

How Residential Builders Respond to Changes in Codes and Energy Efficiency Programs

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Abstract

The requirements of California's low-rise Title 24 residential building standards and the new construction energy efficiency programs offered by the state's four investor owned utilities (IOUs) influence typical building practices through mandated building requirements, education and training, design assistance, and financial incentives. The result is a continual enhancement of building practices and improvements in the energy efficiency of the new housing stock built in the state. This paper explores the impact of the Title 24 standards and the ENERGY STAR[®] new construction program on typical building practices in California. This paper includes a discussion of recent changes in the Title 24 standards and IOU program offerings, a description of how the programs are identifying the barriers to increased energy efficiency in the new construction sector, and detailed characteristics of building practices in the state.

Introduction

California's Title 24 residential low-rise building standards (Standards)^A and the residential new construction energy efficiency programs offered by California's IOUs have had a significant impact on the typical building practices. The periodic revisions of Standards require builders to continually refine and enhance their specification practices. Moreover, the programs offered by the IOUs have increased the energy efficiency of newly constructed homes through a combination of education and training, design assistance, and financial incentives.

This paper focuses on how builders have altered their building practices in response to changes in building standards and changes in the requirements of the IOUs' new construction programs. The following sections present a discussion on the changes in residential standards and residential new construction program offerings, a description of the ENERGY STAR New Homes Program, the current new construction program offered by the IOUs, a discussion of the barriers to energy efficiency in residential new construction and how builders and program planners are overcoming these barriers, and details on measures specified by builders to meet the requirements of the ENERGY STAR New Homes Program.

^A CEC 2000.

Overview of California's Title 24 Building Standards and IOU Residential New Construction Programs

This section provides an overview of California's energy standards and energy efficiency programs for low-rise (three floors or less) residential new construction. Figure 1 provides a timeline view of the residential Standards and publicly funded energy efficiency programs in California since the Standards were first enacted in 1978. As might be expected, the development of energy efficiency standards and new construction programs are interconnected. Since energy efficiency programs strive to increase efficiency above what the Standards mandate, a change to the Standards directly influences the programs. Typically, periodic changes in the Standards incorporate aspects (high efficiency equipment or measures) of the current program. In turn, for the program(s) to continue to be effective, program requirements need to evolve to include even higher efficiency measures.

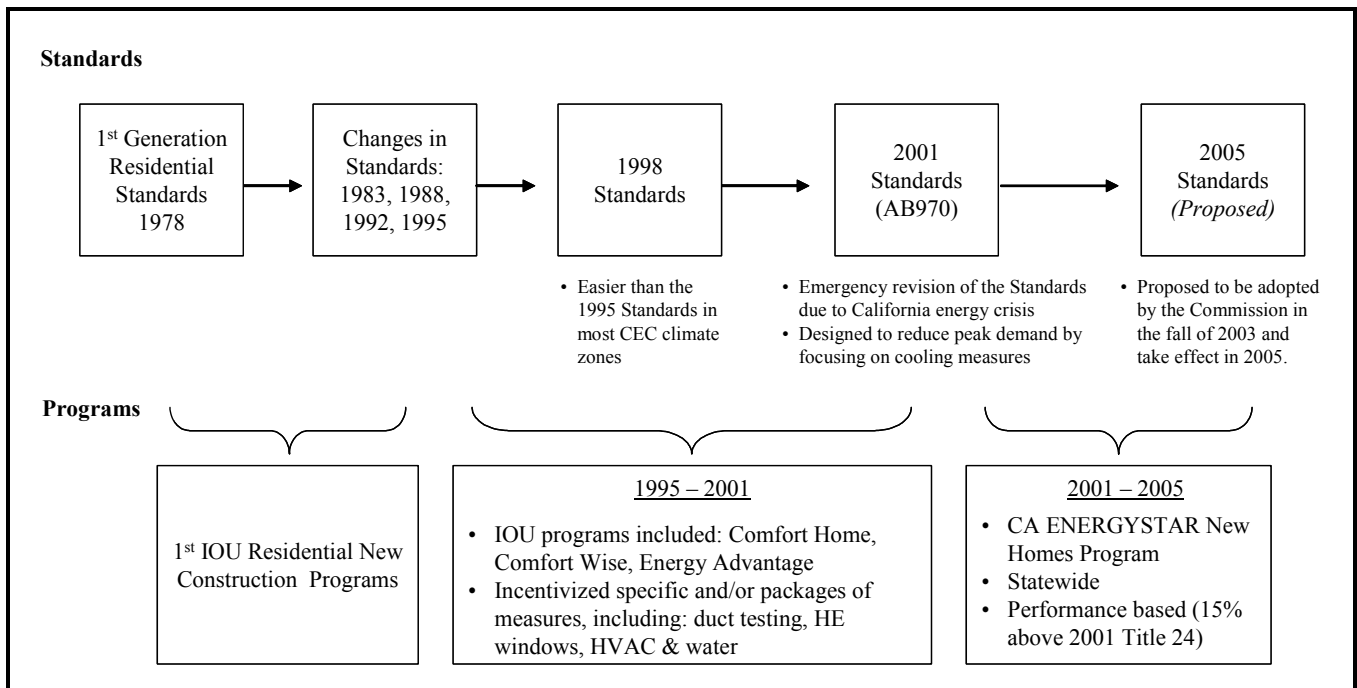


Figure 1: Overview of Changes to California's RNC Standards and Programs

California's Low-Rise Residential Standards

In California, the energy performance requirements for low-rise residential new construction are dictated by the Standards, which are administered by the California Energy Commission (CEC). The Standards referred to in this paper apply to low-rise detached single family homes, attached single family homes, and multifamily residences less than three stories high. Several revisions have been adopted since the original Standards, which, since the late 1980s, have typically been updated on a three-year cycle. This section will focus on changes made to California's low-rise residential Standards between 1995 and the present.

1995 and 1998 Standards

The overarching objective for revising the Standards is to increase the energy efficiency of newly constructed homes. One would expect that a home built under the 1995 Standards would not be able to be built under the 1998 Standards. However, analysis conducted as part of the Residential New

Construction Study^B shows that the 1998 Standards were actually easier than the 1995 Standards for homes in most CEC climate zones.^C Specifically, detached single family homes built under the 1998 Standards were, on average, 6% more efficient than the 1998 Standards and not quite 4% more efficient than the 1995 Standards. This is primarily attributable to the change in the water heating component of the Standards. Space heating also contributes to the 1998 Standards being easier in some climate zones.

Water Heating

The most significant change in residential Standards between 1995 and 1998 pertained to the calculation of the water heating standard budget. Under the 1995 Standards, homes with a water heater blanket installed received a credit. However, under the 1998 Standards, the prescriptive water heating requirements do not include the blanket. The proposed water heater will be compared to a minimally complying water heater (0.53 EF). The effect is that applicants who formerly modeled water heating with an R-12 wrap will receive the same credit they have been receiving and no blanket will be required as long as it is 0.58 EF or higher.^D Nearly 98% of detached single family homes have water heaters that are above standard.^E Further analysis shows that, overall, 99% of detached single family homes have a gas water heater that has an energy factor of 0.58 or higher.^F Therefore, over three-fourths of homes received the water heater blanket credit.^G

Space Heating and Space Cooling

Additional changes to the residential Standards between 1995 and 1998 involved the space heating and space cooling budgets. These changes, which were not as straightforward as the water heater blanket credit, included the following.

- **Glazing.** Internal changes on the calculation of solar heat gain.
- **Duct efficiency.** A new duct efficiency component was established to accommodate a credit for duct sealing.
- **Thermal mass.** Changes to thermal mass were adopted, but did not change the compliance margin because the resultant Standard and Proposed energy budgets were affected equally.

2001 Standards

In response to what the State of California described as “growth trends in electricity peak demand that have strained the adequacy and reliability of California’s electricity system,” the State passed Assembly Bill 970 (AB 970) in September 2000.^H Among other things, AB 970 directed the CEC to “adopt and implement updated and cost-effective standards...to ensure the maximum feasible reductions in wasteful, uneconomic, inefficient, or unnecessary consumption of electricity.” The CEC considered amendments to the Standards that could be “quickly analyzed and justified, and which would have a clear and significant impact on peak energy demand.” Subsequently, the AB 970 Standards were developed and adopted in January 2001. *Under these Standards, statewide annual source energy*

^B RER 2002.

^C RER 2001 and RER 2002.

^D http://www.energy.ca.gov/title24_1998_standards/summary_changes.html

^E RER 2002.

^F The percentage of homes with a 0.58 EF or higher water heater could be greater since 1.9% of homes were given the default standard water heater due to inaccessibility.

^G RER 2002.

^H CEC 2000.

savings are estimated at 14% from the 1998 Standards, which includes a 39% or 155 MW reduction in cooling energy use on a statewide basis.^I

The major change to the Standards is that radiant barriers,^J low solar heat gain fenestration,^K duct sealing,^L and TXV valves^M for air conditioners (certified by a Home Energy Rating System (HERS) provider/rater) are now part of prescriptive component of the Standards for some climate zones. These added features also affected the performance component calculations and made it much tougher to achieve compliance. Another change is the addition of an alternative to Prescriptive Package D. This package is an alternative to HERS-certified measures (duct sealing and TXV valves for air conditioners) and requires higher performance windows and high efficiency HVAC equipment instead.

2005 Standards (Proposed)

The CEC is planning on adopting the proposed 15-Day Language for the 2005 Building Energy Efficiency Standards in the fall of 2003. The primary objectives for these new revisions are: *respond to California's energy crisis to reduce energy bills, increase the reliability of the energy system, and contribute to an improvement in California's economic condition.^N*

The proposed revisions to the low-rise residential Standards include the following.^O

- Time-dependent valuation will replace source energy in calculating compliance using the performance method. In other words, measures that reduce peak energy (i.e., air conditioners) will be favored over those that reduce non-peak energy (i.e., furnaces).
- Multifamily buildings will no longer receive credit for having glazing percentages less than 20% and they will also no longer receive credit for having a central water heater.
- The minimum SEER for air conditioners increases from 10 to 12 SEER.
- The standard energy factor for 50-gallon gas water heaters increases from 0.53 to 0.58 EF.
- R-6 and R-8 duct insulation will be required in some CEC climate zones.
- Third party verification protocols and procedures will be changed to encourage quality installation.

California's Residential New Construction Programs

Publicly funded residential new construction programs have undergone a major transformation over the past decade in response to changes in California Public Utilities Commission's (CPUC) policy objectives and as a result of years of program and process evaluations. Prior to 2001, IOU programs were individually developed and administered, meaning they were unique to each utility. These programs were prescriptive-based, offering rebates for the installation of specific measures and/or packages of measures, such as high efficiency HVAC systems and tight ducts. Throughout the 1990s,

^I CEC 2000.

^J A radiant barrier is a reflective foil or metal-coated surface usually placed on or against the underside of a roof.

^K Low solar heat gain fenestration products are typified by a dual-paned, vinyl-framed window with low solar/low emissivity (spectrally selective) glass.

^L Duct sealing involves actively testing and sealing a duct system with a "duct blaster" or equivalent apparatus.

^M Air conditioning system performance is dependent on proper refrigerant charge and airflow across the coil. TXVs mitigate the problems of improper refrigerant charge and airflow by making the system operate at its rated efficiency.

^N CEC 2003.

^O Eley 2003.

residential new construction programs adopted strategies to produce increased energy efficiency in the short run, and sustainable changes in building practices in the long run. In addition to financial incentives, the ComfortHome, ComfortWise, and Energy Advantage Home programs provided design assistance, marketing and advertising support, homebuyer education, and training. Program offerings targeted not only builders, but others involved in critical aspects of design, specification, and construction, including architects, energy consultants, and engineers.

Programs developed in the late 1990s began to move toward improving whole-building efficiency. This recognition and acceptance of the benefits of integrated design began the migration to the infusion of ENERGY STAR into residential new construction programs in 2001. The national ENERGY STAR program requires homes to exceed the Model Energy Code by at least 30% and does not dictate which measures must be installed to meet those goals. While homes qualifying for the ComfortHome program did not necessarily meet the ENERGY STAR threshold (though many did), the upgrades required by the program helped to move homes toward the ENERGY STAR level. The ComfortWise program actually used ENERGY STAR as a benchmark and involved inspection of all energy-related components of the house.

The migration toward developing consistent statewide programs in 2001 furthered the natural progression toward a fully integrated ENERGY STAR platform for the residential new construction program. The development of a California-specific ENERGY STAR benchmark linked the program directly to California's Title 24 Standards, while providing builders with the flexibility to meet program requirements in the most cost-effective manner. The following section summarizes California's current residential new construction program.

Current New Construction Program – California ENERGY STAR New Homes Program

Program Concept

The basic premise of California's current statewide ENERGY STAR New Homes Program is to stimulate the energy efficient design and construction practices for single and multifamily new construction. The program targets various professionals involved in all aspects of the residential new construction market – builders/developers, architects, energy consultants, and others - with education, design assistance, and financial incentives. Consistent with the overarching policy goals for energy efficiency in California, this statewide program targets builders of homes in the hard-to-reach segment of the market.^P

The program is performance-based rather than prescriptive – the program rewards builders for increasing whole-building efficiency rather than incentivizing the installation of specific measures. This approach is consistent with premise of the ENERGY STAR program, so it made sense to build the new statewide program upon the ENERGY STAR platform. The minimum requirement for participation is a total source energy use reduction of at least 15% above the Standards. By configuring the program to increase whole-building efficiency, the incentive structure automatically accounts for differences in energy efficiency requirements across California's 16 unique climate zones.

^P The hard-to-reach segment of the residential new construction market, as defined by the CPUC, includes housing for senior citizens, individuals with speech needs, low-to-moderate income households, housing in rural areas, and rentals.

Marketing and Outreach

Marketing and outreach of the program's early years focused primarily on developing consistent statewide messaging and outreach materials to introduce the new statewide program to single and multifamily builders and other industry professionals. In 2003, the marketing campaign specifically targeted builders and developed trade advertisements that highlighted the success of the 2002 program. Plans for 2004 will expand the campaign to include homebuyer education on energy efficient housing by co-branding with ENERGY STAR and leveraging the successful and highly recognized Flex Your Power conservation campaign launched to thwart the California's 2001 energy crisis.

The California IOUs have demonstrated numerous advantages of a consistent statewide program that is managed locally by each utility. Identical program requirements, application forms, and procedures have made it easier for builders to participate, since many builders have projects throughout the state. Moreover, economies of scale have been realized from the development of outreach and training materials with consistent messaging. Advantages were also realized through collaboration and cooperation of trade allies; it became easier to market the unified program through industry associations and through professionals who work directly with builders/developers. Recognizing, however, that the residential new construction industry has unique needs across California's diverse geography and population base, the IOUs also offered training, design assistance, and marketing support customized to the needs of their respective service areas. Similarly, each IOU coordinated local and regional outreach through the Building Industry Association, the Affordable Housing Association, and other prominent industry associations.

Program Accomplishments

The California ENERGY STAR New Homes Program is recognized in both the building and energy efficiency communities as a valuable resource in advancing increased energy efficiency. Most notably, the significance of the program was recognized by the Environmental Protection Agency, which presented the 2002 ENERGY STAR Partner of the Year Award to the four IOUs for the program's success in enrollment and promotion of the program with the ENERGY STAR label. Table 1 includes a summary of program accomplishments, in terms of market penetration and energy and demand savings.

Table 1: 2002 Program Accomplishments

	Single-Family	Multifamily
Market Penetration	9%	24%
Units	11,295	9,870
kWh	6,297,426	1,413,117
kW	6,753	1,684
Therms	412,287	214,455

Not reflected in Table 1 are the indirect impacts that are believed to result in long-term sustainable energy efficiency improvements. Specifically, through its outreach and training components, the program has educated builders about energy efficient equipment, new design techniques, the non-energy benefits of energy efficiency to homebuyers, and the early adoption of building standards. The success of the program has contributed to the development of enhanced energy efficiency building standards. The cause and effect relationship between the Standards and the program has led to widespread adoption of increased energy efficiency in residential new construction.

Barriers to Energy Efficiency in Residential New Construction

The late 1990s ushered in a new era for publicly funded energy efficiency programs in California. In addition to the development of several statewide programs, the CPUC directed the four IOUs to identify specific market barriers to energy efficiency that existed in the target market for each program. IOUs must now justify their program not only on cost effectiveness and energy and demand savings, but also on how programs address market barriers.

Single Family

The primary barriers to energy efficiency in the single family new construction market are lack of consumer information/awareness about the benefits of energy efficiency, and high first costs for high efficiency measures compared to those specified for a home that just meets the minimum requirements. The former is addressed through targeted marketing and outreach that focuses on the benefits of an energy efficient (i.e., ENERGY STAR) home. While reduced energy bills are an obvious benefit, other non-energy benefits, such as increased comfort, reduced noise, and reduced callbacks for HVAC contractors, have been identified as important features to both builders and homebuyers. The financial incentives^Q offered to builders help to offset the incremental costs of high efficiency measures incurred by builders. The marketing support and esteemed ENERGY STAR label also attract builders to the program and encourages investment in the construction of energy efficient homes.

Multifamily

Prior to administration of the 2002 statewide program, multifamily residential new construction was virtually an untapped market for energy efficiency. This, and the fact that much of the hard-to-reach segment of residential new construction lies in the multifamily sector suggest barriers to energy efficiency in multifamily housing are unique and more arduous to address. These barriers include:

- Multifamily builders – affordable housing builders, in particular – have increased information needs regarding energy efficiency,
- Multifamily projects have longer construction lead times, and
- The nonprofit housing segment has difficulty securing funding.

The first barrier was addressed in 2003 with a design and training course developed specifically for builders, architects, energy consultants, engineers, HVAC contractors, and verification and building inspectors of the multifamily housing market.^R Response to this specialized program was tremendous and served to increase program participation. The latter two barriers are institutional barriers not likely to be eliminated by the program and, in fact, have served as disincentives to participation because the annual program funding cycles were too short for builders to develop and complete qualifying projects within the required deadlines. Recent adoption of a biannual funding cycle for 2004-05 should provide more opportunities for developers to plan projects, secure necessary funding, obtain permits, and begin construction within the allotted timeframe.

^Q Financial incentives vary for single family and multifamily homes and for inland versus coastal homes.

^R See RER 2001 and RER 2002 for detailed information about and results of these on-site surveys.

Changes in Builder Practices to Meet Current Standards and Program Requirements

As part of the ongoing statewide RNC study,^S on-site surveys of newly constructed homes and interviews with builders and Title 24 consultants have been conducted over the last four years. Specifically, two rounds of on-site surveys have been completed and a third will be completed by December 2003. During each of the first two years of the study, on-site surveys were completed for 800 residential buildings, including detached and attached single family homes, and multifamily buildings. The third on-site survey effort currently underway will survey 600 detached single family homes. In addition to the on-site surveys, in-depth interviews and telephone interviews with builders and Title 24 consultants have proved invaluable due to the lag time in surveying newly built residential buildings. The combination of these data sources allows for detailed analysis of the measures being installed in new homes since 1998 and those specified in the new homes to be built through early 2004. These research efforts provide interesting insight into the changes in building practices between the 1998 and 2001 Standards and the strategies utilized by builders to upgrade “standard” homes (those that just comply with the Standards) to qualify for the California ENERGY STAR New Homes Program.

Changes in Builder Practices to Meet 2001 Standards

Analysis of the 2001 Standards suggested that builders in most CEC climate zones would have to change their building practices in order for their homes to comply with the new Standards. To investigate this hypothesis, the on-site survey results for detached single family homes built between July 1999 and June 2000 (under the 1998 Standards) were compared to the preliminary results of on-sites surveys of detached single family homes built between January 2003 and June 2003 (under the 2001 Standards).^T Table 2 presents the percentage of homes with low-E glass windows and the percentage of homes with vinyl-framed windows built under the 1998 Standards and under the 2001 Standards. As shown, the percentage of homes with low-E windows increased dramatically after the implementation of the 2001 Standards. This corresponds with the results of interviews with Title 24 consultants in 2001 who anticipated that builders would opt for high performance windows as a first option for complying with the more difficult Standards. In fact, recent interviews with both builders and Title 24 consultants suggest that low-E windows are becoming the standard in most regions of California. Table 2 also reveals that the percentage of homes with vinyl-framed windows has not experienced much change statewide.

Table 2: Changes in Window Types – Under 1998 and 2001 Standards

Window Type	Standards	Statewide	North Coastal	South Coastal	South Inland	Central Valley	Desert & Mountains
Low-E	1998	10%	8%	0%	1%	21%	0%
	2001	68%	60%	27%	68%	90%	100%
Vinyl-framed	1998	84%	94%	100%	99%	64%	97%
	2001	83%	100%	27%	95%	100%	100%

On-site survey data.

Table 3 presents the percentage of homes built under the 1998 and 2001 Standards that have high efficiency HVAC equipment. As shown, the percentage of homes with high efficiency central air

^S RER 2001 and RER 2002.

^T Note that results including all 600 homes will be available by December 2003.

conditioners increased from 3% to 36%. This is not surprising since the 2001 Standards were intended to decrease the summer peak load, comprised primarily of cooling loads. The saturation of high efficiency furnaces also increased somewhat from 3% to 9% statewide, with the largest increases in the saturation of high efficiency furnaces observed in the North Coastal and Mountain regions.

Table 3: Changes in Efficiencies of HVAC Equipment – Under 1998 and 2001 Standards

Measure	Standards	Statewide	North Coastal	South Coastal	South Inland	Central Valley	Desert & Mountains
CACs > 11 SEER	1998	3%	3%	0%	0%	6%	1%
	2001	36%	0%	11%	19%	61%	67%
Furnaces > 90 AFUE	1998	3%	4%	0%	0%	5%	1%
	2001	9%	60%	0%	0%	8%	20%

On-site survey data.

Interviews with Title 24 consultants in 2001 indicated that duct sealing was specified for approximately 9% of the homes that they conducted compliance analysis for in 2000 (under the 1998 Standards). Consultants believed that duct sealing might not be specified as often as high performance windows and high efficiency air conditioners to achieve compliance. Doing so would require builders to coordinate with third party inspectors, which would lengthen the overall construction schedule. More recent interviews support this early sentiment; Title 24 consultants estimate that approximately 16% of the homes they conducted compliance analysis for in 2002 (under the 2001 Standards) included sealed ducts.

Upgrading Standard Homes to California ENERGY STAR New Homes

The specification practices relating to California ENERGY STAR homes were obtained through the in-depth surveys conducted with high volume Title 24 consultants and turnkey service providers.^U Two approaches were taken in order to get the best estimates of the types of measures being installed. First, in order to compare the percentages of measures installed in ENERGY STAR homes to those installed in “standard” homes (see Table 4), these “high volume” participants were asked to estimate how frequently each high efficiency measure (listed in Table 5) was specified in the ENERGY STAR homes that they conducted the compliance analysis for in 2002. Then, to gain insight into how these consultants go about upgrading a “standard” home to an ENERGY STAR home, they were asked to explain the differences, in general, between their plans for “standard” homes and those for ENERGY STAR homes that they worked on in 2002.

^U These consultants reported planning approximately 7,800 California ENERGY STAR new homes in 2002. The data in Table 5 represents 7,141 homes because estimates of specific measures installed were not available for approximately 650 of the homes.

Table 4: Incidence of High Efficiency Measures in “Standard” Homes

	Overall	North Coastal	South Coastal	South Inland	Central Valley	Desert	High Desert	Mtn.
# of Respondents	40	23	12	15	27	5	5	15
Homes represented	55,801	13,246	5,103	10,398	22,625	1,778	2,120	530
HERS-cert. sealed ducts	16%	1%	1%	9%	20%	72%	93%	5%
TXV / Ref charge air flow test	25%	1%	0%	23%	34%	99%	100%	7%
ACCA Manual D duct design	3%	3%	0%	9%	1%	0%	19%	0%
Duct location	8%	19%	2%	11%	1%	0%	0%	35%
Duct surface area	3%	4%	1%	9%	1%	0%	0%	0%
R-8 duct insulation	2%	2%	1%	7%	0%	0%	0%	2%
Bldg. envelope sealing (Blower Door)	0%	0%	0%	0%	0%	0%	0%	1%
High perf. windows	66%	52%	33%	49%	84%	100%	100%	70%
Radiant barriers	10%	21%	7%	5%	3%	10%	44%	51%
Higher eff. water heater	91%	85%	75%	91%	97%	100%	90%	89%
Higher eff. CAC	43%	11%	10%	31%	65%	100%	90%	57%
Higher eff. furnace	13%	29%	10%	12%	5%	0%	0%	90%
Increased roof/wall insulation	66%	51%	54%	89%	64%	95%	75%	74%

Values are weighted means.

Table 5 presents the percentage of single family ENERGY STAR homes planned in 2002 that included each high efficiency measure. The following are observations made when comparing these results to the percentages of “standard” homes with the same measures.

- **Duct system-related measures.** Duct design, sealing, and testing are specified by builders to upgrade homes to the ENERGY STAR level. As shown in Table 5, HERS-certified sealed ducts are specified for all ENERGY STAR homes in extreme climate zones and in over three-fourths of the homes in the North Coastal region. Comparing these results to Table 4, duct upgrades are most prevalent in the Central Valley, South Inland, and North Coastal climate zones. Note, however, that duct location, duct surface area, and R-8 duct insulation are not utilized for ENERGY STAR qualification.
- “High volume” respondents reported that approximately 55% of the ENERGY STAR homes they conducted the compliance analysis for were specified to have **building envelop sealing**. In comparison, none of the consultants interviewed reported specifying building envelop sealing in their “standard” homes.
- **TXVs and higher efficiency central air conditioners** are also common upgrades to meet ENERGY STAR requirements for homes in cooling climate regions, particularly in the South Inland and Central Valley regions.

- Although **high performance windows** are becoming standard in a majority of new “standard” homes, low-E glass is even more commonly specified by builders when developing plans for ENERGY STAR homes. One consultant explained that in regions requiring 16% glazing, having low-E windows and sealed ducts will raise the house to the ENERGY STAR level – if the prescriptive glazing requirement is met.
- Survey results do not reveal significant differences between ENERGY STAR and non-ENERGY STAR homes with respect to **water heaters**.

Table 5: Incidence of High Efficiency Measures in ENERGY STAR Homes

	Overall	North Coastal	South Coastal	South Inland	Central Valley	Desert	High Desert	Mtn.
# of Respondents	3	2	1	2	3	1	1	1
CA ENERGY STAR Homes represented ^V	7,141	974	240	912	4,295	240	240	240
HERS-cert. sealed ducts	88%	83%	10%	50%	100%	100%	100%	100%
TXV / Ref charge air flow test	79%	17%	0%	75%	100%	100%	100%	0%
ACCA Manual D duct design	37%	33%	0%	0%	40%	100%	100%	50%
Duct location	0%	0%	0%	0%	0%	0%	0%	0%
Duct surface area	0%	0%	0%	0%	0%	0%	0%	0%
R-8 duct insulation	0%	0%	0%	0%	0%	0%	0%	0%
Bldg. envelope sealing (Blower Door)	55%	33%	0%	0%	71%	75%	100%	50%
High perf. windows	95%	67%	75%	100%	100%	100%	100%	100%
Radiant barriers	7%	0%	0%	0%	5%	25%	75%	0%
Higher eff. water heater	97%	87%	100%	100%	99%	100%	100%	100%
Higher eff. CAC	67%	0%	0%	100%	78%	100%	100%	0%
Higher eff. furnace	8%	0%	0%	0%	7%	0%	0%	100%
Increased roof/wall insulation	76%	100%	100%	100%	61%	100%	100%	100%

Values are weighted means

When the “high volume” consultants were asked to explain the additional features that a “standard” home, that just meets Title 24, needs to meet ENERGY STAR, their answers corresponded to the results presented above. Duct sealing was mentioned by all three respondents as one of the first upgrades to push homes to the ENERGY STAR level. One consultant specifically mentioned that duct sealing is the *first* measure used and another pointed out that duct sealing *alone* would elevate homes in some CEC climate zones to the ENERGY STAR threshold. Two consultants reported using high efficiency windows

^V The number of ENERGY STAR homes by region for each consultant is estimated using the following calculation: total number of homes that the consultant analyzed in 2002 (including ENERGY STAR and “standard” homes) times the percentage ENERGY STAR homes, times the percentage of homes built in each region.

as an upgrade while the other consultant said that these were specified even for all of their “standard” homes.

TXVs and 12 SEER air conditioners were reported to be the next upgrades implemented depending on the climate zone. While two of the three “high volume” consultants reported specifying building envelop sealing (blower door testing), one mentioned that a home with this measure was considered “ENERGY STAR *plus*” since it is not necessarily needed to get to ENERGY STAR, rather to surpass it. Duct design and high efficiency furnaces were each reported to be used by one “high volume” participant and only as a last resort – primarily in extreme climate zones.

Conclusion

Reciprocal changes in California’s residential building energy efficiency standards and revisions in residential new construction programs over the past decade have increased the energy efficiency of the residential building stock throughout the state. Moreover, the evolution of the utility-specific prescriptive rebate programs to statewide consistent performance-based program has further enhanced standard practices of the building industry. The current California ENERGY STAR New Homes Program benefits from the nationally esteemed ENERGY STAR brand and a benchmark established specifically to account for California’s stringent building energy efficiency requirements. Evaluations of California’s residential new construction programs have revealed methods builders have adopted to adjust to changes in the Standards and for participating in the programs. Recent research suggests that commonly specified measures to qualify a home for ENERGY STAR in California include duct sealing, building envelop sealing, and high performance windows.

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