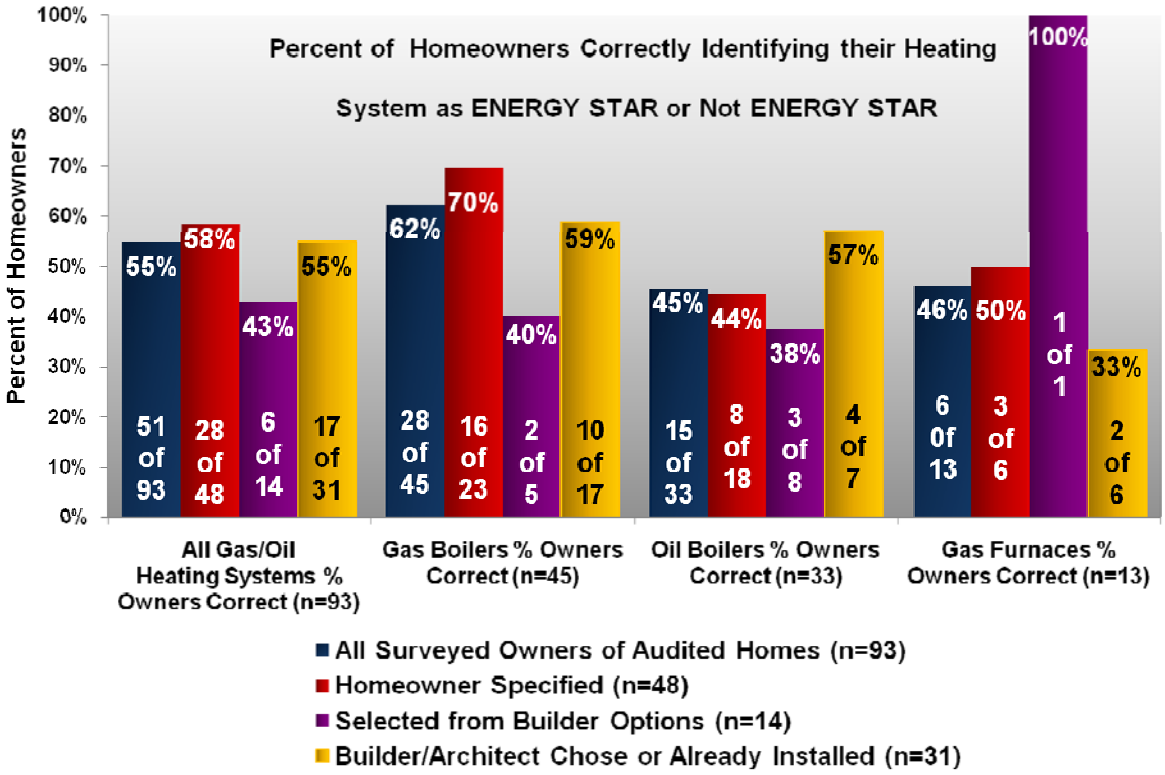
systems, dishwashers, and clothes washers. Homeowners were least likely to accurately describe the ENERGY STAR status of their refrigerators (37%). Overall, homeowners were correct just over half of the time about the ENERGY STAR status of their windows, heating systems, and appliances—only slightly better than would happen by chance.

**Figure ES 3: Homeowners Correctly Identifying ENERGY STAR Components**



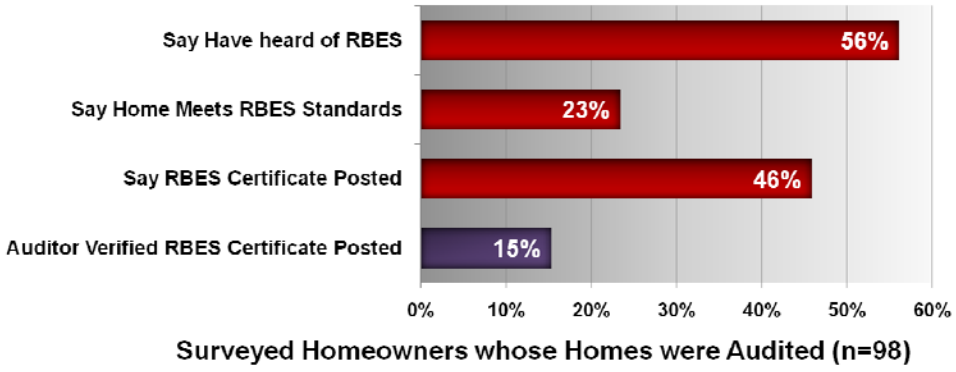

**Owners who Specified Home Components.** One might expect homeowners who say they specified specific components in their home to be more likely to know if these components are ENERGY STAR qualified. However, this is not necessarily true. It appears that when homeowners say they specified their windows, heating systems, or appliances they may have specified what type of windows, heating system or appliances they wanted, but not necessarily the efficiency of these components. For example, they may have specified the window style they wanted; that they wanted a boiler, not a furnace; or that they wanted a stainless steel dishwasher and a side-by-side refrigerator. Using heating systems as an example, Figure ES 4 on the next page shows that there is almost no difference between the percentage of all surveyed homeowners whose homes were inspected (55%) and the percentage of homeowners who say they specified the furnace or boiler (58%) able to accurately describe their furnace or boiler as ENERGY STAR or not ENERGY STAR. (In some cases the number of homeowners falling into a specific heating system/how specified category are very small. Therefore, the number of homeowners correctly identifying the efficiency of their heating system and the total number of homeowners falling into each heating system/how specified category are included in each data column.)

**Figure ES 4: Homeowners Correctly Identifying ENERGY STAR Heating Systems**




**RBES.** Figure ES 5 shows that 56% of the 98 surveyed homeowners whose homes were inspected say that they are aware of RBES, 23% say they think their home meets RBES standards, and 46% say that there is an RBES certificate posted in their home. However, auditors were able to verify that an RBES certificate was posted in only 15% of these 98 homes.

**Figure ES 5: RBES Awareness**




## Comparing Energy Efficiency of Different Groups of Homes

In several cases, comparisons of one group of homes to another show each group is more efficient than the other in some ways and less efficient in others. Detailed tables showing the

characteristics of homes in each grouping explored and a summary of significant differences are in Appendix A; all differences statistically significant at the 90% confidence level are noted.

As discussed previously, ENERGY STAR homes are clearly more energy efficient than non-ENERGY STAR, and homes in the targeted regions are not that different from homes in the remainder of Vermont. Other findings not previously discussed include:

- Custom homes, built on land the homeowner already owned, have several more energy-efficient characteristics than spec-built homes or homes where the owner chose from home plans offered by a builder.
- Whether or not an architect is involved appears to have almost no impact on a home's energy efficiency.
- There are few differences between the homes of owners who say that they built their home, or acted as the general contractor, and other homes.
- Detached homes are more energy efficient than attached homes in some ways and less energy efficient in other ways.
- Modular homes have less energy-efficient characteristics than homes built on site.
- There are few significant differences between homes completed in 2005 or 2006 and homes completed in 2007 or 2008.
- Homes whose owners are aware of the ENERGY STAR label, are aware of EVT, say they have participated in an EVT program, or are aware of RBES have more energy-efficient characteristics than other homes.
- Homes of owners who have heard of ENERGY STAR homes are very similar to the homes of owners who have not heard of ENERGY STAR homes.
- Homes that owners think are ENERGY STAR, but are not, have several characteristics that are significantly less energy efficient than in verified ENERGY STAR homes.
- Homes of first-time home buyers have less wall and ceiling insulation compared to homes whose owners previously owned a home.
- Homes whose owners have a college degree have more energy-efficient characteristics than homes whose owners do not have a college degree.
- Energy efficiency does not appear to be highly related to how long owners expect to stay in their new homes, their age, or their annual income.

## Conclusions

The following conclusions form the basis of our recommendations to increase the energy efficiency of new homes in Vermont.

- Based on the builder interviews and on-site inspections, many new homes in Vermont may be ENERGY STAR equivalent, or close to it, but not participating in the VESH Program.

- Builders who have worked with EVT value the training and support EVT provides. All 25 interviewed builders were familiar with EVT; ten said they had participated in EVT-based training; and another six builders have worked with EVT to successfully build

ENERGY STAR homes. This puts EVT in a position to offer appropriate training opportunities to builders at all levels of energy-efficiency awareness.

- Looking ahead, EPA is proposing several changes to the requirements for ENERGY STAR certification; it will be important to provide training to ensure builders are ready to meet the new requirements when they are implemented.

- Efficient framing practices, ENERGY STAR windows, and ENERGY STAR heating systems appear to be almost standard practice. Fiberglass batts remain the most commonly used wall insulation, but spray foam insulation and SIPs are gaining acceptance.

- Few builders know how HVAC equipment is sized—they rely on their HVAC contractors or supply houses.

- There are likely many builders ready and willing to build homes that meet or exceed current ENERGY STAR requirements if they can find a way to do it cost effectively and remain price competitive.

- Some builders currently building energy-efficient homes, but not participating in the VESH Program, may not be easily recruited into the program until buyers say they want an ENERGY STAR-qualified home.

- Most homebuyers are not yet demanding ENERGY STAR-qualified homes. Verified ENERGY STAR builders had just over one-half (55%) of the 91 homes they built in 2007 certified, and just over one-half (55%) of builders who say they build ENERGY STAR homes say they always put the label on their ENERGY STAR homes.

- Based on the homeowner survey and builder interviews, cost is a major barrier to getting homebuyers to choose energy-efficient options.

- Energy efficiency is still not a top priority for many new-home buyers. The average of builder estimates of the percentage of homebuyers asking about heating and cooling cost is 55% (median is 50%) and of homebuyers asking about energy efficiency is 58% (median is 60%).

- There is ample room to increase the penetration of ENERGY STAR appliances and the number of CFLs installed in new homes.

- Homeowners may be aware of the ENERGY STAR label and exhibit a good understanding of what it means, but very few homeowners mention the ENERGY STAR label as a reason for selecting specific appliance models or HVAC equipment.

- At least 44% of the time owners of audited homes were unable to accurately describe their windows, heating systems, and appliances as ENERGY STAR or not ENERGY STAR. The percentage of owners accurately describing the ENERGY STAR status of components in their homes is only slightly better than would happen by chance.

## Recommendations

The challenge for Vermont is how to simultaneously increase customer demand for ENERGY STAR lighting, appliances, and homes; encourage builders currently building ENERGY STAR homes to have all their homes certified; and convince builders not currently building ENERGY STAR homes that EVT can help them become more competitive in today's tight housing market by identifying and helping them incorporate cost-effective ways to build ENERGY STAR homes. The NMR team makes the following recommendations, some of which Vermont is already doing, to increase the energy-efficiency of new homes in Vermont and the proportion of consumers choosing ENERGY STAR options for their homes.

### Builder Recommendations

#### Education and Training

- Educate both builders and potential homebuyers about what is required for a home to be ENERGY STAR certified to preserve the value of the ENERGY STAR label on a home.

- Provide training to ensure builders are ready to meet the new EPA requirements for ENERGY STAR certification when they are implemented.

- Provide training specifically aimed at builders interested in building beyond ENERGY STAR standards. Training should include presenting case studies, including cost information, of completed homes approaching net-zero energy. There appear to be many builders interested in meeting green program standards, incorporating renewables, and building net-zero energy homes. Ideally, appropriate training will provide the information builders need to move them from thinking about building these types of homes to actually building them. It may also be worth considering offering additional incentives for homes that achieve a very low Home Energy Rating (HERS) index.

- Work with both builders and HVAC contractors to encourage the installation of properly sized and tested high-efficiency heating and air conditioning systems. HVAC contractors need to know that a builder is at least somewhat aware of the benefits of installing properly sized and tested high-efficiency equipment, not just interested in the lowest cost option, before they are likely to bid high-efficiency equipment including performance testing. HVAC contractors should be encouraged to submit alternate bids—one for standard equipment and one for high-efficiency, tested equipment—to builders not yet requesting high-efficiency equipment.

#### Marketing

- Interest in green building continues to grow. Now that Vermont Green Building Network programs have adopted ENERGY STAR certification as a requirement, take advantage of opportunities for joint marketing, training, and education. Building green begins with building to ENERGY STAR standards.

- Encourage builders to put the ENERGY STAR label on their certified homes. The VESH Program should do all it can to increase the visibility of ENERGY STAR homes and awareness among homebuyers that there are ENERGY STAR standards for homes, not just appliances and lighting.

- Develop builder recruiting marketing materials using testimonials and/or case studies showing how building and marketing ENERGY STAR homes has helped builders increase their competitiveness in today's slow housing market.

- Continue to encourage builders, using incentives as necessary, to install ENERGY STAR lighting and appliances to increase the penetration of these products in new homes.

## Homebuyer Recommendations

- Consumer oriented educational campaigns continue to be important. Convince homebuyers, and consumers in general, to put a higher priority on looking for the ENERGY STAR label when choosing appliances and other ENERGY STAR-rated components for their new or existing home. Stress that there are both moderately priced and high-end ENERGY STAR options available—something for everyone.

**Education addressing ENERGY STAR homes:**

- Increase consumer awareness of, and interest in, ENERGY STAR homes and, especially, the VESH Program.

- Inform potential homebuyers that ENERGY STAR homes come in all sizes, shapes, and price ranges.

- Describe the benefits of ENERGY STAR homes, stressing that the **ONLY** way to be sure a home is energy efficient is to have it verified by a third party using blower door and duct blaster tests, and that this is what the VESH Program does.

    - Address both the energy and non-energy benefits of living in an ENERGY STAR home.

    - Provide general information on the potential energy cost dollar savings associated with living in an ENERGY STAR home—both annually and over the life of the home.

**EVT website:**

- Let buyers know how easy it is to find an ENERGY STAR builder or home by promoting the EVT website that lets homeowners know how many builders in Vermont have built ENERGY STAR homes, how many ENERGY STAR homes have been built in Vermont,

and how to access lists of qualified ENERGY STAR builders and currently available ENERGY STAR homes.

- Expand the EVT website to include a list, and pictures if possible, of spec homes being built to ENERGY STAR standards.

- Provide a list of questions addressing energy efficiency that homebuyers should ask about any house they are considering buying or building. Make the list easy to print from the website and encourage homebuyers to go over the list with their builder if they decide to build a home, or the real estate agent or builder marketing spec homes already under construction or finished.

**For customers considering buying or building a new home**:

- Encourage buyers to look for the ENERGY STAR label on a home.

- Educate homebuyers about the value of selecting or specifying ENERGY STAR-qualified equipment and materials whenever possible. Buyers of spec homes should be encouraged to ask the builder if they offer ENERGY STAR options. Custom-home clients should be encouraged to specify ENERGY STAR-qualified equipment and materials.

- Encourage custom-home clients to request an ENERGY STAR-qualified home, and let them know that the decision to have their home ENERGY STAR qualified should be made as early as possible because an ENERGY STAR home needs to be inspected before the drywall is installed.

# 1 Introduction

The overall objective of the combined studies covered in this report is to provide the Vermont Department of Public Service (DPS) with residential new construction market assessments and baselines to help identify opportunities for increased energy efficiency in Vermont. Specific objectives include assessing and/or documenting:

- Overall energy efficiency of new homes
- Energy efficiency of new single-family homes by feature
- Characteristics of new homes, including home offices
- Builders' current building practices
- Homeowner demographics
- Homeowner information sources and decision-making
- Homebuyer interest in energy efficiency
- How builders market homes and energy efficiency
- Homeowner, builder, and contractor familiarity with:
    - Efficiency Vermont and its programs
    - ENERGY STAR homes
    - Vermont ENERGY STAR Homes Program
    - Residential Building Energy Standards
- Homeowner and builder knowledge of and use of CFL bulbs and fixtures
- Builder familiarity with solar and green building programs and practices
- Non-ENERGY STAR builder interest in building ENERGY STAR homes
- HVAC and insulation contractor energy efficiency marketing
- HVAC and insulation contractor installation of energy-efficient materials and equipment
- HVAC and insulation contractor installation practices
- Builder, HVAC contractor, and insulation contractor participation in energy-related training

## 1.1 The Samples

The DPS requested state level information on newly constructed single-family homes located in Vermont plus detailed information for four separate geographic regions. The four geographic regions are three geographically targeted (GT) regions (Northern Chittenden, St. Albans, and Newport/Derby) plus the city of Burlington. Efficiency Vermont (EVT) provided data on the number of GT premises in each GT town, and these data were analyzed to identify towns having a large proportion of GT premises.

### 1.1.1 Homeowner Survey Sample

The new construction homeowner survey conducted interviews with 296 owners of recently built single-family homes across Vermont; interviews were conducted from December 2007 through February 2008. (Single-family homes include attached homes that have a wall separating individual units from basement to roof and separate utilities.) To ensure sufficient sample sizes in the targeted regions, data from EVT on the number of GT premises in each GT town were analyzed to identify towns that contain a large proportion of GT premises for inclusion in the survey. Three of the six towns located in the Newport/Derby region (Brownington, Newport, and Derby) were included in the homeowner survey; these three towns represent 95% of the GT premises in the Newport/Derby region. Four of the six towns located in the Northern Chittenden region (Colchester, Essex, Essex Junction, and Winooski) were included in the homeowner survey; these four towns represent 99% of the GT premises in the Northern Chittenden region. Three of the thirteen towns located in the St. Albans region (Georgia, Milton, and St. Albans) were included in the homeowner survey; these three towns represent 79% of the GT premises in the St. Albans region.

Recently constructed single-family homes were identified by analyzing Grandlist databases available from the Vermont Department of Property Valuation (DPV). Annual Grandlist databases provide a comprehensive source of property records in Vermont, including town, property type (residential, vacation, commercial, etc), property value, and property improvement value, as well as the owners' name, address, town, zip code, and state. Identifying adequate numbers of new homes in the GT regions and Burlington required working with Grandlist databases for 2005, 2006 and 2007. Properties that were categorized as R-1 (residential under 6 acres in size), R-2 (residential over 6 acres), V-1 (vacation under 6 acres), or V-2 (vacation over 6 acres) were selected. Comparing consecutive year databases, we identified properties that (1) changed property use from woodland, farm, mobile home, miscellaneous, or other categories to residential or vacation categories; (2) were new residential or vacation properties, indicating the land may have been subdivided, or (3) remained as residential or vacation land but the value of improvements increased substantially (at least $25,000, but higher for certain towns with large increases in property value). For properties that met any of these criteria a search was conducted for phone numbers based on the address of the property owner.

### 1.1.2 On-site Audits

Volunteers for the 106 on-site audits, conducted from January through April 2008, were recruited from the 296 homeowners who participated in the phone survey. When volunteers from the phone survey did not provide enough homes in some of the GT regions, lists of new residential electric service requests provided by EVT and Burlington Electric Department (BED) were used to supplement the surveyed homeowners; these lists yielded eight additional on-site audits.

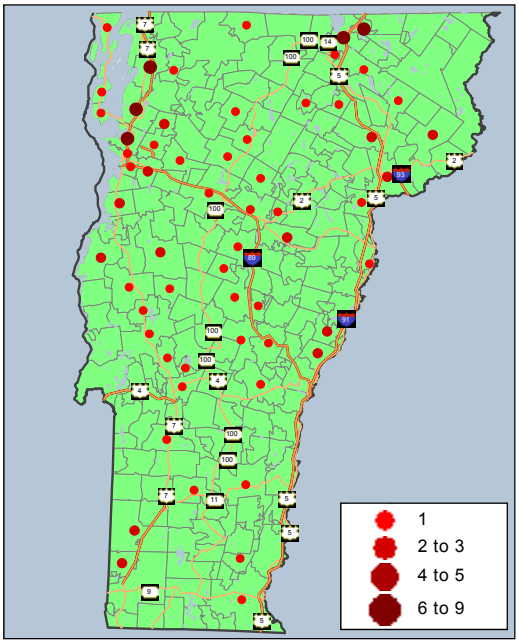
On-site sample recruiting and scheduling was performed by RLW Analytics, Inc. (RLW) staff. Homeowners were introduced to the on-site audits during the phone survey; they were told what the on-site audit would involve, how long it would take, and about the $50 incentive they would receive if they agreed to, and were selected to, have their home audited. RLW recruited from the list of surveyed homeowners who said that they would be willing to have their home audited.

Audited homes range from simple to complex. Figure 1–1 shows examples of two homes with simple designs and front and back views of a third very complex home.

**Figure 1–1: Two Simple Homes and a Complex Home**

Audits were conducted in 106 homes in 64 towns across Vermont. Figure 1–2 shows the location of the on-site audits.

**Figure 1–2: Location of On-site Audits**



To the best of our knowledge, only 15 of the audited homes have access to natural gas. The NMR team matched the street addresses of audited homes to Vermont Gas maps of streets where they provide service. Of the 15 homes with access to natural gas, 14 are in the targeted regions, one is in the remainder of Vermont; ten are ENERGY STAR homes, and five are non-ENERGY STAR homes. All 15 of the homes with access to natural gas have natural gas space and water heating systems.

Table 1–1 shows the size of inspected homes ranges from 775 to 5,378 square feet of conditioned space; the average home size is 2,507 square feet and the median is 2,352 square feet. Table 1–1 also shows the sample of inspected homes is consistent with the sample of all surveyed homeowners with respect to home size, length of time owners expect to stay in their new homes, and percentage of first-time home buyers.

**Table 1–1: Homeowner Sample Characteristics**

| Sample Characteristics | Homeowner Survey | On-site Inspections |
|---|---|---|
| **Home Size Square Feet of Conditioned Area** | **(n=296)** | **(n=106)** |
| < 800 square feet | 1% | 2% |
| 800 to 1,199 | 5% | 5% |
| 1,200 – 1,599 | 15% | 11% |
| 1,600 – 1,999 | 21% | 14% |
| 2,000 – 2,499 | 25% | 25% |
| 2,500 – 2,999 | 14% | 17% |
| 3,000 – 3,999 | 13% | 17% |
| 4,000 – 4,999 | 4% | 6% |
| 5,000 or Higher | 4% | 3% |
| Don't know/Refused | 30% | 0% |
| Minimum Home Size | na | 775 $ft^2$ |
| Maximum Home Size | na | 5,378 $ft^2$ |
| Average Home Size | na | 2,507 $ft^2$ |
| Median Home Size | na | 2,352 $ft^2$ |
| **Length of Time Expect to Stay in Home** | **(n=296)** | **(n=98)** |
| Five Years or Less | 9% | 13% |
| Six to ten years | 10% | 17% |
| More than Ten Years | 19% | 16% |
| Indefinitely | 55% | 54% |
| Don't Know | 7% | 1% |
| **First Time Homebuyer** | **15%** | **13%** |

Table 1–2 shows that the sample of inspected homes and the sample of all surveyed homeowners are very similar with respect to how homeowners say they purchased their home.

**Table 1–2: How Home was Purchased**

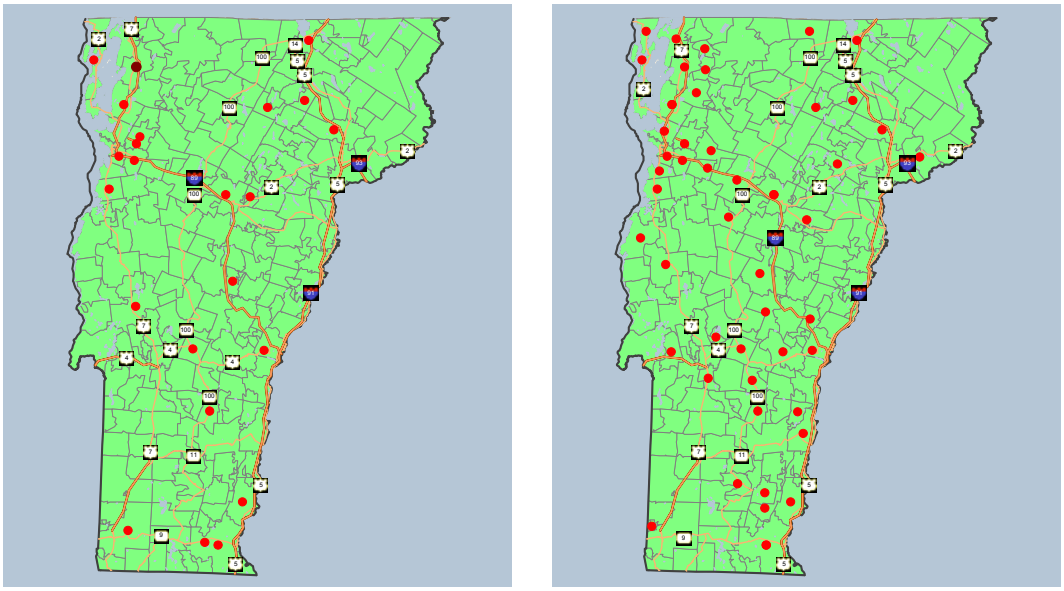
| How Home was Purchased | All Surveyed Homeowners (n=296) | Inspected Homes (n=103) |
|---|---|---|
| **Purchased land and worked with an architect and/or builder to design and build the home.** | 38% | 39% |
| **Had a house plan and a lot and hired a contractor/builder to build the home.** | 20% | 25% |
| **Purchased land and built home myself.** | 12% | 9% |
| **Purchased land and ordered a modular home.** | 5% | 3% |
| **Rebuilt an existing home.** | 2% | 1% |
| **Purchased a lot from a builder, selected one of several house plans offered by the builder and selected from various available upgrade options.** | 5% | 4% |
| **Purchased a home that was under construction and selected from various available upgrade options.** | 7% | 11% |
| **Purchased a finished home.** | 9% | 9% |
| **Don't Know** | 1% | 0% |

### 1.1.3 Builder Interviews

The large majority of the 25 interviewed builders (19 out of 25) were recruited from the pool of builders who built homes that participated in the on-site inspections. Additional builders were recruited from home builder association member lists and internet searches for Vermont builders. Builders were screened to ensure they had completed at least one new home in Vermont in the last year. In addition, they were offered $50 to encourage their participation. Due to the small sample size, all findings should be viewed as qualitative in nature. Also, builders willing to commit to a 45 minute interview are sometimes hard to find, and builders who build below or just to code levels are probably less willing to talk about their building practices; conversely, builders who are familiar with EVT or who have experience building ENERGY STAR homes may be more likely to agree to be interviewed. Therefore, the builder sample may be biased toward builders with better-than-average construction practices. Section 2 explores potential bias in more detail.

Interviewed builders come from all areas of Vermont and built homes in 51 different Vermont towns in 2007. Interviews were conducted from February through May 2008. Figure 1–3 shows where the interviewed builders are based and the towns where they built homes in 2007.

**Figure 1–3: Where Interviewed Builders Based and Where 2007 Homes Built**



**Where Builders Based (n=25)** **Towns Where 2007 Homes Built (n=51)**

### 1.1.4 HVAC and Insulation Contractor Interviews

In-depth interviews were conducted from January through April of 2008 with ten HVAC contractors who work on new and/or existing homes in Vermont. Interviewed contractors received $50 for their participation. Questions pertaining to installation practices in new homes were asked only if at least 25% of the contractor's gross revenues from residential work was from work on new residential construction projects. Due to the small sample size, all findings should be viewed as qualitative in nature.

In-depth interviews were conducted from January through March of 2008 with ten insulation contractors who work on new and/or existing homes in Vermont. Interviewed contractors received $50 for their participation. A list of potential interview candidates was obtained from InfoUSA (www.infousa.com), an online database of businesses in the United States, the Home Builders and Insulators Association of Northern Vermont[10], the Home Builders and Insulators Association of Southern Vermont[11], and internet searches for "Vermont insulation contractors" through google.com and yellowpages.com. Nine of the interviewed insulation contractors work on new homes. Specific questions pertaining to work on new homes were asked only if at least 25% of the contractor's gross revenues from residential work was from work on new residential construction projects. Due to the small sample size, all findings should be viewed as qualitative in nature.

[10] http://www.vtbuilders.com/
[11] http://www.cvthomebuilders.com/

## 1.2 Weighting and Precision

### 1.2.1 Weighting

Because homes in the GT regions were over sampled, in order to estimate the statewide results we weight the results from the GT regions and the remainder of Vermont. The weights for each of the GT regions, the combined GT regions, and the remainder of Vermont are developed by dividing the number of new single-family homes in the individual regions by the total number of new single-family homes in Vermont. Table 1–3 shows the estimated number of new single-family homes in each region, the weighting factor for each region, the number of homeowner surveys completed in each region, and the number of on-site inspections conducted in each region.

**Table 1–3: Weighting Factors for Homeowner Survey and On-Site Audit Results**

| Region | Estimated Number of New Single-Family Homes* | Percent of New Single-Family Homes (Weighting Factor) | Number of Homeowner Surveys Completed | Number of On-site Audits Completed |
|---|---|---|---|---|
| Northern Chittenden | 349 | 8.4% | 28 | 9 |
| St. Albans | 473 | 11.4% | 33 | 15 |
| Newport/Derby | 168 | 4.1% | 22 | 14 |
| Burlington | 20 | 0.5% | 3 | 1 |
| **Combined Targeted Regions** | **1,010** | **24.4%** | **86** | **39** |
| Remainder of Vermont | 3,132 | 75.6% | 210 | 67 |
| State Total | 4,142 | 100.0% | 296 | 106 |

* Homes built in 2006 or 2007; derived from one-unit permit data from U.S. Census Bureau data for 2006.

The previously issued homeowner survey report showed unweighted results for each targeted region and weighted state level results. Given the small number of on-site audits conducted in the individual GT regions, the previously issued on-site inspection analysis report showed unweighted results for the combined targeted regions and for the remainder of Vermont, and weighted state level results. On-site weighted state level results weight combined targeted region results by the combined target region weighting factor (24.4%) and remainder of Vermont results by the remainder of Vermont weighting factor (75.6%). In cases where the number of observations for a particular home feature was less than ten for either homes in the targeted regions or homes in the remainder of Vermont, state level data were presented unweighted.

Unless otherwise noted, the state level results from both the homeowner survey and on-site audits discussed in this report are weighted results. The one exception is that state level results based on comparisons of what individual homeowners said when they were surveyed to what was observed during the on-site inspections of their homes are not weighted.

### 1.2.2 Precision

All statistical testing was done at the 90% confidence level. Estimates of sampling error for the homeowner survey assume that proportions are 50% (i.e., 50% of respondents reply "yes" to a

given question). A proportion of 50% results in the maximum sampling error and thus presents the worst-case scenario for sampling design. At the 90% confidence level, the homeowner survey provides a sampling error of 4.7% for the state, 5.5% for the remainder of Vermont region, and between 14% and 17% for the individual geographically targeted regions.

A primary objective of on-site audits is to document the existing building and equipment status of new single-family homes by feature. Since there is no single variable that quantifies a home's construction features, we identified results that we believe are influential in the determination of a home's overall efficiency. Table 1–4 lists these key parameters along with the coefficient of variation associated with their measurement. Based on these coefficients, we used the poorest coefficient of variation (0.49) to provide a sense of the precision around the final results.

**Table 1–4: Coefficients of Variation for Key Residential Measurements**

| Parameter | Coefficient of Variation |
|---|---|
| Conditioned/Ambient Wall Insulation (R Value) | 0.29 |
| Ceiling Insulation (R Value) | 0.30 |
| Heating System Efficiency (AFUE) | 0.05 |
| Air Infiltration—Natural Air Changes per Hour (ACHnat) | 0.49 |

Table 1–5 shows the final precision calculations for each GT region[12], the combined targeted regions, the remainder of Vermont, and the entire state. At the 90% confidence interval, the precisions associated with the individual targeted regions range from ± 25.5% to ± 21.5% using a CV of 0.49. The relative precision is ±12.9% for the combined targeted regions and ±9.8% for the remainder of Vermont. Statewide, the relative precision is better than ± 8.0%.

**Table 1–5: Relative Precisions**

| Geographic Area | Number of On-site Audits | Coefficient of Variation | Relative Precision |
|---|---|---|---|
| Northern Chittenden/Burlington | 10 | 0.49 | +/- 25.5% |
| St. Albans | 15 | 0.49 | +/- 20.8% |
| Newport/Derby | 14 | 0.49 | +/- 21.5% |
| Combined Targeted Regions | 39 | 0.49 | +/- 12.9% |
| Remainder of Vermont | 67 | 0.49 | +/- 9.8% |
| All Vermont New Single Family Homes | 106 | 0.49 | +/- 7.8% |

[12] Because there is little construction of new single-family homes in Burlington, the one audited home in Burlington was combined with the homes from the North Chittenden region, whose towns are adjacent to Burlington.

## 1.3 On-site Audit Data Collection

The on-site audits included collecting information on a multitude of home features and having the homeowner complete a short questionnaire to assess obstacles to their improving the energy efficiency of their home based on the findings of the on-site audit. The main data collection areas are:

- **General Information.** Home style, stand alone or in a development, primary or seasonal residence, etc.
- **Basic Home Characteristics.** Total square footage, number of stories, type of basement, conditioned space square footage, etc.
- **Building Envelope.** Wall, ceiling, floor, foundation wall, and slab construction, square footage, insulation type and level, etc., and glazing type, square footage, orientation, U-value, etc.
- **Heating, Cooling and Water Heating Equipment.** Manufacturer and model, age, type, location, fuel, size, efficiency and, for heating systems, the number and type of thermostats and number of control zones
- **Supplemental Heating**. Number of fireplaces, stoves and portable space heaters and what fuel they use
- **Heating and Cooling Distribution Ducts.** Duct type (supply or return), location, insulation type and level, and how sealed
- **Envelope and Duct Leakage.** Blower door and duct blaster testing if acceptable to homeowner
- **Appliances in the Home.** Dishwashers, clothes washers, clothes dryers, ranges, ovens, refrigerators, freezers, televisions, and computers. Data collected include make and model, type, age, general use, approximate age and, when available, appliance size and efficiency.[13]
- **Lighting.** Main area lighting fixture inventory including all plug-in fixtures. Includes a count by type of bulb and fixture, wattages, control types, and number of sockets

Auditors defined conditioned space as intentionally heated space, which is the same definition used in the 2002 baseline study, but different from the definition used in the 1995 baseline study (finished living space) and different from the definition in the Vermont Residential Building Energy Code Handbook. The RBES handbook definition of conditioned space is:

> A space is "**conditioned**" if heating and/or cooling is deliberately supplied to it or is indirectly supplied through uninsulated surfaces of water or space heating equipment, through uninsulated ducts, or though adjacent uninsulated building

[13] Model numbers were recorded for most appliances during the on-site audits; the ENERGY STAR status of these models was checked at http://www.energystar.gov/index.cfm?c=appliances.pr_appliances, the ENERGY STAR website. Model number are not always visible on appliances; in addition, model numbers have a variety of configurations (due to differing colors, features, etc) and an exact match is required to positively identify a model as ENERGY STAR. For these reasons, the percent of ENERGY STAR units reported is likely a conservative estimate.

surfaces. Basements and crawl spaces without ceiling insulation are considered conditioned space.

As part of the data review process, the NMR team reviewed the population of data in each audit data field for reasonableness and consistency. Questions were referred to the RLW audit team leader for resolution.

# 2 Potential Sample Bias Addressed

## 2.1 Homeowner Survey Sample

Comparing demographic information on the sample of surveyed homeowners to U.S. Census Bureau annual American Community Survey[14] data for 2006 and 2007 is one way to assess how well the homeowner survey sample represents the targeted population—owners of recently constructed homes in Vermont. Table 2–1 shows the percentage of surveyed homeowners, and homeowners whose homes were inspected, falling into various age, education, and income categories compared to state level data. As shown, the demographics of the owners whose homes were inspected are very similar to the demographics of all surveyed homeowners. The percentages of surveyed homeowners falling into various age categories are similar to state level demographics with one exception; surveyed homeowners are much less likely to be under 25, and it is not surprising that people under 25 are less likely to be buying or building a new home. Also, surveyed homeowners are more likely to have at least a college degree, less likely to fall into lower income categories, and more likely to fall into higher income categories; again, it is reasonable to expect home buyers to have higher socioeconomic status.

**Table 2–1: Sample and Vermont State Demographics**

| Sample Characteristics | Homeowner Survey | On-site Inspections | 2006 ACS | 2007 ACS |
|---|---|---|---|---|
| **Age Categories** | **(n=296)** | **(n=98)** | **(n=517,561) (15 & older)** | **(n=516,558) (15 & Older)** |
| **18 to 24** | 1% | 2% | 18% | 17% |
| **25 to 34** | 16% | 16% | 14% | 14% |
| **35 to 44** | 20% | 19% | 18% | 17% |
| **45 to 54** | 22% | 23% | 20% | 20% |
| **55 to 64** | 23% | 23% | 15% | 16% |
| **65 or over** | 17% | 15% | 16% | 16% |
| **Don't Know or Refused** | 1% | 0% | na | na |

[14] http://factfinder.census.gov/servlet/ADPTable?_bm=y&-context=adp&-qr_name=ACS_2007_1YR_G00_DP5&-ds_name=ACS_2007_1YR_G00_&-gc_url=null&-tree_id=307&-redoLog=false&-geo_id=04000US50&-format=&-_lang=en

**(Table 2–1 continued)**

| Sample Characteristics | Homeowner Survey | On-site Inspections | 2006 ACS | 2007 ACS |
|---|---|---|---|---|
| **Education Categories** | **(n=296)** | **(n=98)** | **(n=426,930) (25 & older)** | **(n=427,339) (25 & older)** |
| **Less than College Degree** | 36% | 31% | 67% | 66% |
| **College Degree** | 30% | 36% | 20% | 21% |
| **Post Graduate** | 31% | 32% | 13% | 13% |
| **Refused** | 2% | 2% | na | na |
| **Income Categories** | **(n=296)** | **(n=98)** | **(n=253,808) (total households)** | **(n=252,580) (total households)** |
| **< $35,000** | 9% | 12% | 35% | 34% |
| **$35,000 to $49,999** | 10% | 11% | 17% | 17% |
| **$50,000 to $74,999** | 23% | 27% | 21% | 20% |
| **$75,000 to $99,999** | 16% | 17% | 12% | 13% |
| **$100,000 to $149,999** | 11% | 11% | 11% | 11% |
| **$150,000 or more** | 12% | 9% | 4% | 6% |
| **Don't Know or Refused** | 19% | 12% | 0% | na |

## 2.2 On-site Inspection Sample

Potential bias is a concern in any sample based on voluntary participation. There are many factors that may influence a homeowner's willingness to have their home audited. For example, homeowners familiar with EVT programs may be more willing to participate; homeowners who think their home is very energy efficient may be more willing to participate because they are proud of their home or less interested in participating because they feel confident their home is energy efficient and that the audit would not tell them anything they do not already know; conversely, homeowners who think their home may not be as energy efficient as they thought it would be may be more interested in participating to learn what they could do to improve the energy efficiency of their home or less interested because they feel their home might not meet Vermont code standards; homeowners who acted as the general contractor for their home or who played an active role in specifying construction materials and mechanical equipment may be more interested in participating to see if they made wise choices.

There is no clear indication of bias in the sample of audited homes. Some homes are very energy efficient and some are not. Some have simple designs and some have complex designs. There are a mix of custom- and spec-built homes; site built and modular homes; large and small homes; ENERGY STAR and non-ENERGY STAR homes; homes that were purchased completed and homes where the owner played a major role in specifying materials and mechanical equipment. The homeowner survey results showed 12% of respondents said they built their homes themselves, and 9% of the owners of audited homes (9 out of 103 who responded to the question asking how their home was purchased) said they built their own home. These percentages may

seem high, but U.S. Census Bureau data reports show 11% of new single family homes completed in 2007 in the Northeast are owner-built homes.[15]

## 2.3 ENERGY STAR Home Penetration

EVT verified that 30 (28%) of the 106 newly constructed homes participating in the on-site inspections are ENERGY STAR qualified, and that 41 (33%) of the homes built by all 25 interviewed builders in 2007 were ENERGY STAR qualified through the VESH Program (38 homes) or the EPA program (3 homes). State level data reported by EPA shows 27% of single-family homes built in Vermont in 2007 and 33% in 2008 were ENERGY STAR qualified.[16] Although the percentage of all inspected homes that could be verified as being ENERGY STAR qualified and the percentage of all homes built by interviewed builders in 2007 that could be verified as being ENERGY STAR qualified are higher than the overall 2007 state percentage of ENERGY STAR-certified homes reported by EPA, they are not dramatically higher, which suggests that neither the sample of all inspected homes nor the sample of builders interviewed are severely biased with respect to the penetration of ENERGY STAR homes.

## 2.4 Builder Sample

Builders willing to commit to a 45 minute interview are sometimes hard to find, and builders who build below or just to code levels are probably less willing to talk about their building practices; conversely, builders who are familiar with Efficiency Vermont (EVT) or who have experience building ENERGY STAR homes may be more likely to agree to be interviewed. Therefore, the builder sample is likely to be somewhat biased toward builders with better-than-average construction practices.

One way of assessing the potential bias of the interviewed builder sample is to compare the results of on-site audits conducted at homes built by interviewed builders to the results of on-site audits conducted at homes built by non-interviewed builders. Twenty-six of the 106 homes audited were built by 19 interviewed builders. One clear difference between the two groups of homes is that the audited homes built by interviewed builders are more than twice as likely as audited homes built by non-interviewed builders to be ENERGY STAR qualified (54% vs. 20%); this difference is statistically significant. However, as described earlier, the percentage of all the homes built by interviewed builders in 2007 that were ENERGY STAR qualified is only slightly higher than the percentage of ENERGY STAR-qualified homes in the sample of 106 audited homes.

[15] http://www.census.gov/const/www/charindex.html#singlecomplete (Northeast includes the following states: Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont, New Jersey, New York and Pennsylvania.)
[16] http://www.energystar.gov/index.cfm?fuseaction=qhmi.showHomesMarketIndex

Table 2–2 on the next page shows that the only statistically significant differences between audited homes built by interviewed builders and audited homes built by non-interviewed builders are that audited homes built by interviewed builders:

- Have a higher average wall insulation R-value (R-24 vs. R-20);
- Are more likely to have wall insulation exceeding R-19 (42% vs. 20%);
- Have lower average total CFM50 air infiltration (1,259 vs. 1,676 CFM50);
- Are more likely to have an ENERGY STAR heating system (92% vs. 81%)
- Have a higher average heating system AFUE (89.4 vs. 87.5)
- Are more likely to have CFLs installed (96% vs. 77% of homes).

Differences in ceiling insulation levels, below grade foundation wall insulation levels, and the percentage of homes exceeding RBES code requirements for ceiling and foundation wall insulation levels are not statistically significant. The percentages of homes with ENERGY STAR windows, and the percentage of gas boilers, oil boilers, and gas furnaces that are ENERGY STAR are not significantly different. Differences in the average number of CFLs installed per home and the proportion of total bulbs that are CFLs are not significant.

As reported above, average total CFM50 air infiltration is significantly lower in audited homes built by interviewed builders. However, average air changes per hour, which takes a home's size into consideration, measured in either natural air changes per hour (ACHnat) or at 50 pascals (ACH50), is not significantly different between audited homes built by interviewed builders and audited homes built by non-interviewed builders.

As reported above, the average heating system AFUE is significantly higher in audited homes built by interviewed builders. This reflects differences in the mix of heating system types between the two groups; audited homes built by interviewed builders have a much higher percentage of gas boilers (62% vs. 33%), which have higher AFUEs than oil boilers, and the audited homes built by non-interviewed builders includes two AFUE 80 oil furnaces. Differences in the average gas boiler AFUE, oil boiler AFUE, and gas furnace AFUE are not statistically significant.

## Table 2–2: Interviewed versus Non-Interviewed Builder Homes

| Building Characteristic | On-site Audits of Homes Built by Interviewed Builders | On-site Audits of Homes NOT Built by Interviewed Builders | All On-site Audits |
|---|---|---|---|
| **ENERGY STAR Qualified** | | | |
| Number of Audited Homes | 26 | 80 | 106 |
| Percent ENERGY STAR-Qualified Homes | 54%* | 20%* | 28% |
| **Framing** | | | |
| Number of Homes with Framing Data | 26 | 80 | 106 |
| Percent Log Homes or 2x4 Framing | 0 | 6% | 5% |
| **Wall Insulation** | | | |
| Number of Homes with Wall Insulation Data | 26 | 80 | 106 |
| Average Wall Insulation R-value | 24* | 20* | 21 |
| Percent > R-19 Wall Insulation | 42%* | 20%* | 25% |
| **Flat Ceiling Insulation** | | | |
| Number of Homes with Flat Ceiling Insulation Data | 25 | 69 | 94 |
| Average Flat Ceiling Insulation R-value | 42 | 37 | 38 |
| Percent > R-38 Flat Ceiling Insulation | 28% | 26% | 27% |
| **Cathedral Ceiling Insulation** | | | |
| Number of Homes with Cathedral Ceiling Insulation Data | 9 | 46 | 55 |
| Average Cathedral Ceiling Insulation R-value | 39 | 34 | 34 |
| Percent > R-30 Cathedral Ceiling Insulation | 89% | 50% | 56% |
| **Below Grade Foundation Wall Insulation** | | | |
| Number of Homes with Below Grade Foundation Wall Insulation Data | 23 | 65 | 88 |
| Average Below Grade Found Wall Insulation R-value | 13 | 11 | 11 |
| Percent > R-10 Below Grade Foundation Wall Insulation | 70% | 58% | 61% |
| **Windows** | | | |
| Number of Homes with Window U-value Data | 25 | 80 | 105 |
| Percent with ENERGY STAR Windows | 92% | 95% | 94% |
| **Air Infiltration** | | | |
| Number of Homes with Blower Door Test CFM50 Data | 23 | 59 | 82 |
| Average CFM50 Air Infiltration | 1,259 * | 1,676 * | 1,559 |
| Average Natural Air Changes per Hour (ACHnat) | 0.27 | 0.28 | 0.28 |
| Percent with <.35 ACHnat | 83% | 68% | 72% |
| Average Air Changes per Hour at 50 Pascals (ACH50) | 4.83 | 5.02 | 4.97 |
| Percent with 5 or Lower ACH50 | 61% | 47% | 51% |
| Percent with 3 or Lower ACH50 | 17% | 24% | 22% |
| **Gas Boilers** | | | |
| Number of Homes with Natural Gas or Propane Boiler Data | 16 | 34 | 50 |
| Average Natural Gas and Propane Boiler AFUE | 89.5 | 87.9 | 88.4 |
| Percent ENERGY STAR Natural Gas or Propane Boilers | 100% | 79% | 86% |
| **Oil Boilers** | | | |
| Number of Homes with Oil Boiler Data | 5 | 31 | 36 |
| Average Oil Boiler AFUE | 85.5 | 86.1 | 86.0 |
| Percent ENERGY STAR Oil Boilers | 80% | 84% | 83% |

**(Table 2–2 continued)**

| Building Characteristic | On-site Audits of Homes Built by Interviewed Builders | On-site Audits of Homes NOT Built by Interviewed Builders | All On-site Audits |
|---|---|---|---|
| **Gas Furnaces** | | | |
| Number of Homes with Natural Gas or Propane Furnace Data | 3 | 11 | 14 |
| Average Natural Gas and Propane Furnace AFUE | 92.7 | 91.4 | 91.7 |
| Percent ENERGY STAR Natural Gas or Propane Furnaces | 100% | 91% | 93% |
| **Oil Furnaces** | | | |
| Number of Homes with Oil Furnaces | 0 | 2 | 2 |
| Average Oil Furnace AFUE | na | 80.0 | 80.0 |
| Percent ENERGY STAR Oil Furnaces | na | 0% | 0% |
| **All Heating Systems** | | | |
| Number of Homes with Heating System Efficiency Data* | 26 | 78 | 104 |
| Average Heating System AFUE ** | 89.4 * | 87.5* | 87.9 |
| Percent ENERGY STAR Heating Systems | 92%* | 81%* | 84% |
| **Lighting** | | | |
| Number of Homes with Lighting Data | 26 | 79 | 105 |
| Percent of Homes with CFLs Installed | 96%* | 77%* | 82% |
| Percent of Homes with CFLs in Storage | 27% | 28% | 28% |
| Percent of Homes with Dimmable Incandescent Bulbs Installed | 15% | 14% | 14% |
| Average Number of CFLs per Home | 12.7 | 14.4 | 14.0 |
| Average Number of Incandescent and CFL Bulbs per Home | 57.8 | 57.2 | 57.3 |
| Proportion of Incandescent and CFL Bulbs that are CFLs | 22% | 25% | 24% |
| Average Proportion of Incandescent and CFL Bulbs that are CFLs | 28% | 30% | 29% |

*Significantly different at the 90% confidence level.

# 3 ENERGY STAR Awareness

Most surveyed homeowners (91%) are aware of the ENERGY STAR label and 80% of these homeowners showed a good understanding of what the label means. Awareness among surveyed Vermont homeowners is higher than national awareness rates reported in the "National Awareness of ENERGY STAR for 2008"[17] report. Nationally, awareness of the ENERGY STAR label was 58% unaided recognition in 2007 and 62% in 2008; aided recognition was 74% in 2007 and 76% in 2008; in markets where utilities or other organizations use the ENERGY

[17] http://www.cee1.org/eval/2008_ES_survey_rep.pdf

STAR label to promote energy efficiency, unaided awareness was 66% and aided awareness was 80% in 2008.

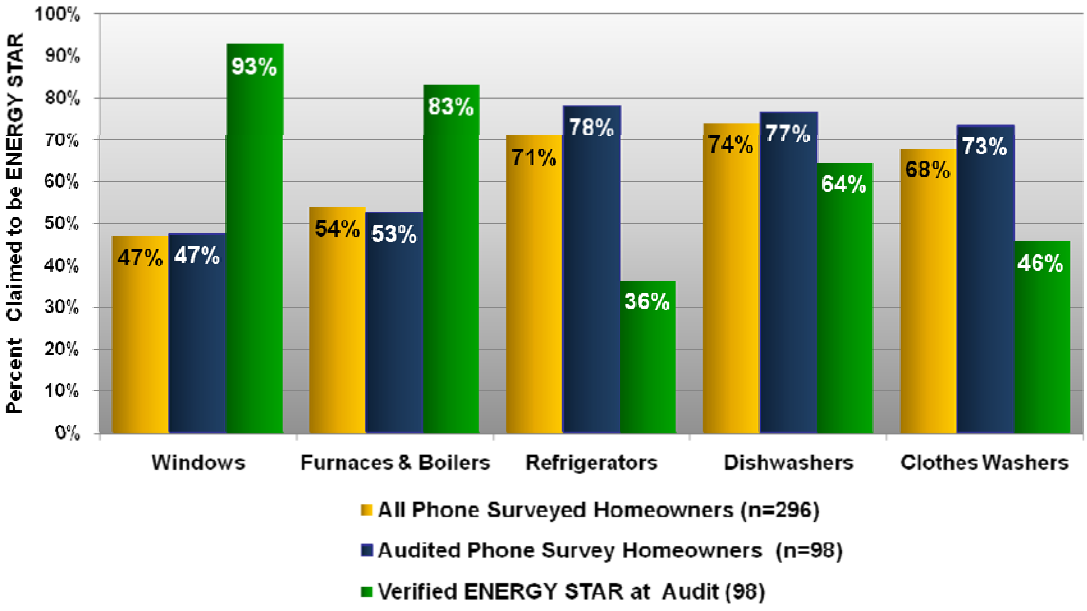
Most homeowners (81%) also said that they had heard of or seen a newly constructed home referred to as an ENERGY STAR home. Of homeowners aware of ENERGY STAR homes, 71% report that they were aware before they started shopping for or planning a new home. However, fewer than one-half (42%) of homeowners who said that they are aware of ENERGY STAR homes said that they are aware of the VESH Program.

## 3.1 Homeowner Perception of Efficiency versus Actual Efficiency

Despite high awareness of the ENERGY STAR label among Vermont homeowners, combining information from the on-site inspections and the homeowner survey shows that many homeowners are unable to provide accurate information on whether or not their windows, heating systems, and appliances are ENERGY STAR labeled.

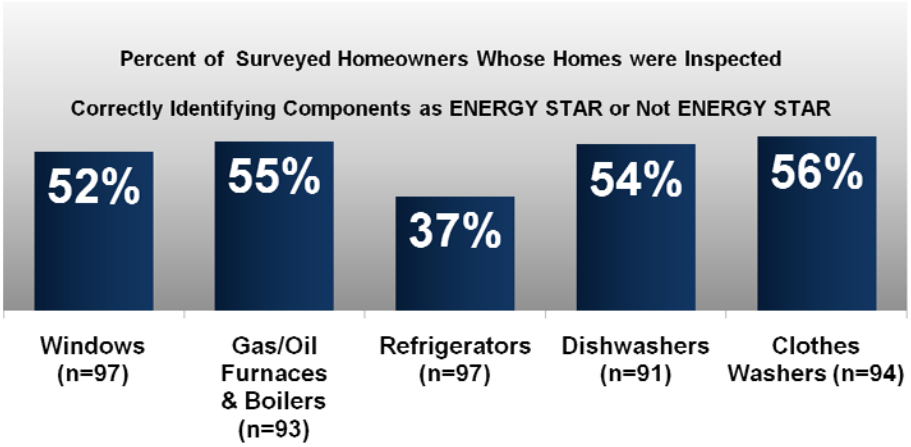
Homeowners were asked if they believed various components of their homes are ENERGY STAR qualified, energy efficient but not ENERGY STAR labeled, of average efficiency, or not energy efficient. Figure 3–1 shows the percentages of all surveyed homeowners saying the windows, furnaces/boilers, and appliances in their homes are ENERGY STAR qualified, the percentages of surveyed homeowners whose homes were audited saying these components of their home are ENERGY STAR qualified, and the percentages of audited homes where auditors verified that these components are ENERGY STAR qualified. As shown, the percentages of all surveyed homeowners and those whose homes were inspected saying specific components in their home are ENERGY STAR qualified are very similar. However, on-site audit findings show much higher percentages of ENERGY STAR-qualified windows and furnaces/boilers, much lower percentages of ENERGY STAR-qualified refrigerators and clothes washers, and a somewhat lower percentage of ENERGY STAR-qualified dishwashers. (Note that study estimates of ENERGY STAR appliance percentages are likely conservative.)

**Figure 3–1: Perceived vs. Actual ENERGY STAR Penetrations**




Comparing how individual homeowners described the energy efficiency of various components in their home to what auditors found during the on-site audit, many homeowners described ENERGY STAR-qualified components as not ENERGY STAR qualified or described non-ENERGY STAR-qualified components as ENERGY STAR qualified. Figure 3–2 shows the percentage of owners of audited homes correctly identifying the ENERGY STAR status of the windows, gas and oil heating systems, and appliances in their homes. As shown, just over half of homeowners accurately described the ENERGY STAR status of their windows, heating systems, dishwashers, and clothes washers. Homeowners were least likely to accurately describe the ENERGY STAR status of their refrigerators (37%). Overall, homeowners were correct just over half of the time about the ENERGY STAR status of their windows, heating systems, and appliances—only slightly better than would happen by chance.

**Figure 3–2: Homeowners Correctly Identifying ENERGY STAR Components**



## 3.2 Home Component Efficiencies by Who Selected

Homeowners were asked to identify who selected the framing, insulation, windows, heating system, water heating system, appliances, and lighting fixtures in their homes. For each home component they were asked if they specified it, if they selected it from options offered by their builder, or if the builder or architect chose it.

Table 3–1 on the next page shows how the homes of 95 homeowners who participated in both the homeowner phone survey and on-site inspections were purchased and the percentage of homeowners in each purchase category who say they selected all key building envelope components (windows, level and type of insulation, and framing) and the percentage of homeowners who say they selected both their space and water heating systems.

All nine homeowners who say they built their own home say they selected all of the following: windows, level and type of insulation, and framing. All three homeowners who say they purchased land and ordered a modular home say they selected both water heating and space heating systems. Owners of modular homes saying they selected their water and space heating systems is reasonable because these systems are not typically included in modular home packages. Overall, 29% of homeowners say they selected the framing, type and level of insulation, and windows in their homes, and 39% of homeowners say they the selected their water and space heating systems. (Many more homeowners say they selected individual components of their homes; this will be addressed later in this section.)

One might expect almost all homeowners who say they built their own home or acted as the general contractor to say they selected all the components of their home. However, as

Table 3–1 shows, only 52% to 61% of these homeowners say that they selected the framing, type and level of insulation, and windows, and only 56% to 58% say they chose both their water heating and space heating systems. Obviously, many of these homeowners relied on the builders and subcontractors they worked with to select some of the key components in their homes.

**Table 3–1: How Home Purchased and Who Selected Home components**

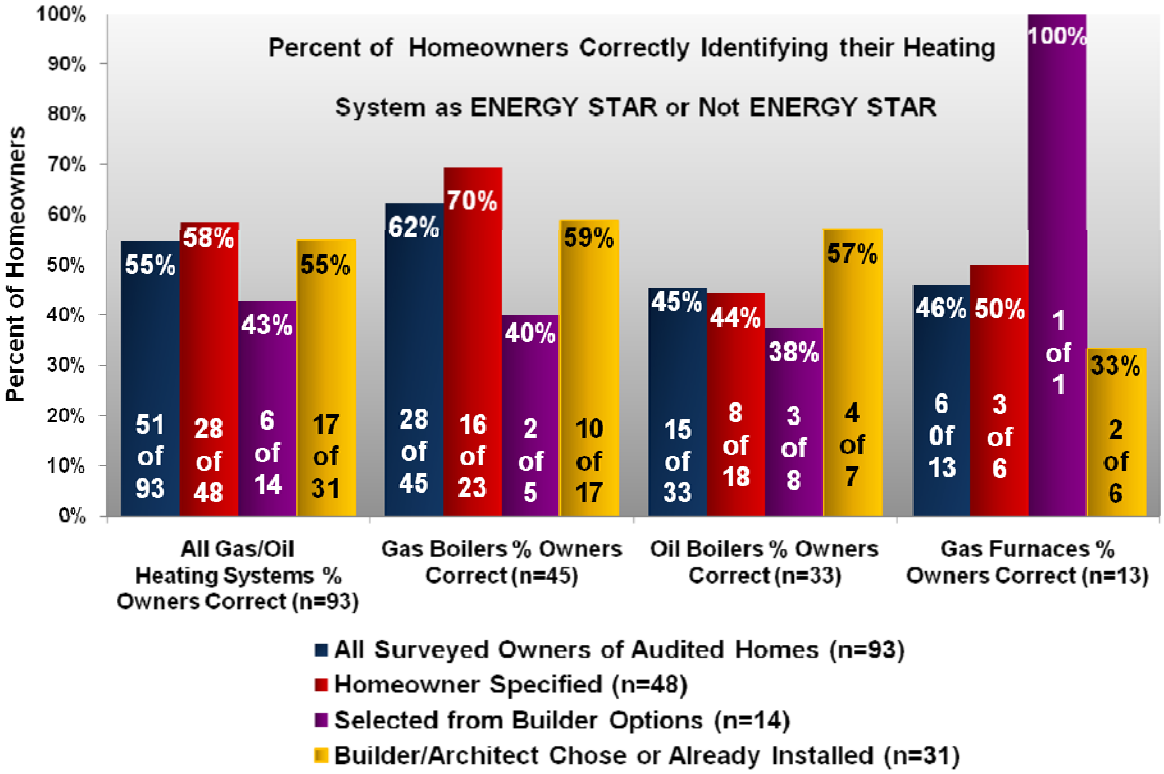
| How Purchased Home | Number of Homeowners | Percentage of Homeowners who Specified all of the Following: Windows, Insulation Level and Type, and Framing | Percentage of Homeowners who Specified Both Water Heater and Heating System |
|---|---|---|---|
| Purchased land and worked with an architect and/or builder to design and build the home. | 37 | 22% | 38% |
| Had a house plan and a lot and hired a contractor/builder to build the home. | 21 | 48% | 48% |
| Purchased land and built home myself. | 9 | 100% | 78% |
| Purchased land and ordered a modular home. | 3 | 33% | 100% |
| Rebuilt an existing home. | 1 | 0% | 0% |
| Purchased a lot from a builder, selected one of several house plans offered by the builder and selected from various available upgrade options. | 4 | 0% | 25% |
| Purchased a home that was under construction and selected from various available upgrade options. | 11 | 0% | 18% |
| Purchased a finished home. | 9 | 0% | 0% |
| **Total:** | **95** | **29%** | **39%** |

| Homeowners who Acted as their Own General Contractor or Builder | Number of Homeowners | Percentage of Homeowners who Specified Windows, Insulation Level and Type, and Framing | Percentage of Homeowners who Specified Water Heater and Heating System |
|---|---|---|---|
| Including Owners who Built their Own Home | 31 | 61% | 58% |
| Excluding Owners who Built their Own Home | 25 | 52% | 56% |

One might expect homeowners who say they specified specific components in their home to be more likely to know if these components are ENERGY STAR qualified. However, this is not necessarily true. It appears that when homeowners say they specified their windows, heating systems, or appliances they may have specified what type of windows, heating system or appliances they wanted, but not necessarily the efficiency of these components. For example, they may have specified the window style they wanted; that they wanted a boiler, not a furnace; or that they wanted a stainless steel dishwasher and a side-by-side refrigerator. Using heating systems as an example, Figure 3–3 shows that there is almost no difference between the percentage of all surveyed homeowners whose homes were inspected (55%) and the percentage of homeowners who say they specified the furnace or boiler (58%) able to accurately describe

their furnace or boiler as ENERGY STAR or not ENERGY STAR. In some cases the number of homeowners falling into a specific heating system/how specified category are very small. Therefore, the number of homeowners correctly identifying the efficiency of their heating system and the total number of homeowners falling into each heating system/how specified category are included in each data column. (Not included in Figure 3–3 are two homes with AFUE 80 oil furnaces and eight homes where owners said they did not know the efficiency of their heating system.)

**Figure 3–3: Homeowners Correctly Identifying ENERGY STAR Heating Systems**




Gas boilers are the one type of heating system for which homeowners who say they specified the equipment were able to more accurately describe the ENERGY STAR status of their heating system than homeowners who said either that they selected their boiler from options offered by their builder or that their builder or architect specified the boiler. There are two plausible explanations for why homeowners with gas boilers are more likely to know if they have an ENERGY STAR-qualified boiler. First, builders may be explaining the benefits of installing one of the more energy-efficient—and more expensive—wall-hung condensing gas boilers now available instead of a traditional gas boiler. Second, the highly efficient wall-hung condensing boilers do not look anything like a traditional boiler; therefore, homeowners who have a wall-hung condensing gas boiler, and know what their boiler looks like, may not know the AFUE of their boiler, but know that it is a very energy-efficient heating system.

Table 3–2 shows who surveyed homeowners say selected the windows, level of insulation, type of insulation, and type of framing in their homes; the average efficiency of the components by who homeowners say selected the components; and the percent of homeowners who believe the components are ENERGY STAR. As shown, many homeowners described the level and type of insulation in their homes as ENERGY STAR, but these components do not have ENERGY STAR ratings.[18] The average efficiency of windows and insulation levels are similar regardless of who homeowners say selected them. No matter who homeowners say selected the windows, many homeowners do not know they have ENERGY STAR windows. Homes where homeowners say the builder or architect selected the framing are least likely to have 2x8 framing or SIPs walls.

**Table 3–2: Who Specified Building Components and Efficiency of Selections**

| Who Specified Building Shell Components → | Homeowner Specified | Selected from Builder Options | Builder/Architect Selected or Already Installed |
|---|---|---|---|
| **Windows** | | | |
| **Number of Homeowners** | **50** | **15** | **33** |
| Window Average U-value | 0.34 | 0.34 | 0.35 |
| Percent Verified ENERGY STAR | 92% | 93% | 91% |
| Percent Owners Claim ENERGY STAR | 54% | 47% | 36% |
| **Wall Insulation Level** | | | |
| **Number of Homeowners** | **42** | **16** | **38** |
| Average R-value | 22 | 23 | 20 |
| Percent Greater than R-19 | 40% | 25% | 13% |
| Average R-value | 27 | 34 | 29 |
| Percent Owners Claim ENERGY STAR | 55% | 25% | 24% |
| **Wall Insulation Type** | | | |
| **Number of Homeowners** | **41** | **15** | **41** |
| Percent Fiberglass Batts or Log Homes | 54% | 80% | 85% |
| Percent not Fiberglass Batts* | 46% | 20% | 15% |
| Percent Owners Claim ENERGY STAR | 46% | 40% | 27% |
| **Type of Framing** | | | |
| **Number of Homeowners** | **40** | **13** | **44** |
| Percent 2x4 | 8% | 0% | 5% |
| Percent 2x6 | 78% | 77% | 93% |
| Percent 2x8 or SIPs | 15% | 23% | 2% |

Homes of owners who say they selected the type of insulation used in their homes are considerably less likely to have fiberglass batt insulation. Homes of owners who say they selected the type of framing, or chose it from options offered by the builder, are less likely to have 2x6 framing and more likely to have 2x8 framing or SIPs walls than homes where the architect or builder selected the framing.

[18] Some specific insulation products are ENERGY STAR rated, but not generic types of insulation.

Table 3–3 shows who owners of inspected homes say selected the water heating and space heating systems in their homes; the average efficiency of the systems by who homeowners say selected them; and the percent of homeowners who believe the systems are ENERGY STAR.

As shown, many homeowners described their water heaters as ENERGY STAR even though no water heaters had ENERGY STAR ratings at the time of the survey. The average water heater Energy Factor is highest in homes where owners said they selected the water heater, and all the homes with on-demand or solar assisted water heating are homes where the owner said they selected the water heating system. Also, homes where owners said they selected the water heating system are less likely to have stand alone tanks. The percentages of homes with integrated tanks vary little by who homeowners say selected the water heating system.

**Table 3–3: Who Specified Mechanical Equipment and Efficiency of Selections**

| Who Specified Mechanical Equipment → | Homeowner Specified | Selected from Builder Options | Builder/Architect Selected or Already Installed |
|---|---|---|---|
| **Water Heaters** | | | |
| **Number of Homeowners** | **45** | **9** | **39** |
| Water Heater Average Energy Factor | 0.78 | 0.72 | 0.74 |
| Percent Integrated with Tank | 71% | 67% | 74% |
| Percent On-demand or Solar Assisted | 16% | 0% | 0% |
| Percent Storage Stand Alone | 9% | 22% | 23% |
| Percent Tankless Coil | 4% | 11% | 3% |
| Percent Owners Claim ENERGY STAR | 60% | 22% | 38% |
| **Heating System** | | | |
| **Number of Homeowners** | **51** | **14** | **31** |
| Average Heating System AFUE | 87.8 | 86.7 | 88.2 |
| Percent ENERGY STAR | 80% | 79% | 87% |
| Percent Owners Claim ENERGY STAR | 55% | 50% | 52% |
| **Gas Boilers** | | | |
| **Number of Homeowners** | **23** | **5** | **17** |
| Gas Boiler Average AFUE | 88.3 | 86.9 | 88.0 |
| Percent ENERGY STAR | 83% | 80% | 88% |
| Percent Owners Claim ENERGY STAR | 70% | 60% | 59% |
| **Oil Boilers** | | | |
| **Number of Homeowners** | **18** | **8** | **7** |
| Oil Boiler Average AFUE | 86.2 | 85.8 | 86.0 |
| Percent ENERGY STAR | 89% | 75% | 86% |
| Percent Owners Claim ENERGY STAR | 44% | 38% | 57% |
| **Gas Furnaces** | | | |
| **Number of Homeowners** | **7** | **1** | **6** |
| Gas Furnace Average AFUE | 90.4 | 93.0 | 92.7 |
| Percent ENERGY STAR | 71% | 100% | 100% |
| Percent Owners Claim ENERGY STAR | 43% | 100% | 33% |

Regardless of who owners of inspected homes say chose their heating system, many do not know they have an ENERGY STAR heating system. The average heating system AFUE and the percent of heating systems that are ENERGY STAR vary little by who homeowners say selected the heating system and what type of heating system was selected.

Table 3–4 shows who owners of inspected homes say selected the appliances and lighting fixtures in their homes; the average efficiency of appliances and lighting by who homeowners say selected them; and the percent of homeowners who believe their appliances and lighting are ENERGY STAR. A large majority of homeowners say they selected their appliances and somewhat fewer homeowners say they selected their lighting fixtures. As shown, homeowners claimed higher percentages of ENERGY STAR appliances than auditors were able to verify. Homes with the highest percentages of verified ENERGY STAR dishwashers and clothes washers are homes where the homeowner said they selected the appliances.

**Table 3–4 Who Specified Appliances and Lighting and Efficiency of Selections**

| Who Specified Appliances and Lighting → | Homeowner Specified | Selected from Builder Options | Builder/Architect Selected or Already Installed |
|---|---|---|---|
| **Refrigerators** | | | |
| **Number of Homeowners** | **84** | **2** | **11** |
| Percent Verified ENERGY STAR | 36% | 50% | 36% |
| Percent Owners Say are ENERGY STAR | 80% | 50% | 73% |
| **Dishwashers** | | | |
| **Number of Homeowners** | **77** | **3** | **11** |
| Percent Verified ENERGY STAR | 69% | 33% | 36% |
| Percent Owners Claimed ENERGY STAR | 79% | 33% | 64% |
| **Clothes washers** | | | |
| **Number of Homeowners** | **90** | **0** | **4** |
| Percent Verified ENERGY STAR | 47% | na | 25% |
| Percent Owners Claimed ENERGY STAR | 74% | na | 50% |
| **Hard-wired Lighting Fixtures** | | | |
| **Number of Homeowners** | **68** | **6** | **24** |
| CFLs—Avg. Percent of All Bulbs in Home | 35% | 15% | 18% |
| Percent of Homes with Screw-in and/or Pin-based CFLs | 79% | 83% | 79% |
| CFLs—Avg. Percent of All Bulbs in Homes with Screw-in and/or Pin-based CFLs | 43% | 18% | 23% |
| Percent of Owners who Claimed Lighting is ENERGY STAR | 35% | 33% | 29% |

Homeowners were asked who selected the lighting fixtures in their home. Because auditors were not always able to determine whether lighting fixtures had screw-in or pin-based bulbs, we do not have specific information on lighting fixtures from the on-site inspections. On-site inspections provided information on the number of CFL bulbs installed and the number of incandescent bulbs installed. The percentage of homeowners saying they have ENERGY STAR lighting and the percentage of homes auditors verified as having CFL bulbs are relatively

consistent regardless of who homeowners say selected the hard-wired fixture. However, CFL bulbs are a higher percentage of all bulbs in homes where the owners said they selected the hard-wired fixtures.

# 4 EVT Awareness and Participation

A majority of surveyed homeowners and all of the interviewed builders and contractors are aware of EVT. Surveyed homeowners are much less likely than interviewed builders or subcontractors to say that they have participated in an EVT program.

## 4.1 Homeowners

Almost two-thirds (63%) of all surveyed homeowners are aware of EVT, but only slightly more than one-third (38%) of homeowners aware of EVT (23% of all homeowners) say that they have participated in an EVT program; these percentages are likely low because some EVT programs, such as the CFL markdowns, are transparent to the customer. More than one-third (38%) of homeowners who say that they participated in an EVT program (9% of all homeowners) say that they participated in the Compact Fluorescent Lights (CFL) rebate program. Other EVT programs that ten percent or more of homeowners who said they participated in an EVT program mentioned are the ENERGY STAR Homes Program (30% of homeowners who participated in EVT programs or 7% of all homeowners), energy audits (24% of homeowners who participated in EVT programs or 6% of all homeowners), clothes washer rebate (15% of homeowners who participated in EVT programs or 3% of all homeowners), and Home Performance with ENERGY STAR (10% of homeowners who participated in EVT programs or 2% of all homeowners).

Overall, nearly all respondents are satisfied or very satisfied with the Efficiency Vermont programs in which they have participated. Only two homeowners who participated in the programs mentioned above said they were dissatisfied. Both dissatisfied homeowners participated in the CFL bulb rebate program; one homeowner said that the bulbs did not work well or that they broke, and the second homeowner said that LED lights will soon replace CFLs.

## 4.2 Builders

All 25 interviewed builders are familiar with EVT and 24 of the 25 builders are aware of Vermont's ENERGY STAR Homes Program. Builders who have worked with EVT value the training and support EVT provides. Most builders who say they have had energy-related training (10 out of 16) mention EVT-based training; one builder who did not cite EVT as providing training says he learned how to build homes from an EVT book; another six builders have worked with EVT to successfully build ENERGY STAR homes. This puts EVT in a position to offer appropriate training opportunities to builders at all levels of energy-efficiency awareness.

Four of five interviewed builders who say they have not built an ENERGY STAR home are familiar with the VESH Program. All five builders who say have not built an ENERGY STAR home say they would be interested in building an ENERGY STAR home, especially if a client requested an ENERGY STAR home.

## 4.3 Insulation Contractors

All ten of the interviewed insulation contractors are familiar with EVT and seven say that they are familiar with EVT programs or rebates. Six interviewed insulation contractors attended BPI training courses sponsored by EVT and say that they were satisfied with the course. In addition, two insulation contractors have attended an EVT Better Buildings by Design Conference. One insulation contractor who is involved with the EVT Home Performance with ENERGY STAR Program believes it provides good training and support, and that EVT marketing is helpful, particularly the sponsoring of trade shows and inviting contractors to host booths. Another insulation contractor is familiar with the EVT rebates for ENERGY STAR appliances and lighting products and reports that the BPI auditors sometimes recommend his company for projects.

Six insulation contractors who work on new homes are aware of Vermont's ENERGY STAR Homes Program. Only one contractor reports charging builders more to work on ENERGY STAR homes due to the extra labor and materials needed to meet air sealing requirements, but he was not able to provide an estimate of the incremental cost. One contractor says that one of the advantages of working on ENERGY STAR homes is that the strict air sealing requirements gives him a competitive advantage; he also believes ENERGY STAR builders are more knowledgeable regarding energy efficiency so less explaining is necessary. Another contractor mentions that owners of ENERGY STAR homes know the job was done right because of the testing. One insulator reports he has created a niche market helping builders and owners participate in the ENERGY STAR Homes Program.

Two insulation contractors believe the program has lax air sealing requirements. One of these contractors reports that he has been called in to fix the insulation on some ENERGY STAR homes. He says, "Some auditors are not doing a good job catching builder mistakes, especially regarding air infiltration in dormers."

## 4.4 HVAC Contractors

All ten HVAC contractors interviewed have heard of EVT and nine of the ten are familiar with EVT programs or rebates. All nine HVAC contractors familiar with EVT programs or rebates could name a specific EVT program or rebate. Nearly all interviewed HVAC contractors are aware of the Vermont ENERGY STAR Homes, ENERGY STAR furnace rebates and ENERGY STAR central air conditioning rebates; seven contractors say that they have participated in at least one of these programs. Of the seven HVAC contractors who have participated in an EVT program, two are very satisfied, two are satisfied, one is neither satisfied nor dissatisfied, and two are dissatisfied.

When asked what aspects of the EVT programs work well, two contractors responded that the programs help encourage customers to adopt more efficient equipment, and one simply stated that he thinks it is important that EVT is getting the information out. When asked how the programs could be improved, three contractors offered suggestions. Suggestions focus on improving outreach to contractors and customers, improving the continuity of the programs, and simplifying the rebate process.

Only one contractor was familiar with any rebates or programs offered by Vermont Gas— the Natural Gas Hot Air Furnace Rebate—but has not participated in the rebate program.

# 5 Builders

The 25 interviewed builders are a diverse group serving diverse markets. There are builders who built one or two homes in 2007 and builders who built 14 or 15 homes. There are modular and stick-built home builders, custom- and spec-home builders, ENERGY STAR and non-ENERGY STAR builders, builders who serve the first-time homebuyer market and builders who serve the multi-million dollar custom and vacation home market. Some builders sub all their work out and/or hire part-time help as needed; some have full-time staff; one is a father and son business. Some builders do no advertising except maybe a sign on their truck—all their business comes from word-of-mouth—while other builders have sophisticated websites. One builder was the managing contractor for one of the ABC television program "Extreme Makeover: Home Edition" homes.

Given the wide diversity of builders, it is difficult to group them when discussing their responses to interview questions. There are some statistically significant differences in interview responses between builders falling into different categories based on the number of homes they built in 2007; their concentration on residential new construction work; the type, size, and price of homes they build; experience building ENERGY STAR homes; and how they market energy efficiency. However, the sample sizes are small and, in most cases, the characteristics of the individual builders in any one sub-group category vary considerably. For example, builders of one or two homes in 2007 include builders with from one to 18 employees and with from 10% to 100% of their residential work in new construction; some built only custom homes, some built only spec homes, and one built both spec and custom homes; the homes they built ranged from less than 2,000 square feet to over 5,000 square feet and were priced from $230,000 to $3,000,000. Builders of three or more homes include builders with from one to 80 employees and with from 30% to 100% of their revenue coming from residential work; some built only custom homes, some built both spec and custom homes, and one built only spec homes; the homes they built ranged from 900 square feet to 7,000 square feet and were priced from $120,000 to $3,000,000. Therefore, we believe the results are not particularly useful for program planning purposes and provide little insight on how to target unique builder groups. With a larger sample it would be possible to separate builders into sub-groups that include more than just three or four builders with several common characteristics, for example small high-end custom-home builders or large spec-home builders.

Almost two-thirds of interviewed builders (64% or 16 builders who built 50% of the homes built in 2007 by interviewed builders) say they and/or their employees have had energy-related training. The most frequently mentioned type of training is EVT-based training. Combining builders who say that they have had some type of formal energy-related training with those who have received on-site training from EVT, almost three-fourths of interviewed builders (73%) who built 56% of the homes built in 2007 by interviewed builders have had some type of energy-related training.

All interviewed builders are familiar with EVT and they clearly listen to, respect, and value the advice and support EVT provides. Several builders mentioned at some point in the interview that builders who are not familiar with, or not having their homes certified through, the VESH Program will need to know what ENERGY STAR builders are doing and what they are telling their clients if they [non-ENERGY STAR builders] want to remain competitive. This suggests that many builders not currently participating in EVT programs may soon, if not already, be hungry for information and training that will enable them to effectively compete for clients demanding energy-efficient homes. EVT is clearly in a position to offer appropriate training opportunities to builders at all levels of energy-efficiency awareness.

Looking ahead, EPA is proposing several more changes to the requirements for ENERGY STAR certification; their plan is to introduce the changes in 2010 and fully implement them in 2011. Training becomes particularly important when program requirements change to ensure both new and experienced ENERGY STAR builders are aware of what will be required for certification and are prepared to implement necessary changes in their construction process to meet all program requirements. Ideally, training on new requirements will take place before builders start construction on homes having to meet the new requirements; this will help to minimize the hassle and inconvenience of builders having to make changes during construction.

Several builders talked about building "5 Star ENERGY STAR homes." However, 5 Star and ENERGY STAR requirements are no longer consistent; a 5 Star home requires a HERS index of 71 to 85, and ENERGY STAR certification in Vermont requires a HERS index of 80 or lower. We understand EVT is working to break the link between 5 Star and ENERGY STAR homes in program marketing and, based on the builder interviews, this will be a challenge because builders seem to fixate on the number of stars their homes earn. It is important that EVT do all it can to educate both builders and potential homebuyers on what is required for a home to be ENERGY STAR certified to preserve the value of the ENERGY STAR label on a home

## 5.1 Current Building Practices

Interviewed builders are building energy-efficient homes—none of the interviewed builders could be categorized as building inefficient homes. They all use efficient framing practices, over one-half say they always exceed the RBES R-19 requirement for wall insulation, almost one-third say they use spray foam to insulate walls, almost two-thirds say they always exceed the RBES R-38 requirement for flat ceiling insulation, and they all say they install ENERGY STAR windows. (Three builders say they install windows with U-values below 0.30 and two additional builders mention using triple-pane windows.) Twenty-two of the 25 builders say they always install ENERGY STAR boilers, several builders are installing high-efficiency condensing wall-hung gas boilers, and four builders installed ground source heat pumps last year. Nine builders have received the $2,000 federal tax credit for some of their homes (42 homes total), and another builder was planning on submitting six homes at the time he was interviewed. Although, as mentioned earlier, builders agreeing to be interviewed are likely to use better-than-average building practices, it appears there are many Vermont builders who are capable of building well beyond minimum ENERGY STAR standards, some who do not currently participate in the VESH Program, and who are receptive to trying new things.

## 5.2 Interest in Building Beyond ENERGY STAR

Just over two-thirds of interviewed builders (17 of 25) are aware of green building programs and could name at least one program. All of these 17 builders are familiar with LEED homes, six builders are familiar with Vermont green building programs, and two builders are familiar with net-zero energy homes. Individual builders named a variety of additional programs.

Six of the 25 interviewed builders are either currently building or considering building a green home. Three builders, including two who have not built ENERGY STAR-qualified homes in Vermont, say they are currently building to a green building program's standards—two are building to LEED standards and one to National Association of Home Builders (NAHB) National Green Building Standard™ Program requirements. Three additional builders are considering building homes to meet green building standards: one says he may seek a LEED rating on a home he is currently building through the VESH Program; another ENERGY STAR builder says he may personally build a home this year that will approach LEED standards; and an ENERGY STAR builder and manufacturer of modular homes says he may build a LEED development this year.

Eighteen builders say they currently incorporate at least some green building practices in their homes. By far the most frequently mentioned practices involve recycling—mentioned by 17 builders. The second most frequently mentioned type of green practice is using more energy-efficient building practices, equipment or materials—mentioned by 12 builders. The third most frequently mentioned type of green practice is using local products—more than a third of the interviewed builders (9 builders) mention using local products, especially wood. One builder says, "We are open to anything. Clients are doing more research on this than I am—I need to catch up."

We understand that all the Vermont Green Building Network programs have adopted ENERGY STAR certification as a requirement. This provides a valuable opportunity for joint marketing.

## 5.3 Electric Savings

ENERGY STAR lighting is a key source of electric savings. Builders provide mixed views on customer interest in and satisfaction with CFL fixtures and bulbs. However, all but one interviewed builder say they install CFL fixtures in at least some of their homes and 20 of the 25 interviewed builders say they install screw-in CFL bulbs in at least some of their homes. Several builders say they have seen a big increase recently in homebuyers wanting ENERGY STAR lighting, but builders also say getting some of their clients to install ENERGY STAR lighting remains an obstacle—especially high-end custom-home clients. It seems clear that the VESH Program requirement that all certified homes have four CFL fixtures installed in non-low-use locations and offering additional rebates for installing CFL bulbs has encouraged more builders to install more of these products. Given that builders and consumers are gaining experience with CFL lighting and appear to be becoming more comfortable with its performance, it may be more a matter of time than anything else to get more builders to install more CFL lighting and more homebuyers to specify ENERGY STAR lighting.

Getting builders who install central air conditioning to install more efficient systems and perform the testing necessary to ensure the systems operate properly is another potential source of electric savings. Few new homes in Vermont have central air conditioning, but many of the homes that do are high-end custom homes. Owners of high-end custom homes are much more likely to install what their architect or builder recommends because cost is not as much of an issue for them as it is for buyers of starter or moderately priced homes. Many builders do not work directly with an architect, and almost all custom-home builders say they (the builders) play a key role in specifying materials and HVAC equipment. However, most builders also say they rely on their HVAC contractor to size and recommend equipment. Therefore, it seems important to work with both builders and HVAC contractors to encourage the installation of properly sized and tested high-efficiency air conditioning. HVAC contractors need to know that a builder is at least somewhat aware of the benefits of installing properly sized and tested high-efficiency equipment, not just interested in the lowest cost option, before they are likely to bid high-efficiency equipment including performance testing. HVAC contractors should be encouraged to submit alternate bids—one for standard equipment and one for high-efficiency, tested equipment—to builders not yet requesting high-efficiency equipment.

## 5.4 Marketing

All interviewed builders say they encourage homebuyers to make energy-efficient choices. However, when asked if they specifically market energy efficiency to homebuyers, builders are split—13 say yes and 12 say no. It appears that many interviewed builders interpreted "marketing" as paid advertising and did not include one-on-one marketing to homebuyers. Thus, to say that almost one-half (12 out of 25) of the interviewed builders, including eight who say they have built ENERGY STAR homes, do not market energy efficiency would be extremely misleading. Both groups of builders tend to say they tell buyers about the energy-efficient measures and practices used in building their homes and encourage potential buyers to make energy-efficient choices.

### 5.4.1 Obstacles to Getting Buyers to Incorporate Energy Efficiency

Builders say the biggest obstacle to getting customers to choose energy-efficient options is cost. When simply asked what the biggest obstacles are to getting home buyers to incorporate energy-efficient options, 22 of the 25 interviewed builders say cost. However, there is clearly a sizeable market of both builders and consumers ready and willing to build homes that exceed current ENERGY STAR requirements if they can find a way to do it cost effectively. Some builders are personally very interested in building more energy-efficient and green homes, and some builders say they need to get up to speed on energy-efficiency and green building because their clients know more than they do. It appears anything EVT can do to show builders how to build more energy-efficient and green homes cost effectively, perhaps using case studies and/or testimonials, would be of interest to both builders and homebuyers.

Builders were asked to rate the importance of several specific obstacles on a scale of one to five, where one means it is not an obstacle and five means it is a major obstacle. Higher equipment cost received the highest average rating (3.4), but the rating is not as high as one might expect given the dominance of cost when builders were simply asked to name the biggest obstacles to getting homebuyers to incorporate energy-efficient options. Builders may have included any increased labor cost associated with incorporating more energy-efficient options in a home when

they said "cost" was the biggest obstacle to getting buyers to incorporate more energy-efficient options, but builders were not asked to rate the importance of increased labor cost as an obstacle. Also, cost is inherent in another obstacle builders were asked to rate, "other features more important than energy efficiency," which received an average rating of 3.0. Given limited budgets and having to make choices, many homebuyers will give a higher priority to cosmetic options, such as granite counters or stainless steel appliances, than to less visible energy-efficient options.

At the other end of the spectrum, the obstacle receiving the most low ratings is concerns about equipment quality/reliability—average rating is 2.1. This is a positive finding, indicating that homebuyers have confidence that recommended high-efficiency equipment will perform reliably and suggesting that builders feel confident that the energy-efficient equipment they recommend will perform reliably and not result in call backs. One builder commented that concerns about equipment quality/reliability are not a big obstacle for buyers, but that he personally has some concerns about wall hung boilers with on-demand hot water—he installed wall hung boilers and each home required two service calls during the first year the boilers were in service.

### 5.4.2 Customer Interest in Energy Efficiency

Almost one-third of builders say all homebuyers ask about what heating and cooling cost will be, but only eight percent say all homebuyers ask about energy efficiency or how to cut heating and cooling costs. Overall, roughly one-half of interviewed builders say more than 50% of homebuyers ask about heating and cooling costs and/or energy efficiency, and one-half say 50% or fewer homebuyers ask. (The average of builders' estimates of the percentage of homebuyers asking about heating and cooling cost is 55% (median is 50%) and of homebuyers asking about energy efficiency is 58% (median is 60%).

All but three of the 25 interviewed builders say they have seen an increase in the number of homebuyers asking about energy efficiency over the last year or two. Two builders say they have seen a "**huge**" increase in buyers asking about energy efficiency. Another builder says 75% of buyers now ask about energy efficiency, but that two or three years ago only 30% asked.

In a separate series of questions builders were asked how important they think energy efficiency is to the typical homebuyer or homeowner they work with and almost all builders (84% or 21 builders) say extremely important (36%) or important (48%).

## 5.5 Custom-Home Builders

Custom-home builders were asked a series of questions addressing their role in the design of the custom homes they build and client requests for energy-efficient measures and equipment, solar options, and green building materials. All 21 custom builders say either that they recommend energy-efficient materials and equipment (15 builders) or that their standard specs are energy-efficient (six builders).

Custom-home builders play a major role in home design and equipment selection. Just over one-half of custom-home builders (55%) say they work with clients to design homes and an additional 36% say that clients provide basic architectural plans and they, the builder, work with clients to select materials and equipment.

Ten of the 21 custom-home builders say 70% or more of their clients specify or request high-efficiency materials or equipment; five of these builders say their clients want energy-efficient options, but do not know what to ask for. Several builders say clients start out wanting the highest-efficiency options, but they are the first things to be cut out of the budget. Builders say their clients are most likely to specify or request energy-efficient insulation and heating systems, followed by appliances, lighting, instantaneous hot water systems, and a tight home. Builders say their clients do not tend to specify or specifically request ENERGY STAR-labeled materials or equipment; more than three-fourths of custom-home builders (76%) say their clients only occasionally, or less often, request or specify ENERGY STAR-labeled options.

Most custom-home builders, all but three, say all of their customers last year chose energy-efficient window, heating system, and insulation options. One builder, who builds modular homes, says all his clients chose energy-efficient windows and insulation, but that HVAC equipment is not part of the modular home package and only 85% of his clients selected energy-efficient heating systems. Two builders say only 50% of their clients chose energy-efficient options. One of these builders says all his clients who chose energy-efficient options chose energy-efficient windows, heating systems, and insulation; the other builder says all of his clients who chose energy-efficient options chose energy-efficient windows and heating systems, but only one-third chose energy-efficient insulation.

One builder, who recommends very high-efficiency options, says some clients did not choose the highest energy-efficient options available. This builder recommends using spray foam insulation and says only about one-third of his clients chose spray foam. He also recommends triple pane windows, which he says are a hard sell because they are so expensive.

### 5.5.1 Custom-Home Client Interest in Solar and Green Building

Over one-half of custom-home builders say their clients ask about solar water heating (57%) and/or PV panels (52%). Almost one-fourth of custom-home builders (24%) say their clients ask about orienting their home for maximum solar gain and 5% simply say clients ask more general questions about solar options. Several builders comment that only a small percentage of clients who ask about solar measures actually end up installing them. No builders mentioned The Vermont Solar and Small Wind Incentive Program, established in 2003, which offers incentives for solar installations.[19]

Two-thirds of custom-home builders (14 builders) say at least some of their clients specify or request green building materials; six of these builders say at least one-half of their clients request green building materials. When asked what green building materials clients request, the most common response is that clients do not know what specific products to request—they think more in terms of the concept of green than specific products. Green products that two or three builders say clients request are: low VOC (Volatile Organic Compounds) products and materials such as paint and carpeting, green flooring products, local materials, cellulose insulation, fiber-cement

[19] Vermont's Solar and Small Wind Incentive Program, initiated in June 2003, provides funding for new solar water heating, solar electric (photovoltaic) and wind energy system installations. Currently in its third round of funding ($980,000), the program is available to single- and multi-family residences, businesses, farms, schools, and local & state governments.
Source: http://www.dsireusa.org/library/includes/GenericIncentive.cfm?Incentive_Code=VT17F&currentpageid=3

siding instead of vinyl siding, and natural products such as stone or slate. Other green products/practices mentioned by individual builders are straw-bale construction, recycling building wastes, and using recycled products.

## 5.6 Spec-Home Builders

Nine interviewed builders build spec homes. Seven of the nine spec-home builders say they at least sometimes offer upgrades; one of these builders offers only cabinet upgrades. The two builders who do not offer upgrade options say they install some ENERGY STAR lighting products and only ENERGY STAR appliances in their spec homes, but do not offer energy-efficient upgrades because the way they build does not lend to substitutions or they do not market their spec homes until they are finished.

Only two of the nine spec-home builders offer insulation upgrades; four builders offer and recommend ENERGY STAR appliances and lighting. One ENERGY STAR builder insists on ENERGY STAR appliances because he uses the VESH Program rebates to help pay for a high-efficiency boiler. Another ENERGY STAR builder says, "If clients choose less efficient appliances, then they have to make up the efficiency elsewhere in the home to meet VESH requirements."

Only one spec-home builder says homebuyers ordered high-efficiency upgrades last year. However, this does not mean buyers did not install energy-efficient options, because all of the spec-home builders say they always install ENERGY STAR windows, and all but one say they always install ENERGY STAR heating systems.

## 5.7 Residential Building Energy Standards

Most interviewed builders (84% or 21 builders) are familiar with RBES. Fourteen builders were able to list at least some specific RBES requirements. Several builders not able to list specific RBES requirements say that they know they meet RBES requirements either because they build ENERGY STAR homes and RBES compliance is part of that process or that the architect they work with runs the compliance model and makes sure everything complies. Only four builders say they had to make any changes in their building practices to meet RBES requirements.

Over three-fourths of interviewed builders (80% or 20 builders) say they know how many of their 2007 homes complied with RBES. Eight of these builders say they post the certificate of compliance and send a copy of the certificate to the Vermont Department of Public Service; six say they post the certificate of compliance but do not send a copy to DPS; three say they do not post the certificate of compliance or send a copy to DPS. Of the three remaining builders who say they know how many of their homes complied, one says all his homes complied, but he doesn't know how often the certificates were posted or sent to DPS; one says 50% of his homes complied and he posted and sent the certificates for these homes to DPS; and one says 80% of his homes complied and he posted the certificates, but did not send copies to DPS.

Overall, 12 (63%) of the 19 interviewed builders who built homes that received on-site audits say they at least sometimes post the RBES certificate of compliance. Auditors report that RBES

certificates of compliance were posted at homes built by eight (42%) of the 19 interviewed builders with audited homes.

## 5.8 Builders Who Say They Have Built ENERGY STAR Homes

Twenty of the interviewed builders (80%) claim they have built from one to 150 ENERGY STAR homes and say the feedback they get from homeowners homes is positive. EVT was able to verify that 19 of these 20 builders have had a home ENERGY STAR certified through either the VESH or EPA programs; one builder has enrolled several homes in the VESH Program but has not had a home certified.

The 20 builders who say they build ENERGY STAR homes built 105 homes in 2007. They claim that 49 homes (47%) they built in 2007 are ENERGY STAR certified, 40 homes (38%) are not ENERGY STAR certified, but are equivalent to the homes they had certified; and 16 homes (15%) are non-ENERGY STAR homes not equivalent to the homes they had certified. Three builders say they did not have any of their 2007 homes certified; two of these builders say none of their clients requested ENERGY STAR certification or, if they were given the option, were not interested; the other builder says, "The changes to the EVT program priced us out. We built to 2006 specs last year." EVT verified that 41 (33%) of the 123 homes built by all 25 interviewed builders in 2007, were ENERGY STAR certified through the VESH Program (38 homes) or the EPA program (3 homes).

Only two of eight builders who say they built ENERGY STAR-equivalent homes in 2007 say they ever tell buyers that their homes are equivalent to their ENERGY STAR-certified homes. This may seem low, but is consistent with what interviewed ENERGY STAR builders in Massachusetts report. Three of 24 ENERGY STAR builders interviewed in Massachusetts in 2006 said they build homes that they do not have ENERGY STAR certified, but are equivalent to their ENERGY STAR homes, and all three said they never tell buyers the homes are ENERGY STAR equivalent.[20]

[20] NMR, Inc. and Dorothy Conant. 2006 Massachusetts ENERGY STAR® Homes Builder Interview Report, Final March 27, 2007. Submitted to: The Joint Management Committee of the Massachusetts New Homes with ENERGY STAR Program.

Thirteen of 17 custom-home builders who say they build ENERGY STAR homes say they always encourage their clients to build to ENERGY STAR standards. Just over one-half of the builders who say they build ENERGY STAR homes (55% or 11 builders) say they always put the ENERGY STAR label on their certified homes; most of these builders (9 of 11 builders) say they put the label on or near the electric panel. (EVT does not tell builders where they should put the label.) The percentage of builders saying they always put the label on their ENERGY STAR homes may seem low, but, once again, is consistent with what interviewed ENERGY STAR builders in Massachusetts report. Of 16 builders of ENERGY STAR-certified homes in Massachusetts interviewed in 2006 just under one-third said they always put the label on their homes.[21]

Three builders commented on Vermont's bronze ENERGY STAR plaque—they do not like it. One builder says it is too heavy to hang on vinyl siding. Another says, "There is no good spot for it—maybe the basement, but that is awkward."

### 5.8.1 Incremental Cost of ENERGY STAR Homes

Nine of the 20 builders who say they build ENERGY STAR homes say it cost more to build an ENERGY STAR home, but only one builder says he charges more for an ENERGY STAR home, and the only extra charge is $200 for ENERGY STAR CFL lighting fixtures. Of the nine builders who say it cost more to make a home ENERGY STAR compliant, three say they do not know how much more it cost, one builder says less than 10% more, and five estimate the extra cost to be from $200 to $5,000. The wide range of incremental cost estimates is reasonable because it all depends on where a builder is starting from—for some it could be nothing and for others it could be several thousand dollars.

EVT reports that they do not have any specific data on the increased cost to builders of building an ENERGY STAR-certified home. .They say that in the past they have generally defaulted to $2,000 plus or minus based on the incremental cost for better foundation insulation and more attention to sealing thermal bypasses, but that is an estimate that is not based on an independent assessment. EVT also reports that the increased costs for lighting should be fully covered by program incentives.

### 5.8.2 Advantages and Disadvantages of Building ENERGY STAR Homes

The most frequently cited advantage of building ENERGY STAR homes is lower operating cost, followed closely by improved marketability. Other advantages cited by more than one builder are building a better home, environmental benefits, energy efficiency, and a more comfortable home. Non-ENERGY STAR builders cite similar advantages.

Eight builders think there are disadvantages to building ENERGY STAR homes. Four builders say additional cost is a disadvantage. Other disadvantages cited by individual builders include certain design limitations, the hassle, schedule delays, and additional effort. One builder says, "People get the perception you are an expensive builder—it is not going into our pocket, but into their house." The only disadvantages cited by non-ENERGY STAR builders are added cost and hassle.

[21] Ibid.

### 5.8.3 Impact on Builders Outside the Program

Over one-half of the builders who say that they build ENERGY STAR homes (12 out of 20 builders) think the program is having an effect on builders outside the program. Builders say customers are asking questions and some are requesting ENERGY STAR homes—builders need to be able to answer their clients' questions and meet their needs. ENERGY STAR materials, equipment, and building supplies are widely available and marketed, more builders and subcontractors are offering high-efficiency insulation options, and energy awareness is rising. One builder sees the VESH Program as a resource for builders to turn to as customers ask for more energy-efficient houses.

Three builders say they do not think the ENERGY STAR Homes Program has affected builders outside the program. One builder thinks if builders are building energy-efficient homes they would be doing that anyway and, if they are not, the program would not influence them to build more energy-efficient homes. Another builder does not think the program has had an impact on other builders to date, but thinks it will have an impact going forward as fewer people will be willing to settle for a minimally efficient home.

Five builders say they don't know if the program is having an impact on builders outside the program. One of these builders says, "I think it will eventually, if it hasn't already. As owners get more attuned to cost savings they will drive the market." Another builder comments that builders outside the program probably put more emphasis on cost, and are just not interested in building more energy-efficient homes.

### 5.8.4 Need for Another Premium Label

Builders who say they build ENERGY STAR homes were asked if they would like a premium label for housing that signifies a home performs better than an ENERGY STAR home. Views are mixed: 12 builders say no, six say yes, and two say they don't know. Builders who would like another label say labels mean a lot to some customers or that another label "wouldn't hurt." Builders who say a new label is not necessary say the current EVT program is working well, the administrative cost of introducing a new label would outweigh the benefits, or that there are already enough different labels.

## 5.9 Builders Who Have Not Built an ENERGY STAR Home

Only one of the five interviewed builders who say they have not built an ENERGY STAR home is not familiar with the VESH Program. Non-ENERGY STAR builders who are aware of the VESH Program say they learned about it from EVT and literature. All five builders say they would be interested in building an ENERGY STAR home, especially if a client requested an ENERGY STAR home.

# 6 Efficiency Differences in Home Groupings

This section summarizes differences in the efficiency characteristics of homes falling into different groupings. In several cases, comparisons of one group of homes to another show each group is more efficient than the other in some ways and less efficient in others. Detailed tables showing the characteristics of homes in each grouping and a summary of significant differences are in Appendix A; all differences statistically significant at the 90% confidence level are noted.

As discussed previously, ENERGY STAR homes are clearly more energy efficient than non-ENERGY STAR homes, and homes in the combined targeted regions are not that different from homes in the remainder of Vermont. There are many significant differences between homes in individual targeted regions compared to homes in all other targeted regions, but the sample sizes of inspected homes in individual targeted regions are low.

Not surprisingly, homes of owners who are not satisfied with the thermal comfort of their homes have less wall and ceiling insulation and are less likely to have 2x8 framing or SIPs walls.

Custom homes, built on land the homeowner already owned, have several more energy-efficient characteristics than spec-built homes or homes where the owner chose from home plans offered by a builder. Whether or not an architect is involved appears to have almost no impact on a home's energy efficiency. Also, there are few differences between the homes of owners who say that they built their home, or acted as the general contractor, and other homes.

Comparing detached to attached single-family homes shows detached homes are more energy efficient than attached homes in some ways and less energy efficient in other ways. Modular homes have less energy-efficient characteristics than homes built on site. There are few significant differences between homes completed in 2005 or 2006 and homes completed in 2007 or 2008.

Homes whose owners are aware of the ENERGY STAR label, are aware of EVT, say they have participated in an EVT program, or are aware of RBES have more energy-efficient characteristics. However, the homes of owners who have heard of ENERGY STAR homes are very similar to the homes of owners who have not heard of ENERGY STAR homes. Homes that owners think are ENERGY STAR, but are not, have several characteristics that are significantly less energy efficient than in verified ENERGY STAR homes.

Homes whose owners think that, in general, all new homes are energy efficient have less energy-efficient characteristics than homes whose owners do not think all new homes are energy efficient. In general, homeowners appear to have a fairly good sense of how energy efficient their homes are. Homeowners were asked how strongly they agreed or disagreed with the statement, "My new home is energy efficient." All but three homeowners, who neither agreed or disagreed, said they "strongly agreed" or "agreed." Homes of the owners who said they "strongly agreed" have more energy-efficient characteristics than the homes of owners who said they "agreed." Similarly, homes whose owners rated the energy efficiency of their homes as nine or ten on a zero to ten scale have more energy-efficient characteristics than homes whose owners gave their homes a rating of six, seven or eight—no homeowners gave a rating below six.

Homes of first-time home buyers have less wall and ceiling insulation compared to homes whose owners previously owned a home. Homes whose owners have a college degree have more energy-efficient characteristics than homes whose owners do not have a college degree. Energy efficiency does not appear to be highly related to how long owners expect to stay in their new homes, their age, or their annual income.

# 7 Insulation

Information on insulation in residential new construction was collected through a phone survey of 296 homeowners, on-site inspections of 106 homes, interviews with 25 builders, and interviews with nine insulation contractors who install insulation in new homes in Vermont.

## 7.1 Homeowners

Ninety-six percent of the 163 homeowners participating in the phone survey who were asked to rate the importance of the level of insulation in their decision to purchase or build their home rated it very important (8 to 10 on a zero to 10 scale). Forty-three percent of all surveyed homeowners say they specified the level of insulation in their homes and 42% say they specified the type of insulation. One-fifth of 90 surveyed homeowners reporting that they have energy-efficient insulation say they chose the type and level of insulation to install in their home based on builder or contractor recommendations. This is consistent with almost all (19 of 21) interviewed builders who build custom homes saying that they recommend energy-efficient insulation and that in the last year all their clients chose high-efficiency insulation options. Also, 17% of 235 surveyed homeowners who are aware of ENERGY STAR homes and who were asked how they think a new ENERGY STAR home is different from a new non-ENERGY STAR home mentioned they believe ENERGY STAR homes have better or more insulation than other homes. However, only 12% of 48 surveyed homeowners who say they discussed the energy efficiency of their home with their builder or real estate agent say they discussed insulation levels.

Seventy-six percent of all surveyed homeowners rate the energy efficiency of the level of insulation in their home as better than average and 71% rate the energy efficiency of the type of insulation used in their home as better than average efficiency. However, combining phone survey and on-site inspection data shows homeowners' ratings of the efficiency of the level of insulation in their homes are not necessarily related to the R-value of the wall insulation in their homes, and 27% of homeowners said they did not know how efficient the level of insulation in their home was. Homeowners were asked to describe the level of insulation and the type of insulation in their homes as ENERGY STAR qualified, energy efficient but not ENERGY STAR labeled, of average efficiency, or not energy efficient.[22] Figure 7–1 shows how surveyed homeowners whose homes were inspected described the level of insulation in their homes and, for each efficiency category, the percentages of homes exceeding, meeting, and failing to meet the RBES prescriptive compliance path minimum requirement of R-19 wall insulation. As shown, one-half or more of the homes in each efficiency category have R-19 wall insulation. Of the 26 homes with wall insulation exceeding R-19, owners of 17 of these homes described the level of wall insulation in their homes as ENERGY STAR, five described the insulation level as energy efficient, and four said that they did not know.

[22] There is no ENERGY STAR qualification of insulation levels, and although specific insulation products are ENERGY STAR labeled, generic types of insulation are not. However, surveyed homeowners were given the option of indentifying the level and type of insulation in their homes as ENERGY STAR.

**Figure 7–1: Perceived Insulation Level Efficiency vs. Code**

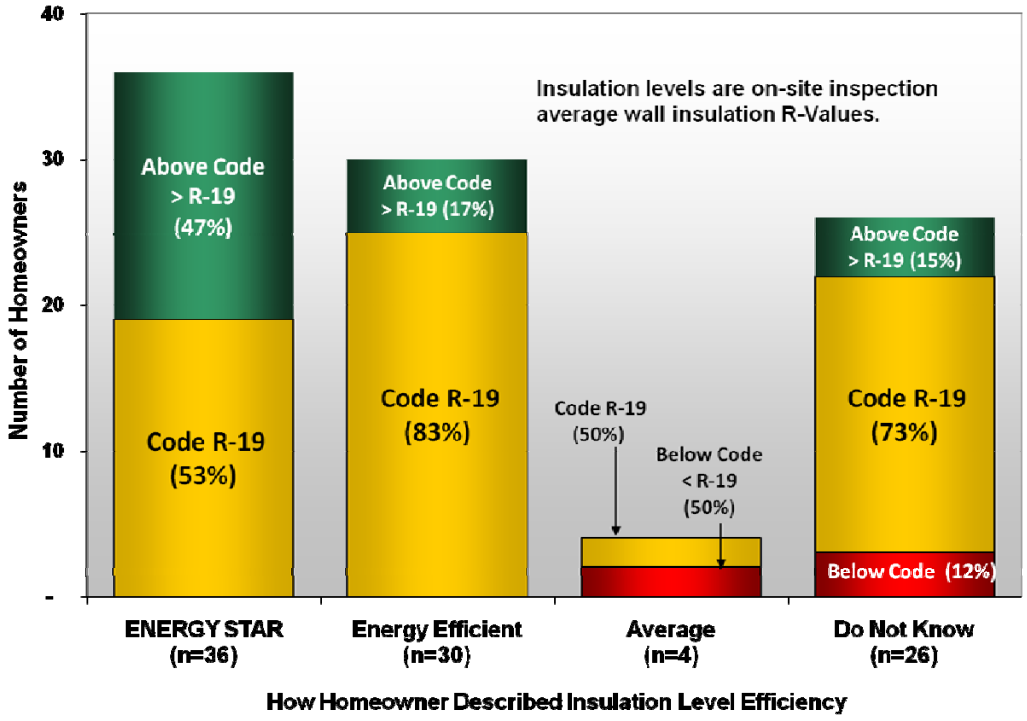
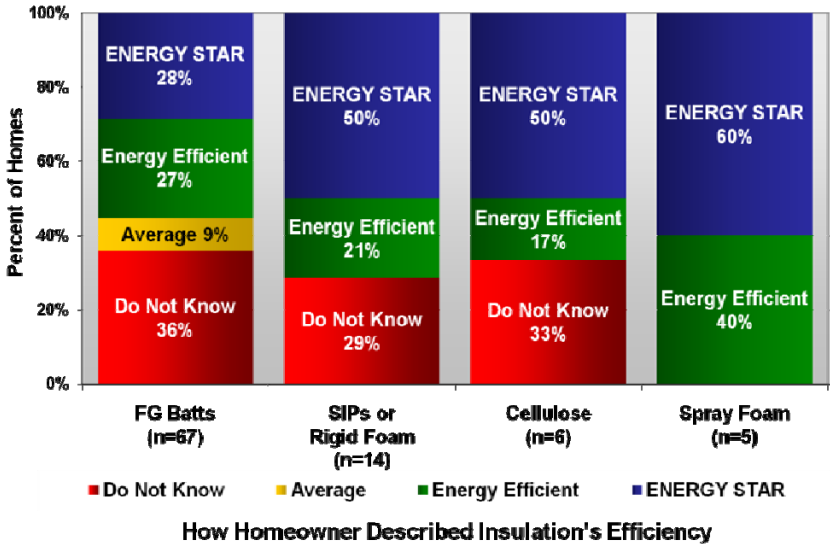



Figure 7–2 shows that surveyed homeowners whose homes were inspected also were inconsistent in how they described the efficiency of specific types of insulation. (The on-site inspection insulation type is the type of wall insulation.)

**Figure 7–2: Perceived Insulation Efficiency by Type of Insulation**




Owners of homes with fiberglass batt wall insulation described the efficiency of their insulation as ENERGY STAR (28%), energy efficient (27%), or average (9%). Owners of homes with SIPs or rigid foam wall insulation described the efficiency of their insulation as ENERGY STAR (50%) or energy efficient (21%), and owners of homes with cellulose wall insulation described the efficiency of their insulation as ENERGY STAR (50%) or energy efficient (17%). In

addition, for 29% to 36% of homes insulated with fiberglass batts, cellulose, or rigid foam (including SIPs), the homeowners said that they did not know how efficient the type of insulation used in their home was. The owners of the five homes that have spray foam wall insulation all described the type of insulation in their homes as ENERGY STAR (three homeowners) or energy efficient (two homeowners). This is not surprising because spray foam is one of the more expensive insulation options and would typically be an option that builders marketed to these homeowners as being very energy efficient. All five of these homes are custom-built homes and four of the homes are ENERGY STAR homes, but only one of the owners identified their home as being ENERGY STAR.

## 7.2 Insulation Contractors

We interviewed nine insulation contractors who work on new homes. Five of these contractors have five or fewer Vermont employees and worked on 3 to 50 new homes in Vermont in 2007; three have 7 to 13 Vermont employees and worked on 17 to 163 new homes in Vermont in 2007; and one has no employees in Vermont (all employees are located in New York) and worked on 100 new homes in Vermont in 2007.

**High Efficiency Options.** All nine interviewed contractors were asked if they include pricing options for high-efficiency options (exceeding code insulation level requirements, insulation of basement slab, using spray foam instead of fiberglass batts, air sealing, etc.) when they submit bids or proposals to owners or builders/developers of new homes. Four contractors, accounting for 62% of the new homes worked on by interviewed contractors, say that they always include pricing for high-efficiency options in their bids or proposals; two contractors (24% of homes) say they sometimes do; and three contractors (14% of homes) say they never include high-efficiency options in their bids. All interviewed contractors say that higher cost is the primary obstacle to installing extra-high efficiency insulation options.

**R-values.** Six of the interviewed insulation contractors say 25% or more of their residential work is new construction; they account for 96% of the new Vermont homes interviewed contractors worked on in 2007 (431 homes). These six contractors were asked who typically specifies the R-value of the insulation they install in new homes; two contractors say they work with the architect or builder in deciding the R-value (49% of homes), two say the architect or builder specifies the R-value (27% of homes), and two say the insulation contractor specifies the R-value (23% of homes). All six of these contractors say that over the past two years a builder or general contractor has requested that they install insulation that exceeds minimum code levels.

Seven interviewed insulation contractors say the average R-value of the insulation they install has not changed over the past few years and two say it has decreased. The two contractors who say the average R-value of the insulation they install has decreased are two of the largest interviewed contractors in terms of the number of new Vermont homes worked on in 2007; together they account for 57% of the Vermont new homes worked on by interviewed contractors in 2007. Both of these contractors install spray foam insulation and report that the formulas were changed due to ozone restrictions, thus reducing the long-term R-value. One of these contractors insulated 90 new Vermont homes in 2007 using spray foam in all 90 homes; all R-values in the homes this contractor worked on exceeded code except for flat ceilings/attics where the average insulation level was R-35 (code is R-38). The other contractor insulated 163 new Vermont

homes in 2007 using cellulose in 90% of the homes, spray foam in 8% of the homes, and other non-fiberglass batt high-efficiency options in 2% of the homes; all R-values exceeded code except for foundation walls and slabs, which were insulated to code (R-10).

**Efficiency Vermont.** All nine contractors have heard of EVT and six say they have participated in EVT programs. Only two contractors know how many ENERGY STAR homes they worked on in the past two years; one worked on 30 and one worked on one. Both of these contractors say they always include pricing for high-efficiency options when they submit bids or proposals to the owners or builders/developers of new homes.

**Air Sealing.** Nine of the ten interviewed insulation contractors report that they perform some manner of air sealing as part of their normal service. The one contractor who does not perform air sealing believes that the cellulose he installs does a good air sealing job by itself. Another contractor says that some customers do not want air sealing, they just want insulation, but that he can usually convince them to include air sealing. Most contractors report that they air seal in the attic and basement, wood-to-wood joints (including door frames, window frames, etc), and electrical and plumbing holes in the thermal envelope; a few also mention sealing light fixtures, bath fans, and the chimney. They typically use canned spray foam or caulk.

**Testing.** Six of the interviewed insulation contractors offer some type of testing: all six offer blower door tests, three offer infrared cameras, two offer combustion safety tests, and one offers theatrical fog to map air pathways.

## 7.3 On-site Inspections

### 7.3.1 Wall Insulation

Auditors recorded insulation information on conditioned/ambient, conditioned/garage, conditioned/attic and conditioned/basement walls.

Conditioned/ambient walls in a majority of inspected homes have 2x6 framing (83%) and a majority are insulated with fiberglass batts (67%). Conditioned/ambient wall insulation levels range from R-7 to R-48. The weighted statewide average level of conditioned/ambient wall insulation is R-21 and the median is R-19; only 5% of inspected homes have wall insulation levels lower than R-19, which is the minimum requirement under prescriptive RBES compliance paths, and insulation levels exceed R-19 in 29% of inspected homes.

Of the 106 inspected homes, 49 have conditioned/garage walls, nine have conditioned/attic walls, and one has a conditioned/basement wall. In the home with the wall separating conditioned space from the basement, the wall is insulated with R-19 blown-in fiberglass. Similar to conditioned/ambient walls, the majority of inspected conditioned/garage walls (85%) and conditioned/attic walls (8 of 9) have 2x6 framing and the majority are insulated with fiberglass batts (72% of conditioned/garage walls and six of nine conditioned/attic walls).

Conditioned/garage wall insulation levels range from R-6 to R-48. The weighted statewide average level of conditioned/garage wall insulation is R-21; in 12% of the 49 inspected homes with conditioned/garage walls the level of insulation is below code (R-19) and in 32% of homes insulation levels exceed code.

Conditioned/attic wall insulation levels range from R-19 to R-39. The statewide average level of conditioned/attic wall insulation in the nine homes with conditioned/attic walls is R-22 and the median is R-19. The level of insulation meets or exceeds code (R-19) in all nine homes.

### 7.3.2 Flat Ceiling Insulation

Auditors recorded insulation information for flat and cathedral (sloped) ceilings. More than half (55%) of homes have at least some cathedral ceilings; 12 inspected homes have all cathedral ceilings. The most energy-efficient practice for flat ceilings is to cover the joists with insulation; joists were covered in 82% of the 94 homes with flat ceilings.

Most (85%) of the 94 flat ceilings inspected are insulated with either cellulose (45%) or fiberglass batts (40%). Flat ceiling insulation levels range from R-19 to R-100. The overall weighted average flat ceiling insulation level is R-39 and the median is R-38. Almost one-half (46%) of flat ceilings have R-38 insulation, which is the minimum requirement under prescriptive RBES compliance paths; 26% of homes with flat ceilings have less than R-38 insulation and 28% have insulation levels exceeding R-38.

### 7.3.3 Cathedral (sloped) Ceiling Insulation

Fifty-five of the 106 inspected homes have cathedral ceilings. Cathedral ceilings are less likely than flat ceilings to be insulated with fiberglass batts or cellulose—59% of observed cathedral ceilings compared to 85% of flat ceilings. Less than half (41%) of cathedral ceilings are insulated with fiberglass batts, 29% are insulated with rigid foam (including SIPs), 18% with cellulose, and the remaining 13% of cathedral ceilings are insulated with spray foam (7%), blown-in fiberglass (4%) or a combination of cellulose and rigid foam (2%).

Cathedral ceiling insulation levels range from R-16 to R-66. The overall weighted average cathedral ceiling insulation level is R-34 and the median is R-36. Almost a quarter (24%) of cathedral ceilings are insulated to R-30, which is the minimum requirement under prescriptive RBES compliance paths; 20% of homes with cathedral ceilings have less than R-30 insulation and 56% have insulation over R-30. In 17% of homes cathedral ceiling insulation levels exceed R-40.

### 7.3.4 Floor Insulation

Inspected homes have several floor configurations including floors over unconditioned space, floors over conditioned basements, floors over garages, floors over unvented crawl spaces, and floors over outside air. The minimum insulation level requirement for floors over unconditioned spaces under prescriptive RBES compliance paths is R-30. Auditors defined conditioned space as intentionally heated space, which is different from the definition in the Vermont Residential Building Energy Code Handbook. The handbook definition of conditioned space is:

> A space is "**conditioned**" if heating and/or cooling is deliberately supplied to it or is indirectly supplied through uninsulated surfaces of water or space heating equipment, through uninsulated ducts, or though adjacent uninsulated building surfaces. Basements and crawl spaces without ceiling insulation are considered conditioned space.

Ninety-six inspected homes have basements: 41 have all unconditioned basements, 11 have partially conditioned basements, and 44 have all conditioned basements. No inspected homes have R-30 floor insulation; the highest level of floor insulation observed is R-22 and the average in homes with floor insulation is R-13.

Fifty-two inspected homes have floors over unconditioned (not intentionally heated) basement space. In most of these homes (75%) the floors are not insulated. Floor insulation levels in the 13 homes with floor insulation range from R-2 to R-21 and average R-14; none of the inspected homes have floors insulated to R-30, which is the RBES requirement for insulating floors over unconditioned space.

Forty-four inspected homes have floors over a conditioned (intentionally heated) basement. Sixty-six percent of the homes with floors over conditioned basement space have no floor insulation and 34% have floor insulation levels ranging from R-2 to R-22 and averaging R-13.

Fourteen inspected homes have floors over an unheated garage. The RBES prescriptive compliance paths require a minimum of R-30 in floors over unheated garages. In all 14 homes the floors are insulated with fiberglass batts. Insulation levels range from R-19 to R-30, average R-20 and the median is R-19; only one home has R-30 insulation.

Four inspected homes have floors over outside air. In all four homes the floors are insulated, but only one meets the RBES prescriptive compliance path minimum requirement of R-38. Two are insulated with R-19 fiberglass batts and two are insulated with rigid foam: one to R-25 and one to R-50.

Six inspected homes have floors over unvented crawl spaces; no homes have vented crawl spaces. RBES does not have a requirement for insulating floors over unvented crawl spaces. Of the six inspected homes with unvented crawl spaces, four have no floor insulation and two have floors insulated with R-19 batts.

### 7.3.5 Foundation Wall Insulation

Auditors found a multitude of foundation wall configurations. Just over one-third of homes (34%) have all below grade foundation walls enclosing conditioned (intentionally heated) basement space and just over-one-fourth of homes (27%) have all below grade foundation walls enclosing unconditioned (not intentionally heated) basement space. Only 5% of homes have all above grade foundation walls enclosing unconditioned basement space and only 3% have all above grade foundation walls enclosing unconditioned basement space. Twenty-one percent of inspected homes have a combination of above and below grade foundation walls enclosing conditioned and unconditioned basement space.

RBES prescriptive compliance paths require that below grade foundation walls be insulated to at least R-10 and above grade foundation walls be insulated to at least R-19. All foundation walls in 69% of homes with basements meet RBES requirements and 17% of homes have no foundation wall insulation. In 7% of homes all foundation walls are insulated, but none to RBES requirements. In 8% of homes the foundation walls are a mix of walls insulated to RBES standards, walls insulated to below RBES standards, and uninsulated walls.

### 7.3.6 Crawl Space Insulation

Six inspected homes have unvented crawl spaces. RBES requires that the exterior walls of unvented crawl spaces below uninsulated floors be insulated. In two of the six homes with unvented crawl spaces the floors over the crawlspace are insulated with R-19 fiberglass batts. One of these homes has no foundation wall insulation information. The other home has a partial unconditioned (not intentionally heated) basement and a 308 square foot unvented crawl space. The below grade foundation walls in this home are insulated with R-35 rigid foam; there is no information on crawl space wall insulation.

Four of the six homes with unvented crawl spaces have no insulation in the floors over the crawl spaces. One of these homes has a dirt crawl space with taped vapor barrier; the foundation is composed of 2" rigid foam board, PT sheathing and 6" of cellulose insulation—there is no concrete. Of the remaining three homes, the walls of the crawl space are not insulated in one home and for two homes there is no information on crawl space wall insulation.

### 7.3.7 Slab Insulation

RBES does not have insulation requirements for the floors of conditioned basements or crawl spaces, but requires slab on grade floors to have at least R-10 perimeter insulation, and prescriptive compliance paths require slab edge insulation. Auditors collected information on the location of slab floors in 105 homes and categorized the slabs as on grade, below grade, or a mix (on/below) grade. In some cases the auditors were unable to determine the location of slab insulation or there was no insulation.

Of slabs for which auditors were able to determine the location and level of insulation, 79% of on grade slabs, 44% of below grade slabs, and 62% of mixed grade slabs have at least R-10 insulation, which is the RBES minimum requirement. More than 44% of below grade slabs may meet RBES requirements because it is our understanding that RBES does not require slabs four feet or more below grade to be insulated. However, auditors did not report how far below grade slabs were located, so there is no way to know how many of the homes with below grade slabs meet or fail to meet RBES insulation requirements.

The average level of slab insulation over all types of slabs in homes where auditors were able to determine the level of insulation, whether or not they were able to determine the location of insulation is R-8.[23] The average insulation level for homes with multiple slabs is calculated using the procedure described in the RBES Handbook for determining the average R-value for a building component with two or more thermal values. In just over one-half (54%) of the homes where the R-value of insulation for all slabs is known, the average slab insulation level is at least R-10.

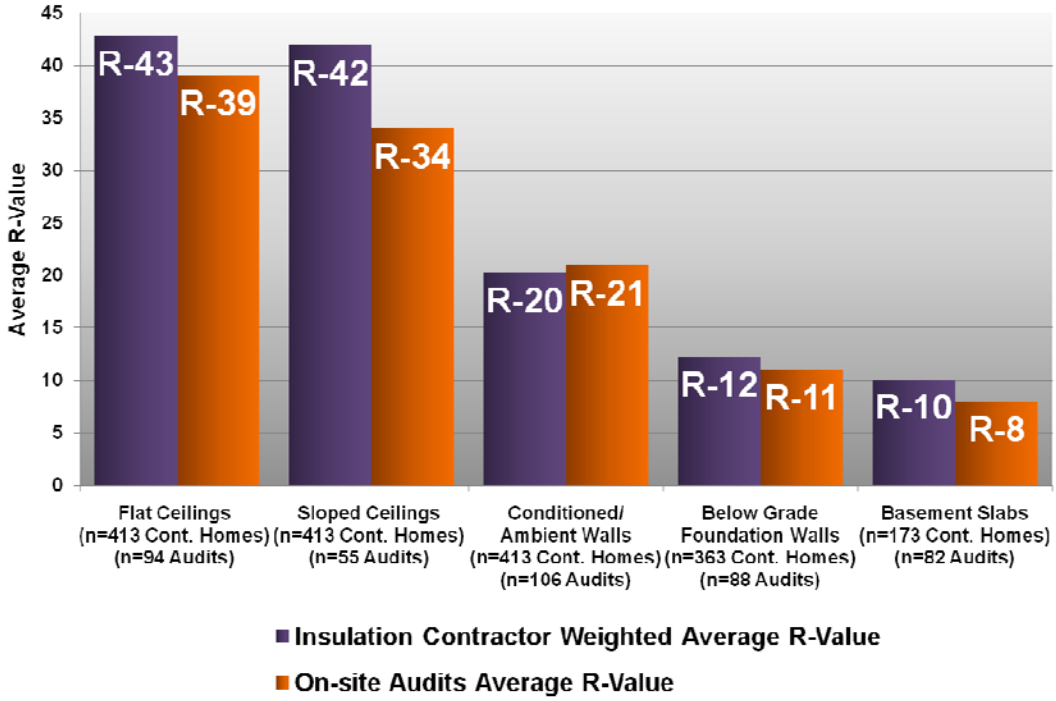
[23] In some cases the homeowner was able to tell or describe to the inspector the type of slab insulation installed, but not where it was installed. In other cases, there were remnants of the insulation on site.

## 7.4 On-sites Findings Compared to Insulation Contractor and Builder Reports

When looking at comparisons of on-site findings to what builders and insulation contractors report it is important to remember that most (74%) of the 106 inspected homes were completed in 2005 (11%) or 2006 (63%). Insulation contractors and builders were interviewed in 2008. Insulation contractors were asked about their work on homes completed in 2007. Builders were asked about their current building practices, and most builders (all but three) say they have changed their construction practices in the last two years. Therefore, it is reasonable to expect the percentage of audited homes incorporating specific energy-efficient options to be somewhat lower than what builders say they are currently doing or insulation contractors report doing in 2007.

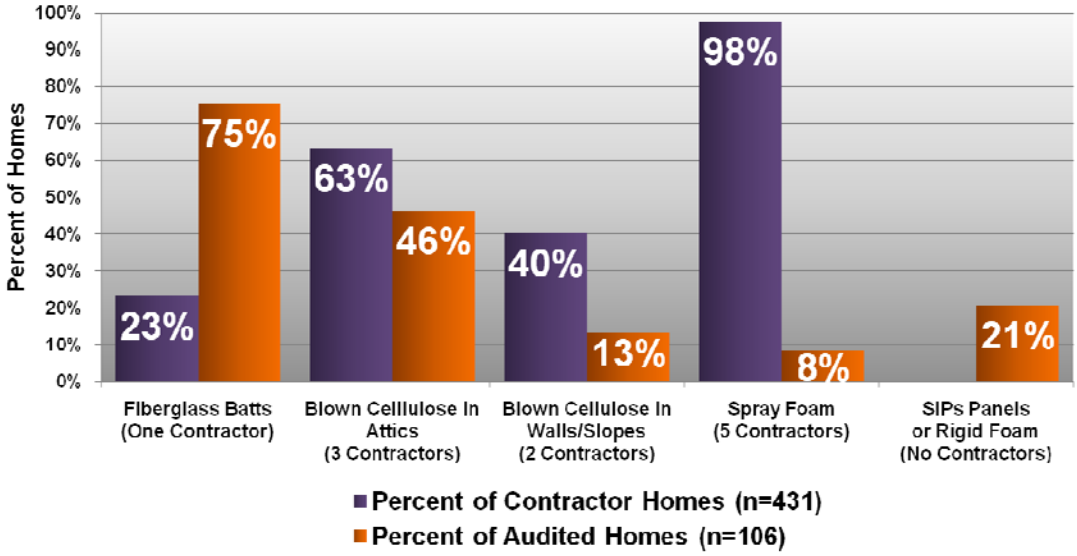
The nine interviewed insulation contractors claim to install somewhat higher average insulation levels than was observed in the on-site inspections for all but conditioned/ambient walls. Figure 7–3 shows the weighted average R-value of insulation installed in different applications by interviewed insulation contractors and the weighted average R-values found in the on-site inspections. As shown, both the insulation contractor and on-site average R-values exceed minimum code requirements for conditioned/ambient walls, flat and cathedral ceilings, and below grade foundation walls. The biggest differences are in average ceiling insulation levels. The average level of flat ceiling insulation installed by interviewed insulation contractors in new homes in 2007 is R-43, compared to R-39 for inspected homes; the average level of sloped ceiling insulation installed by interviewed insulation contractors in new homes in 2007 is R-42, compared to R-34 for inspected homes.

**Figure 7–3: Average Insulation R-values—Insulation Contractors vs. Audits**



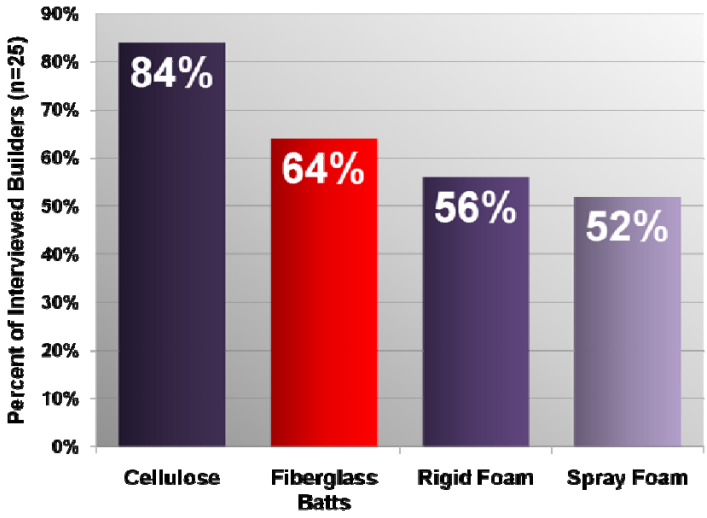
The percentages of homes that insulation contractors worked on in 2007 having specific types of insulation are quite different from what was found in the on-site inspections. Most homes have more than one type of insulation. Figure 7–4 shows the percentages of new homes worked on by interviewed insulation contractors in 2007 and inspected homes that have fiberglass batt insulation in at least one location, blown cellulose in attics, blown cellulose in walls or sloped ceilings, spray foam in at least one location, and SIPs or rigid foam in at least one location. As shown, spray foam insulation was used at least somewhere in almost all (98%) of the new homes insulation contractors worked on in 2007 compared to only eight percent of inspected homes. Conversely, just under one quarter (23%) of the new homes that insulation contractors worked on in 2007 have any fiberglass batts, while three quarters of the on-site inspected homes have fiberglass batts in at least one location. None of the insulation contractors report using rigid foam insulation in 2007. Although several interviewed builders say they now recommend using spray foam insulation, not all homebuyers are willing, or able, to pay the additional cost of upgrading to spray foam. Therefore, it appears the sample of insulation contractors interviewed is biased toward those who insulate with spray foam; three of the interviewed insulation contractors, accounting for 35% of new homes worked on in 2007, used nothing but spray foam in the new homes they insulated in 2007.

**Figure 7–4: Types of Insulation Installed—Insulation Contractors vs. Audits**



Interviewed builders, consistent with on-site findings, say that they generally use more than one type of insulation in their homes. Figure 7–5 shows that interviewed builders, compared to on-site inspection findings shown in Figure 7–4, are somewhat more likely to say they use cellulose insulation; less likely to say they use fiberglass batts, though almost two-thirds say they still use fiberglass batts; and much more likely to say they use rigid or spray foam insulation. The 106 inspected homes include 26 homes built by interviewed builders. Consistent with interviewed builders saying they are less likely to use fiberglass batts than what was observed in the on-sites, 44% of the 26 inspected homes built by interviewed builders had fiberglass batt wall insulation compared to 67% of all inspected homes.

**Figure 7–5: Types of Insulation Used by Interviewed Builders**




# 8 Ducts

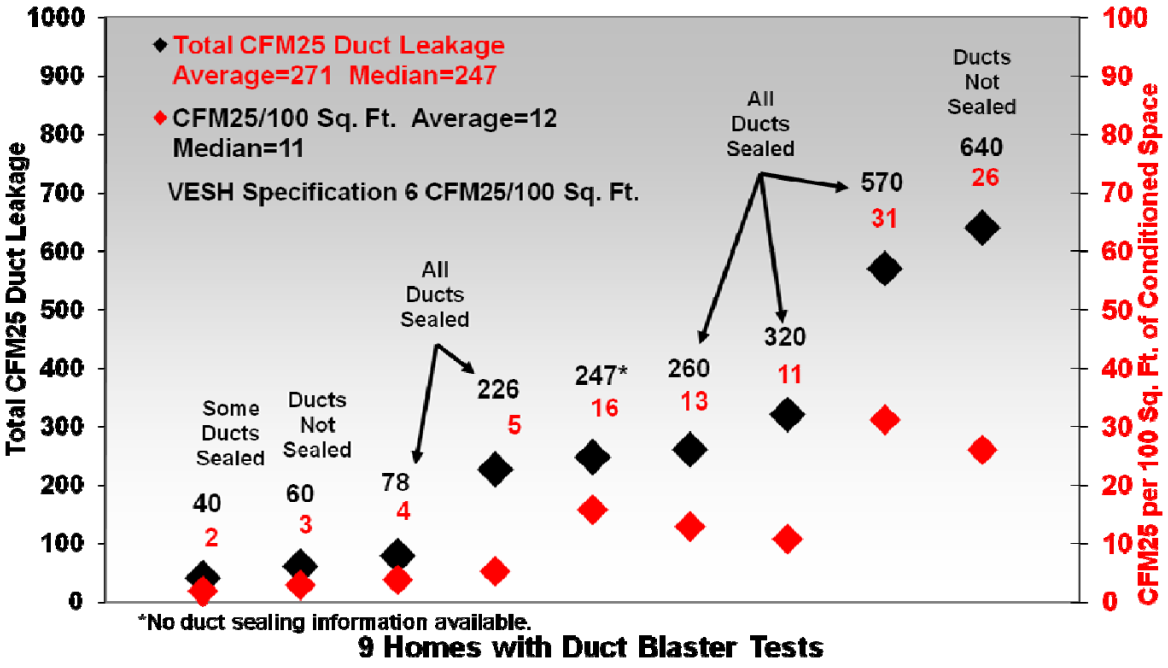
Twenty audited homes have heating and/or cooling ducts. Auditors collected information on 22 supply and 19 return duct runs in 18 homes. Two homes have only supply ducts—return air is taken from the basement. RBES requirements include insulating heating and cooling system supply and return ducts in unconditioned basements, crawlspaces and attics to R-5 and using mastic with fibrous backing tape to seal ducts in unconditioned space; for return ducts in unconditioned basements the minimum insulation requirement is R-3.3. Using the definition of conditioned space used by auditors (intentionally heated space), 5 of the 18 homes with duct information have all ducts located in conditioned space and, therefore, the ducts are not required to be insulated or sealed. None of the 13 homes with ducts in attics or unconditioned (not intentionally heated) space meet all RBES duct sealing and insulation requirements.

Auditors conducted duct blaster tests at nine homes. Current specifications for ENERGY STAR certification require duct leakage to be no more than six cubic feet per minute measured at 25 pascals (CFM25) per 100 square feet of conditioned space; however, duct leakage testing can be waived if all ducts and air handling equipment are located in conditioned space and envelope air

leakage is three or less air changes per hour measured at 50 pascals (ACH50). Duct leakage in four of the nine tested homes meet the current ENERGY STAR-certification requirements—one ENERGY STAR and three non-ENERGY STAR homes.

Figure 8–1 shows the duct blaster test results in both total CFM25 and CFM25 per 100 square feet of conditioned (intentionally heated) space. As shown, total CFM25 duct leakage ranges from 40 to 640 CFM25; the average is 271 and the median is 247 CFM25. CFM25 per 100 square feet of conditioned space duct leakage ranges from 2 to 26; the average is 12 and the median is 11. Also noted in Figure 8–1 for each home is whether or not the ducts are sealed and, as shown, whether or not ducts are sealed appears to be unrelated to duct leakage rates.

**Figure 8–1: Duct Blaster Test Results**




# 9 Envelope Leakage

Auditors conducted blower door tests at 82 homes. Blower door tests results can be reported in several ways: natural air changes per hour (ACHnat), air changes per hour at 50 pascals (ACH50), or total CFM leakage measured at 50 pascals. RBES does not have specific air infiltration requirements; however, the VESH Program specifications call for house air leakage to test less than 0.35 ACHnat at the final inspection. Just over two-thirds (68%) of the homes where blower door tests were conducted meet the VESH Program requirement for certification of less than 0.35 ACHnat. The average natural air changes per hour (ACHnat) for the 82 tested homes is 0.28, which is an improvement over the average 0.31 ACHnat found in the 2002 baseline study.

Average total CFM leakage measured at 50 pascals is 1,598; ENERGY STAR homes are more likely than non-ENERGY STAR homes to have total CFM50 leakage of 750 CFM50 or less (29% vs. 7%) and this difference is statistically significant. Figure 9–1 and Figure 9–2 show

average and median total CFM50 envelope leakage, respectively, by home size as well as the minimum and maximum leakage in each home size category. As shown, average and median leakage tend to increase as home size increases until home size reaches 3,500 square feet, but the ranges of CFM50 leakage are broad in almost all home size categories and there are homes with very low leakage in every home size category. The lowest total leakage (437 CFM50) is for a 4,083 square foot ENERGY STAR home with conditioned/ambient walls and ceilings constructed with SIPS; air changes per hour for this home are 0.04 ACHnat and 0.80 ACH50. The home with the highest total leakage (4,455 CFM50) is a 3,152 square foot non-ENERGY STAR home with R-19 rigid foam wall insulation, fiberglass batt ceiling insulation, and double pane clear windows; air changes per hour for this home are 0.53 ACHnat and 9.5 ACH50.

**Figure 9–1: Average Total CFM50 Envelope Leakage by Home Size**

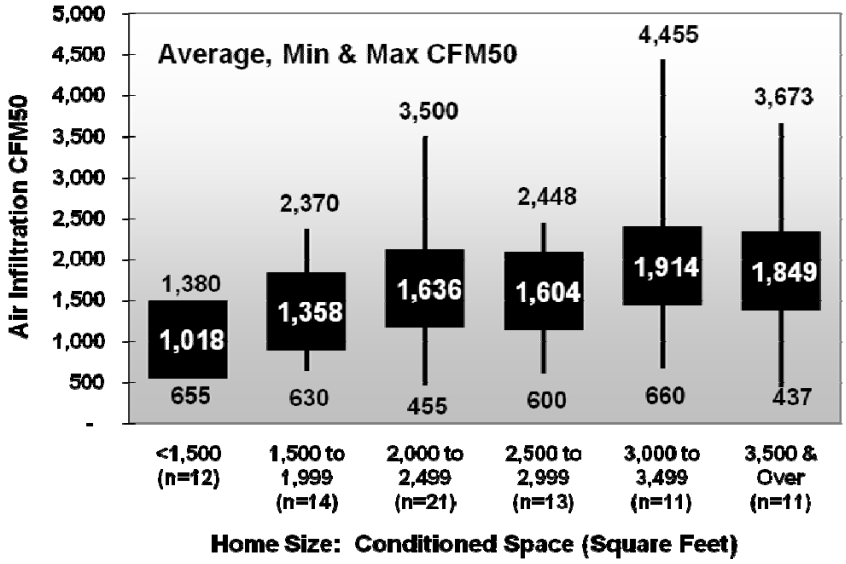
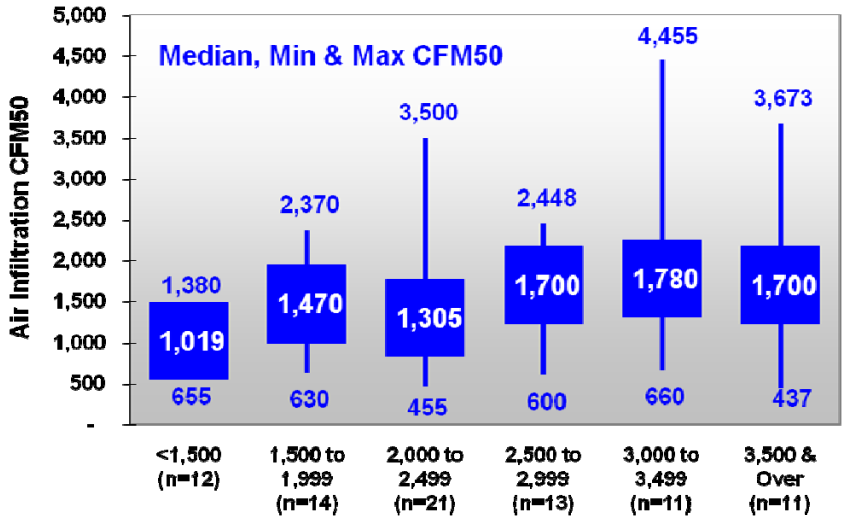



**Figure 9–2: Median Total CFM50 Envelope Leakage by Home Size**



# 10 Heating Systems

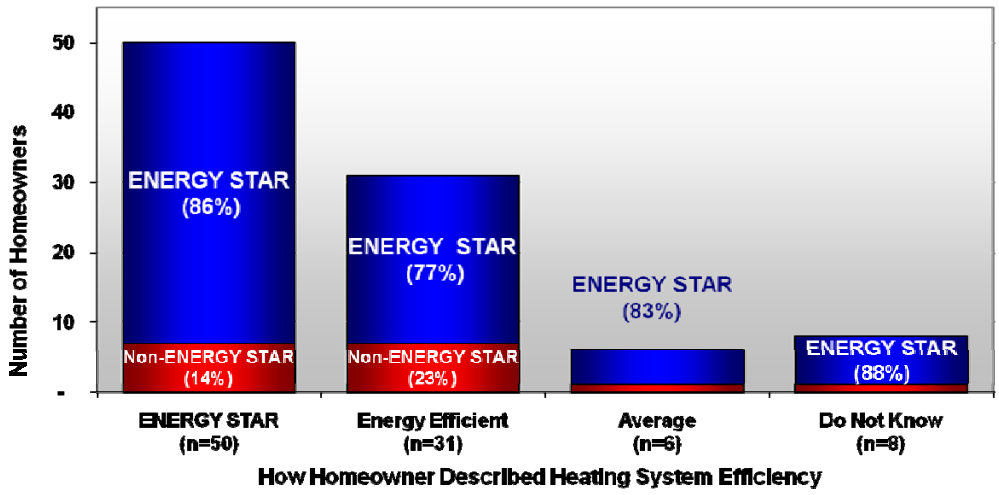
Information on heating equipment in residential new construction was collected through the phone survey of 296 homeowners, on-site inspections of 106 homes, interviews with 25 builders, and interviews with ten HVAC contractors who install heating systems in new homes in Vermont.

## 10.1 Homeowners

Ninety-one percent of the 163 homeowners participating in the phone survey who were asked to rate the importance of the efficiency level of the furnace or boiler in their decision to purchase or build their home rated it very important (8 to 10 on a zero to 10 scale). Over one-half (55%) of surveyed homeowners who did **not** build a home on land that they already owned say they discussed heating and cooling costs with their real estate agent or builder; 22% of these homeowners say they were provided with estimates of what heating costs would be and 16% say they were told that heating and cooling costs would be low because the heating and cooling systems were cost effective.

Fifty-three percent of all surveyed homeowners say that they specified the furnace or boiler in their homes and 54% of surveyed homeowners say they have ENERGY STAR heating systems; an additional third (33%) say that their heating systems are energy efficient, but not ENERGY STAR. Comparing phone survey responses to on-site inspection findings shows that many homeowners who think they have ENERGY STAR heating systems in fact do not, while many homeowners who have ENERGY STAR heating systems do not know they have them. Figure 10–1 shows that most (86%) of the surveyed homeowners whose homes were inspected and who say they have an ENERGY STAR heating system are correct, but 14% think they have an ENERGY STAR heating system when they do not. Furthermore, over three quarters (77%) of homeowners who say their heating systems are energy efficient, but not ENERGY STAR, actually have ENERGY STAR heating systems, as do five of the six homeowners who say the efficiency of their heating system is average and seven of the eight homeowners who say they do not know how efficient their heating system is.

**Figure 10–1: Perceived vs. Actual Heating System Efficiency**



**Thermostat Settings.** Fewer than one-half of homeowners whose homes were audited say they turn down thermostat settings at night or during the day when their home is not occupied. Homeowners are more likely to turn down thermostat settings at night than during the day (45% vs. 36%). Homeowners with programmable thermostats are twice as likely to turn temperature settings down during the day and/or night (74%) as those with non-programmable thermostats (37%); overall, 51% of homeowners say they do not change thermostat settings.

## 10.2 HVAC Contractors

Interviews were conducted with ten HVAC contractors who worked on 257 new homes in Vermont in 2007; they installed heating systems in 238 homes. Only one interviewed HVAC contractor worked on more than 25 new homes in 2007; this contractor worked on 150 new homes and reports he installed both gas furnaces and central air conditioning in all 150 homes.

**High Efficiency Options.** Eight of the interviewed contractors, accounting for 97% of the new homes in Vermont that interviewed contractors worked on in 2007, say that they at least sometimes recommend or include different equipment efficiency level options in their bids: two contractors (11% of homes) say they always include efficiency options, three contractors (72% of homes) say they offer efficiency options a majority of the time, and three contractors (14% of homes) say they offer efficiency options less than one-half the time. Four contractors, accounting for 18% of the new homes in Vermont that interviewed contractors worked on in 2007, say they always recommend or include options for ENERGY STAR-qualified equipment; three additional contractors (21% of homes) say they recommend or include ENERGY STAR-qualified equipment options a majority of the time. The largest individual contractor (58% of homes) says that he recommends high-efficiency equipment; all 150 furnaces installed by this contractor in new homes in Vermont in 2007 are ENERGY STAR qualified.

**Boilers**. Nine of the interviewed HVAC contractors install boilers; all nine install oil boilers, one installs oil and natural gas boilers and one installs oil and propane boilers. Six HVAC contractors, who worked on from 2 to 19 new homes in 2007, installed only one or two oil boilers each in new homes in 2007 (total of nine oil boilers); four of these contractors report they installed only AFUE 87 or higher oil boilers (six oil boilers) and two report all the oil boilers they installed had AFUEs below 87 (three oil boilers). Three HVAC contractors, one who worked on ten new homes in Vermont in 2007 and two who worked on 25 new homes each, installed from 5 to 15 oil boilers each in 2007 (total of 28 oil boilers); only one of these contractors reports he installed AFUE 87 or higher oil boilers—all eight oil boilers installed by this contractor were AFUE 87 or higher. Only two interviewed HVAC contractors say they installed gas boilers in new homes in Vermont in 2007. One of these contractors, who worked on ten new homes in 2007, installed three natural gas boilers, and the other contractor, who worked on 19 new homes in 2007, installed 16 propane boilers; all 16 propane boilers had AFUEs of 87 or higher.

**Furnaces**. Seven of the ten interviewed HVAC contractors installed furnaces in new homes in Vermont in 2007 (total of 182 furnaces); three installed only oil furnaces, three installed only gas furnaces, and one installed both oil and gas furnaces. The four contractors installing oil furnaces worked on 10 to 25 new homes each in 2007 and installed a total of seven oil furnaces; they also installed 22 gas furnaces, 29 oil boilers, and 3 natural gas boilers. Only one contractor, who

worked on 25 homes, installed more than one oil furnace; this contractor installed four oil furnaces and eight oil boilers. Six of the interviewed HVAC contractors, accounting for 99% of the furnaces that interviewed contractors installed in 2007, say builders sometimes request high-efficiency furnaces.

Five interviewed HVAC contractors installed 175 gas furnaces in new homes in Vermont in 2007; one of these contractors worked on 150 new homes and the other four contractors worked on 3 to 25 new homes in 2007. The contractor who worked on 150 new homes reports installing 150 gas furnaces in new homes in 2007— half with AFUEs of 90 to 92 and half with AFUEs over 92 but lower than 95. Two contractors installed a total of 22 gas furnaces of varying efficiencies; most (80%) of these furnaces had AFUES of 90 to 92, ten percent had AFUES over 92 but lower than 95, and 10% had AFUEs of 95 or higher. One contractor installed only two gas furnaces, both with AFUEs over 95, and one contractor installed only one gas furnace and it had an AFUE below 90.

**Testing**. Eight of the interviewed HVAC contractors have equipment to measure proper air flow through ductwork to individual rooms; four contractors use air flow hoods, one uses a velocicalculator, and one uses a CFM meter. Two contractors say they use the equipment on all installations, one only on new construction installations, three use it for troubleshooting, and one uses the equipment only when installing high velocity systems. Five of the interviewed HVAC contractors say that they use a combustion efficiency test to check the operating performance of new furnaces; three say they use a Bacharach system, one conducts a heat rise test across the coil, and one does not typically check operating performance.

**Ducts**. Contractors use a variety of products to seal ducts. Some contractors use more than one sealing product; five contractors use mastic, four use sealant, one uses fiberglass, and one uses FSK (Foil/Scrim/Kraft) tape. One of the interviewed contractors says he occasionally uses a duct blaster to test for duct leakage; the other nine contractors say that they never use a duct blaster.

**Sizing**. Interviewed contractors use a variety of methods to size heating and cooling systems, and some use more than one method; six contractors conduct heat gain calculations, three use Manual J software, two calculate square footage per ton for sizing air conditioning systems and BTU per square foot for sizing heating systems, two use manufacturer provided software, and two who use software could not recall the name or sponsor of the software they use. All interviewed contractors say they size HVAC equipment based on home specs provided by the builder and conduct heat loss calculations, heat gain calculations, or other sizing calculations.

## 10.3 On-site Inspections

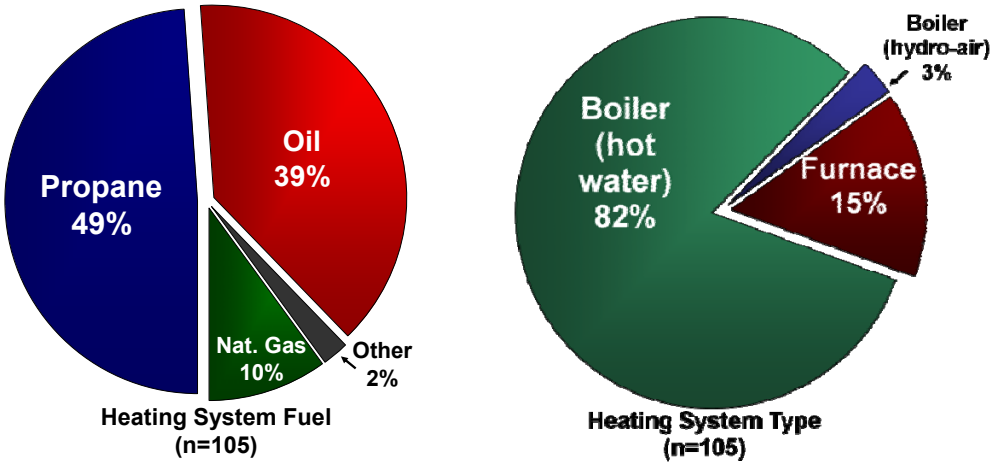
All but two of the 106 inspected homes have a propane, natural gas, oil, kerosene or electric boiler or furnace heating system; one home has only a wood boiler and one has only a wood stove. Owners of 12 homes with oil or propane boilers or furnaces say wood is their primary heating fuel. However, even though the oil or propane heating systems in these homes are not the primary heating source, all but one of the 11 heating systems with a known AFUE are ENERGY STAR qualified. Over one-half of inspected homes (59%) have one or more stoves, fireplaces or portable space heaters; 38% of homes have one stove, fireplace or portable space

heater, 19% have two, 3% have three, and 41% of homes do not have a stove, fireplace or portable space heater. Very few homes (5%) have electric portable space heaters.

Most inspected homes have propane or oil hot water boiler heating systems. Figure 10–2 shows the percentage of homes by heating system fuel and type of heating system. The first pie chart shows that almost one-half (49%) of homes have propane heating systems, 39% have oil, and 10% have natural gas heating systems—all homes with access to natural gas have natural gas heating systems. The "other" category includes one home with a wood boiler and one with an electric boiler. The second pie chart shows that a large majority of homes (82%) have hot water boiler heating systems, 15% have furnaces, and 3% have hydro-air boiler systems.

**Figure 10–2: Heating System Fuels and Types**

(weighted state data)




Annual Fuel Utilization Efficiency (AFUE) ratings were determined for all but one fossil fuel-fired heating system—a propane furnace. In some cases the AFUE was listed on the equipment; in other cases we were able to use nameplate model number and output capacity information to look up AFUEs on manufacture websites, EPA's listing of ENERGY STAR-qualified heating systems, or Gas Appliance Manufacturer Association (GAMA) listings. The average heating system AFUE across all types of heating systems is 87.8 and the median is 86.8.

Most (83%) gas and oil boilers are ENERGY STAR qualified and 20% have AFUEs over 90. Oil boiler AFUEs range from 83.3 to 87.0; the average AFUE is 86.0 and the median is 86.2. In 17% of homes with oil boilers the boilers are not ENERGY STAR qualified—AFUEs are below 85. Gas boiler AFUEs range from 80.5 to 95.2; the average AFUE is 88.5 and the median is 87.2. In 16% of homes with gas boilers the boilers are not ENERGY STAR qualified —AFUEs are below 85.

Only 15 inspected homes have gas furnaces (AFUE unknown for one propane furnace). Two additional homes have non-gas furnaces—one oil and one kerosene—and both are 80 AFUE. Only one home has a gas furnace that is not ENERGY STAR qualified. Gas furnace efficiencies range from 80 to 93.5 AFUE; the average AFUE is 91.7 and the median is 92.5. In 86% of homes with gas furnaces the AFUEs are over 92.

Heating system BTUH output per square foot of heated space was calculated for 103 homes with heating system output capacity information; values range from 15 to 108 BTUH capacity output per square foot of heated area, the average is 45, and the median is 42. This wide range of values suggests that the heating systems in many homes are oversized. More than one-half of the heating systems (56%) are located in conditioned (intentionally heated) space; 48% are located in conditioned basements, and 8% in conditioned primary areas. The remaining 44% of heating systems are located in unconditioned basements.

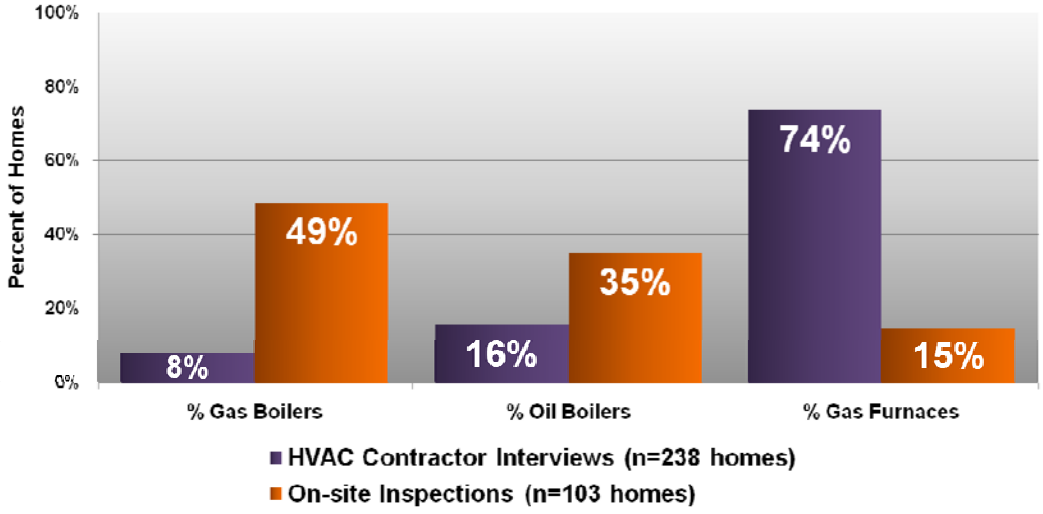
In all but one home with a ducted heating system the fan control is automatic. Inspected homes have from one to eight thermostats and from one to nine control zones. Close to one-half (43%) of the homes have one or two thermostats, 38% have three or four, and 18% have five or more. More than one-half (62%) of the homes have manual thermostats, 32% have programmable thermostats, and 6% have electronic non-programmable thermostats.

## 10.4 On-site Findings vs. HVAC Contractor and Builder Reports

As described previously, when looking at comparisons of on-site findings to what builders and HVAC contractors report, it is important to remember that most (74%) of the 106 inspected homes were completed in 2005 (11%) or 2006 (63%). Therefore, it is reasonable to expect the percentage of audited homes incorporating specific energy-efficient options to be somewhat lower than what builders say they are currently doing or HVAC contractors report doing in 2007.

The mix of heating systems by fuel and type of system (boiler or furnace) installed by interviewed HVAC contractors in new homes in Vermont in 2007 is wildly different from the mix found in the 106 inspected homes. Figure 10–3 shows that a large majority (74%) of heating systems installed by interviewed HVAC contractors are gas furnaces, while a large majority (84%) of heating systems in inspected homes are boilers—49% gas boilers and 35% oil boilers. Much of this difference is explained by the largest interviewed HVAC contractor installing only gas furnaces; this contractor worked on 150 new homes in Vermont in 2007 (58% of all new homes worked on by interviewed HVAC contractors in 2007) and installed gas furnaces in all 150 homes.

**Figure 10–3: Heating System Fuel and Type—HVAC Contractors vs. Audits**

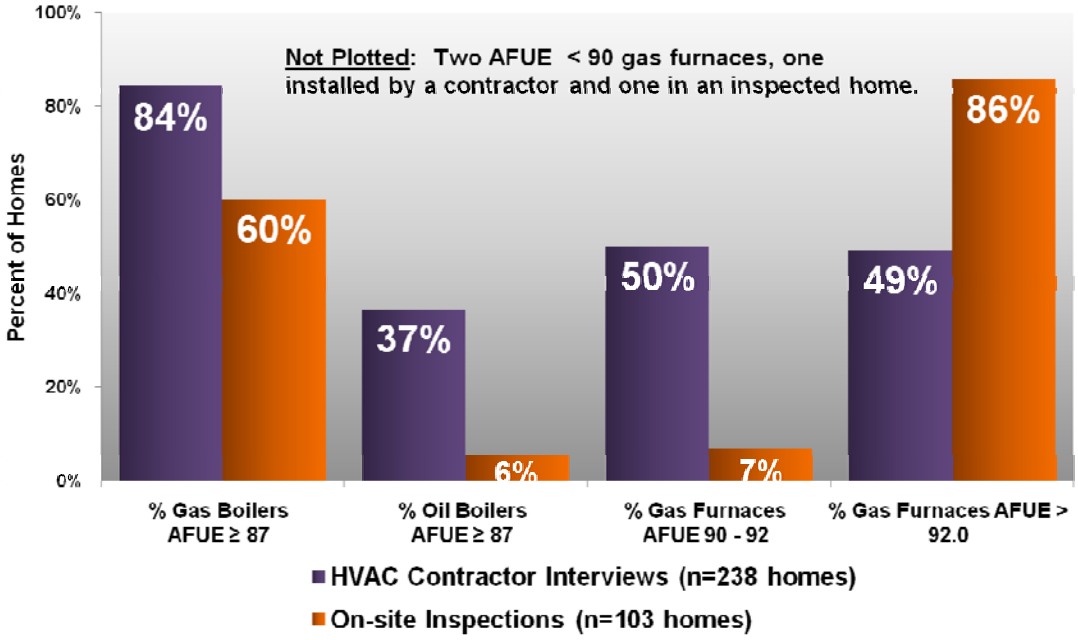


Interviewed builders, similar to what was found in audited homes, are more likely to install boilers than furnaces. Almost all interviewed builders (92%) say that they install gas boilers, just over one-half (56%) install oil boilers, 16% install ground source heat pumps, and only 12% install gas furnaces.

Figure 10–4 shows that the percentages of gas and oil boilers with AFUEs of 87 or above installed by interviewed HVAC contractors are much higher than what was found in audited homes. However, it may not be appropriate to put much weight on this finding. The HVAC contractor gas boiler data is based on only two HVAC contractors who installed a total of 19 gas boilers in new homes in 2007; the oil boiler data is based on nine contractors who installed 37 oil boilers (only one contractor installed more than eight boilers). Also, HVAC contractors were not asked how many of the gas boilers they installed had AFUEs higher than 90; over one-third (38%) of the gas boilers in inspected homes are over 90 AFUE.

Figure 10–4 also shows that the percentage of gas furnaces with AFUEs of 90 to 92 installed in new homes in 2007 by interviewed HVAC contractors is much higher, and the percentage of gas furnaces with AFUEs over 92 much lower, than what was found in audited homes. Again, the HVAC contractor data are heavily influenced by the one contractor who installed 150 of the 175 gas furnaces installed by five interviewed HVAC contractors.

**Figure 10–4: Heating System Efficiencies—HVAC Contractors vs. Audits**




Most interviewed builders (88%; 22 of 25 builders) say that all the boilers and furnaces they install are ENERGY STAR; this is consistent with on-site findings that show 84% of gas boilers, 83% of oil boilers, and 93% of gas furnaces (13 of 14 with known AFUEs) are ENERGY STAR. All 16 gas boilers and four of five oil boilers in audited homes built by interviewed builders are ENERGY STAR.

Several interviewed builders say that they now offer high-efficiency wall-hung condensing gas boilers, which is consistent with the on-site inspection findings that 38% of all gas boilers in inspected homes and 44% of the 16 gas boilers in audited homes built by interviewed builders have AFUEs over 90. Interviewed builders reported varying client interest in the high-efficiency gas boilers. One builder, whose standard practice is to install 87.3 AFUE gas boilers, offers an upgrade to a 91.0 AFUE gas boiler and says no homebuyers choose to upgrade; another builder, who typically installs oil boilers, offers an upgrade to a wall-hung condensing gas boiler and says that recently all homebuyers have chosen the upgrade.

# 11 Central Air Conditioning

Information on central air conditioning equipment in residential new construction was collected through the phone survey of 296 homeowners, on-site inspections of 106 homes, interviews with 25 builders, and interviews with nine HVAC contractors who install central cooling equipment in new homes in Vermont.

## 11.1 Homeowners

Statewide, 18% of all surveyed homeowners say that they have central air conditioning. This 18% penetration among surveyed homeowners is three times as high as the 6% penetration found in the previous (2002) survey of owners of new homes. In the current study, homeowners in the Burlington/North Chittenden area are much more likely than homeowners in other areas of Vermont to say they have central air conditioning—51% of surveyed homeowners in the Burlington/North Chittenden area. One possible explanation for the high penetration of central air condition in the Burlington/North Chittenden region is that the surveyed homeowners in this region tended to have high annual-incomes; of the 13 Burlington/North Chittenden homeowners who provided income information, 50% had annual incomes of $100,000 or more, compared to 29% of all surveyed homeowners who provided income information.

Over one-half (56%) of the 53 surveyed homeowners who say they have central air conditioning say that they selected their central air conditioners. Over one-third (36%) of surveyed homeowners with central air conditioning say that their central air conditioners are ENERGY STAR qualified, 23% say they are energy efficient but not ENERGY STAR, 10% say they are average efficiency, and 32% say they do not know how efficient their central air conditioner is. When homeowners who said that they have energy-efficient central air conditioners were asked why they chose a particular model, 64% said they chose it because it was energy efficient and 20% said they chose it because it was what their builder or contractor recommended.

Although the sample size is small, comparing what homeowners say about the efficiency of their air conditioning to what was found in the on-site inspections suggests homeowners are not very aware of how efficient their air conditioners are. Of eight surveyed homeowners who responded to the question asking how efficient they think their central air conditioning is, and whose homes were inspected and auditors able to verify the SEER, two said their air conditioners are ENERGY STAR; one has a SEER 11.3 unit installed in 2005, and one has a SEER 13.0 unit installed in 2006. Three homeowners said their air conditioners are energy efficient; one has an

SEER 10.8 unit and two have SEER 13 units, all installed in 2006. One homeowner, with a 13 SEER air conditioner, said it is average efficiency. Two homeowners said they do not know how efficient their air conditioner is; one has a SEER 11.1 unit installed in 2005 and the other, a non-ENERGY STAR home, has a SEER 15 ENERGY STAR unit installed in 2006. SEER 13 became the federal standard in January 2006; current ENERGY STAR requirements are SEER of at least 14 and EER of at least 12.

## 11.2 HVAC Contractors

Nine HVAC contractors who installed central air conditioning in new homes in Vermont in 2007 were interviewed. These contractors say that they worked on 255 new homes in Vermont in 2007 and installed air conditioning in 204 (80%) of the new homes they worked on. Only one interviewed contractor installed air conditioning in more than 12 new homes in Vermont in 2007; this contractor worked on 150 homes and installed air conditioning in all 150 homes. Excluding the largest HVAC contractor, the remaining eight interviewed contractors installed air conditioning in 51% of the 105 new homes they worked on in Vermont in 2007.

**High Efficiency Options.** Most interviewed contractors say that they recommend ENERGY STAR air conditioning equipment, include high-efficiency options in their bids, and that builders sometimes request high-efficiency air conditioning. Eight contractors, accounting for 98% of the homes worked on and 97% of the air conditioning systems installed by interviewed contractors, say that they recommend ENERGY STAR or higher SEER equipment at least 50% of the time. Eight contractors, accounting for 98% of the homes worked on and 99% of the air conditioning systems installed by interviewed contractors, say that they include high-efficiency options in their bids 25% or more of the time. Seven interviewed contractors, accounting for 96% of the homes worked on and 96% of the air conditioning systems installed by interviewed contractors, say builders sometimes request high-efficiency central air conditioning.

**Ductless Mini-split Systems.** Five contractors, accounting for 91% of the homes worked on and 95% of the air conditioning systems installed by interviewed contractors, installed ductless mini-split systems in new homes in Vermont in 2007; they installed a total of 17 ductless mini-split systems, representing nine percent of all the air conditioning systems installed by these five contractors.

**Recommend ENERGY STAR.** Eight of the nine HVAC contractors who install central air conditioning say they recommend ENERGY STAR or higher efficiency at least some of the time. Four contractors, accounting for 17% of the homes worked on and 4% of the air conditioning systems installed by interviewed contractors, installed four or fewer air conditioning systems each (total of eight systems) in new homes in Vermont in 2007. Two of these four contractors say they always recommend ENERGY STAR equipment and two say that they recommend ENERGY STAR equipment at least 70% of the time; two of these contractors each installed two ENERGY STAR air conditioning systems in 2007. Three of these four contractors say that they include efficiency options in their bids a majority of the time and that builders sometimes request high-efficiency equipment.

Four interviewed contractors, accounting for 24% of the homes worked on and 22% of the air conditioning systems installed by interviewed contractors, installed 6 to 19 air conditioning

systems each (total of 45 systems) in new homes in Vermont in 2007. Three of these contractors say they recommend ENERGY STAR air conditioning equipment and that builders sometimes request high-efficiency air conditioning; two of these contractors say they always recommend ENERGY STAR equipment and one says that he recommends ENERGY STAR equipment 50% of the time. Three of these four contractors installed ENERGY STAR air conditioning systems in 2007 (total of seven ENERGY STAR systems; 16% of systems they installed); two installed two ENERGY STAR systems each and one installed three. All four of these contractors say they provide efficiency options in their bids; two say they provide options 25% of the time, one says 40% of the time, and one says he always includes efficiency options.

The one very large contractor interviewed, accounting for 59% of all the homes worked on and 74% of the air conditioning systems installed by interviewed contractors, installed air conditioning in all 150 new homes he worked on in Vermont in 2007; three-quarters (75%) of the systems he installed are ENERGY STAR. This contractor says he recommends high SEER equipment that exceeds ENERGY STAR requirements, that he includes efficiency options in his bids 75% of the time, and that builders sometimes request high-efficiency air conditioning.

**ENERGY STAR Installations.** Overall, six contractors installed a total of 124 ENERGY STAR-qualified central air conditioning systems (SEER ≥ 14 & EER ≥ 12) in new homes in Vermont in 2007; this is 60% of all systems installed by all interviewed contractors. Of the six contractors who say that they installed ENERGY STAR systems, four installed two ENERGY STAR systems each, one installed three, and one installed 113.

**Testing.** Six of nine HVAC contractors who regularly install central air conditioning determine the proper charge by weighing in the charge according to the manufacturer's specifications and one adds or removes refrigerant based on the refrigerant system pressures; two contractors said they do not know what method their technicians use. Three contractors say they use a flow hood and two say they use a velocicalculator to check the airflow across the indoor coil; other methods used by individual contractors are a CFM meter, temperature difference across the coils, and air balance sensor.

## 11.3 On-site Inspections

The percentage of inspected homes with central air conditioning is higher than in the previous(2002) study. Ten percent of the 106 homes inspected in 2008 have central air conditioning, compared to six percent of new homes inspected as part of the 2002 study. Ten of the 11 homes inspected in 2008 with central air conditioning have one central air conditioning system and one home has two. All the systems were new when the homes were built, so all are no more than three years old. Most evaporator coils are located in an unconditioned basement. The sizes of the systems range from two to five tons per home; the average is 3.4 tons and the median is 3.5 tons. The average efficiency of the systems in the 10 homes where auditors were able to verify the efficiency is 12.6 SEER and the median is 13.0 SEER. In three homes, two completed in 2005 and one in 2006, the efficiencies of the central air conditioning systems are below SEER 13, the federal standard since January 2006. In six homes, five completed in 2006 and one in 2007, the systems are 13 SEER. Only one home has a system with a SEER higher than 13; this home has a SEER 15 system and is a non-ENERGY STAR home completed in 2006. Homeowners saying they have central air conditioning tend to fall into the higher income

categories; three claimed annual incomes of $150,000 or more, three claimed annual incomes of $75,000 to $99,999, one claimed annual income of $50,000 to $74,999, three declined to provide income information, and one did not participate in the phone survey.

Consistent with the particularly high percentage (51%) of surveyed homeowners in the Burlington/Chittenden region saying that they have central air conditioning, five of the eleven inspected homes with central air conditioning are in the Burlington/Chittenden region. Owners of two of the Burlington/North Chittenden homes with central air conditioning have annual incomes over $150,000, two declined to provide income information, and one did not participate in the phone survey; three of the five homes are ENERGY STAR-qualified homes, but only two of the homeowners knew their homes were ENERGY STAR; one homeowner thinks his home is ENERGY STAR, but EVT verified that it is not.

## 11.4 On-site Findings vs. HVAC Contractor and Builder Reports

Interviewed HVAC contractors say they installed central air conditioning in 80% of the 255 new homes they worked on in Vermont in 2007, which is dramatically higher than the 10% penetration of central air conditioning in the 106 inspected homes. The HVAC contractor data are heavily influenced by one large contractor who installed central air conditioning in all 150 new homes he worked on in Vermont in 2007. As mentioned earlier, excluding the largest HVAC contractor, the remaining eight interviewed contractors installed air conditioning in 51% of the 105 new homes they worked on in Vermont in 2007, which is still much higher than the 10% of inspected homes with central air conditioning. This suggests the sample of interviewed HVAC contractors is biased toward contractors who work on high-end homes, or perhaps attached single-family housing projects, which are more likely to have central air conditioning.

Information from the interviews with 25 builders on how often they install central air conditioning is consistent with the on-site findings. Slightly fewer than one-fourth of interviewed builders (24% or six builders) say they often or always install central air conditioning— all six builders build high-end custom homes; almost one-third of builders (32% or eight builders) say they never install central air conditioning, and 44% of builders (11 builders) say they rarely or only occasionally install central air conditioning. Only one of the 26 inspected homes built by interviewed builders has central air conditioning.

Interviewed HVAC contractors say that over one-half (60%) of the air conditioning systems they installed in new homes in Vermont in 2007 were ENERGY STAR qualified—SEER 14 or higher and EER 12 or higher. Again, the largest contractor heavily influenced this high percentage. Excluding the largest contractor, 19% of the 54 systems installed in new homes in Vermont in 2007 by interviewed contractors were ENERGY STAR. Only one of the ten inspected homes with efficiency information is ENERGY STAR—SEER 15.

Only three interviewed builders knew the SEER of the central air conditioning they install; all three of these builders say they install SEER 13 systems, which is consistent with what was found in the on-site inspections. Only one builder says he ever installs over SEER 13 units—he installed a 17 SEER system last year at the owner's request. Another builder says he has not installed any systems with SEERs over 13, but that he would if a customer requested.

# 12 Room Air Conditioners

Twenty-one percent of all surveyed homeowners say they have room air conditioners and 20% of the 106 inspected homes have room air conditioners. The 21 inspected homes with room air conditioners have from one to three units. The total number of room air conditioners in inspected homes is 38, including four portable air conditioners in three homes. The average number of units in homes with room air conditioners is 1.8 and the median is 2.0 units. The individual units are from one to 15 years old, with almost one-half of the units (47%) five years or older; the average and median age is four years. Auditors were unable to determine the EER of 13 of the 38 units. The average efficiency (EER) of the 25 room air conditioners with known EERs is 10.1 and the median is 10.0.

# 13 Windows

Information on windows in residential new construction was collected through the phone survey of 296 homeowners, on-site inspections of106 homes, and interviews with 25 builders.

## 13.1 Homeowners

Almost all (93%) of the 174 homeowners participating in the phone survey who were asked to rate the importance of the efficiency level of the windows in their decision to purchase or build their home rated it very important (8 to 10 on a zero to 10 scale). Just over one-half (52%) of all surveyed homeowners say they specified the windows in their homes and just under one-half (47%) of all surveyed homeowners say they have ENERGY STAR windows; an additional 41% of surveyed homeowners say their windows are energy efficient, but not ENERGY STAR. However, only nine percent of 48 surveyed homeowners who say they discussed the energy efficiency of their home with their builder or real estate agent say they discussed the home having energy-efficient windows.

## 13.2 On-site Inspections

Auditors recorded the type of glazing and U-value, orientation, window area, frame material, type of window (operable, fixed, skylight), if windows had a thermal break and if they had storm windows.

The majority of inspected homes have all double pane Low-E windows; 58% of homes have double pane Low-E windows, one-third have double pane Low-E with argon windows, and a few have all double pane clear windows (6%) or all triple pane Low-E with argon windows (2%). Few homeowners could provide documentation on the type of glazing in their windows or the U-value. In all, auditors gathered actual glazing and U-value information for only 18 homes. When homeowners could not provide information on the type of glazing in their windows, auditors used a Low-E coating detector to determine if windows were Low-E and made their best guess as to whether or not windows were argon filled. Assuming auditors correctly identified the

type of glazing, default U-values based on the type of glazing can be used to estimate the average U-value of windows in inspected homes.

The default U-values for operable windows provided in the Vermont Residential Building Code Handbook are inconsistent with windows currently on the market. All default U-values in the handbook are higher than the ENERGY STAR level for Vermont (U-0.35); the lowest default U-value is U-0.37 for a vinyl/wood framed operable window with double pane Low-E with argon glazing. Table 13–1 shows the Vermont Residential Building Code Handbook default U-values and the default U-values that more closely reflect the U-values of currently available windows used to estimate the average U-value of windows in inspected homes.[24] Using these default values, the average U-value of windows in inspected homes is 0.34 and the median value is 0.35.

**Table 13–1: Default Window U-values**

| Glazing → Frame ↓ | Single Pane | Double Pane | Double Pane Low-E | Double Pane Low-E with Argon |
|---|---|---|---|---|
| **Vermont Residential Building Code Handbook default U-values** | | | | |
| **Wood/Vinyl** | 0.94 | 0.56 | 0.40 | 0.37 |
| **Updated Default U-values** | | | | |
| **Wood/Vinyl** | 0.94 | 0.48 | 0.35 | 0.31 |

More than one-half of homes have wood-framed windows (61%). Most homes have windows with thermal breaks (84%) and windows with thermal breaks account for 87% of total window area. Auditors found very few storm windows—just three homes had storm windows on a total of 67 square feet of window area. Operable windows account for 95% of all window area.

Glazing percentages, defined as window area not including windows in unconditioned basements as a percentage of wall area, range from a low of 5% to a high of 30%; the average and median glazing percentages are 13%. RBES maximum allowable glazing percentages under prescriptive RBES compliance paths range from 12% to 18% depending on the compliance path and package followed; 12% of inspected homes have glazing percentages over 18%.

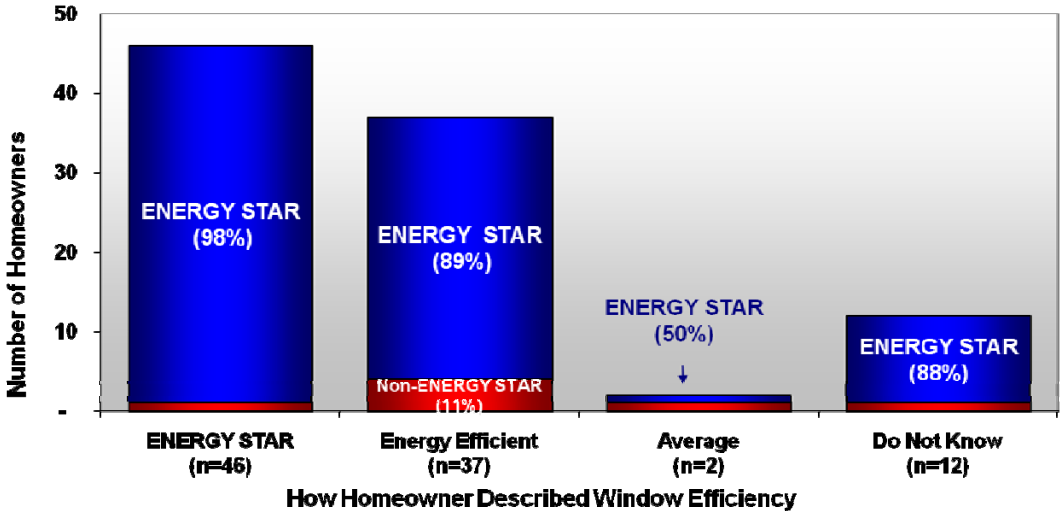
The average percent of glazing area oriented to the south is 30% and the median is 26%; average north oriented glazing is 23% and the median is 20%; average east oriented glazing is 25% and the median is 23%; average and median west glazing are 22%. In 19% of homes the south oriented glazing percentage is 15% or less; in 26% of homes it is more than 15% but not more than 25%; in 40% of homes it is more than 25% but not more than 50%; and in 15% of homes it is more than 50%. Almost one-fourth (23%) of homes have no glazing in at least one wall; three inspected homes have no south oriented glazing.

[24] The default U-values used to estimate the average U-value of windows in inspected homes are based on National Fenestration Rating Council (NFRC) performance data on currently available double-hung windows manufactured by Andersen, Harvey Industries, Loewen, Marvin, Pella, Silverline, American Integrity, Jeld-Wen, K&C Industries, Paradigm, and Peachtree. Source of performance data: http://cpd.nfrc.org/pubsearch/psMain.asp.

## 13.3 Combined On-site, Homeowner Survey and Builder Report Findings

Comparing phone survey responses to on-site inspection findings shows many homeowners are not aware that they have ENERGY STAR windows. Figure 15–1 shows that virtually all (98%) of the surveyed homeowners whose homes were inspected and who say they have ENERGY STAR windows are correct; only 2% of homeowners think they have ENERGY STAR windows when they do not. However, 89% of the homeowners whose homes were inspected and who think their windows are energy efficient, but not ENERGY STAR, do have ENERGY STAR windows, as do one of the two homeowners who think that their windows are average efficiency, and 11 of 12 homeowners who say that they do not know how energy efficient their windows are. Overall, only slightly more than one-half (52%) of surveyed homeowners whose homes were inspected accurately identified their windows as ENERGY STAR or non-ENERGY STAR.

**Figure 13–1: Perceived vs. Actual Window Efficiency**




All 25 interviewed builders say they now install only ENERGY STAR windows. Three builders cite U-values below 0.30 (U-0.21 to U-0.29). Two additional builders mention using triple pane windows—one uses them now and the other says he will be installing them in a home he is currently building. The percentage of audited homes built by interviewed builders having ENERGY STAR windows (92%) is virtually the same as for all audited homes (93%).

# 14 Water Heating

Information on water heating in residential new construction draws from the phone survey of 296 homeowners and on-site inspections of 106 homes.

## 14.1 Homeowners

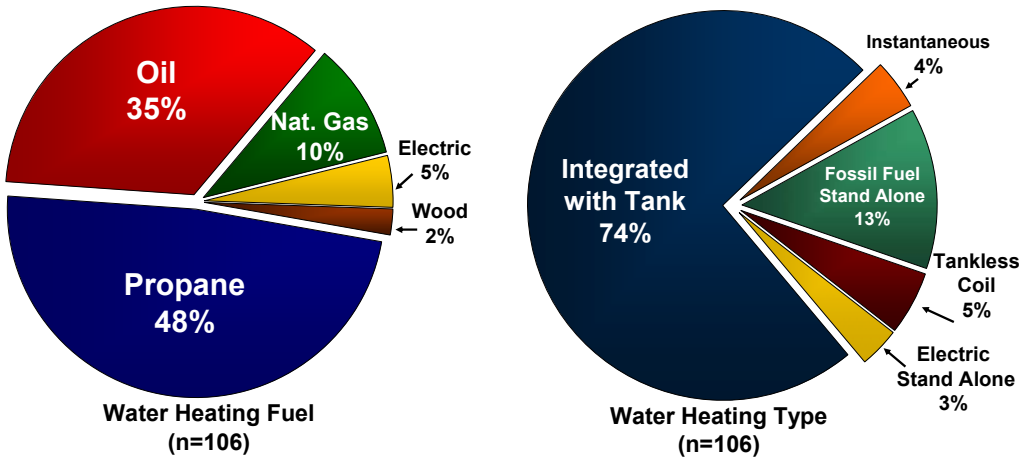
Roughly one-half (49%) of all surveyed homeowners say they specified the water heaters in their homes; 35% say the builder or architect chose the water heater and 16% say they selected their water heater from options offered by the builder. Most surveyed homeowners (84%) rate the energy efficiency of their water heaters above average. Almost one-half (45%) of 179 surveyed homeowners reporting that they have energy-efficient water heaters say they selected their water heater because it was more energy efficient, and almost one-fourth (24%) say they selected their water heater based on builder or contractor recommendations.

## 14.2 On-site Inspections

Most of the 106 inspected homes (74%) have boiler heating systems with integrated tank water heating. Four homes have solar assisted water heating: one with an oil integrated tank, one with a propane stand alone tank, one with an electric stand alone tank, and one with an electric instantaneous water heater. Only one water heater is wrapped—a wood-fired integrated tank. Only 12 homes have water heating piping insulation; ten have R-2 insulation, one has R-3 insulation and one has R-4.7 insulation. Almost all water heaters (91%) are located in basements—47% in conditioned basements and 44% in unconditioned basements.

Figure 14–1 shows the percentage of homes by water heating fuel and by type of water heating. The first pie chart shows that almost one-half (48%) of homes use propane to heat water, 35% use oil, 10% use natural gas, 2% use wood, and 5% have electric water heaters. The second pie chart shows that the large majority of homes (74%) have integrated tank water heating, 13% have stand alone fossil fuel-fired water heaters, 4% have instantaneous water heaters, 5% have tankless coils, and 3% have electric stand alone tank water heaters.

**Figure 14–1: Water Heating by Fuel and Type**

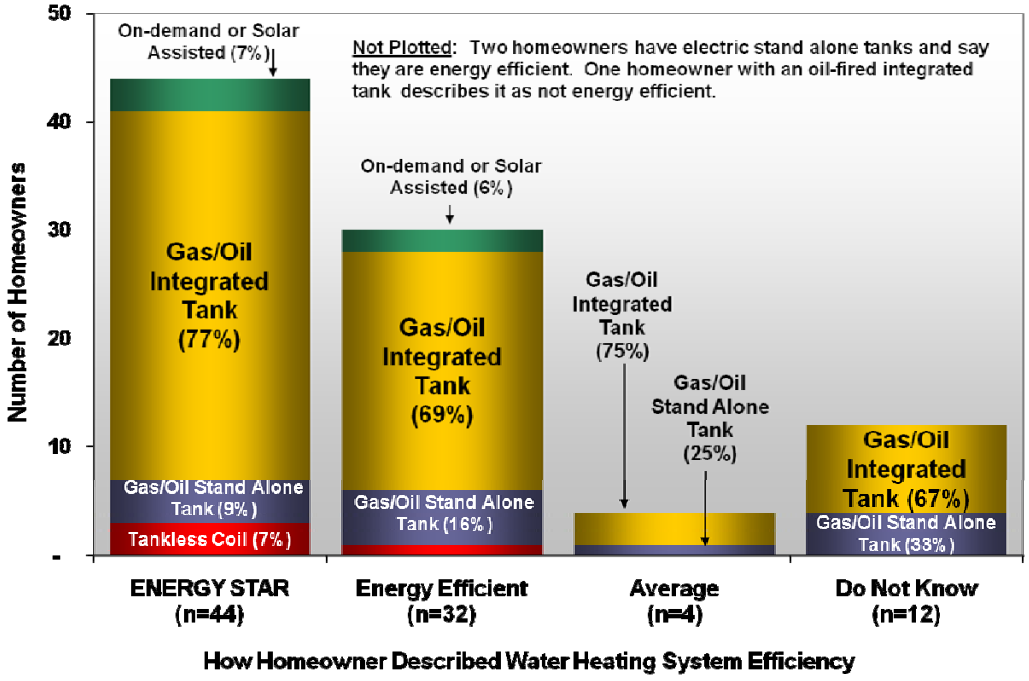


The average water heater Energy Factor across all 106 homes is 0.76 and the median is 0.79. Overall, 88% of homes with boiler heating systems have integrated tank water heating. The average Energy Factor for fossil-fuel-fired integrated tank water heating systems, found in the majority of homes, is 0.81 and the median is 0.80. The average water heater tank size is 52 gallons and the median is 50 gallons for all 96 water heating systems with integrated or stand alone tanks. Stand alone tanks tend to be larger than integrated tanks; the average stand alone tank size is 60 gallons (median is 65 gallons) and the average and median integrated tank size is 50 gallons. Almost all water heaters (91%) are located in basements; 47% of water heaters are located in conditioned basements and 44% in unconditioned basements.

## 14.3 Combined On-site and Homeowner Survey Findings

As stated earlier, most surveyed homeowners (84%) rate the energy efficiency of their water heaters above average. Combining phone survey and on-site inspection data shows homeowners' ratings of the efficiency of their water heaters are not related to the type of water heating system they have. Homeowners were asked to describe the efficiency of their water heater as ENERGY STAR qualified, energy efficient but not ENERGY STAR labeled, of average efficiency, or not energy efficient.[25] Figure 14–2 shows how surveyed homeowners whose homes were inspected described the efficiency of their water heating system and, for each efficiency category, the percentages of homes with on-demand or solar assisted water heating, gas or oil integrated tanks, gas or oil stand alone tanks, and tankless coil systems. As shown, a majority of the water heaters in every efficiency category are integrated tanks, which is an efficient water heating option.

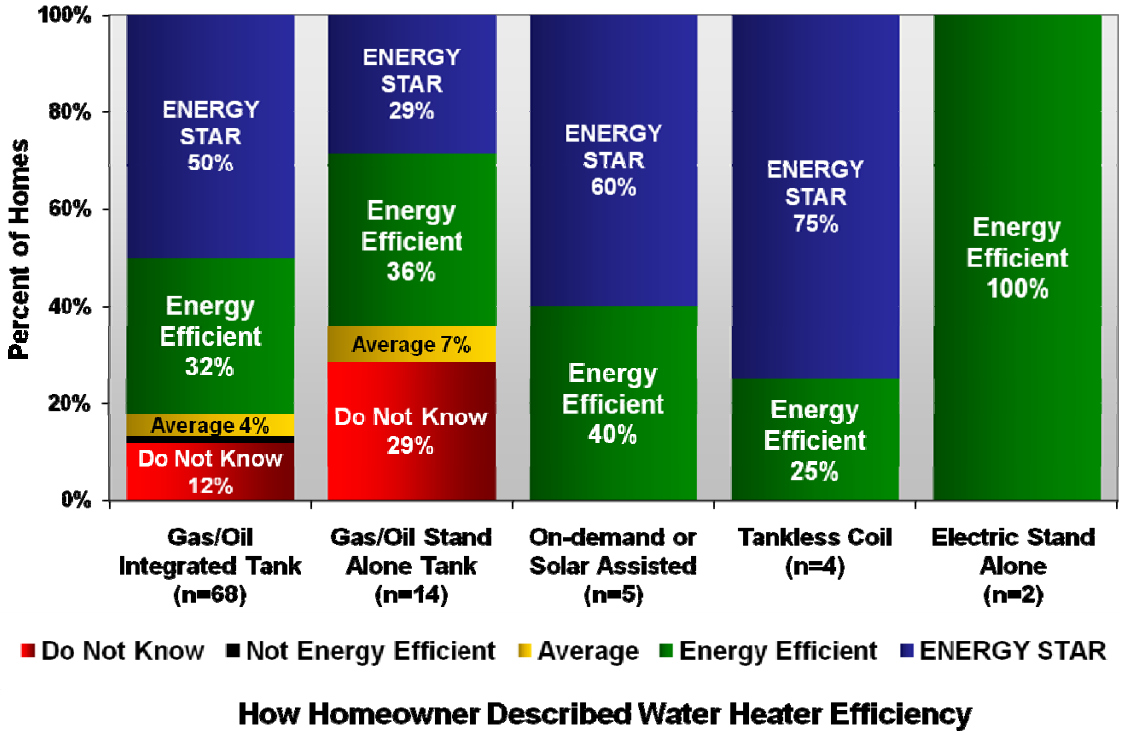
**Figure 14–2: Type of Water Heating by Perceived Efficiency.**




[25] There was no ENERGY STAR qualification of water heaters when the homeowner survey was conducted. However, surveyed homeowners were given the option of indentifying their water heaters as ENERGY STAR.

Figure 14–3 shows the percentages of each type of water heating that surveyed homeowners whose homes were inspected believe are ENERGY STAR, energy efficient but not ENERGY STAR, average efficiency, not energy efficient, or that do not know how energy efficient there water heater is. As shown, some owners of each type of water heating believe their water heaters are ENERGY STAR. Overall, almost one-half (47%) of homeowners think they have ENERGY STAR water heaters. Obviously, these homeowners are not aware that there was no ENERGY STAR rating for water heaters when their water heater was purchased.

**Figure 14–3: Perceived Efficiency by Type of Water Heating**




# 15 Appliances

Information on appliances in residential new construction draws from the phone survey of 296 homeowners and on-site inspections of 105 homes that had appliances installed at the time of the inspection.

## 15.1 Refrigerators

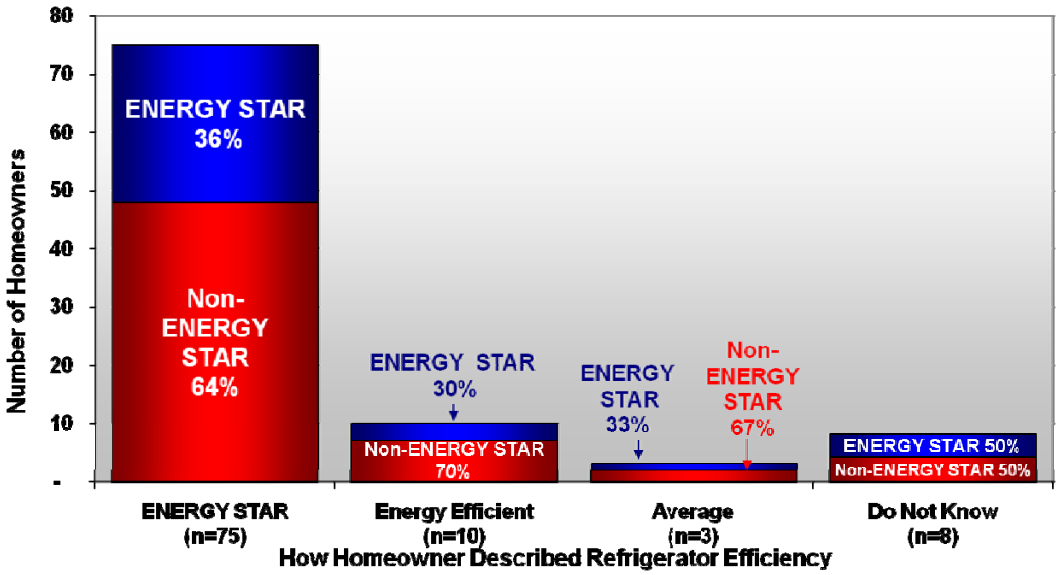
Most surveyed homeowners (88%) say that they chose the refrigerators in their homes, and most (87%) say they believe their refrigerators are energy efficient; 71% say that their refrigerators are ENERGY STAR and 16% say their refrigerators are energy efficient, but not ENERGY STAR. When the 216 surveyed homeowners who say their refrigerators are energy efficient were asked why they selected a particular refrigerator, reasons cited by ten percent or more of homeowners

are: more energy efficient (45%), better design or style (17%), better features and capabilities (17%), good value (15%), and saves energy (13%). Only five percent of homeowners cited the ENERGY STAR label as a reason for purchasing a specific refrigerator.

On-site inspections of 105 homes where appliances were installed showed almost one-fifth (19%) of homes also had a second working refrigerator. Overall, 30% of the refrigerators in audited homes are ENERGY STAR, which is only slightly higher than the 27% penetration of ENERGY STAR refrigerators found in the 2002 baseline study. (Note that study estimates of ENERGY STAR appliance percentages are likely conservative.) Virtually all (99%) of primary refrigerators and 83% of second refrigerators are less than five years old. Auditors found all the primary refrigerators and 90% of the secondary refrigerators to be in good condition.

Combining phone survey and on-site inspection data on primary refrigerators shows that many of the surveyed homeowners whose homes were inspected and who think they have ENERGY STAR refrigerators do not. Homeowners were asked to describe the efficiency of their primary refrigerator as ENERGY STAR qualified, energy efficient but not ENERGY STAR labeled, of average efficiency, or not energy efficient. Figure 15–1 shows that only 36% of the 75 homeowners who think they have an ENERGY STAR refrigerator really do. Also, more than one-third (38%) of the 21 homeowners who think their refrigerators are energy efficient but not ENERGY STAR, average efficiency, or do not know how efficient their refrigerator is, have ENERGY STAR refrigerators. Overall, only 37% of homeowners accurately described their primary refrigerator as ENERGY STAR or not ENERGY STAR. Again, the method used to verify the ENERGY STAR status of appliances likely produced conservative estimates of the percentage of ENERGY STAR appliances; however, we believe the trends described in this report are accurate, though the magnitude may be smaller.

**Figure 15–1: Perceived vs. Actual Refrigerator Efficiency**



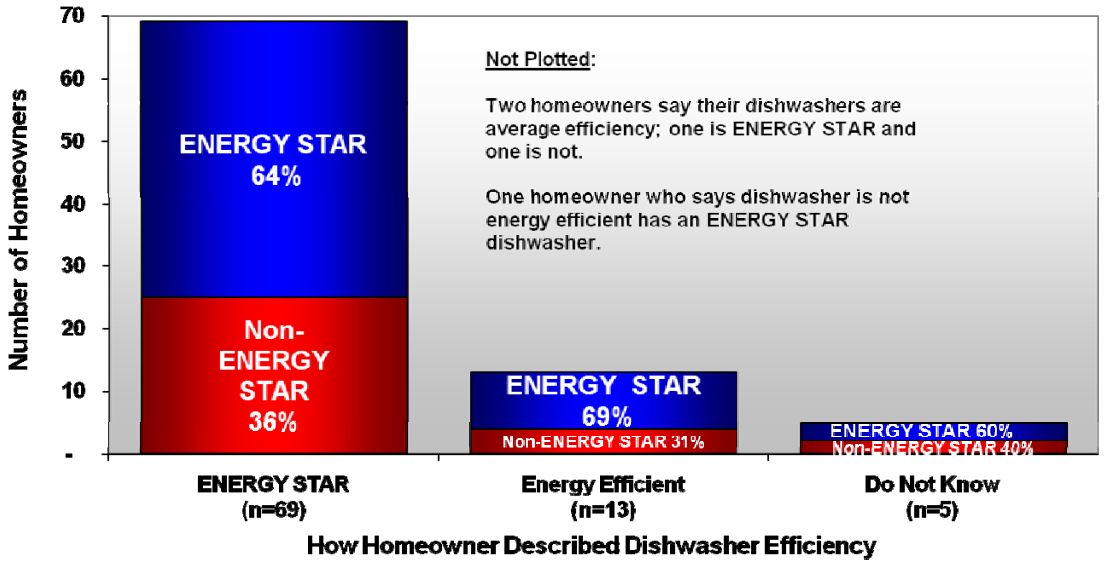
## 15.2 Dishwashers

Based on the homeowner survey, 92% of new homes in Vermont have dishwashers. Most surveyed homeowners (84%) say they chose the dishwashers in their homes, and most (88%) say they believe their dishwashers are energy efficient; 74% say that their dishwashers are ENERGY STAR and 14% say their dishwashers are energy efficient, but not ENERGY STAR. When 97 of the surveyed homeowners who say their dishwashers are energy efficient were asked why they selected a particular dishwasher, reasons cited by ten percent or more of these homeowners are: more energy efficient (50%), better design or style (18%), good value (16%), and saves energy (10%). Only four percent of homeowners cited the ENERGY STAR label as a reason for purchasing a specific dishwasher.

On-site inspections of 105 homes where appliances were installed found almost all homes (92%) have dishwashers and that 69% of them are ENERGY STAR, which is almost double the 36% of dishwashers that were ENERGY STAR in the 2002 baseline study.

Combining phone survey and on-site inspection data on dishwashers shows many of the surveyed homeowners whose homes were inspected and who think they have ENERGY STAR dishwashers do not. Homeowners were asked to describe the efficiency of their primary dishwasher as ENERGY STAR qualified, energy efficient but not ENERGY STAR labeled, of average efficiency, or not energy efficient. Figure 15–2 shows that almost two-thirds (64%) of the 69 homeowners who think they have an ENERGY STAR dishwasher really do, and just over one-third (36%) who think they have an ENERGY STAR dishwasher do not. Also, 69% of the 13 homeowners who think their dishwashers are energy efficient but not ENERGY STAR, and three of the five homeowners who do not know how efficient their dishwashers are, actually have ENERGY STAR dishwashers. Overall, only slightly more than one-half (54%) of surveyed homeowners whose homes were inspected accurately described their dishwasher as ENERGY STAR or not ENERGY STAR.

**Figure 15–2: Perceived vs. Actual Dishwasher Efficiency**



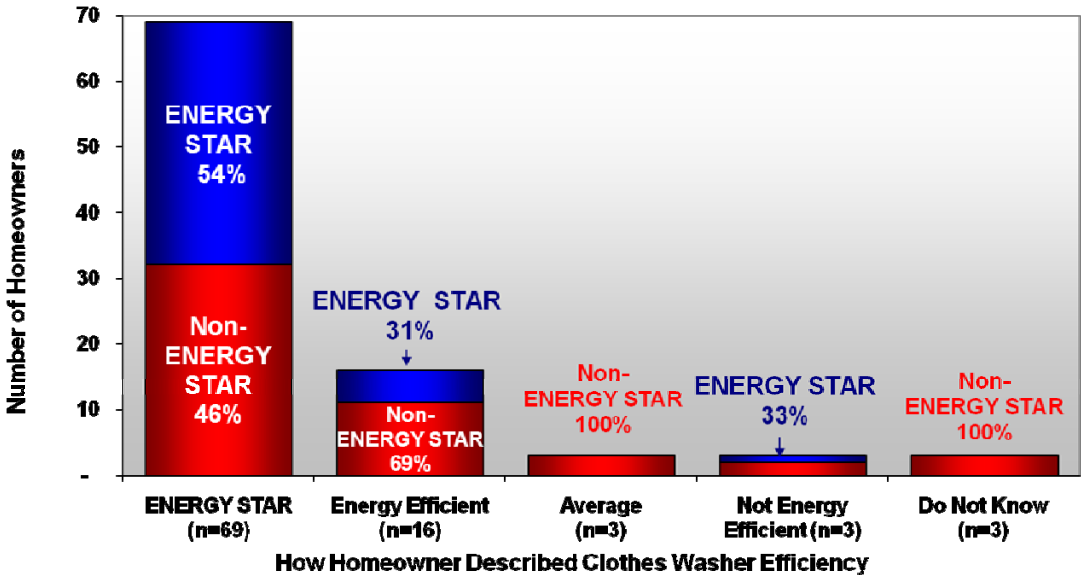
## 15.3 Clothes Washers

Based on the homeowner survey, 94% of new homes in Vermont have clothes washers. Almost all (96%) surveyed homeowners who have clothes washers say they chose the clothes washers in their homes. Most homeowners (85%) say they believe their clothes washers are energy efficient; 68% say that their clothes washers are ENERGY STAR and 17% say their clothes washers are energy efficient, but not ENERGY STAR. When 34 of the surveyed homeowners who say their clothes washers are energy efficient were asked why they selected a particular clothes washer, reasons cited by ten percent or more of these homeowners are: more energy efficient (57%), better features and capabilities (17%), saves energy (13%), and good value (10%). Only three percent of homeowners cited the ENERGY STAR label as a reason for purchasing a specific clothes washer.

On-site inspections of 105 homes where appliances were installed showed almost all homes (97%) have clothes washers and that 48% of them are ENERGY STAR, which is virtually the same as in the 2002 baseline study when 47% of clothes washers were ENERGY STAR.

Combining phone survey and on-site inspection data on clothes washers shows many of the surveyed homeowners whose homes were inspected and who think they have ENERGY STAR clothes washers do not. Homeowners were asked to describe the efficiency of their primary dishwasher as ENERGY STAR qualified, energy efficient but not ENERGY STAR labeled, of average efficiency, or not energy efficient. Figure 15–3 shows that just over one-half (54%) of the 69 homeowners who think they have an ENERGY STAR clothes washer really do, and just under one-half (46%) who think they have an ENERGY STAR clothes washer do not. Also, roughly one third of homeowners who think their clothes washers are energy efficient but not ENERGY STAR, or not energy efficient actually have ENERGY STAR dishwashers. Overall, only slightly more than one-half (56%) of surveyed homeowners whose homes were inspected accurately described their clothes washer as ENERGY STAR or not ENERGY STAR.

**Figure 15–3: Perceived vs. Actual Clothes Washer Efficiency**



# 16 Lighting

Information on lighting in residential new construction draws from the phone survey of 296 homeowners and on-site inspections of 105 homes that had all lighting fixtures installed at the time of the inspection.

## 16.1 Hard-wired Lighting Fixtures

The homeowner survey found 65% of homeowners select the hard-wired lighting fixtures in their homes. More than one-third (37%) of homeowners believe their lighting is ENERGY STAR; 29% say their lighting is energy efficient, but not ENERGY STAR; 11% say their lighting is average efficiency, 2% say their lighting is not energy efficient; and almost one fourth (22%) do not know how efficient their lighting is. When 34 of the surveyed homeowners who say their lighting fixtures are energy efficient were asked why they selected particular lighting fixtures, reasons cited by ten percent or more of these homeowners are: more energy efficient (29%), better design or style (24%), recommended by builder or contractor (18%), and saves energy (15%). No homeowners mentioned the ENERGY STAR label as a reason for purchasing a specific lighting fixture.

One-third (33%) of surveyed homeowners report that all the hard-wired lighting fixtures in their homes were included in the purchase price of the home—they had no options; 21% report that the fixtures were included in the purchase price and they could choose the fixtures; 14% report that all the fixtures were included in the purchase price and they could choose from several options; and 11% report that no fixtures were included in the purchase price of the home. The remaining 21% of homeowners had some combination of the above scenarios.

Over one-third (38%) of homeowners report having ENERGY STAR CFL fixtures installed in their homes; 47% report they do not have any ENERGY STAR CFL fixtures, and another 15% do not know if they have any. Of homeowners with ENERGY STAR CFL fixtures, 20% say that they have five or less, 20% say they have six to ten, and 42% say they have more than ten ENERGY STAR CFL fixtures.

Interviewed builders provided mixed views on customer interest in and satisfaction with CFL fixtures and bulbs. However, all but one interviewed builder said they install CFL fixtures in at least some of their homes and 20 of the 25 interviewed builders say they install screw-in CFL bulbs in at least some of their homes. Several builders say they have seen a big increase recently in homebuyers wanting ENERGY STAR lighting, but builders also say that convincing some of their clients to install ENERGY STAR lighting remains an obstacle—especially high-end custom-home clients.

## 16.2 Compact Fluorescent Light Bulbs

Based on phone survey findings, most homeowners are aware of CFLs, have CFLs in their homes, and are satisfied with the CFLs' performance. Almost all (94%) owners of new homes have unaided recognition of CFLs and another five percent have aided recognition. Unaided

awareness of CFLs is based on whether or not respondents say that they are familiar with screw-in compact fluorescent light bulbs. Aided awareness is based on whether or not respondents are familiar with CFLs after hearing a description of what the bulbs look like.[26] Of the 287 homeowners aware of CFLs just over two-thirds say they have CFLs in their homes; almost one-half (49%) report that CFL bulbs were installed in their new homes before they moved in and 59% report that they have installed CFL bulbs since they moved in. Three-quarters of homeowners with CFLs installed say they have six or more CFLs installed in their home. Almost one-half (46%) of all homeowners with CFLs installed in their home say they have purchased CFLs with an instant rebate coupon.

Most homeowners (82%) with CFLs installed in their home are satisfied with their bulbs—32% very satisfied and 50% satisfied. Homeowners who are dissatisfied with CFLs (15 respondents) are most likely to be dissatisfied with the color of the light (39%), the lack of light (32%), the delay in the light coming on (22%), or the overall quality of the light (21%). Of homeowners who have not installed any CFLs (35 respondents), the only specific reasons that five percent or more of these homeowners give for not installing CFLs are the overall light quality (6%), the delay in the light coming on (6%), and the bulbs are not bright enough. In addition, 25% of these homeowners without any CFL bulbs say that they do not know why they have not installed any and 10% claim to be waiting until their incandescent bulbs burn out.

## 16.3 On-site Inspections

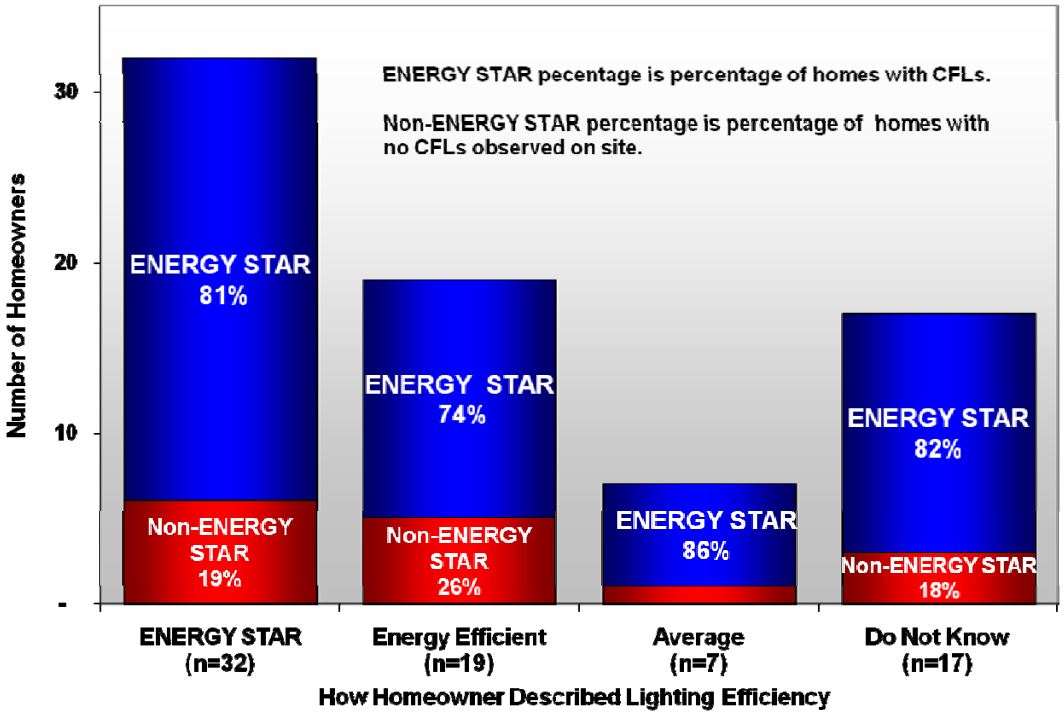
Auditors found CFL bulbs (screw-in and/or pin-based) installed in 81% of inspected homes, which is a big increase from 2002 when CFLs were found in less than one-half (47%) of inspected homes. Over one-quarter of homes (28%) have screw-in CFLs in storage and 13% have installed dimmable incandescent bulbs. Twenty percent of homes have T12 fluorescent tube fixtures installed, about one-third have T8 tubes installed, 10% have T5 tubes installed, and 13% have circlines installed. Statewide, an average of 14.2 and median of 10 CFL bulbs (screw-in and pin-based) are installed per home, representing 25% of the average total 56.3 incandescent and CFL bulbs installed per home. This penetration of CFL lighting is much higher than in 2002 when the average number of CFL bulbs per home was three.

It is impossible to directly compare homeowner survey and on-site inspection findings for hard-wired lighting fixtures or for CFL bulbs. The reason for this is that when reviewing the on-site inspection data it became clear that auditors were not always able to accurately determine whether a CFL bulb located inside an inaccessible fixture (such as an enclosed ceiling-mounted fixture) was a screw-in CFL bulb or a pin-based CFL bulb. In homes where the ceilings were too high to remove the fixture covers, auditors usually relied on the homeowner knowing whether the CFL bulb was a screw-in model or a pin-based model. Therefore, all on-site inspection CFL lighting findings are based on total screw-in and pin-based CFL bulbs.

[26] Respondents who replied that they were not familiar with CFLs were read the following description: "Compact fluorescent bulbs don't look like regular incandescent light bulbs. They often have unusual shapes, such as with bent tubes; sometimes they have a circular shape with one ring; a lot of them are spiral tubes, and they fit in regular light sockets. After hearing this description, are you familiar with screw-in compact fluorescent bulbs?"

However, it is possible to compare how surveyed homeowners whose homes were inspected described the energy efficiency of their lighting to what auditors found in the on-site inspections. Combining phone survey and on-site inspection data on lighting shows most of the surveyed homeowners whose homes were inspected and who think they have ENERGY STAR lighting do. However, many homeowners who do not say they have ENERGY STAR lighting do have screw-in and/or pin-based CFL bulbs. Homeowners were asked to describe the efficiency of their lighting as ENERGY STAR qualified, energy efficient but not ENERGY STAR labeled, of average efficiency, or not energy efficient. Figure 16–1 shows that 81% of the 32 homeowners who think they have ENERGY STAR lighting really do, and 19% who think they have ENERGY STAR lighting do not. Almost three-quarters (74%) of the 19 homeowners who think their lighting is energy efficient, but not ENERGY STAR, actually have CFL bulbs, as do six of seven homeowners who think their lighting is average efficiency, and 82% of the 17 homeowners who do not know how efficient their lighting is. Overall, only slightly more than one-half (52%) of the 75 surveyed homeowners whose homes were inspected, and who responded to the survey question asking how efficient they believe their lighting is, accurately described their lighting as ENERGY STAR or not ENERGY STAR. These results may understate the percentage of homeowners who know they have ENERGY STAR lighting because some homeowners may have said their lighting was ENERGY STAR only if they thought that all their lighting was ENERGY STAR and others may have said their lighting was ENERGY STAR if they knew that at least some of their lighting was ENERGY STAR. Also, not all CFLs are ENERGY STAR labeled, though many are.

**Figure 16–1: Perceived vs. Actual Lighting Efficiency**



# Appendix A—Homeowner Group Comparisons

# List of Tables

## Significant Differences by Home Grouping

**Targeted regions vs. the remainder of Vermont:** There are few significant differences between homes in the targeted regions and homes in the remainder of Vermont. Homes in the targeted regions: (Appendix A Table 1)

- Are less likely to have 2x4 framing and more likely to have 2x6 framing
- Have lower R-value wall insulation
- Have lower total CFM50 envelope leakage and lower ACHnat
- Have lower average SEER central air conditioning

**Homes in individual targeted regions vs. all other targeted regions:** There are many significant differences between homes in each targeted region compared to homes in all other targeted regions. There are significant differences in home size, average cathedral ceiling insulation R-value, average window U-value, average ACHnat, average heating system AFUE, percentage of homes with boiler heating systems, percentage of AFUE 90 or higher boilers, percentage of homes with central air conditioning, average water heater Energy Factor, percentage of homes with CFLs, and percentage of homes with ENERGY STAR dishwashers. (Appendix A Table 1 and Appendix A Table 2)

**Homes completed in 2005 or 2006 vs. homes completed in 2006 or 2007:** Significant differences are that homes completed in 2005 or 2006 compared to those completed in 2007 or 2008: (Appendix A Table 3)

- Are more likely to have 2x4 framing
- Have lower R-value below grade foundation wall insulation
- Have a lower average glazing percentage
- Have a higher penetration of central air conditioning
- Have a lower number of CFL bulbs and lower percentage of CFL bulbs

**Detached compared to attached homes:** Significant differences are that detached homes compared to attached homes: (Appendix A Table 3)

- Are larger
- More likely to have 2x4 framing, less likely to have 2x6 framing, and more likely to have 2x8 framing or SIPS walls
- Have higher R-value cathedral ceiling insulation
- Have higher average total CFM50 envelope leakage
- Have a lower average heating system AFUE
- Are more likely to have a boiler heating system
- Have a lower overall average boiler AFUE, but the average AFUE of boilers with AFUEs over 90 is higher
- Are less likely to have CFL bulbs

**Homes that owners think are ENERGY STAR qualified, but are not, compared to verified ENERGY STAR homes:** Significant differences are that homes that owners think are ENERGY STAR, but are not: (Appendix A Table 4)

- Are more likely to have 2x6 framing and less likely to have 2x8 framing or SIPs walls
- Have lower average R-value wall and flat ceiling insulation
- Have less energy-efficient windows
- Have higher average total CFM50 envelope leakage and ACHnat
- Have a lower average heating system AFUE
- Have a lower overall average boiler AFUE
- Are less likely to have an AFUE 90 or higher boiler

**Modular homes compared to on-site built homes:** Significant differences are that modular homes: (Appendix A Table 5)

- Are smaller
- Are less likely to 2x8 framing or SIPs walls
- Have lower average R-value wall and ceiling insulation
- Have higher average ACHnat
- Have a lower average heating system AFUE
- Have a lower overall average boiler AFUE
- Are less likely to have an AFUE 90 or higher boiler
- Have a lower number of CFL bulbs and lower percentage of CFL bulbs

**Custom homes that were built on land the homeowner already owned compared to homes built on land the builder owned:** Significant differences are that custom homes: (Appendix A Table 5)

- Are larger
- Are more likely to 2x8 framing or SIPs walls
- Have higher average R-value wall, ceiling, and below grade foundation wall insulation
- Have a higher glazing percentage
- Have more energy-efficient windows
- Have lower average ACHnat
- Are more likely to have a boiler heating system
- Have a higher average water heater Energy Factor
- Have a higher number of CFL bulbs
- Have a higher penetration of ENERGY STAR dishwashers

**Homes where an architect was involved compared to homes where only a builder was involved:** The only significant difference is that homes where an architect was involved have higher average SEER central air conditioning. (Appendix A Table 6)

**Homes where the owner said they built their home or acted as the general contractor compared to other homes:** The only significant differences are that homes where the owner either built the home or acted as the general contractor have lower average R-value flat ceiling insulation and a higher percentage of CFL bulbs. (Appendix A Table 6)

**Homes where owners are satisfied with the thermal comfort of their homes compared to homes where owners are not satisfied with the thermal comfort of their homes:** The only significant differences are that homes where the owners are not satisfied with the thermal comfort are less likely to have 2x8 framing or SIPs walls and have lower average R-value wall and ceiling insulation. (Appendix A Table 7)

**Homes of owners who strongly agree or agree that, in general, all new homes are energy efficient compared to homes of owners who strongly disagree or disagree:** Significant differences are that homes of owners who strongly agree or agree that all new homes are energy efficient: (Appendix A Table 7)

- Are more likely to have 2x4 framing
- Have less energy-efficient windows
- Have higher average ACHnat
- Are less likely to have a boiler heating system
- Have a lower average boiler AFUE
- Are less likely to have an AFUE 90 or higher boiler and the average AFUE of over AFUE 90 boilers is lower
- Have a lower average water heater Energy Factor
- Have a lower number of CFL bulbs and a lower percentage of CFL bulbs

**Homes of owners who "strongly agree" compared to homes of owners who "agree" with the statement "My new home is energy efficient":** Significant differences are that homes of owners who strongly agree that their home is energy efficient: (Appendix A Table 8)

- Are more likely to have 2x8 framing or SIPs walls
- Have higher average R-value wall and below grade foundation wall insulation
- Have lower average total CFM50 envelope leakage
- Have a higher average heating system AFUE
- Have a higher average boiler AFUE
- Have a higher percentage of over AFUE 90 boilers
- Are less likely to have central air conditioning
- Have lower average SEER central air conditioning
- Have a higher average water heater Energy Factor
- Have more CFL bulbs and a higher percentage of CFL bulbs

**Homes whose owners rated their energy efficiency nine or ten compared to homes rated six, seven or eight:** Significant differences are that homes rated nine or ten: (Appendix A Table 8)

- Are more likely to have 2x8 framing or SIPs walls
- Have higher average R-value wall insulation
- Have lower average total CFM50 envelope leakage
- Have a higher average boiler AFUE
- Have a higher percentage of over AFUE 90 boilers, but the average efficiency of over 90 AFUE boilers is lower

**Homes of owners who have heard of RBES compared to homes of owners who have not heard of RBES:** Significant differences are that homes of owners who have heard of RBES: (Appendix A Table 9)

- Are larger
- Have higher average R-value wall, ceiling, and below grade foundation wall insulation
- Have a higher average glazing percentage
- Are less likely to have central air conditioning
- Have a higher average water heater Energy Factor

**Homes of owners who have seen or heard of the ENERGY STAR label compared to homes of owners who have not seen or heard of the ENERGY STAR label:** Significant differences are that homes of owners who have heard or seen of the ENERGY STAR label: (Appendix A Table 9)

- Are more likely to have 2x8 framing or SIPs walls
- Have higher average R-value wall, cathedral ceiling, and below grade foundation wall insulation
- Have a higher glazing percentage
- Are more likely to have a boiler heating system
- Are more likely to have an over AFUE 90 boiler

**Homes of owners who have heard of EVT compared to homes of owners who have not heard of EVT:** Significant differences are that homes of owners who have heard of EVT: (Appendix A Table 10)

- Have higher average R-value wall, flat ceiling, and below grade foundation wall insulation
- Have a higher glazing percentage
- The average efficiency of over AFUE 90 boilers is lower
- Are less likely to have an ENERGY STAR refrigerator

**Homes of owners who say they have participated in an EVT program compared to homes of owners who say they have not participated in an EVT program:** Significant differences are that homes of owners who say they have participated in an EVT program: (Appendix A Table 10)

- Are less likely to have 2x4 framing and more likely to have 2x8 framing or SIPs walls
- Have higher average R-value wall and ceiling insulation
- Have lower average total CFM50 envelope leakage
- Are less likely to have central air conditioning
- Have a higher average water heater Energy Factor
- Are more likely to have CFL bulbs
- Have more CFL bulbs and a higher percentage of CFL bulbs

**Homes of first-time homebuyers compared to homes of owners who previously owned a home:** Significant differences are that homes of first-time home buyers: (Appendix A Table 11)

- Are smaller
- Have lower average R-value wall and ceiling insulation
- Have lower average total CFM50 envelope leakage

**Homes of owners who have heard of ENERGY STAR homes compared to homes of owners who have not heard of ENERGY STAR homes:** Significant differences are that homes of owners who have heard of ENERGY STAR homes: (Appendix A Table 11)

- Have higher average R-value below grade foundation wall insulation
- Have a higher glazing percentage
- Have a higher average heating system AFUE
- Are more likely to have central air conditioning

**Homes with multiple inefficient characteristics compared to all other homes:** Significant differences are that homes with multiple inefficient characteristics: (Appendix A Table 12)

- Have lower average R-value wall and ceiling insulation
- Have higher average total CFM50 envelope leakage
- The average efficiency of over AFUE 90 boilers is higher
- Are less likely to have central air conditioning
- Are more likely to have CFL bulbs

**Homes of owners with a college degree compared to homes whose owners do not have a college degree:** Significant differences are that homes of owners who have a college degree: (Appendix A Table 12)

- Are larger
- Are more likely to have 2x8 framing or SIPs walls
- Have higher average R-value wall and ceiling insulation
- Have a higher average glazing percentage
- Have a higher average heating system AFUE
- Have a higher percentage of over AFUE 90 boilers, but the average AFUE of boilers with AFUEs over 90 is lower
- Are more likely to have central air conditioning

**Homes whose owners' annual income is $75,000 or higher compared to homes whose owners' annual income is below $75,000 :** Significant differences are that homes of owners whose annual income is at least $75,000: (Appendix A Table 14)

- Are larger
- Have lower average ACHnat
- Are more likely to have central air conditioning
- Have a lower average water heater Energy Factor
- Have a lower percentage of CFL bulbs

**Homes of owners who are under 35 years old compared to other homes:** Significant differences are that homes of owners under 35 years old: (Appendix A Table 14)

- Are less likely to have 2x4 framing, more likely to have 2x6 framing, and less likely to have 2x8 framing or SIPs walls
- Have lower average R-value ceiling insulation
- Have a lower average glazing percentage
- Have lower average total CFM50 envelope leakage and ACHnat
- Are more likely to have a boiler heating system

**Homes of owners who are 55 or older compared to other homes:** The only significant difference is that homes of owners 55 or older have a higher average glazing percentage. (Appendix A Table 15)

**Homes of owners who are 35 to 54 years old compared to other homes:** The only significant difference is that the average efficiency of over AFUE 90 boilers is lower in the homes of owners 35 to 54 years old. (Appendix A Table 15)

**Homes of owners who expect to stay in their new home for five or fewer years compared to other homes:** Significant differences are that homes whose owners expect to stay in their new home for five or fewer years: (Appendix A Table 16)

- Are less likely to have 2x8 framing or SIPs walls
- Have lower average R-value wall and cathedral ceiling insulation
- Are less likely to have an ENERGY STAR clothes washer

**Homes of owners who expect to stay in their new home for from six to ten years compared to other homes:** Significant differences are that homes whose owners expect to stay in their new home for from six to ten years: (Appendix A Table 16)

- Are less likely to have 2x4 framing, more likely to have 2x6 framing, and less likely to have 2x8 framing or SIPs walls
- Have lower average R-value wall insulation
- Have lower average SEER central air conditioning
- Are less likely to have an ENERGY STAR dishwasher

**Homes of owners who expect to stay in their new home for more than ten years compared to other homes:** The only significant difference is that in homes owners expect to live in for more than ten years the average efficiency of over AFUE 90 boilers is lower. (Appendix A Table 17)

**Homes of owners who expect to stay in their new home indefinitely compared to other homes:** The only significant differences are that in homes owners expect to stay in indefinitely are more likely to have 2x8 framing or SIPs walls and have higher average R-value cathedral ceiling insulation. (Appendix A Table 17)

## Homeowner Group Comparison Tables

### Appendix A Table 1: Targeted Regions vs. Remainder of Vermont and Burlington/North Chittenden vs. Other Targeted Regions

| Characteristics | Targeted Regions vs. Remainder of Vermont* | | Targeted Region Comparisons * | |
|---|---|---|---|---|
| | Targeted Regions | Rem. of Vermont | North Chittenden and Burlington | Other Targeted Regions |
| Number of Homes | 39 | 67 | 10 | 29 |
| Average Conditioned area s(Sq. Ft.) | 2,427 | 2,532 | 1,999 | 2,575 |
| Percent of Homes 2x4 Framing | 0% | 7% | 0% | 0% |
| Percent of Homes 2x6 Framing | 95% | 79% | 100% | 93% |
| Percent of Homes2x8 or SIPS Walls | 5% | 13% | 0% | 7% |
| Average Wall Insulation R-value | 20 | 22 | 19 | 20 |
| Average Flat Ceiling Insulation R-value | 37 | 39 | 37 | 37 |
| Average Cathedral Ceiling Insulation R-value | 34 | 35 | 38 | 33 |
| Avg. Above Grade Foundation Wall Insulation R-value | 18 | 17 | 19 | 18 |
| Avg. Below Grade Foundation Wall Insulation R-value | 11 | 11 | 12 | 11 |
| Average Glazing Percent (Window/Wall Ratio) | 13% | 13% | 13% | 13% |
| Average Window U-value | 0.34 | 0.34 | 0.32 | 0.35 |
| Average Total Infiltration (CFM50) | 1,376 | 1,670 | 1,495 | 1,334 |
| Average Natural Air Changes per Hour(ACHnat) | 0.24 | 0.30 | 0.27 | 0.22 |
| Average Heating System AFUE | 88.6 | 87.5 | 90.9 | 87.9 |
| Percent of Homes with Boilers | 79% | 85% | 30% | 97% |
| Average Gas/Oil Boiler AFUE | 87.6 | 87.3 | 86.7 | 87.7 |
| Percent of Boilers Super High Efficiency (AFUE>90) | 16% | 21% | 0% | 18% |
| Average Super High Efficiency Boiler AFUE | 94.3 | 93.7 | na | 94.3 |
| Percent of Homes with Central Air Conditioning | 13% | 9% | 50% | 0% |
| Average Central Air Conditioning SEER | 11.6 | 13.3 | 11.6 | |
| Average Water Heating Energy Factor | 0.75 | 0.76 | 0.67 | 0.79 |
| Percent of Homes with CFLs | 85% | 79% | 100% | 79% |
| Average Number of CFLs per Home (All Homes) | 13 | 15 | 14 | 12 |
| Average Percent CFLs (All Homes) | 24% | 33% | 20% | 25% |
| Percent of Homes with ENERGY STAR Refrigerator | 38% | 33% | 20% | 45% |
| Percent of Homes with ENERGY STAR Clothes Washer | 41% | 48% | 50% | 38% |
| Percent of Homes with ENERGY STAR Dishwasher | 64% | 61% | 50% | 69% |

*Shaded cells indicate difference is significant at the 90% confidence level.

## Appendix A Table 2: St. Albans and Newport/Derby vs. Other Targeted Regions

| Characteristics | Targeted Region Comparisons * | | Targeted Region Comparisons * | |
|---|---|---|---|---|
| | St. Albans | Other Targeted Regions | Newport/ Derby | Other Targeted Regions |
| Number of Homes | 15 | 24 | 14 | 25 |
| Average Conditioned area s(Sq. Ft.) | 2,090 | 2,638 | 3,094 | 2,054 |
| Percent of Homes 2x4 Framing | 0% | 0% | 0% | 0% |
| Percent of Homes 2x6 Framing | 100% | 92% | 86% | 100% |
| Percent of Homes2x8 or SIPS Walls | 0% | 8% | 14% | 0% |
| Average Wall Insulation R-value | 20 | 20 | 20 | 20 |
| Average Flat Ceiling Insulation R-value | 35 | 38 | 40 | 36 |
| Average Cathedral Ceiling Insulation R-value | 32 | 34 | 33 | 34 |
| Avg. Above Grade Foundation Wall Insulation R-value | 19 | 17 | 17 | 19 |
| Avg. Below Grade Foundation Wall Insulation R-value | 13 | 11 | 10 | 13 |
| Average Glazing Percent (Window/Wall Ratio) | 13% | 13% | 13% | 13% |
| Average Window U-value | 0.36 | 0.33 | 0.34 | 0.35 |
| Average Total Infiltration (CFM50) | 1,342 | 1,400 | 1,324 | 1,400 |
| Average Natural Air Changes per Hour(ACHnat) | 0.26 | 0.22 | 0.17 | 0.27 |
| Average Heating System AFUE | 87.0 | 89.7 | 88.8 | 88.5 |
| Percent of Homes with Boilers | 100% | 67% | 93% | 72% |
| Average Gas/Oil Boiler AFUE | 87.0 | 88.2 | 88.5 | 86.9 |
| Percent of Boilers Super High Efficiency (AFUE>90) | 7% | 25% | 31% | 6% |
| Average Super High Efficiency Boiler AFUE | 93.0 | 94.6 | 94.6 | 93.0 |
| Percent of Homes with Central Air Conditioning | 0% | 21% | 0% | 20% |
| Average Central Air Conditioning SEER | na | 11.6 | na | 11.6 |
| Average Water Heating Energy Factor | 0.77 | 0.74 | 0.80 | 0.73 |
| Percent of Homes with CFLs | 80% | 88% | 79% | 88% |
| Average Number of CFLs per Home (All Homes) | 12 | 13 | 13 | 13 |
| Average Percent CFLs (All Homes) | 25% | 23% | 25% | 23% |
| Percent of Homes with ENERGY STAR Refrigerator | 53% | 29% | 36% | 40% |
| Percent of Homes with ENERGY STAR Clothes Washer | 27% | 50% | 50% | 36% |
| Percent of Homes with ENERGY STAR Dishwasher | 53% | 71% | 86% | 52% |

*Shaded cells indicate difference is significant at the 90% confidence level.

## Appendix A Table 3: Homes Grouped by Completion Date and Attached vs. Detached

| Characteristics | Year Homes Completed | | Detached vs. Attached | |
|---|---|---|---|---|
| | 2005 or 2006 | 2007 or 2008 | Detached single-family Homes | Attached Single-family Homes |
| Number of Homes | 79 | 27 | 88 | 10 |
| Average Conditioned area s(Sq. Ft.) | 2,439 | 2,654 | 2,525 | 1,748 |
| Percent of Homes 2x4 Framing | 6% | 0% | 6% | 0% |
| Percent of Homes 2x6 Framing | 84% | 89% | 83% | 100% |
| Percent of Homes2x8 or SIPS Walls | 10% | 11% | 11% | 0% |
| Average Wall Insulation R-value | 21 | 22 | 21 | 20 |
| Average Flat Ceiling Insulation R-value | 38 | 39 | 39 | 35 |
| Average Cathedral Ceiling Insulation R-value | 35 | 34 | 35 | 33 |
| Avg. Above Grade Foundation Wall Insulation R-value | 18 | 16 | 18 | 19 |
| Avg. Below Grade Foundation Wall Insulation R-value | 10 | 14 | 11 | 12 |
| Average Glazing Percent (Window/Wall Ratio) | 13% | 14% | 13% | 13% |
| Average Window U-value | 0.34 | 0.34 | 0.34 | 0.33 |
| Average Total Infiltration (CFM50) | 1,567 | 1,530 | 1,620 | 1,264 |
| Average Natural Air Changes per Hour(ACHnat) | 0.28 | 0.27 | 0.28 | 0.29 |
| Average Heating System AFUE | 87.9 | 88.2 | 87.4 | 91.1 |
| Percent of Homes with Boilers | 82% | 85% | 86% | 50% |
| Average Gas/Oil Boiler AFUE | 87.4 | 87.4 | 87.0 | 89.6 |
| Percent of Boilers Super High Efficiency (AFUE>90) | 20% | 17% | 16% | 40% |
| Average Super High Efficiency Boiler AFUE | 93.9 | 94.0 | 93.7 | 93.0 |
| Percent of Homes with Central Air Conditioning | 13% | 4% | 8% | 30% |
| Average Central Air Conditioning SEER | 12.6 | 13.0 | 12.7 | 12.1 |
| Average Water Heating Energy Factor | 0.76 | 0.77 | 0.76 | 0.70 |
| Percent of Homes with CFLs | 80% | 85% | 77% | 100% |
| Average Number of CFLs per Home (All Homes) | 12 | 21 | 14 | 12 |
| Average Percent CFLs (All Homes) | 26% | 41% | 30% | 28% |
| Percent of Homes with ENERGY STAR Refrigerator | 38% | 26% | 38% | 20% |
| Percent of Homes with ENERGY STAR Clothes Washer | 48% | 37% | 44% | 50% |
| Percent of Homes with ENERGY STAR Dishwasher | 58% | 74% | 60% | 50% |

*Shaded cells indicate difference is significant at the 90% confidence level.

## Appendix A Table 4: ENERGY STAR Home Comparisons

| Characteristics | ENERGY STAR vs. Non-ENERGY STAR | | Think ENERGY STAR vs. ENERGY STAR | |
|---|---|---|---|---|
| | Non-ENERGY STAR Homes | ENERGY STAR Homes | Think Home is ENERGY STAR, but is Not | ENERGY STAR Homes |
| Number of Homes | 76 | 30 | 10 | 30 |
| Average Conditioned area s(Sq. Ft.) | 2,576 | 2,285 | 2,207 | 2,285 |
| Percent of Homes 2x4 Framing | 7% | 0% | 0% | 0% |
| Percent of Homes 2x6 Framing | 86% | 83% | 100% | 83% |
| Percent of Homes2x8 or SIPS Walls | 8% | 17% | 0% | 17% |
| Average Wall Insulation R-value | 20 | 25 | 20 | 25 |
| Average Flat Ceiling Insulation R-value | 36 | 44 | 35 | 44 |
| Average Cathedral Ceiling Insulation R-value | 32 | 40 | 28 | 40 |
| Avg. Above Grade Foundation Wall Insulation R-value | 16 | 22 | 19 | 22 |
| Avg. Below Grade Foundation Wall Insulation R-value | 10 | 14 | 14 | 14 |
| Average Glazing Percent (Window/Wall Ratio) | 13% | 14% | 12% | 14% |
| Average Window U-value | 0.35 | 0.33 | 0.35 | 0.33 |
| Average Total Infiltration (CFM50) | 1,702 | 1,212 | 1,762 | 1,212 |
| Average Natural Air Changes per Hour(ACHnat) | 0.29 | 0.23 | 0.32 | 0.23 |
| Average Heating System AFUE | 87.1 | 89.9 | 85.8 | 89.9 |
| Percent of Homes with Boilers | 85% | 77% | 90% | 77% |
| Average Gas/Oil Boiler AFUE | 86.9 | 88.8 | 84.9 | 88.8 |
| Percent of Boilers Super High Efficiency (AFUE>90) | 14% | 35% | 0% | 35% |
| Average Super High Efficiency Boiler AFUE | 94.6 | 93.1 | 0.0 | 93.1 |
| Percent of Homes with Central Air Conditioning | 9% | 13% | 10% | 13% |
| Average Central Air Conditioning SEER | 13.0 | 11.8 | 10.8 | 11.8 |
| Average Water Heating Energy Factor | 0.76 | 0.77 | 0.79 | 0.77 |
| Percent of Homes with CFLs | 76% | 93% | 100% | 93% |
| Average Number of CFLs per Home (All Homes) | 13 | 17 | 11 | 17 |
| Average Percent CFLs (All Homes) | 27% | 35% | 28% | 35% |
| Percent of Homes with ENERGY STAR Refrigerator | 33% | 40% | 40% | 40% |
| Percent of Homes with ENERGY STAR Clothes Washer | 46% | 43% | 40% | 43% |
| Percent of Homes with ENERGY STAR Dishwasher | 62% | 63% | 60% | 63% |

*Shaded cells indicate difference is significant at the 90% confidence level.

## Appendix A Table 5: Grouped by How Home Constructed and How Purchased

| Characteristics | How Home was Constructed* | | How Home Purchased* | |
|---|---|---|---|---|
| | On Site | Modular | Bought Land and Built Home | Choice of Plans or Spec Home |
| Number of Homes | 75 | 15 | 78 | 24 |
| Average Conditioned area s(Sq. Ft.) | 2,579 | 2,104 | 2,706 | 2,005 |
| Percent of Homes 2x4 Framing | 5% | 7% | 4% | 8% |
| Percent of Homes 2x6 Framing | 81% | 93% | 82% | 92% |
| Percent of Homes2x8 or SIPS Walls | 13% | 0% | 14% | 0% |
| Average Wall Insulation R-value | 22 | 19 | 22 | 19 |
| Average Flat Ceiling Insulation R-value | 40 | 35 | 40 | 34 |
| Average Cathedral Ceiling Insulation R-value | 36 | 28 | 36 | 29 |
| Avg. Above Grade Foundation Wall Insulation R-value | 18 | 17 | 19 | 16 |
| Avg. Below Grade Foundation Wall Insulation R-value | 12 | 10 | 12 | 8 |
| Average Glazing Percent (Window/Wall Ratio) | 13% | 13% | 13% | 12% |
| Average Window U-value | 0.34 | 0.35 | 0.34 | 0.36 |
| Average Total Infiltration (CFM50) | 1,591 | 1,675 | 1,562 | 1,596 |
| Average Natural Air Changes per Hour(ACHnat) | 0.27 | 0.33 | 0.25 | 0.32 |
| Average Heating System AFUE | 88.0 | 85.1 | 88.0 | 87.9 |
| Percent of Homes with Boilers | 85% | 87% | 88% | 67% |
| Average Gas/Oil Boiler AFUE | 87.3 | 85.9 | 87.5 | 87.2 |
| Percent of Boilers Super High Efficiency (AFUE>90) | 21% | 0% | 22% | 13% |
| Average Super High Efficiency Boiler AFUE | 93.7 | na | 93.9 | 94.1 |
| Percent of Homes with Central Air Conditioning | 9% | 7% | 8% | 21% |
| Average Central Air Conditioning SEER | 12.2 | 15.0 | 12.4 | 13.0 |
| Average Water Heating Energy Factor | 0.76 | 0.76 | 0.78 | 0.72 |
| Percent of Homes with CFLs | 79% | 73% | 79% | 88% |
| Average Number of CFLs per Home (All Homes) | 15 | 9 | 15 | 10 |
| Average Percent CFLs (All Homes) | 32% | 20% | 31% | 22% |
| Percent of Homes with ENERGY STAR Refrigerator | 36% | 40% | 37% | 29% |
| Percent of Homes with ENERGY STAR Clothes Washer | 45% | 47% | 44% | 54% |
| Percent of Homes with ENERGY STAR Dishwasher | 59% | 60% | 68% | 46% |

*Shaded cells indicate difference is significant at the 90% confidence level.

## Appendix A Table 6: Grouped by Architect, Builder and Owner Involvement

| Characteristics | Worked with Architect or Builder* | | Homeowner was General Contractor or Builder* | |
|---|---|---|---|---|
| | Architect Involved | Builder Only | Yes | No |
| Number of Homes | 16 | 35 | 36 | 34 |
| Average Conditioned area s(Sq. Ft.) | 2,963 | 2,540 | 2,486 | 2,567 |
| Percent of Homes 2x4 Framing | 6% | 0% | 6% | 3% |
| Percent of Homes 2x6 Framing | 75% | 89% | 81% | 88% |
| Percent of Homes2x8 or SIPS Walls | 19% | 11% | 14% | 9% |
| Average Wall Insulation R-value | 25 | 21 | 22 | 22 |
| Average Flat Ceiling Insulation R-value | 46 | 39 | 37 | 42 |
| Average Cathedral Ceiling Insulation R-value | 34 | 36 | 34 | 35 |
| Avg. Above Grade Foundation Wall Insulation R-value | 21 | 20 | 19 | 19 |
| Avg. Below Grade Foundation Wall Insulation R-value | 13 | 11 | 12 | 11 |
| Average Glazing Percent (Window/Wall Ratio) | 15% | 13% | 12% | 14% |
| Average Window U-value | 0.34 | 0.34 | 0.34 | 0.34 |
| Average Total Infiltration (CFM50) | 1,436 | 1,558 | 1,645 | 1,407 |
| Average Natural Air Changes per Hour(ACHnat) | 0.22 | 0.27 | 0.26 | 0.26 |
| Average Heating System AFUE | 88.3 | 87.5 | 87.4 | 88.0 |
| Percent of Homes with Boilers | 88% | 89% | 83% | 82% |
| Average Gas/Oil Boiler AFUE | 87.2 | 86.8 | 86.7 | 87.4 |
| Percent of Boilers Super High Efficiency (AFUE>90) | 14% | 16% | 10% | 25% |
| Average Super High Efficiency Boiler AFUE | 92.7 | 93.7 | 93.7 | 93.4 |
| Percent of Homes with Central Air Conditioning | 19% | 9% | 11% | 15% |
| Average Central Air Conditioning SEER | 13.0 | 11.7 | 12.5 | 13.1 |
| Average Water Heating Energy Factor | 0.75 | 0.79 | 0.76 | 0.75 |
| Percent of Homes with CFLs | 88% | 74% | 83% | 74% |
| Average Number of CFLs per Home (All Homes) | 16 | 15 | 16 | 13 |
| Average Percent CFLs (All Homes) | 26% | 26% | 36% | 23% |
| Percent of Homes with ENERGY STAR Refrigerator | 25% | 37% | 31% | 38% |
| Percent of Homes with ENERGY STAR Clothes Washer | 44% | 46% | 44% | 44% |
| Percent of Homes with ENERGY STAR Dishwasher | 75% | 69% | 64% | 71% |

*Shaded cells indicate difference is significant at the 90% confidence level.

## Appendix A Table 7: Grouped by Satisfaction with Thermal Comfort and Opinion on "All New Homes are Energy Efficient"

| Characteristics | Satisfaction with Thermal Comfort of Home * | | In General, All New Homes are Energy Efficient * | |
|---|---|---|---|---|
| | Not Satisfied | Satisfied | Agree or Strongly Agree | Disagree or Strongly Disagree |
| Number of Homes | 7 | 97 | 43 | 23 |
| Average Conditioned area s(Sq. Ft.) | 2,258 | 2,513 | 2,399 | 2,507 |
| Percent of Homes 2x4 Framing | 14% | 4% | 7% | 0% |
| Percent of Homes 2x6 Framing | 86% | 85% | 84% | 91% |
| Percent of Homes2x8 or SIPS Walls | 0% | 11% | 9% | 9% |
| Average Wall Insulation R-value | 18 | 21 | 21 | 23 |
| Average Flat Ceiling Insulation R-value | 33 | 39 | 38 | 39 |
| Average Cathedral Ceiling Insulation R-value | 27 | 35 | 31 | 37 |
| Avg. Above Grade Foundation Wall Insulation R-value | 13 | 18 | 18 | 16 |
| Avg. Below Grade Foundation Wall Insulation R-value | 9 | 12 | 12 | 11 |
| Average Glazing Percent (Window/Wall Ratio) | 11% | 13% | 12% | 13% |
| Average Window U-value | 0.37 | 0.34 | 0.34 | 0.32 |
| Average Total Infiltration (CFM50) | 1,694 | 1,560 | 1,613 | 1,297 |
| Average Natural Air Changes per Hour(ACHnat) | 0.33 | 0.27 | 0.30 | 0.23 |
| Average Heating System AFUE | 86.9 | 88.0 | 87.3 | 88.9 |
| Percent of Homes with Boilers | 71% | 83% | 74% | 91% |
| Average Gas/Oil Boiler AFUE | 87.0 | 87.3 | 86.5 | 88.2 |
| Percent of Boilers Super High Efficiency (AFUE>90) | 20% | 19% | 9% | 30% |
| Average Super High Efficiency Boiler AFUE | 95.2 | 93.9 | 92.9 | 94.0 |
| Percent of Homes with Central Air Conditioning | 14% | 10% | 12% | 4% |
| Average Central Air Conditioning SEER | 13.0 | 12.6 | 12.6 | 13.0 |
| Average Water Heating Energy Factor | 0.79 | 0.76 | 0.73 | 0.81 |
| Percent of Homes with CFLs | 86% | 81% | 72% | 87% |
| Average Number of CFLs per Home (All Homes) | 11 | 14 | 12 | 18 |
| Average Percent CFLs (All Homes) | 25% | 30% | 23% | 46% |
| Percent of Homes with ENERGY STAR Refrigerator | 43% | 34% | 37% | 22% |
| Percent of Homes with ENERGY STAR Clothes Washer | 29% | 46% | 44% | 52% |
| Percent of Homes with ENERGY STAR Dishwasher | 57% | 63% | 58% | 70% |

*Shaded cells indicate difference is significant at the 90% confidence level.

## Appendix A Table 8: Grouped by Opinion of Own Home Energy Efficiency

| Characteristics | My New Home is Energy Efficient* | | Rated Energy Efficiency of Home Scale of 0 To 10* | |
|---|---|---|---|---|
| | Strongly Agree | Agree | Rated 9 or 10 | Rated 6, 7,or 8 |
| Number of Homes | 69 | 26 | 63 | 32 |
| Average Conditioned area s(Sq. Ft.) | 2,426 | 2,558 | 2,413 | 2,439 |
| Percent of Homes 2x4 Framing | 3% | 8% | 3% | 9% |
| Percent of Homes 2x6 Framing | 83% | 92% | 83% | 88% |
| Percent of Homes2x8 or SIPS Walls | 14% | 0% | 14% | 3% |
| Average Wall Insulation R-value | 22 | 19 | 22 | 19 |
| Average Flat Ceiling Insulation R-value | 40 | 36 | 39 | 36 |
| Average Cathedral Ceiling Insulation R-value | 35 | 35 | 35 | 32 |
| Avg. Above Grade Foundation Wall Insulation R-value | 18 | 21 | 17 | 19 |
| Avg. Below Grade Foundation Wall Insulation R-value | 13 | 8 | 12 | 11 |
| Average Glazing Percent (Window/Wall Ratio) | 13% | 13% | 13% | 13% |
| Average Window U-value | 0.34 | 0.34 | 0.34 | 0.35 |
| Average Total Infiltration (CFM50) | 1,430 | 1,970 | 1,376 | 1,843 |
| Average Natural Air Changes per Hour(ACHnat) | 0.26 | 0.32 | 0.27 | 0.30 |
| Average Heating System AFUE | 88.5 | 86.2 | 88.2 | 86.9 |
| Percent of Homes with Boilers | 85% | 77% | 82% | 84% |
| Average Gas/Oil Boiler AFUE | 87.7 | 85.5 | 87.6 | 86.4 |
| Percent of Boilers Super High Efficiency (AFUE>90) | 24% | 0% | 24% | 7% |
| Average Super High Efficiency Boiler AFUE | 93.6 | na | 93.4 | 95.2 |
| Percent of Homes with Central Air Conditioning | 6% | 23% | 6% | 16% |
| Average Central Air Conditioning SEER | 11.6 | 13.4 | 12.6 | 12.5 |
| Average Water Heating Energy Factor | 0.78 | 0.69 | 0.76 | 0.75 |
| Percent of Homes with CFLs | 80% | 77% | 79% | 81% |
| Average Number of CFLs per Home (All Homes) | 16 | 10 | 14 | 14 |
| Average Percent CFLs (All Homes) | 34% | 20% | 32% | 26% |
| Percent of Homes with ENERGY STAR Refrigerator | 33% | 42% | 35% | 34% |
| Percent of Homes with ENERGY STAR Clothes Washer | 48% | 38% | 43% | 47% |
| Percent of Homes with ENERGY STAR Dishwasher | 59% | 58% | 60% | 53% |

*Shaded cells indicate difference is significant at the 90% confidence level.

## Appendix A Table 9: Grouped by Awareness of RBES and ENERGY STAR Label

| Characteristics | Heard of RBES* | | Seen or Heard of the ENERGY STAR Label* | |
|---|---|---|---|---|
| | Yes | No | Yes | No |
| Number of Homes | 55 | 38 | 93 | 5 |
| Average Conditioned area s(Sq. Ft.) | 2,557 | 2,255 | 2,437 | 2,601 |
| Percent of Homes 2x4 Framing | 4% | 8% | 3% | 40% |
| Percent of Homes 2x6 Framing | 85% | 84% | 86% | 60% |
| Percent of Homes2x8 or SIPS Walls | 11% | 8% | 11% | 0% |
| Average Wall Insulation R-value | 23 | 19 | 21 | 17 |
| Average Flat Ceiling Insulation R-value | 41 | 34 | 39 | 30 |
| Average Cathedral Ceiling Insulation R-value | 37 | 30 | 36 | 19 |
| Avg. Above Grade Foundation Wall Insulation R-value | 19 | 16 | 18 | 15 |
| Avg. Below Grade Foundation Wall Insulation R-value | 13 | 9 | 12 | 6 |
| Average Glazing Percent (Window/Wall Ratio) | 14% | 12% | 13% | 10% |
| Average Window U-value | 0.34 | 0.34 | 0.34 | 0.38 |
| Average Total Infiltration (CFM50) | 1,690 | 1,483 | 1,580 | 1,644 |
| Average Natural Air Changes per Hour(ACHnat) | 0.28 | 0.30 | 0.28 | 0.27 |
| Average Heating System AFUE | 87.9 | 87.1 | 87.9 | 85.2 |
| Percent of Homes with Boilers | 87% | 74% | 85% | 40% |
| Average Gas/Oil Boiler AFUE | 87.1 | 86.5 | 87.2 | 86.5 |
| Percent of Boilers Super High Efficiency (AFUE>90) | 19% | 7% | 18% | 0% |
| Average Super High Efficiency Boiler AFUE | 93.3 | 94.0 | 93.6 | na |
| Percent of Homes with Central Air Conditioning | 5% | 18% | 10% | 20% |
| Average Central Air Conditioning SEER | 12.3 | 12.7 | 12.5 | 13.0 |
| Average Water Heating Energy Factor | 0.78 | 0.71 | 0.76 | 0.74 |
| Percent of Homes with CFLs | 78% | 82% | 80% | 80% |
| Average Number of CFLs per Home (All Homes) | 13 | 13 | 14 | 11 |
| Average Percent CFLs (All Homes) | 32% | 24% | 30% | 22% |
| Percent of Homes with ENERGY STAR Refrigerator | 40% | 32% | 35% | 40% |
| Percent of Homes with ENERGY STAR Clothes Washer | 47% | 42% | 44% | 60% |
| Percent of Homes with ENERGY STAR Dishwasher | 65% | 53% | 59% | 60% |

*Shaded cells indicate difference is significant at the 90% confidence level.

## Appendix A Table 10: Grouped by Awareness of EVT and Participation in EVT Programs

| Characteristics | Heard of Efficiency Vermont* | | Participated in Efficiency Vermont Program* | |
|---|---|---|---|---|
| | Yes | No | Yes | No |
| Number of Homes | 72 | 23 | 32 | 38 |
| Average Conditioned area s(Sq. Ft.) | 2,473 | 2,313 | 2,411 | 2,474 |
| Percent of Homes 2x4 Framing | 4% | 9% | 0% | 8% |
| Percent of Homes 2x6 Framing | 85% | 83% | 81% | 87% |
| Percent of Homes2x8 or SIPS Walls | 11% | 9% | 19% | 5% |
| Average Wall Insulation R-value | 22 | 20 | 25 | 19 |
| Average Flat Ceiling Insulation R-value | 40 | 34 | 44 | 37 |
| Average Cathedral Ceiling Insulation R-value | 35 | 29 | 39 | 32 |
| Avg. Above Grade Foundation Wall Insulation R-value | 18 | 17 | 19 | 19 |
| Avg. Below Grade Foundation Wall Insulation R-value | 12 | 9 | 14 | 11 |
| Average Glazing Percent (Window/Wall Ratio) | 14% | 11% | 14% | 13% |
| Average Window U-value | 0.34 | 0.35 | 0.33 | 0.35 |
| Average Total Infiltration (CFM50) | 1,589 | 1,438 | 1,341 | 1,841 |
| Average Natural Air Changes per Hour(ACHnat) | 0.28 | 0.28 | 0.26 | 0.31 |
| Average Heating System AFUE | 88.0 | 86.7 | 88.4 | 87.4 |
| Percent of Homes with Boilers | 87% | 74% | 88% | 86% |
| Average Gas/Oil Boiler AFUE | 87.3 | 86.7 | 87.7 | 86.6 |
| Percent of Boilers Super High Efficiency (AFUE>90) | 19% | 12% | 21% | 13% |
| Average Super High Efficiency Boiler AFUE | 93.4 | 95.1 | 93.2 | 93.5 |
| Percent of Homes with Central Air Conditioning | 10% | 4% | 3% | 16% |
| Average Central Air Conditioning SEER | 12.7 | 13.0 | 11.3 | 13.0 |
| Average Water Heating Energy Factor | 0.76 | 0.76 | 0.79 | 0.73 |
| Percent of Homes with CFLs | 79% | 87% | 97% | 63% |
| Average Number of CFLs per Home (All Homes) | 14 | 15 | 19 | 7 |
| Average Percent CFLs (All Homes) | 30% | 31% | 43% | 16% |
| Percent of Homes with ENERGY STAR Refrigerator | 31% | 52% | 31% | 32% |
| Percent of Homes with ENERGY STAR Clothes Washer | 43% | 48% | 50% | 37% |
| Percent of Homes with ENERGY STAR Dishwasher | 63% | 48% | 72% | 55% |

*Shaded cells indicate difference is significant at the 90% confidence level.

## Appendix A Table 11: Grouped by First Time Homebuyers vs. Previously Owned Home and Awareness of ENERGY STAR Homes

| Characteristics | First-Time Homebuyer or Previously Owned Home * | | Heard of ENERGY STAR Homes* | |
|---|---|---|---|---|
| | First Time | Owned Home | Yes | No |
| Number of Homes | 13 | 85 | 84 | 12 |
| Average Conditioned area s(Sq. Ft.) | 2,072 | 2,503 | 2,443 | 2,583 |
| Percent of Homes 2x4 Framing | 8% | 5% | 4% | 17% |
| Percent of Homes 2x6 Framing | 85% | 85% | 86% | 75% |
| Percent of Homes2x8 or SIPS Walls | 8% | 11% | 11% | 8% |
| Average Wall Insulation R-value | 19 | 22 | 21 | 21 |
| Average Flat Ceiling Insulation R-value | 34 | 39 | 39 | 38 |
| Average Cathedral Ceiling Insulation R-value | 28 | 36 | 34 | 36 |
| Avg. Above Grade Foundation Wall Insulation R-value | 18 | 18 | 19 | 15 |
| Avg. Below Grade Foundation Wall Insulation R-value | 12 | 11 | 12 | 7 |
| Average Glazing Percent (Window/Wall Ratio) | 12% | 13% | 13% | 11% |
| Average Window U-value | 0.33 | 0.34 | 0.34 | 0.37 |
| Average Total Infiltration (CFM50) | 1,279 | 1,629 | 1,599 | 1,601 |
| Average Natural Air Changes per Hour(ACHnat) | 0.26 | 0.28 | 0.28 | 0.28 |
| Average Heating System AFUE | 88.7 | 87.6 | 88.1 | 86.0 |
| Percent of Homes with Boilers | 92% | 81% | 83% | 75% |
| Average Gas/Oil Boiler AFUE | 88.4 | 86.9 | 87.3 | 86.5 |
| Percent of Boilers Super High Efficiency (AFUE>90) | 25% | 16% | 19% | 11% |
| Average Super High Efficiency Boiler AFUE | 94.4 | 93.4 | 93.7 | 92.7 |
| Percent of Homes with Central Air Conditioning | 8% | 11% | 12% | 0% |
| Average Central Air Conditioning SEER | 13.0 | 12.5 | 12.6 | |
| Average Water Heating Energy Factor | 0.78 | 0.75 | 0.76 | 0.77 |
| Percent of Homes with CFLs | 85% | 79% | 79% | 83% |
| Average Number of CFLs per Home (All Homes) | 14 | 14 | 13 | 17 |
| Average Percent CFLs (All Homes) | 39% | 28% | 29% | 34% |
| Percent of Homes with ENERGY STAR Refrigerator | 38% | 35% | 33% | 42% |
| Percent of Homes with ENERGY STAR Clothes Washer | 46% | 45% | 45% | 42% |
| Percent of Homes with ENERGY STAR Dishwasher | 54% | 60% | 56% | 75% |

*Shaded cells indicate difference is significant at the 90% confidence level.

## Appendix A Table 12: Groupings by Overall Efficiency and by Education Level

| Characteristics | Home Has Inefficient Characteristics *** | | Education Level* | |
|---|---|---|---|---|
| | Yes | No | College Degree or Above | Less than College Degree |
| Number of Homes | 17 | 89 | 66 | 30 |
| Average Conditioned area s(Sq. Ft.) | 2,413 | 2,509 | 2,608 | 2,078 |
| Percent of Homes 2x4 Framing | 18% | 2% | 3% | 10% |
| Percent of Homes 2x6 Framing | 71% | 88% | 82% | 90% |
| Percent of Homes2x8 or SIPS Walls | 12% | 10% | 15% | 0% |
| Average Wall Insulation R-value | 18 | 22 | 22 | 19 |
| Average Flat Ceiling Insulation R-value | 26 | 40 | 41 | 33 |
| Average Cathedral Ceiling Insulation R-value | 24 | 39 | 37 | 28 |
| Avg. Above Grade Foundation Wall Insulation R-value | 14 | 19 | 18 | 17 |
| Avg. Below Grade Foundation Wall Insulation R-value | 11 | 12 | 12 | 11 |
| Average Glazing Percent (Window/Wall Ratio) | 12% | 13% | 14% | 11% |
| Average Window U-value | 0.35 | 0.34 | 0.34 | 0.35 |
| Average Total Infiltration (CFM50) | 1,917 | 1,497 | 1,618 | 1,495 |
| Average Natural Air Changes per Hour(ACHnat) | 0.33 | 0.27 | 0.27 | 0.31 |
| Average Heating System AFUE | 86.6 | 88.2 | 88.4 | 86.3 |
| Percent of Homes with Boilers | 82% | 83% | 85% | 80% |
| Average Gas/Oil Boiler AFUE | 87.2 | 87.4 | 87.5 | 86.3 |
| Percent of Boilers Super High Efficiency (AFUE>90) | 21% | 19% | 22% | 8% |
| Average Super High Efficiency Boiler AFUE | 95.1 | 93.6 | 93.4 | 95.2 |
| Percent of Homes with Central Air Conditioning | 0% | 12% | 12% | 3% |
| Average Central Air Conditioning SEER | na | 12.6 | 12.5 | na |
| Average Water Heating Energy Factor | 0.77 | 0.76 | 0.77 | 0.73 |
| Percent of Homes with CFLs | 94% | 79% | 77% | 87% |
| Average Number of CFLs per Home (All Homes) | 16 | 14 | 15 | 13 |
| Average Percent CFLs (All Homes) | 38% | 28% | 30% | 31% |
| Percent of Homes with ENERGY STAR Refrigerator | 29% | 36% | 35% | 33% |
| Percent of Homes with ENERGY STAR Clothes Washer | 53% | 44% | 45% | 43% |
| Percent of Homes with ENERGY STAR Dishwasher | 65% | 62% | 64% | 50% |

*Shaded cells indicate difference is significant at the 90% confidence level.

**Homes with one or more of the following characteristics: log home, 2x4 walls, below code wall and/or ceiling insulation, double-pane clear windows.

## Appendix A Table 13: Groupings by Income Level

| Characteristics | 2006 Pre-tax Household Income* | | 2006 Pre-tax Household Income* | |
|---|---|---|---|---|
| | Below $50,000 | $50,000 or Higher | $50,000 to $74,999 | NOT $50,000 to $74,999 |
| Number of Homes | 23 | 63 | 26 | 60 |
| Average Conditioned area s(Sq. Ft.) | 2,111 | 2,567 | 2,420 | 2,456 |
| Percent of Homes 2x4 Framing | 9% | 3% | 4% | 5% |
| Percent of Homes 2x6 Framing | 78% | 87% | 85% | 85% |
| Percent of Homes2x8 or SIPS Walls | 13% | 10% | 12% | 10% |
| Average Wall Insulation R-value | 21 | 22 | 22 | 21 |
| Average Flat Ceiling Insulation R-value | 38 | 39 | 37 | 40 |
| Average Cathedral Ceiling Insulation R-value | 33 | 36 | 34 | 35 |
| Avg. Above Grade Foundation Wall Insulation R-value | 16 | 18 | 17 | 18 |
| Avg. Below Grade Foundation Wall Insulation R-value | 13 | 11 | 12 | 11 |
| Average Glazing Percent (Window/Wall Ratio) | 13% | 13% | 14% | 13% |
| Average Window U-value | 0.35 | 0.34 | 0.34 | 0.34 |
| Average Total Infiltration (CFM50) | 1,485 | 1,642 | 1,802 | 1,527 |
| Average Natural Air Changes per Hour(ACHnat) | 0.31 | 0.28 | 0.33 | 0.26 |
| Average Heating System AFUE | 87.4 | 87.8 | 87.4 | 87.8 |
| Percent of Homes with Boilers | 87% | 84% | 88% | 83% |
| Average Gas/Oil Boiler AFUE | 86.8 | 87.2 | 87.0 | 87.2 |
| Percent of Boilers Super High Efficiency (AFUE>90) | 15% | 19% | 13% | 20% |
| Average Super High Efficiency Boiler AFUE | 93.7 | 93.7 | 93.7 | 93.7 |
| Percent of Homes with Central Air Conditioning | 0% | 11% | 4% | 10% |
| Average Central Air Conditioning SEER | na | 12.7 | 13.0 | 12.7 |
| Average Water Heating Energy Factor | 0.81 | 0.76 | 0.78 | 0.77 |
| Percent of Homes with CFLs | 78% | 79% | 85% | 77% |
| Average Number of CFLs per Home (All Homes) | 15 | 14 | 15 | 13 |
| Average Percent CFLs (All Homes) | 41% | 26% | 34% | 29% |
| Percent of Homes with ENERGY STAR Refrigerator | 39% | 37% | 35% | 38% |
| Percent of Homes with ENERGY STAR Clothes Washer | 43% | 48% | 46% | 47% |
| Percent of Homes with ENERGY STAR Dishwasher | 52% | 60% | 62% | 57% |

*Shaded cells indicate difference is significant at the 90% confidence level.

## Appendix A Table 14: Groupings by Homeowner Income and Age

| Characteristics | 2006 Pre-tax Household Income* | | Homeowner Age* | |
|---|---|---|---|---|
| | $75,000 or Higher | Below $75,000 | Under 35 Years | 35 or Older |
| Number of Homes | 37 | 49 | 18 | 80 |
| Average Conditioned area s(Sq. Ft.) | 2,670 | 2,275 | 2,322 | 2,474 |
| Percent of Homes 2x4 Framing | 3% | 6% | 0% | 6% |
| Percent of Homes 2x6 Framing | 89% | 82% | 100% | 81% |
| Percent of Homes2x8 or SIPS Walls | 8% | 12% | 0% | 13% |
| Average Wall Insulation R-value | 22 | 21 | 20 | 21 |
| Average Flat Ceiling Insulation R-value | 41 | 37 | 35 | 39 |
| Average Cathedral Ceiling Insulation R-value | 37 | 34 | 29 | 36 |
| Avg. Above Grade Foundation Wall Insulation R-value | 19 | 17 | 20 | 17 |
| Avg. Below Grade Foundation Wall Insulation R-value | 10 | 12 | 14 | 11 |
| Average Glazing Percent (Window/Wall Ratio) | 13% | 13% | 12% | 13% |
| Average Window U-value | 0.34 | 0.34 | 0.33 | 0.34 |
| Average Total Infiltration (CFM50) | 1,547 | 1,658 | 1,237 | 1,661 |
| Average Natural Air Changes per Hour(ACHnat) | 0.24 | 0.32 | 0.21 | 0.30 |
| Average Heating System AFUE | 88.1 | 87.4 | 86.7 | 88.0 |
| Percent of Homes with Boilers | 81% | 88% | 94% | 80% |
| Average Gas/Oil Boiler AFUE | 87.4 | 86.9 | 87.1 | 87.2 |
| Percent of Boilers Super High Efficiency (AFUE>90) | 23% | 14% | 18% | 17% |
| Average Super High Efficiency Boiler AFUE | 93.7 | 93.7 | 94.4 | 93.4 |
| Percent of Homes with Central Air Conditioning | 16% | 2% | 6% | 11% |
| Average Central Air Conditioning SEER | 12.7 | 13.0 | 13.0 | 12.5 |
| Average Water Heating Energy Factor | 0.74 | 0.79 | 0.75 | 0.76 |
| Percent of Homes with CFLs | 76% | 82% | 78% | 80% |
| Average Number of CFLs per Home (All Homes) | 12 | 15 | 13 | 14 |
| Average Percent CFLs (All Homes) | 21% | 38% | 33% | 29% |
| Percent of Homes with ENERGY STAR Refrigerator | 38% | 37% | 28% | 38% |
| Percent of Homes with ENERGY STAR Clothes Washer | 49% | 45% | 39% | 46% |
| Percent of Homes with ENERGY STAR Dishwasher | 59% | 57% | 56% | 60% |

*Shaded cells indicate difference is significant at the 90% confidence level.

## Appendix A Table 15: Groupings by Homeowner Age

| Characteristics | Homeowner Age** | | Homeowner Age* | |
|---|---|---|---|---|
| | 35 to 54 | NOT 35 to 54 | 55 and Older | Under 55 Years |
| Number of Homes | 42 | 56 | 38 | 60 |
| Average Conditioned area s(Sq. Ft.) | 2,547 | 2,369 | 2,392 | 2,480 |
| Percent of Homes 2x4 Framing | 7% | 4% | 5% | 5% |
| Percent of Homes 2x6 Framing | 79% | 89% | 84% | 85% |
| Percent of Homes2x8 or SIPS Walls | 14% | 7% | 11% | 10% |
| Average Wall Insulation R-value | 21 | 21 | 22 | 21 |
| Average Flat Ceiling Insulation R-value | 40 | 37 | 38 | 39 |
| Average Cathedral Ceiling Insulation R-value | 36 | 33 | 36 | 34 |
| Avg. Above Grade Foundation Wall Insulation R-value | 19 | 17 | 16 | 19 |
| Avg. Below Grade Foundation Wall Insulation R-value | 11 | 12 | 11 | 12 |
| Average Glazing Percent (Window/Wall Ratio) | 13% | 13% | 14% | 12% |
| Average Window U-value | 0.35 | 0.34 | 0.34 | 0.34 |
| Average Total Infiltration (CFM50) | 1,705 | 1,489 | 1,611 | 1,565 |
| Average Natural Air Changes per Hour(ACHnat) | 0.29 | 0.27 | 0.30 | 0.27 |
| Average Heating System AFUE | 87.9 | 87.6 | 88.1 | 87.5 |
| Percent of Homes with Boilers | 80% | 84% | 79% | 85% |
| Average Gas/Oil Boiler AFUE | 86.6 | 87.5 | 87.8 | 86.8 |
| Percent of Boilers Super High Efficiency (AFUE>90) | 12% | 21% | 23% | 14% |
| Average Super High Efficiency Boiler AFUE | 92.8 | 94.0 | 93.8 | 93.5 |
| Percent of Homes with Central Air Conditioning | 10% | 11% | 13% | 8% |
| Average Central Air Conditioning SEER | 12.6 | 12.6 | 12.5 | 12.7 |
| Average Water Heating Energy Factor | 0.75 | 0.76 | 0.77 | 0.75 |
| Percent of Homes with CFLs | 76% | 82% | 84% | 77% |
| Average Number of CFLs per Home (All Homes) | 14 | 13 | 13 | 14 |
| Average Percent CFLs (All Homes) | 32% | 28% | 25% | 32% |
| Percent of Homes with ENERGY STAR Refrigerator | 36% | 36% | 39% | 33% |
| Percent of Homes with ENERGY STAR Clothes Washer | 50% | 41% | 42% | 47% |
| Percent of Homes with ENERGY STAR Dishwasher | 52% | 64% | 68% | 53% |

*Shaded cells indicate difference is significant at the 90% confidence level.

## Appendix A Table 16: Groupings by Length of Time Expected to Stay in New Home

| Characteristics | How Long Expect to Stay in New Home* | | How Long Expect to Stay in New Home * | |
|---|---|---|---|---|
| | 5 or Fewer Years | Other | 6 to 10 Years | Other |
| Number of Homes | 12 | 83 | 16 | 79 |
| Average Conditioned area s(Sq. Ft.) | 2,112 | 2,489 | 2,686 | 2,392 |
| Percent of Homes 2x4 Framing | 8% | 5% | 0% | 6% |
| Percent of Homes 2x6 Framing | 92% | 83% | 100% | 81% |
| Percent of Homes2x8 or SIPS Walls | 0% | 12% | 0% | 13% |
| Average Wall Insulation R-value | 19 | 22 | 19 | 22 |
| Average Flat Ceiling Insulation R-value | 35 | 39 | 38 | 39 |
| Average Cathedral Ceiling Insulation R-value | 24 | 36 | 32 | 35 |
| Avg. Above Grade Foundation Wall Insulation R-value | 0 | 18 | 23 | 17 |
| Avg. Below Grade Foundation Wall Insulation R-value | 15 | 11 | 13 | 11 |
| Average Glazing Percent (Window/Wall Ratio) | 13% | 13% | 13% | 13% |
| Average Window U-value | 0.36 | 0.34 | 0.34 | 0.34 |
| Average Total Infiltration (CFM50) | 1,372 | 1,619 | 1,831 | 1,531 |
| Average Natural Air Changes per Hour(ACHnat) | 0.26 | 0.29 | 0.28 | 0.29 |
| Average Heating System AFUE | 86.5 | 87.7 | 87.9 | 87.5 |
| Percent of Homes with Boilers | 92% | 83% | 75% | 86% |
| Average Gas/Oil Boiler AFUE | 87.1 | 87.1 | 86.4 | 87.2 |
| Percent of Boilers Super High Efficiency (AFUE>90) | 9% | 18% | 8% | 18% |
| Average Super High Efficiency Boiler AFUE | 95.2 | 93.4 | 93.0 | 93.6 |
| Percent of Homes with Central Air Conditioning | 8% | 8% | 19% | 6% |
| Average Central Air Conditioning SEER | 13.0 | 12.7 | 11.7 | 13.5 |
| Average Water Heating Energy Factor | 0.78 | 0.76 | 0.73 | 0.77 |
| Percent of Homes with CFLs | 83% | 78% | 81% | 78% |
| Average Number of CFLs per Home (All Homes) | 11 | 14 | 11 | 14 |
| Average Percent CFLs (All Homes) | 25% | 30% | 24% | 30% |
| Percent of Homes with ENERGY STAR Refrigerator | 50% | 34% | 44% | 34% |
| Percent of Homes with ENERGY STAR Clothes Washer | 17% | 48% | 50% | 43% |
| Percent of Homes with ENERGY STAR Dishwasher | 58% | 60% | 38% | 65% |

*Shaded cells indicate difference is significant at the 90% confidence level.

## Appendix A Table 17: Groupings by Length of Time Expected to Stay in New Home

| Characteristics | How Long Expect to Stay in New Home* | | How Long Expect to Stay in New Home * | |
|---|---|---|---|---|
| | More than 10 Years | Other | Indefinitely | Other |
| Number of Homes | 15 | 80 | 52 | 43 |
| Average Conditioned area s(Sq. Ft.) | 2,373 | 2,454 | 2,461 | 2,417 |
| Percent of Homes 2x4 Framing | 7% | 5% | 6% | 5% |
| Percent of Homes 2x6 Framing | 80% | 85% | 79% | 91% |
| Percent of Homes2x8 or SIPS Walls | 13% | 10% | 15% | 5% |
| Average Wall Insulation R-value | 24 | 21 | 22 | 21 |
| Average Flat Ceiling Insulation R-value | 44 | 38 | 39 | 39 |
| Average Cathedral Ceiling Insulation R-value | 35 | 35 | 37 | 32 |
| Avg. Above Grade Foundation Wall Insulation R-value | 18 | 18 | 18 | 17 |
| Avg. Below Grade Foundation Wall Insulation R-value | 11 | 12 | 11 | 13 |
| Average Glazing Percent (Window/Wall Ratio) | 13% | 13% | 13% | 13% |
| Average Window U-value | 0.35 | 0.34 | 0.34 | 0.35 |
| Average Total Infiltration (CFM50) | 1,523 | 1,607 | 1,560 | 1,640 |
| Average Natural Air Changes per Hour(ACHnat) | 0.29 | 0.28 | 0.29 | 0.28 |
| Average Heating System AFUE | 86.9 | 87.7 | 87.9 | 87.2 |
| Percent of Homes with Boilers | 87% | 84% | 84% | 84% |
| Average Gas/Oil Boiler AFUE | 87.0 | 87.1 | 87.3 | 86.8 |
| Percent of Boilers Super High Efficiency (AFUE>90) | 23% | 15% | 19% | 14% |
| Average Super High Efficiency Boiler AFUE | 92.7 | 93.8 | 93.7 | 93.2 |
| Percent of Homes with Central Air Conditioning | 7% | 9% | 6% | 12% |
| Average Central Air Conditioning SEER | 13.0 | 12.7 | 14.0 | 12.2 |
| Average Water Heating Energy Factor | 0.77 | 0.76 | 0.76 | 0.76 |
| Percent of Homes with CFLs | 73% | 80% | 79% | 79% |
| Average Number of CFLs per Home (All Homes) | 15 | 13 | 15 | 12 |
| Average Percent CFLs (All Homes) | 30% | 29% | 32% | 26% |
| Percent of Homes with ENERGY STAR Refrigerator | 27% | 38% | 33% | 40% |
| Percent of Homes with ENERGY STAR Clothes Washer | 47% | 44% | 48% | 40% |
| Percent of Homes with ENERGY STAR Dishwasher | 67% | 59% | 65% | 53% |

*Shaded cells indicate difference is significant at the 90% confidence level.

# Appendix B—1995, 2002 and 2008 Baseline Studies

# List of Tables

# Appendix B—1995, 2002 and 2008 Baseline Studies

This appendix compares the results of three Vermont new residential construction baseline studies: the 1995, 2002 and 2008 studies. Construction practices have clearly improved. Appendix B Table 1, with cells showing improvement over 2002 highlighted in light gray, shows higher percentages of homes in the current study meet or exceed RBES prescriptive compliance path code minimum insulation requirements for walls, flat and cathedral ceilings, and below grade foundation walls. A higher percentage of homes have double pane Low-E or better windows, and the average heating system AFUE is higher. More homes have more CFL lighting, and refrigerators, dishwashers and clothes washers are more likely to be ENERGY STAR. A few things have not changed, or changed only minimally. There are still a few homes with tankless coil water heating. The average glazing percentage dropped, but only slightly, from 14% in 2002 to 13% in 2008. The percentage of separate freezers that are ENERGY STAR is unchanged. Air infiltration is much lower than in 1995, but only slightly lower than in 2002.

## Appendix B Table 1: Summary Comparison of Vermont 1995, 2002 and 2008 Baseline Study Home Features

| Feature | Vermont 1995 Baseline (n=151)* | Vermont 2002 Baseline (n=158)* | Vermont 2008 Baseline (n=106)* |
|---|---|---|---|
| **Flat ceiling insulation meets or exceeds code requirements (R-38)** | 62% | 68% | **74%** |
| **Sloped/Cathedral ceiling insulation meets or exceeds code requirements (R-30)** | 65% | 64% | **80%** |
| **Conditioned/ambient wall insulation meets or exceeds code requirements (R-19)** | 57% | 90% | **95%** |
| **Below grade basement wall insulation meets or exceeds code requirements (R-10)** | 48% | 62% | **73%** |
| **Percent glazing area double pane Low-E** | 70% | 80% | **94%**** |
| **Average percent glazing area (window to wall ratio)** | n/a | 14% | **13%** |
| **Average air infiltration—natural air changes per hour** | .45 | .31 | **.28** |
| **Average AFUE of central heating system** | n/a | 85.0 | **87.8** |
| **Percent of homes with tankless coil water heating** | 32% | 3% | 5% |
| **Percent of Homes with Screw-in or Pin-based CFL Bulbs** | ≈33% | 47% | **81%** |
| **Average Number of Screw-in or Pin-based CFLs per Home** | n/a | 3.0 | **14.2** |
| **Percent ENERGY STAR Refrigerators** | n/a | 27% | **30%** |
| **Percent ENERGY STAR Dishwashers** | n/a | 36% | **69%** |
| **Percent ENERGY STAR Clothes washers** | n/a | 47% | **48%** |
| **Percent ENERGY STAR Separate freezers** | n/a | 12% | 12% |

*The 1995 study sample was developed from lists provided by Green Mountain Power, Central Vermont Public Service and Citizens Utilities. The sample selection process did not cover the full state, and documentation for sample development is incomplete. The sample for the 2002 survey was developed through a random process using a statewide list of new homes developed from municipal records.
**Includes double pane and triple pane Low-E with argon as well as double pane Low-E.

The remainder of this appendix is tables from previous Vermont reports updated to include 2008 study results. Appendix B Table 2 shows the average home size increased from 1995 to 2002 and then remained almost the same in the 2008 study—only three square feet lower than in 2002. The increase in home size between the 1995 and 2002 studies is likely overstated because conditioned space in the 1995 study included only finished living space while in the 2002 study conditioned space was defined as all heated space, whether or not it was finished living space.

**Appendix B Table 2: Vermont Studies—Home Size**

| Home Size (Heated Area) Square Feet | Vermont 1995 Baseline | Vermont 2002 Baseline | Vermont 2008 Baseline Weighted Data (n=106) |
|---|---|---|---|
| **< 1,000** | 4% | 0% | 3% |
| **1,000 to 1,499** | 12% | 8% | 12% |
| **1,500 to 1,999** | 29% | 25% | 20% |
| **2,000 to 2,499** | 21% | 25% | 25% |
| **2,500 to 2,999** | 11% | 19% | 17% |
| **3,000 to 3,499** | 10% | 9% | 10% |
| **3,500 to 3,999** | 6% | 8% | 6% |
| **4,000 to 4,499** | 4% | 3% | 5% |
| **4,500 to 4,999** | 2% | 2% | 1% |
| **5,000 or More** | 2% | 2% | 3% |
| **Average** | 2,380 | 2,510 | 2,507 |
| **Median** | 2,130 | 2,390 | 2,352* |

*Not weighted.

Appendix B Table 3 shows homeowners in the 2008 study continued the 1995 to 2002 trend to be less likely to heat with oil. Homeowners in 2008 are more likely to say they heat with wood.

**Appendix B Table 3: Vermont Studies—Primary Heating Fuel**

| Primary Heating Fuel | Vermont 1995 Baseline | Vermont 2002 Baseline | Vermont 2008 Baseline Weighted Data (n=106) |
|---|---|---|---|
| **Oil/Kerosene** | 60% | 45% | 34% |
| **Natural Gas** | 6% | 19% | 11% |
| **Propane** | 29% | 29% | 40% |
| **Wood** | 0% | 6% | 14% |
| **Electric/Other/Combination** | 5% | 1% | 1% |

Appendix B Table 4 shows a few homes continue to have tankless coil water heating; the percentage of homes with fossil fuel-fired integrated tank water heating is lower than in 2002, but the average Energy Factor for these systems is higher. Also customers are beginning to install instantaneous water heating and a few homes in the 2008 study have solar assisted water heating.

### Appendix B Table 4: Vermont Studies—Water Heating Type and Energy Factor

| Water Heating Type | Vermont 1995 Baseline | | Vermont 2002 Baseline | | Vermont 2008 Baseline Weighted Data | |
|---|---|---|---|---|---|---|
| | Percent of Homes (n=151) | Median Energy Factor | Percent of Homes (n=137) | Median Energy Factor | Percent of Homes (n=106) | Median Energy Factor* |
| Tankless Coil | 32% | 0.50 | 3% | n/a | 5% | 0.40 |
| Indirect Fired: Fossil Fuel | 50% | 0.78 | 83% | 0.77 | 74% | 0.80 |
| Stand Alone: Electric | 8% | 0.82 | 6% | 0.88 | 3% | 0.90 |
| Stand Alone: Fossil Fuel | 11% | 0.52 | 11% | 0.60 | 13% | 0.59 |
| Instantaneous | 0% | n/a | 0% | n/a | 4% | 0.84 |

*Median Energy Factors not weighted.

Appendix B Table 5 shows the percentage of homes meeting or exceeding code for flat ceiling insulation (R-38) increased from 68% in 2002 to 74% in 2008, but the average R-value did not increase.

### Appendix B Table 5: Vermont Studies—Flat Ceiling Insulation

| Flat Ceiling Average R-value<br><br>Minimum RBES Requirement R-38 | Vermont 1995 Baseline | Vermont 2002 Baseline (n=141) | Vermont 2008 Baseline Weighted Data (n=94) |
|---|---|---|---|
| R-value Below Code | n/a | 28% | 26% |
| R-value Meets or Exceeds Code | 62% | 68% | 74% |
| **R-value Statistics*** | | | |
| Minimum R-value | n/a | 15 | 19 |
| Maximum R-value | n/a | 83 | 100 |
| Average R-value | 33 | 40 | 39 |
| Median R-value | n/a | 38 | 38 |
| Average Area (sq. ft.) | n/a | 1,115 | 1,129 |

*Only the average R-value and area are weighted for 2008.

Appendix B Table 6 shows not only did the percentage of homes meeting or exceeding code for cathedral ceilings increase from 64% in 2002 to 80% in 2008, the average R-value increased from R-32 to R-34 and the median increased from R-30 to R-36.

### Appendix B Table 6: Vermont Studies—Cathedral Ceiling Insulation

| Cathedral Ceiling Average R-value<br><br>Minimum RBES Requirement R-30 | Vermont 1995 Baseline | Vermont 2002 Baseline (n=113) | Vermont 2008 Baseline Weighted Data (n=55) |
|---|---|---|---|
| R-value Below Code | n/a | 36% | 20% |
| R-value Meets or Exceeds Code | 65% | 64% | 80% |
| R-value Statistics* | | | |
| Minimum R-value | n/a | 19 | 16 |
| Maximum R-value | n/a | 60 | 66 |
| Average R-value | 33 | 32 | 34 |
| Median R-value | n/a | 30 | 36 |
| Average Area (sq. ft.) | n/a | 775 | 703 |

*Only the average R-value and area are weighted for 2008.

Appendix B Table 7 shows the percentage of homes meeting or exceeding code for wall insulation continues to rise, growing from 90% in 2002 to 95% in 2008. The average R-value increased from R-20 in 2002 to R-21 in 2008; the median R-value is unchanged at R-19.

### Appendix B Table 7: Vermont Studies—Conditioned/Ambient Wall Insulation

| Conditioned/Ambient Walls Average R-value<br><br>Minimum RBES Requirement R-19 | Vermont 1995 Baseline | Vermont 2002 Baseline (n=141) | Vermont 2008 Baseline Weighted Data (n=106) |
|---|---|---|---|
| R-value Below Code | n/a | 10% | 5% |
| R-value Meets or Exceeds Code | n/a** | 90% | 95% |
| R-value Statistics* | | | |
| Minimum R-value | n/a | 8 | 7 |
| Maximum R-value | n/a | 40 | 48 |
| Average R-value | 19 | 20 | 21 |
| Median R-value | n/a | 19 | 19 |
| Average Area (sq. ft.) | n/a | 1,931 | 2,167 |

*Only the average R-value and area are weighted for 2008.

**Previous baseline reports include multiple estimates of the percentage of homes meeting or exceeding R-19 wall insulation. Reported estimates range from 57% to 94%. Without knowing which estimate is consistent with the 2002 and 2008 data, this cell is not populated.

Appendix B Table 8 shows all audited homes with knee walls met or exceeded code insulation requirements in 2008, up from 89% of homes in 1995 and 79% of homes in 2002. The average R-value increased from R-19 in 1995 and 2002 to R-22 in 2008; the median R-value remained constant at R-19.

### Appendix B Table 8: Vermont Studies—Attic/Knee Wall Insulation

| Attic/Knee Walls Average R-value<br><br>Minimum RBES Requirement R-19 | Vermont 1995 Baseline | Vermont 2002 Baseline (n=34) | Vermont 2008 Baseline Raw Data (n=9) |
|---|---|---|---|
| R-value Below Code | n/a | 21% | 0% |
| R-value Meets or Exceeds Code | 89% | 79% | 100% |
| **R-value Statistics** | | | |
| Minimum R-value | n/a | 0 | 19 |
| Maximum R-value | n/a | 32 | 39 |
| Average R-value | 19 | 19 | 22 |
| Median R-value | n/a | 19 | 19 |
| Average Area (sq. ft.) | n/a | 297 | 273 |

Appendix B Table 9 shows the percentage of homes meeting or exceeding code requirements for below grade foundation wall insulation has consistently grown from 48% in 1995 to 73% in 2008. The average and median R-values increased to R-11 in 2008.

### Appendix B Table 9: Vermont Studies—Below Grade Foundation Wall Insulation

| Below Grade Foundation Walls Average R-value<br><br>Minimum RBES Requirement R-10 | Vermont 1995 Baseline | Vermont 2002 Baseline (n=146) | Vermont 2008 Baseline Weighted Data (n=88) |
|---|---|---|---|
| R-value Below Code | n/a | 38% | 27% |
| R-value Meets or Exceeds Code | 48% | 62% | 73% |
| **R-value Statistics*** | | | |
| Minimum R-value | n/a | 0 | 0 |
| Maximum R-value | n/a | 29 | 35 |
| Average R-value | 7 | 8 | 11 |
| Median R-value | n/a | 10 | 11 |
| Average Area (sq. ft.) | n/a | 1,036 | 1,134 |

*Only the average R-value and area are weighted for 2008.

Appendix B Table 10 shows that only four homes in the 2008 study have floors exposed to outside air and that only one of them met the insulation code requirement of R-38. Despite the small number of homes with floors exposed to outside air in 2008, the percentage meeting or exceeding code is 25% (1 out of 4).

**Appendix B Table 10: Vermont Studies—Insulation in Floors Exposed to Outside Air**

| Floors Over Outside Air Average R-value<br><br>Minimum RBES Requirement R-38 | Vermont 1995 Baseline | Vermont 2002 Baseline (n=26) | Vermont 2008 Baseline Raw Data (n=4) |
|---|---|---|---|
| R-value Below Code | n/a | 73% | 75% |
| R-value Meets or Exceeds Code | n/a | 23% | 25% |
| **R-value Statistics** | | | |
| Minimum R-value | n/a | 8 | 19 |
| Maximum R-value | n/a | 43 | 50 |
| Average R-value | 30 | 30 | 28 |
| Median R-value | n/a | 30 | 22 |
| Average Area (sq. ft.) | n/a | 134 | 59 |

Appendix B Table 11 shows that none of the homes in the 2008 study meet the code requirement of R-30 insulation in floors over unconditioned space compared to 23% meeting code in the 2002 study.

**Appendix B Table 11: Vermont Studies—Insulation in Floors Over Unconditioned Space**

| Floors Over Unconditioned Space Average R-value<br><br>Minimum RBES Requirement R-30 | Vermont 1995 Baseline | Vermont 2002 Baseline (n=26) | Vermont 2008* Baseline Weighted Data (n=41) |
|---|---|---|---|
| R-value Below Code | n/a | 73% | 100% |
| R-value Meets or Exceeds Code | n/a | 23% | 0% |
| **R-value Statistics*** | | | |
| Minimum R-value | n/a | 8 | 0 |
| Maximum R-value | n/a | 43 | 21 |
| Average R-value | 30 | 30 | 3 |
| Median R-value | n/a | 30 | 0 |

*2008 data based on floors over fully unconditioned basements.

Appendix B Table 12 shows that homes in the 2008 study are more likely to meet code requirements for slab insulation than in the 2002 study. Overall, auditors were able to determine the R-value of slab insulation in 84 of the homes audited in 2008 and 54% of those homes met the code requirement of R-10 insulation compared to 37% of homes in the 2002 study.

**Appendix B Table 12: Vermont Studies—Slab Insulation**

| Basement Slab Average R-value<br><br>Minimum RBES Requirement R-10 | Vermont 1995 Baseline | Vermont 2002 Baseline (n=63) | Vermont 2008 Baseline | | | |
|---|---|---|---|---|---|---|
| | | | On-Grade Slab* Raw Data (n=19) | Below Grade Slab* Weighted Data (n=51) | Mix (on/below) Grade Slab* Raw Data (n=17) | All Slabs** Weighted Data (n=82) |
| **R-value Below Code** | n/a | 63% | 21% | 56% | 38% | 46% |
| **R-value Meets or Exceeds Code** | n/a | 37% | 79% | 44% | 62% | 54% |
| **R-value Statistics*** ** | | | | | | |
| **Minimum R-value** | n/a | 0 | 0 | 0 | 0 | 0 |
| **Maximum R-value** | n/a | 11 | 28 | 14 | 16 | 30 |
| **Average R-value** | n/a | 4 | 12 | 6 | 8 | 8 |
| **Median R-value** | n/a | 0 | 14 | 8 | 10 | 10 |

*All homes with known slab insulation location and R-value.
**All homes with known slab insulation R-value.
***Only the "Below Grade" and "All Slab" averages for 2008 are weighted.

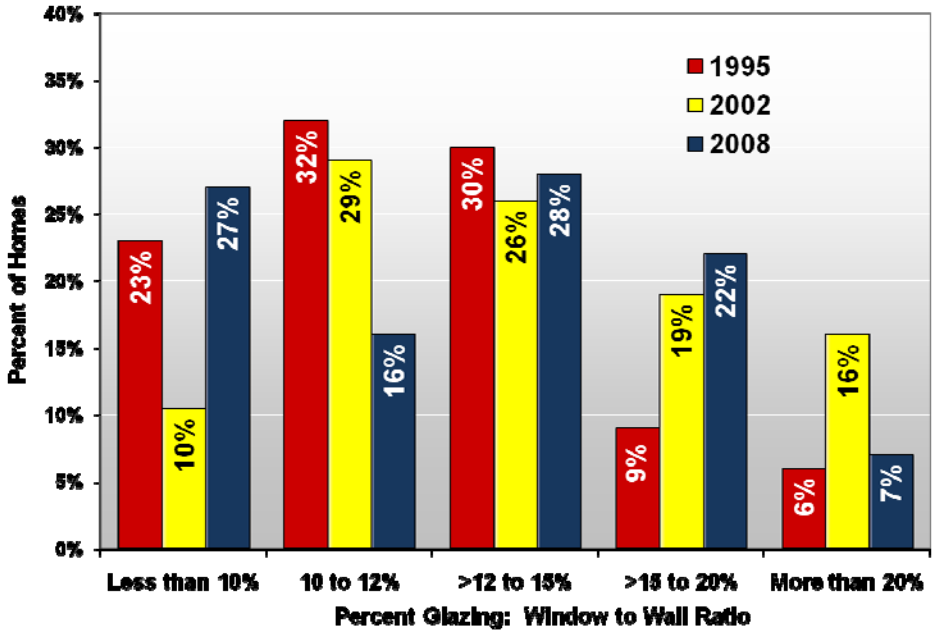
Appendix B Table 13 and Appendix B Figure 1 show that the percentage of homes with less than 10% glazing is much higher than in the 2002 study, but only slightly higher than in the 1995 study; the percentage of homes in 2008 with more than 20% glazing is lower than in the 2002 study, but roughly the same as in the 1995 study. The average glazing percentage in 2008 (13%) is lower than in the 2002 study (14%), but the medians are the same in both studies (13%).

**Appendix B Table 13: Vermont Studies—Glazing Percentage**

| Glazing Area Window to Wall Area Ratio | Vermont 1995 Baseline (n-151) | Vermont 2002 Baseline (n=139) | Vermont 2008 Baseline Weighted Data (n=105) |
|---|---|---|---|
| Less than 10% | 23% | 10% | 27% |
| 10 to 12% | 32% | 29% | 16% |
| >12 to 15% | 30% | 26% | 28% |
| >15 to 20% | 9% | 19% | 22% |
| More than 20% | 6% | 16% | 7% |
| **Glazing Percentage Statistics*** | | | |
| Min Glazing % | n/a | 6% | 5% |
| Max Glazing % | n/a | 27% | 30% |
| Average Glazing % | n/a | 14% | 13% |
| Median Glazing % | n/a | 13% | 13% |

*Only the average for 2008 is weighted.

**Appendix B Figure 1: 1995, 2002 and 2008 Glazing Percentages**



Appendix B Table 14 shows that homes in the 2008 study are tighter, on average, than homes in the 2002 study, and much tighter than homes in the 1995 study. A smaller percentage of homes in the 2008 study have ACHnat of less than 0.31 but the average ACHnat dropped from 0.31 in 2002 to 0.29 in 2008.

### Appendix B Table 14: Vermont Studies—Natural Air Changes per Hour

| Natural Air Changes per Hour (ACHnat) | Vermont 1995 Baseline (n-151) | Vermont 2002 Baseline (n=156) | Vermont 2008 Baseline Weighted Data (n=82) |
|---|---|---|---|
| **Less than .31** | n/a | 70% | 60% |
| **.31 to .50** | n/a | 24% | 32% |
| **Over .50** | n/a | 6% | 8% |
| **ACHnat Statistics*** | | | |
| **Minimum ACHnat** | n/a | n/a | 0.04 |
| **Maximum ACHnat** | n/a | n/a | 0.65 |
| **Average ACHnat** | .45 | 0.31 | **0.28** |
| **Median ACHnat** | n/a | n/a | 0.26 |

*Only the average for 2008 is weighted.

Appendix B Table 15 shows the average boiler AFUE increased from 84.8 in 2002 to 87.4 in 2008 and the median AFUE increased from 85.0 to 86.6. Twenty percent of boilers in 2008 study homes have AFUEs of 91.0 or higher, while no boilers in homes in the 2002 study had AFUEs that high.

### Appendix B Table 15: Vermont Studies—Boiler Heating System AFUE

| Heating System AFUE Boilers | Vermont 1995 Baseline | Vermont 2002 Baseline (n=120) | Vermont 2008 Baseline Weighted Data (n=86) |
|---|---|---|---|
| **<78.0** | n/a | 0% | 0% |
| **78.0 to < 80.0** | n/a | 0% | 0% |
| **80.0 to < 83.0** | n/a | 20% | 4% |
| **83.0 to < 87.0** | n/a | 65% | 61% |
| **87.0 to < 91.0** | n/a | 15% | 14% |
| **91.0 or Higher** | n/a | 0% | 20% |
| **AFUE Statistics*** | | | |
| **Federal Minimum Standard** | 80.0 | 80.0 | 80.0 |
| **ENERGY STAR Minimum** | 85.0 | 85.0 | 85.0 |
| **Minimum AFUE** | n/a | 80.2 | 80.5 |
| **Maximum AFUE** | n/a | 89.0 | 95.2 |
| **Average AFUE** | n/a | 84.8 | **87.4** |
| **Median AFUE** | n/a | 85.0 | 86.6 |

*Only the average for 2008 is weighted.

Appendix B Table 16 shows the average 2008 furnace AFUE is lower but the median is higher than in 2008.

### Appendix B Table 16: Vermont Studies—Furnace Heating System AFUE

| Heating System AFUE Furnaces | Vermont 1995 Baseline | Vermont 2002 Baseline (n=20) | Vermont 2008 Baseline Raw Data (n=15) |
|---|---|---|---|
| **<78.0 AFUE** | n/a | 0% | 0% |
| **78.0 to < 80.0** | n/a | 25% | 0% |
| **80.0 to < 83.0** | n/a | 15% | 20% |
| **83.0 to < 87.0** | n/a | 0% | 0% |
| **87.0 to < 91.0** | n/a | 0% | 7% |
| **91.0 or Higher AFUE** | n/a | 60% | 73% |
| **AFUE Statistics** | | | |
| **Federal Minimum Standard AFUE** | 78.0 | 78.0 | 78.0 |
| **ENERGY STAR Minimum AFUE** | 90.0 | 90.0 | 90.0 |
| **Minimum AFUE** | n/a | 78.0 | 80.0 |
| **Maximum AFUE** | n/a | 93.0 | 93.5 |
| **Average AFUE** | n/a | 91.0 | 89.9 |
| **Median AFUE** | n/a | 86.5 | 92.5 |

Appendix B Table 17 presents the CFL bulb results from the previous Vermont baseline studies and the current study. Based on our understanding of the 2002 Vermont baseline study, the lighting results do not distinguish between screw-in CFL bulbs and pin-based CFL bulbs. Thus, we present the cumulative CFL bulb results (including both screw-in and pin-based models) from all studies in order to provide as consistent a comparison as possible.

Compared to 2002, a substantially higher percentage of homes in Vermont now contain CFL bulbs (81% vs. 47%) and also contain a much greater number of CFLs (14.2 vs. 3.0).

### Appendix B Table 17: Vermont Studies—CFL Bulbs

| Screw-in or Pin-based CFL Bulbs | Vermont 1995 Baseline | Vermont 2002 Baseline (n=158) | Vermont 2008 Baseline Weighted Data (n=105) |
|---|---|---|---|
| **Percent of Homes with Screw-in or Pin-based CFL Bulbs** | About one-third | 47% | 81% |
| **Average Number of Screw-in or Pin-based CFLs per Home** | n/a | 3.0 | 14.2 |

Appendix B Table 18 compares the saturation of appliances from the current study to the other studies. Overall, there appears to be little change in the saturation of appliances between 2002 and 2008 in Vermont, though secondary refrigerators increased from 12% to 19%.

### Appendix B Table 18: Vermont Studies—Appliance Saturation

| Percent of Homes with … | 2002 Vermont Baseline (n=159) | Vermont 2008 Baseline Weighted Data (n=105) |
|---|---|---|
| Primary Refrigerators | 100% | 100% |
| Secondary Refrigerators | 12% | 19% |
| Dishwashers | 90% | 92% |
| Clothes washer | 98% | 97% |
| Clothes dryer | 96% | 94% |
| Separate Freezer | n/a | 33% |
| Room Air Conditioner | 15% | 20% |
| Central Air Conditioner | 6% | 10% |

Between 2002 and 2008, there was little change in the percentage of refrigerators and clothes washers that are ENERGY STAR qualified in Vermont (Appendix B Table 19). However, the proportion of ENERGY STAR dishwashers increased from 36% to 69%, which may partially be due to the high prevalence of ENERGY STAR-qualified models on the market before the ENERGY STAR dishwasher criteria were upgraded in January 2007.

### Appendix B Table 19: Vermont Studies—ENERGY STAR Appliances

| Percent of Homes with … | Vermont 2002 Baseline | Vermont 2008 Baseline Weighted Data |
|---|---|---|
| ENERGY STAR Refrigerators | 27% | 30% |
| Total No. of refrigerators | 140 | 125 |
| ENERGY STAR Dishwashers | 36% | 69% |
| Total No. of dishwashers | 116 | 96 |
| ENERGY STAR Clothes washers | 47% | 48% |
| Total No. of clothes washers | 87 | 101 |
| ENERGY STAR Separate freezers | n/a | 12% |
| Total No. of freezers | n/a | 36 |