EVALUATION, MEASUREMENT AND VERIFICATION OF THE 2002 CALIFORNIA STATEWIDE ENERGY STAR® NEW HOMES PROGRAM

PHASE I REPORT

March 1, 2004

Prepared for California's Investor-Owned Utilities:

Pacific Gas and Electric Company
San Diego Gas and Electric Company
Southern California Edison Company
Southern California Gas Company

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Measurement and Evaluation

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1. Introduction

This document is the Phase I evaluation, measurement and verification (EM&V) report for the 2002 California ENERGY STAR® New Homes Program. California's Investor Owned Utilities (PG&E, SCE, SDG&E, and SoCalGas) implemented the program in each of their respective service territories. The evaluation of the 2002 California ENERGY STAR New Homes Program is a study mandated by California Public Utility Commission (CPUC). RLW Analytics (RLW) of Sonoma, California was the sole evaluation, measurement and verification contractor on this project.

Program Overview

The California ENERGY STAR New Homes Program (Program) provides financial incentives and education to California builders who construct new residences that exceed the state's mandatory minimum energy efficiency standards. California's energy efficiency standards for residential and non-residential new buildings are set by the California Energy Commission in the Title 24 energy code.[1] Participating builders that exceed California's Title 24 residential standards by 15% or more receive cash incentives, in addition to training and marketing support. Table 1 summarizes the dollar amount a builder received for each unit that met ENERGY STAR standards.[2]

Type	15-19.99% Compliance	20% + Compliance
Single Family (CZ 1-7)	$ 400	$ 700
Single Family (CZ 8-16)	$ 500	$ 900
Multifamily	$ 150	$ 250

Table 1: 2002 Incentive Rates Per Unit

Figure 1 gives a brief description of the process of program participation and the connection between the various parties involved with the California ENERGY STAR program.

Step 1: Once builders have the building designs prepared, all builders submit the plans to Title 24 consultants who then prepare the required compliance documentation.

Step 2: If builders choose to build above and beyond the minimum requirements to meet ENERGY STAR standards, they must submit their building plans and a short program application to the IOU to demonstrate they have indeed designed energy efficient homes. At this stage, construction is usually in the planning and design, or early construction stage. If the utility approves the application, the ENERGY STAR program reserves incentive funds for the builder based on the projected number of units approved.

Step 3: After the utility reviews and approves the builder's project(s), it submits the building plans to a plan check agency that re-verifies Title 24 and ENERGY STAR compliance. Once approved, the plan check agency uploads the Title 24 output file (called the "transfer file") to the CHEERS registry.

[1] http://www.energy.ca.gov/title24/

[2] For the 2003 program, the incentive rates changed; single family units (CZ 8-16) with 20% or more compliance margin received $700 per unit (instead of $900/unit in 2002) and all other units that exceed 20% compliance receive no additional incentive than the amount from the 15% compliance rate.

Step 4: Once builders have actually constructed the homes, they must hire a CHEERS rater to verify the building measures specified in the Title 24 file, which are contained in the CHEERS registry. Verifications are completed via an on-site inspection of the constructed unit. CHEERS is a non-profit organization that has been approved by the California Energy Commission (CEC) to provide testing, verification, and certification of the California Home Energy Rating System (C-HERS) regulations. ENERGY STAR New Homes may include a number of C-HERS energy efficiency measures that require verification by a trained and certified CHEERS rater. All new or renovated homes that include C-HERS measures are contained in the CHEERS Registry. Therefore, the CHEERS registry is a database of building and energy characteristics for homes with one ore more C-HERS measures, and ENERGY STAR homes. Again, the CHEERS Registry is populated by extracting data from the Title 24 building file,[3] which is then uploaded to the CHEERS registry via the Internet.

Builders receive incentives from the utility once their homes pass the CHEERS verification process.

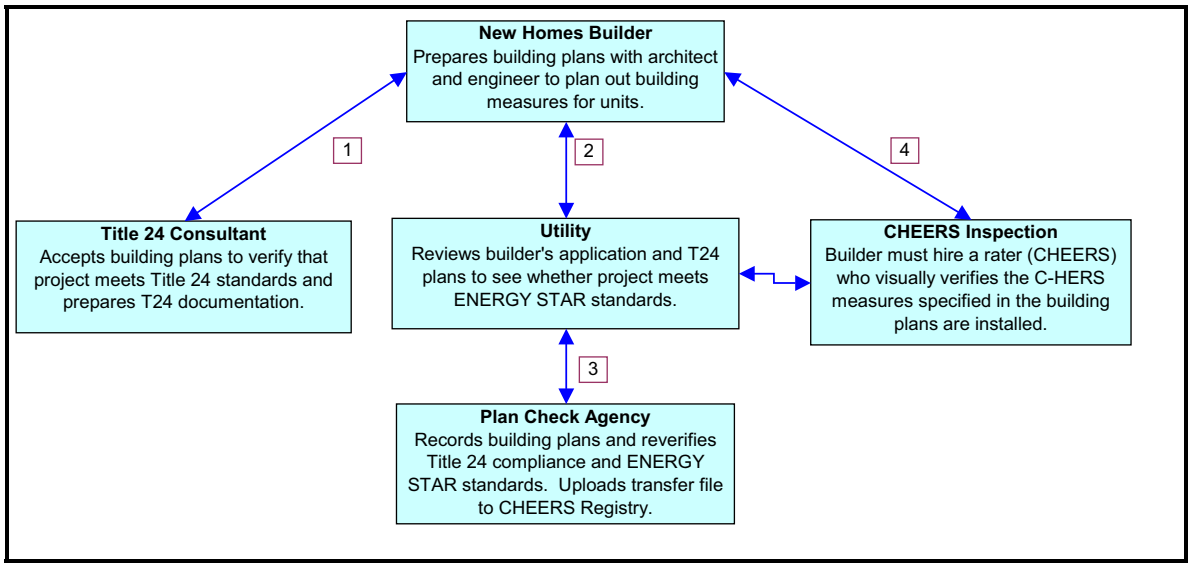

Figure 1: ENERGY STAR Compliance Process

The 2002 program provided incentives to builders that applied and reserved program funds during calendar year 2002. Due to the nature of residential new construction, many of the participant homebuilders do not complete construction until 2003. In order to be eligible for the 2002 cash incentives, builders are required to complete all construction and inspection activities within 24 months or before December 31, 2004 (whichever comes first).

Evaluation, Measurement and Verification Overview

This is the Phase I evaluation, measurement and verification report for the 2002 California ENERGY STAR New Homes Program. This report covers program activities completed in calendar year 2002 and 2003. The Phase I evaluation leverages the transfer files that have been verified by the various plan check agencies. These are the participant builder's

[3] A Title 24 building file, also known as a C-2R file, is an inspection report that qualifies the newly constructed home to comply with California's Title 24 standards.

best estimate of the building characteristics that will be installed during construction. Therefore using this information, Phase I provides preliminary analysis and estimates of ex post energy savings.

The Phase II report will be completed mid-year 2004, when the majority of construction and incentive filing by 2002 program participant builders will be complete. The Phase II report will reassess the actual ex post energy savings by including as-built information gathered as part of the CHEERS inspections. Additionally, not only will RLW replicate the ex-post savings methodology used for the Phase I study, RLW will also execute a billing analysis and use a forthcoming residential new construction baseline study as an additional approach to estimating gas and electric savings.

The immediate objectives of the Phase I EM&V report were to:

- Provide the preliminary ex post energy savings of the program;
- Provide a market assessment of building characteristics used in the participant dwellings by summarizing building characteristics information contained in the CHEERS registry and program tracking databases;
- Provide a baseline analysis of market actors by conducting surveys of participating and non-participating builders, CHEERS raters, and Title-24 consultants;
- Measure indicators of the effectiveness of the program by analyzing the results of the non-participant builder and Title-24 consultant surveys;
- Provide ongoing feedback and corrective and constructive guidance regarding the implementation of the program by interviewing IOU program managers and program participants; and
- Assess the overall level of performance and success of the program by including specific recommendations and comments regarding the implementation of the program.

Findings

The 2002 ENERGY STAR New Homes program was overall a tremendous success in California. Although some builders felt the incentives were not enough to cover the added cost of energy efficient construction, demand for participation overwhelmed all four utility implementers. In junction with US Environmental Protection Agency, RLW applauds the efforts of the utilities to educate and improve building practices in new residential construction. Before delving into specific findings, we begin by presenting our high-level conclusions and recommendations.

Conclusions

- **We commend the utilities on an excellent job on collaborating.** The collaboration between the utilities has been successful in that it established uniform services offered to customers. In addition, it allowed for an opportunity to exchange ideas and to combine efforts.
- **Demand for, and participation in the 2002 California ENERGY STAR New Homes Program was incredible, with more than 20,000 dwellings participating.** More than 11,000 single family homes participated in the program, and nearly 10,000 multifamily dwellings participated in the multifamily program. These findings

demonstrate equity in the distribution of program funds across the residential market segments. Moreover, although the program was not approved until March of 2002, the utilities were still able to fully subscribe the program prior to the program application deadline.

- **Statewide, the 2002 California ENERGY STAR New Homes Program exceeded preliminary energy savings estimates reported in the AEAP.** Overall, the EM&V of this program finds that for the single family program the utilities exceeded their Annual Earnings Assessment Proceeding (AEAP) filing by 22%, and by 34% for the multifamily program. Actual savings will be presented in the Phase II report.
- **As indicated by builders participating in the program, the California ENERGY STAR New Homes Program has fostered a change in the way builders construct new homes in California.** Two-thirds of participant builders report that they would now specify energy efficient measures that they would not have previous to program participation. As a result, we emphasize the value of continuing the program, while at the same time ensuring that the mix of participants is renewed each year in order to maximize program benefits.
- **Builder awareness of the California ENERGY STAR New Homes Program was good.** Of those who did not participate, the overwhelming majority of single family builders (94%) and only 40% of multifamily builders were aware of the program. Participation levels would be greater if program uncertainties surrounding program timelines and incentive availability were removed.

Recommendations

- **The utilities should work toward a common approach to estimating energy savings.** The four utilities used varying approaches to estimate AEAP filed savings. Utilizing a common approach would benefit program administration as well as program evaluation. Moreover, a common approach may actually be more cost effective and accurate.
- **The utilities should make a better effort to track Hard-to-reach customers that participate in the program.** The CPUC has placed a mandatory requirement on serving hard-to-reach customers. Because the Energy Policy Manual's definition of hard-to-reach is loosely defined for this type of program, the utilities should agree upon a uniform classification of hard-to-reach characteristics. This data should then be consistently tracked by all utilities.
- **RLW strongly encourages the CPUC to authorize programs on time in order to maintain program continuity.** Low satisfaction with the program timeframe and funding uncertainty was a common theme heard by RLW from the program participants. In order to maintain builder motivation and satisfaction with the program, it is extremely important that participation barriers related to program timing and funding uncertainties be removed.
- **The required margin of compliance for low-rise multifamily projects should be no less than 20%.** Issues relating to the ease of program compliance for low-rise multifamily projects could be mitigated by a higher compliance margin for low-rise projects. Disallowing negative savings in any of the three end-use categories would also mitigate the ease of compliance issues. Upon implementation of the 2005 standards, the program should then restructure the multifamily program

metrics to match single family compliance metrics. Additionally, these changes will better prepare low-rise builders for the eminent code changes.

- **Additional on-site inspections, or other means of verification may be prudent due to problems concerning program inspection, quality control and data in the CHEERS Registry identified by the evaluation.** In various sections of this report, we discuss issues that could lead to projects not being built with the energy efficient characteristics reported by program implementers. For example, we discuss:
    - The ability to easily modify a transfer file prior to uploading the data to the registry.
    - Although a 2003 CHEERS Quality assurance report[4] found that 96% of the field data matched the data in the Registry, it does not verify whether the data collection by raters is accurate when not in the presence of the CHEERS QA inspector.
    - Less than adequate "to do lists" resulting from poorly parsed transfer files. Particularly an issue relating to multifamily inspections.
    - Potential conflict of interest when the same agency is a.) The builder's agent for program participation requirements, b.) Responsible for authoring the Title 24 documentation, c.) Responsible for conducting the CHEERS inspections, and d.) Conducts the final plan check and uploads the transfer files.

  Based on these findings, we suggest that utilities consider conducting on-site inspections by a third party to verify the building characteristics and measures being installed are in fact the same as what is shown in the CHEERS registry and/or transfer file. These activities may be most suitable for the EM&V contractor early on, and may only be needed until the aforementioned issues have been resolved.
- **Improvements and standardization of the utility data tracking systems would greatly improve the efficiency of the evaluation activities.** RLW has recommended variables for the utilities to track as part of program implementation activities. Standardizing the tracking systems would be a significant cost savings to the evaluation and would also remove some of subjectivity that goes into the evaluation.
- **A common identifier that links the projects in the CHEERS registry to the utility tracking systems should be added.** RLW found that there is no clear link between the utility tracking data and the CHEERS registry. For the evaluation RLW needed to link the registry to the tracking data in order to assign the appropriate weighting (units built from the tracking data) to the energy savings for each plan in the registry. When RLW tried to link the tracking data to the registry, we found that the plan names in the tracking data did not provide sufficient detail to allow us to link it to the matching file in the registry. We further recommend that the registry allow for the input of a plan ID that is the same as what is used in the utility tracking data. We also recommend a standard naming convention for the

[4] CHEERS® Quality Assurance Report 2003, provided by Tom Hamilton.

Title-24 transfer files that are uploaded into the registry. An example would be: 'Utility-Builder ID -Project ID-Plan ID.'

- **Problems occurring due to poorly parsed transfer files in the CHEERS Registry must be eliminated.** Transfer files, the text file output created by Micropas and EnergyPro for the CHEERS registry, must be parsed in order to be uploaded into the registry. Detailed review of the CHEERS registry by RLW found that the file parsing programs used by CHEERS for this process were not adequately parsing single family or multifamily transfer file data.
- **A database control issue exists in the program process that could allow for manipulation of the system.** Once an ENERGY STAR home is approved by the plan check agency the "transfer" file is exported from the software (i.e. Micropas, EnergyPro) and is uploaded to the CHEERS registry. The transfer file is a text file. Since the file is easily editable, the person responsible for uploading the data to the registry could easily change any number of building characteristics or efficiency values, while at the same time leaving unchanged the energy budgets and compliance margins. We strongly recommend that the utilities and CHEERS encourage and work with the Title 24 software vendors to address this issue. One possible way to alleviate this control issue would be to modify the format of the transfer file from text (.txt) based to an encrypted type file.

Discussion of Findings

In the following sections we discuss some of the more important findings as they relate to each of the tasks conducted for the evaluation. In this section we concentrate on three primary areas: Builders, CHEERS, and Ex Post Savings.

Single Family Builders

The evaluation of the ENERGY STAR new homes program began with a survey of new home builders, including both single family and multifamily builders. Both participating and non-participating builders were surveyed in order to gauge program acceptance, satisfaction and awareness.

It is clear from the surveys conducted with builders that the majority of the program participants are high volume production builders. More than 90% of the respondents built 100 homes or more per year, while 25% built more than 500 homes per year. As a result of the program, nearly 70% of builders say that they now specify energy efficient measures that they previously did not. These findings reveal that the program is changing construction practices to include energy efficiency as an end goal.

In terms of program participation motivation, respondents clearly indicated that financial incentives were their primary reason for participating. In addition to the incentives, approximately 50% of the builder respondents participated for the direct benefits of marketplace differentiation and advertising partnerships. Furthermore, about 80% of the builders responding believe that the ENERGY STAR label has had a positive impact on the marketability of their homes.

Overall satisfaction with the program was good, with an overall score of 3.62, out of a possible 5 points. Areas of the program scoring the highest were 'communication with the utility' (4.07) and 'required margin of compliance' (4.02). Scoring the lowest in terms of participant satisfaction was "advertising partnership' (2.71). RLW recommends that the utilities make an effort to strengthen and improve this area of program delivery.

RLW assessed program barriers as part of the builder surveys. About 48% of builders who participated reported that they did experience some barriers certifying homes as ENERGY STAR. Most commonly, builders reported that the program timeline and funding uncertainty were the cause of the certification barriers. As a result, RLW strongly recommends that the CPUC allow for timely program approval, which should resolve both of these issues. Recently the CPUC approved a two-year funding cycle for the program, for 2004-05. Evaluation of this upcoming 2004-05 program should determine if the two-year program resolves implementation challenges faced in 2002.

In addition to participant builders, a number of non-participant builders were also surveyed. Nearly all (94%) of the non-participant builders surveyed were aware of the ENERGY STAR homes program. RLW asked why builders did not participant given that they were aware of the program. Inability to work within the program timeline and lack of program funding were the most common responses. Since the 2004-05 program will now enjoy a longer implementation period we suspect these participation barriers will be mitigated. Other responses showed a general lack of time and interest in participating, while others shared concerns that the cost of participating was greater than the benefit. Lastly, we found that non-participants perceived the third party CHEERS inspections as a larger barrier than the participants' responses indicated. In order to increase the participant pool in future year's program implementers should consider addressing this barrier as well.

Lastly, the study also found that neither participants nor non-participants reported the required margin of compliance as a barrier. On a scale of 1-5, where "1" is not at all a barrier and "5" is a large barrier, responses for participants and non-participants scored 1.98 and 2.45 respectively. Participants scored their satisfaction level with the 'amount of incentives' at 3.08 out of a possible 5 points. These findings suggest that builders do not find the required margin of compliance to be a notable barrier, as they do with other aspects of the program, and the incentive appears to be more than satisfactory.

In 2005-06 the new residential Title 24 standards will take effect, which will make it more difficult for builders to comply with minimum standards. A case could be made (based on the builders' attitude toward the required margin of compliance and incentive levels) that it may be possible for the program to raise the compliance margin without adversely impacting participation rates. The result of such a change would likely better prepare builders for the inevitable code change and increase the amount of energy savings.

Multifamily Builders

In 2002, the ENERGY STAR program certified over 9,000 multifamily units (over 8,000 in southern California) as ENERGY STAR-compliant. RLW interviewed 61 multifamily builders to better assess construction practices and attitudes of ENERGY STAR program participants and non-participants.

Both participants and non-participants solely depended on a Title 24 consultant or energy consultant to complete documentation for Title 24 compliance. The vast majority of both groups found it very or somewhat easy to meet Title 24 standards, although program participants seemed to rate the easiness with a higher percentage. In addition, both groups claim to be building better than code. About 94% of program participants and 89% of non-participants stated that they built at least 10% or better than code. The majority of builders were not aware of the planned 2005 energy code changes. Based on these responses, the utilities should consider increasing the Program's qualifying level of

efficiency to be greater than 15% better than Title 24, at least until the 2005 energy code changes are implemented.

Participant builders rated the importance of an energy efficient design with an average score of about 4 (of out a high of 5). Non-participants voted the importance with a slightly lower average, but the difference is not statistically different with 95% confidence.

The main motivation that participants listed as their reason for joining the program was the financial incentives. Although the financial incentives help builders incur the additional costs of building with greater energy efficiency, it is also important that builders recognize other benefits they gain from being ENERGY STAR-compliant such as the marketing support.

All participants did receive some type of marketing support. Over half of the participants stated that they received ongoing sales support, point-of-sale brochures, and ENERGY STAR displays. Overall program satisfaction ranked fairly high with an average score of 4.33 out of 5.

On average, participants said they typically specified high efficiency glazing, high efficiency furnaces, and increased attic/wall insulation as a result of program participation. About half of participants who built affordable multifamily housing stated that it helped them gain credits on tax exempt financing.

Fewer multifamily builders attended training sessions related to energy efficiency than did single family builders. Almost all the builders who did not attend training sessions stated that they relied on outside sources of information as their reason for not attending. However, the ones who did attend found it to be useful.

Non-participants who were aware of the program were asked about the barriers they experienced to participation. Non-participants mostly disagreed that it is difficult to find qualified contractors who are knowledgeable about energy efficient measures. Non-participants somewhat agreed that the ENERGY STAR program's timeline made it difficult to participate in the 2002 program. The 2002 ENERGY STAR program was not approved until March 2002. The uncertainty around future funding of the program most likely discouraged and disabled some builders from participating.

CHEERS Registry, Inspections and Quality Control

The California ENERGY STAR New Homes program relies on the CHEERS organization for several aspects of program delivery. In the course of the evaluation an assessment of various program delivery mechanisms that utilize CHEERS could not be avoided. For example, at the beginning of 2002 CHEERS was the only CEC approved registry for tracking C-HERS measures. CHEERS is the organization responsible for training and certifying CHEERS inspectors, and they are also responsible for conducting quality assurance on the data input into the CHEERS registry by the raters. Since all ENERGY STAR homes must be entered in the CHEERS Registry, and because one of every seven ENERGY STAR homes must have a certified CHEERS inspector inspect the home, it is evident that the utilities heavily depend on CHEERS for several areas of program delivery.

One of the most notable findings of the evaluation is that the CHEERS Registry is not a reliable database of building information. RLW had originally planned to use the data from the Registry to conduct the evaluation. Early in the evaluation it was determined that the data stored in the registry was input incorrectly, so much so that the Registry became useless to the evaluation. The utility program managers also expressed to RLW their

concern regarding the design and functionality of the Registry. Specifically, we found the following problems regarding the Registry data and operation:

- Single family and multifamily data incorrectly parsed from the transfer files into the registry,
- CHEERS rater "to do" lists with either incorrect or inadequate information,
- General reporting needs not met by subscribers of the Registry,
- Inspection data entered by raters not useful (no standardization) for analysis,
- Inspection data inputs overwrites existing data, rather than appending data, and
- The Registry is much less capable of handling multifamily building projects than single family building projects.

RLW conducted a survey with CHEERS inspectors to gauge their level of satisfaction with the Registry. The CHEERS inspectors reported the "ease of data input" into the registry to be unsatisfactory, although they were satisfied with the user friendliness and user support provided by CHEERS. The turnkey companies, who are the most frequent users of the Registry, were asked about their experience with the Registry. Both agencies interviewed were not satisfied with the user-friendliness of the Registry, or the "to do" lists generated by the Registry software.

CHEERS is responsible for training and certifying CHEERS raters. Findings from the surveys with CHEERS raters show that raters believe the training they receive is effective in all areas. Only 30% of the raters interviewed reported that they received in-field training by CHEERS, which 100% of raters are supposed to receive as part of their first two inspections. However, interviews with the turnkey agencies revealed that the training provided was not adequate for their needs.

CHEERS' other responsibility that arose as part of the evaluation was Quality Assurance (QA). The purpose of the QA activities is to provide a system of checks and balances on parties conducting CHEERS inspections. Through the course of the evaluation activities RLW identified discrepancies between how some of the utility program managers understood the QA protocols were being handled by CHEERS, and the way in which they are actually conducted.

Ex Post Savings

The most telling measurements used to evaluate the impact of the 2002 ENERGY STAR program are the overall energy savings that are produced as a result of constructing more energy efficient homes. RLW utilized each builder's Title 24 compliance files that qualified the home as ENERGY STAR as a preliminary approach to estimate the energy savings. Again, the final ex post energy savings estimates will be based on Phase II reassessment of as built data and /or alternative approaches to estimating savings.

Each utility submitted estimates of gas and electric savings resulting from the program as part of the Annual Earnings Assessment Proceeding (AEAP) filing in April 2003. Filings varied based on assumptions made about the baseline gas versus electric fuel type. Since Title 24 compliance software is fuel blind, meaning that all energy is converted into Btu's, it is irrelevant (to Title 24) whether energy savings result from gas or electric measures. Therefore a home can reach ENERGY STAR criteria (15% better than the Title 24 prescriptive baseline) with only gas measures, only electric measures, or a combination

of both. However, these differences are adjusted for when summed for the total energy (electric and gas) savings presented in Kbtu and associated realization rate.

Table 2 presents the overall EM&V savings and the utility filed (AEAP) savings with the associated realization rates. As the table shows, all utilities exceeded the AEAP estimate of kBtu savings. SoCalGas had the highest realization rate of 240% while PG&E reported savings closest to the EM&V estimate with a realization rate of 101%. The AEAP estimate shown for SCE only includes the fraction of kBtu savings that SCE believes is resulting from electric measures (in essence removing gas measure savings). The EM&V estimate of total savings includes both electric and gas savings for SCE while the AEAP filing only includes electric savings, so it is by no means an "apple-to-apple" comparison. For this reason, RLW does not present a total realization rate for SCE. Interestingly, SoCalGas, an all gas utility, does claim electric savings. It was not made clear to RLW why SCE and SCG have different filing requirements.

	Total Savings (kBtu)		Realization
Utility	**EM&V Estimate**	**AEAP Estimate**	**Rate**
PG&E	49,410,150	48,826,028	101%
SCE*	60,551,406	42,998,425	
SoCalGas	8,501,121	3,547,142	240%
SDG&E	15,137,253	13,883,593	109%
Overall	**133,599,930**	**109,255,187**	

*EM&V Estimate includes both gas and electric savings, while AEAP estimate is electric savings only.

Table 2: Single Family kBtu Savings by Utility

Single Family Energy Savings

While it is straightforward to determine the total kBtu savings (fuel neutral savings), measuring the proportion of the kBtu savings that is gas and electric can be subjective without having detailed construction data.

We present two approaches in this section for determining the fraction of kBtu savings that are gas or electric. The first approach we present (Approach A) is what the utilities selected as part of the original EM&V plan and the second approach (Approach B) is an alternative method that utilizes data from a recent residential new construction study, herein referred to as "Approach A" and "Approach B," respectively.

Approach A Evaluation Methodology

Approach A is based on Title 24 files that were obtained from each of the four utilities represented in the evaluation. The Title 24 files were all approved by the utilities for participation in the 2002 program, and represent the best approximation of how the new homes will actually be built. Energy savings are based on a comparison of the "as specified"[5] home compared to the prescriptive baseline home.

[5] "As specified" refers to how the ENERGY STAR home is modeled in Title 24. In most cases this is an accurate representation of the home's material and equipment characteristics. However, it is possible that the home was ultimately constructed slightly differently, which would be identified by the CHEERS rater at the time of the CHEERS inspection.

For each single family residential end-use (i.e., heating, cooling and water heating) the difference in energy use was determined in units of kBtu. Depending on the fuel type of the equipment installed in the home, the kBtu savings for each end-use was converted to either gas or electric savings. Each housing plan in the program underwent this analysis before being weighted to the total number of plans represented in the program.

Table 3 shows the results of the Approach A analysis. Using this approach, all utilities' claiming gas savings exceeded their AEAP estimate, while on the electric side some exceeded the estimate while others fell short. For example, PG&E had the closest realization rate for both gas and electric (101% and 102%) because they used a similar methodology to compute their AEAP estimate of savings. The other utilities, not including PG&E, may have used other approaches to calculate the amount of gas and electric savings their programs would produce. Using Approach A, the data shows that both SDG&E and SCE fell short of their electric savings filing. However, SDG&E produced an extremely high gas realization rate (1318%). The stark difference in estimation may due to differing methodologies used between the EM&V Approach A and SDG&E's approach to calculate their AEAP. SoCalGas was the only utility that highly exceeded both gas savings and electric savings. SoCalGas also had the highest overall realization rate.

	Gas Savings (thm)		Realization	ElectricSavings (kWh)		Realization
Utility	AEAP Estimate	EM&V Estimate	Rate	AEAP Estimate	EM&V Estimate	Rate
PG&E	403,299	407,443	101%	829,781	846,362	102%
SCE	n/a	395,617	N/A	4,199,475	2,049,974	49%
SoCalGas	6,163	18,851	306%	286,243	646,158	226%
SDG&E	8,988	118,434	1318%	1,268,170	321,698	25%
Overall	**418,450**	**940,345**	**225%**	**6,583,669**	**3,864,192**	**59%**

Table 3: Single Family Gas and Electric Energy Savings by Utility using Approach A

Approach B Evaluation Methodology

In California, builders can use either a performance-based method to meet Title 24 standards that use "trade-off" savings between end-use categories (cooling, heating, hot water) or a prescriptive method to meet the minimum requirements by each specified category. Builders very seldom use the prescriptive method due to its cost-ineffectiveness.

In this section, RLW presents the Approach B method of calculating energy savings by each fuel type in order to account for differing assumptions in the baseline figures. In our previous presentation of gas and electricity savings, RLW assumed the prescriptive based standards[6] as the baseline. In this section we utilize data from a previous study done by Itron.[7] The Itron study sought to identify a baseline that would more accurately reflect actual construction practice in California.

Under Approach B, RLW utilized ratios that estimate the actual proportion of savings by fuel-type, which was based on the results of the Itron study. The study was based on interviews with Title 24 consultants and builders to gain an understanding of building measures that would be used to comply with baseline and/or ENERGY STAR standards.

[6] The prescriptive standards refer to the specific Title 24 minimum standards in each end-use category (cooling, heating, hot water).

[7] Citation of the Study, year.

Because these ratios are based on opinions of Title 24 consultants and builders, RLW reiterates that this is only a broad estimate to correct the difference in prescriptive versus performance based compliance methods. Inconsistencies in a comparison, conducted in this report, of the 2002 ENERGY STAR building characteristics and Title 24 consultant responses in regards to ENERGY STAR building characteristics leads us to believe that there is added subjectivity to this approach. Ideally, the utilities would compute energy savings based on the energy efficiency features that would be installed if the builder were not participating in the program.

Table 4 presents the estimated ratios by each utility and by inland homes and coastal homes as determined by Itron. This study stated that more electricity savings resulted in inland regions (Climate zones 8-16) than in coastal regions (Climate zone 1-7). SCE had the greatest variance between regions where coastal homes had on average, electricity savings of 42% where as inland homes had an average of 87% electricity savings.[8]

Utility COASTAL	Gas (Therms)	Electricity (kWh)	Total
SCE	58%	42%	100%
PG&E	71%	29%	100%
SDG&E/SoCalGas	12%	88%	100%

Utility INLAND	Gas (Therms)	Electricity (kWh)	Total
SCE	13%	87%	100%
PG&E	58%	42%	100%
SDG&E/SoCalGas	11%	89%	100%

Table 4: Fuel-Type Ratios by Itron Study

RLW applied the ratios shown in Table 4 between fuel-type savings to each utility's evaluated total kBtu savings in order to gain an alternate estimate of gas versus electric savings. Note this methodology is only to account for the difference in gas versus electric savings, but the combined/total energy savings between the two methodologies remains equal. Table 5 summarizes the total savings by gas/electric and coastal/inland areas.

The ratios used in Approach B makes evident the favoring of electric savings to gas savings, which is clearly demonstrated in SCE's electric realization rate. SCE's realization rate under this approach is 123%, while under Approach A it was 49%. Under this scenario, PG&E is the only utility that has a realization rate of gas or electric fall below 100% (73% gas). Note that one can compare the difference in realization rates by fuel-type for each utility, except SCE because they do not report gas savings.

	Gas Savings (kBtu)		Realization	Electric Savings (kBtu)		Realization
Utility	AEAP Estimate	EM&V Estimate	Rate	AEAP Estimate	EM&V Estimate	Rate
PG&E	40,329,900	29,549,712	73%	8,496,128	19,860,438	234%
SCE	-	7,610,670	N/A	42,998,425	52,940,736	123%
SoCalGas	616,300	933,970	152%	2,930,842	7,567,151	258%
SDG&E	898,800	1,778,598	198%	12,984,793	13,358,655	103%
Total	**41,845,000**	**39,872,949**	**95%**	**67,410,187**	**93,726,981**	**139%**

Table 5: Gas and Electric Energy Savings by Utility using Approach B Methodology

Alternative Indicators of Single Family Program Effectiveness

For this report, RLW encourages readers to not only draw on the realization rate as an indicator of program success, but to also utilize other metrics that go further than verifying

[8] The percentages are the amount of kBtu savings for electric as apposed to gas.

AEAP claimed savings. Since program implementation budgets and numbers of participants vary by utility, we have included additional indicators of program cost effectiveness that are perhaps equally, if not more, important to assess program success. These metrics provide further insight into the evaluation and use equivalent methodologies of calculation.

Table 6 presents three indicators of program effectiveness: cost per single family recruited, cost per 1,000 kBtu saved, and kBtu savings per unit. The data in Table 6 clearly shows SDG&E as having the lowest cost per unit recruited and the lowest cost per 1,000 kBtu saved, however they produced the lowest savings per unit. On the other hand, SoCalGas saved the most energy per unit, but also had the fewest projects in the program and highest recruitment cost. SCE had the highest number of single family units in the program. Although PG&E had the highest cost per 1000 kBtu saved, they had the second highest energy savings per unit. On average, it cost $1,009 per unit recruited, $83 per therm (1,000 kBtu) saved, and each home saved on average 12,092 kBtu.

Utility	EM&V Total kBtu Reduction	2002 Single-Family Budget	Participating Single-Family Units	Cost Per Unit Recruited	Cost per 1000 kBtu Saved	kBtu Savings Per Unit
PG&E	49,410,150	$ 4,412,000	3,520	$ 1,253	$ 89	14,037
SCE	60,551,406	$ 4,917,183	5,234	$ 939	$ 81	11,569
SoCalGas	8,501,121	$ 742,000	432	$ 1,718	$ 87	19,679
SDG&E	15,137,253	$ 1,080,066	1,863	$ 580	$ 71	8,125
Overall	**133,599,930**	**$ 11,151,249**	**11,049**	**$ 1,009**	**$ 83**	**12,092**

Table 6: Alternative Indicators of Program Cost Effectiveness for Single Family Program

Multifamily Energy Savings

This section presents the preliminary ex post savings for participating multifamily projects. This includes both low-rise and high-rise multifamily dwellings. The key difference between these two types of multifamily housing is that high-rise projects are subject to Title 24's commercial building standards, while low-rise (3 stories or less) are subject to Title 24's residential building standards. For comparison purposes, the multifamily program is less than half the size of the single family program in terms of claimed (AEAP) savings.

Table 7 shows the results of the total kBtu savings, comparing the EM&V estimate to the AEAP filed savings. SoCalGas produced the highest realization rate of 120%, while PG&E's and SDG&E's AEAP Filing were slightly below the EM&V estimate with realization rates of 98% and 86%, respectively. RLW does not present an overall realization rate for SCE because their AEAP filing does not include gas savings, while the overall EM&V estimate does, therefore, making a comparison not possible.

Utility	Total Savings (kBtu)		Realization Rate
	EM&V Estimate	AEAP Estimate	
PG&E	8,988,113	9,147,454	98%
SCE*	12,852,193	6,846,963	
SoCalGas	16,173,208	13,443,982	120%
SDG&E	17,143,419	19,919,988	86%
Overall	**55,156,933**	**41,314,187**	

*EM&V Estimate includes both gas and electric savings, while AEAP estimate is electric savings only.

Table 7: Multifamily Total kBtu Savings by Utility

The approach to estimating gas and electric savings for multifamily housing was the same as Approach A, discussed earlier in the single family energy savings section. Using this approach, a comparison of the as-built energy consumption to the prescriptive baseline, RLW calculated total kBtu savings.

Table 8 shows that SCG had the greatest gas realization rate and PG&E had the greatest electric realization rate. While PG&E did not meet their projected savings for gas savings (87%), SDG&E and SCE did not meet their electric savings estimates. Statewide, or overall, gas measures saved 400,201 kBtu, resulting in a realization rate of 187% when compared to the utilities AEAP filing. On the electric side, nearly 1.5 million kBtu were saved, resulting in a 76% realization rate when compared to the utility AEAP filing.

Utility	Gas Savings (thm)		Realization Rate	Electric Savings (kWh)		Realization Rate
	AEAP Estimate	EM&V Estimate		AEAP Estimate	EM&V Estimate	
PG&E	88,157	77,039	87%	32,401	125,422	387%
SCE	-	82,997	-	668,714	444,621	66%
SoCalGas	80,442	98,539	122%	527,374	617,184	117%
SDG&E	126,298	141,626	112%	712,002	291,128	41%
Overall	**214,455**	**400,201**	**187%**	**1,940,491**	**1,478,355**	**76%**

Table 8: Multifamily Gas and Electric Energy Savings by Utility Using Approach A

Unlike the single family analysis, data to support an Approach B savings analysis is not available for the multifamily market segment. Since the Itron study did not survey multifamily market actors, applicable ratios could not be calculated. Therefore, Approach A was used to determine the amount of gas and electric savings resulting from the program.

Alternative Indicators of Multifamily Program Cost Effectiveness

Similar to single family, RLW calculated added metrics in order to evaluate program cost effectiveness. These metrics include the cost of recruitment per participant unit, the cost of saving 1,000 kBtu, and the savings per multifamily dwelling unit.

Table 9 shows the results of this analysis for each of the utilities. Like the single family analysis, the SCE EM&V numbers include gas and electric kBtu savings. This consistency allows us to make equivalent comparisons between utilities.

SCE produced the lowest cost per unit recruited, with an average cost of $248 per unit participating in the program. PG&E's costs were nearly 3 times higher than SCE, although PG&E projects also saved more energy per unit than any of the other utilities. In terms of cost per energy unit saved, SDG&E had the lowest cost at only $42 per 1,000 kBtu, SCE

and SDG&E were nearly equal at $58 and $59 respectively, while PG&E faired the worst at nearly double the other three. The lowest cost per unit recruited was SCE ($248) and the highest cost per unit recruited was PG&E ($734). Despite PG&E's high recruitment cost and cost per energy saved, they did have the highest amount of energy saved for each ENERGY STAR multifamily unit.

Utility	EM&V Total kBtu Reduction	2002 Multifamily Budget	Multifamily Units	Cost Per Unit Recruited	Cost per 1000 kBtu Saved	kBtu Savings Per Unit
PG&E	8,988,113	$ 828,837	1,129	$ 734	$ 92	7,961
SCE	12,852,193	$ 742,000	2,030	$ 248	$ 58	6,331
SoCalGas	16,173,208	$ 946,608	2,994	$ 286	$ 59	5,402
SDG&E	17,143,419	$ 728,149	3,313	$ 359	$ 42	5,175
Overall	**55,156,933**	**$ 3,245,594**	**9,466**	**$ 343**	**$ 59**	**5,827**

Table 9: Alternative Indicators of Program Cost Effectiveness for Multifamily Units

Ex Post Savings Conclusions

RLW has presented two approaches for evaluating gas and electric savings for the single family program. Each of the approaches has its merits, even though they produce considerably different energy-specific results. While calculating overall energy (fuel neutral) savings is equal in both approaches, determining the fraction of savings that is gas and electric is not. The value of having a reliable approach to dividing gas and electric savings cannot be underestimated since these are some of the primary inputs that determine the program's total resource cost (TRC) test (cost effectiveness testing). Because of the importance surrounding this issue, the Phase II EM&V report will utilize alternative methods and data sources in order to evaluate gas and electric savings resulting from the program.

Currently the EM&V team is considering a billing analysis, using a non-participant control group that is currently part of a single family residential new construction baseline study being conducted by Itron, and the 2002 single family participants of the ENERGY STAR New Homes Program. Similarly, data from the upcoming Itron baseline study may also be used to determine what the actual construction baseline is, and how similar it is to either of the two previously presented approaches (i.e., Approach A and Approach B). Therefore, the Phase II EM&V report will delve more deeply into this issue and will make recommendations for future EM&V methodology for this program.

Because Itron did not study multifamily market actors, RLW did not utilize an alternate approach to estimate the gas versus electric split for the multifamily analysis. Within several sections of this report we discuss existing issues related to low-rise multifamily compliance. Currently, in Title 24, compliance software algorithms allow low-rise multifamily projects to comply with the ENERGY STAR program compliance margin (i.e., 15% better than Title 24) with little, and sometime no measures that are above the prescriptive baseline. Without going into detail, the issues stem from the software algorithms that compute compliance margins related to fenestration and hot water heating. The algorithms used by the software are CEC approved calculations, however as part of the 2005 energy code modifications these problems will be removed. The result of the code changes will have a significant impact on multifamily builders, no longer will they enjoy the ease of compliance as they currently do. Builders will be required to design much more energy efficient buildings than they currently are simply to meet code, not to mention the added measures they will need to implement in order to reach ENERGY STAR criteria.

RLW is not confident that Approach A, used to measure gas and electric savings for single family, accurately measures the same for multifamily housing. Multifamily new construction is a relatively new market to energy efficiency programs in California, therefore there has been less attention paid to this segment in the past, and as a result there is less secondary information to be gleaned for addressing this deficiency. Although a multifamily new construction baseline study was conducted in 2001 in California, the study was not able to gather enough representative and quantitative data to leverage for the purpose of understanding actual baseline construction practice. With little other information available, it is extremely difficult to gauge the accuracy of Approach A for the same reasons as we mention in the single family discussion.

Since this market will undergo a mandated transformation in 2005 RLW is recommending continued use of the Approach A method to evaluate energy savings in the multifamily segment. We believe the cost of conducting an in depth study in order to identify a baseline that will soon change is an inefficient use of ratepayer funds. Instead, we recommend leveraging the lessons learned from the single family process of identifying an EM&V method, we believe these activities will assist in determining the most cost effective and logical approach to estimating energy savings by fuel type in the multifamily new construction program.

2. Single Family Builders

RLW conducted a single family builder survey analysis in order to provide the California utilities with a broader understanding of the barriers facing builders with respect to program participation, builder satisfaction and attitudes toward the program, program awareness, and builder recommendations.

Concurrent with RLW Analytics' EM&V of the ENERGY STAR Homes Program, Itron/RER was conducting the Single Family Residential New Construction Incremental Measure Cost Study. Similar to RLW's scope of work, Itron's study also included a survey of residential single family homebuilders. Moreover, the Itron builder survey captured much of the intended survey questions that RLW had planned to ask as part of the ESH evaluation. Some questions that were not captured by the RER study were related to builder's impressions, attitudes and understanding of the ESH program, for both participating and non-participating builders.

Although RLW participated in the survey development, Itron survey staff completed the majority of the telephone surveys with builders. Responses to questions formulated by Itron are not included in this report, but they can be found in the Single Family Residential New Construction Incremental Measure Cost Study report. Responses to questions formulated for the survey by RLW were developed for both participant and non-participant builders.

Participant survey questions addressed:

- How participants heard of the program,
- The reasons for program participation,
- Program requirements,
- Measures that have been implemented resulting from program participation,
- Program strengths and weaknesses, and
- Program satisfaction and recommended improvements.

Non-participant survey questions addressed:

- Awareness of the program,
- Attitudes toward program,
- Understanding of the program, and
- Willingness to participate.

Supplementary SF Homebuilder Telephone Surveys

RLW conducted an additional 14 telephone surveys with participant production builders, these builders were not included in the Itron survey data. Participant builders were identified using utility tracking data, which summarized the builders that submitted applications for program year 2002. RLW compared the Itron completion list to the utility tracking data to determine which builders were not surveyed. The original survey instrument was used by RLW, however only questions relating to the ENERGY STAR Homes program were included as part of the 14 surveys. The added surveys targeted high

volume, or production builders, e.g., those builders that represented a substantial portion of residential new construction activities in California.

Survey Analysis

RLW analyzed builder responses to the telephone survey using a statistical software program called SAS. The survey analysis weights were based on the number of homes built in 2002 by each individual builder, for both participants and non-participants. All statistical tests were performed at the 95% level of confidence.

The respondents were asked if they had constructed any homes for the ENERGY STAR Homes program. Table 10 and Table 11 summarize background information of the 91 builders surveyed. Of the 91 builders, 48% participated in the 2002 ENERGY STAR program.

Did any of your projects participate in the 2002 Energy Star Program?	% of Respondents	n
Yes	48%	44
No	52%	47

Table 10: Percentage of Program Participants

Of the 91 builders, 39% built 101 to 500 single family units, 43% built 100 or less homes, and less than 20% built more than 500 single family units in 2002. Participant builders had a higher percentage of very large builders (more than 500 homes) than the overall average and fewer in the other three builder size categories. However, the differences between non-participants and participants vary at most by only 10%.

How many single-family new homes did your company build in 2002 in CA?	% of all Builders	% of Non-Participants	% of Participants
25 or less homes	10%	11%	9%
26 to 100 homes	32%	34%	30%
101 to 500 homes	39%	40%	36%
501 or more homes	20%	15%	25%

Table 11: Size of Builder by Participant Status

Participant Builder Analysis

Participant builder respondents said that in order to meet ENERGY STAR standards, 88% installed low e-glass windows, 84% increased insulation, 41% sealed ducts, and 38% installed an energy efficient HVAC system. These four measures were overwhelmingly accepted by homebuilders, likely because they offer lower incremental measure cost and higher returns in energy efficiency than other measures that might also be used to exceed Title 24 by at least 15%.

What measures does your company specify to meet the California Energy Star Homes requirements compared to homes that are designed to just meet Title 24?	% of Respondents (n=44)
Low e-glass	88%
Insulation	84%
Duct Sealing	41%
HVAC	38%
Other	4%

Table 12: Measures specified to meet ENERGY STAR

All participant builder respondents were asked if they requested any specific measures after program participation that they did not ask for previously. The ENERGY STAR homes program not only looks to bring energy efficient measures into new homes through incentives, but also hopes that participants will continue to install more energy efficient measures even without the financial incentives in the future.

Table 13 summarizes the results. Although 32% of the participant respondents stated they are not specifying any measures after participation in the ENERGY STAR program, a majority (68%) of builders who took part in the 2002 program have since added more energy efficient features in their new homes. Of the respondents who did specify measures after program participation, the most common measures were roof insulation, high efficiency air conditioners, and high efficiency furnaces. High efficiency air conditioners not only benefit homeowners with added energy savings, but they also tend to be less noisy than standard air conditioners.

Water heaters and ACCA duct design were the least common in added measures after program participation. Perhaps water heaters are not used by builders to exceed Title 24 because they are already installing high efficiency water heaters as standard practice. The ACCA duct design is a very prescriptive design for ducts and does require a HERS inspection in order to receive C-HERS Title 24 credits. Such inspections, and the rigid formula of design, may be deterring some builders from installing this particular measure in order to gain only marginal energy efficiency benefits. However, about 18% of participant builders are continuing to seal ducts in their new homes.

As a result of what you have learned through the program, are there any measures you now typically specify for all of your homes that you did not previously?	% of Respondents (n=44)
None	32%
Yes	68%
Of those who did specify, % of Respondents	
Roof Insulation	62%
High Efficiency Air Conditioner	60%
High Efficiency Furnaces	55%
Radiant Barriers	43%
TXV- Thermostatic Expansion Valves	30%
High Performance Glazing	23%
Sealed Ducts	18%
Other	7%
ACCA Duct Design	2%
Water Heaters	1%
Do not know	-

Table 13: Requested Measures by Builders as a Result of Program Participation

Table 14 indicates 63% of builder participants believed the construction cost of ENERGY STAR homes to be more than the cost of non-ENERGY STAR homes. Of those who indicated ENERGY STAR homes to be higher than non-ENERGY STAR homes, the vast majority of the respondents stated a 1% to 5% increase in construction costs. ENERGY STAR homes produce benefits in the long run, but costs are incurred during initial construction. Consequently, it is key that homeowners are aware that they are investing in a more efficient home in order to reap savings in future years through reduced electricity bills and longer life spans on less utilized equipment such as air conditioners and furnaces.

On average, how does the construction cost on an Energy Star home compare to that of an equivalent non-Energy Star home?	% of Respondents (n=44)
More	63%
Do not know	35%
About the Same	2%
Less	-

Table 14: Construction Cost of an ENERGY STAR vs. a non-ENERGY STAR home

All participants were asked how they first learned about the ENERGY STAR program and Table 15 shows that 42% of the builders found out through a Title 24 consultant. Title 24 consultants work very closely with the new homes construction industry and may have similar, if not more, builder contacts than the utilities. About 39% of participant builders became aware of the ENERGY STAR program through trade shows.

About one third of the respondents stated that they learned about the program through a utility representative. Since the utilities implemented the ENERGY STAR program, it is logical that the utilities were a primary source that raised awareness of the program.

Most other means served as supplementary conventions to disseminate program information. None of the respondents who participated in the 2002 program learned of the program through newspapers, television commercials, radios or signs. Coincidently, these means were likely the most costly methods of reaching a broad audience, but evidently an ineffective one. However, these marketing tools should not be undervalued because it may have indirectly enhanced program success in that it may have increased homebuyer awareness of ENERGY STAR and possibly supported sales of these homes.

Because of the utility's influence, it is key to the program's success that the utilities reach out to the maximum number of builders who would most benefit from participation.

How did you first become aware of the Energy Star homes program?	% of Respondents (n=44)
Title 24 Consultant	42%
Trade Show	39%
Utility Representative	33%
Other Builder	30%
Do not know	8%
Utility Website Other builder	5% 3%
Other	2%
Pamphlet	2%
EPA Website	1%
Bill Insert	0.4%
Friend	-
Newspaper	-
Television commercial	-
Radio	-
Sign	-
Refused	-

Table 15: Awareness of ENERGY STAR Program

Table 16 indicates the respondent's motivation to participate in the program. About 69% of the respondents stated financial incentives as their primary reason for joining the program. However, about half of the respondents stated that the differentiation in the market place as a benefit and 46% of the respondents also indicated the advertising partnership as a catalyst to participate in the program. In essence, these secondary benefits help increase the new home's selling price, which increases the builder's profits. Part of the utility's marketing strategy in the ENERGY STAR program was to help builders and new homebuyers realize the financial benefits of energy efficient measures. Ideally, the builders and homebuyers will recognize that the energy savings heavily outweighs the marginal added cost of energy efficient building measures and support building energy efficient homes without subsidies.

Other reasons for pursuing the ENERGY STAR homebuilder program included:

More sophisticated buyers are asking questions about energy savings.

To gain the ENERGY STAR *brand/logo.*

Consumers look for energy efficient homes, as a result of California's energy crisis.

What were your motivations for participating in the 2002 California Energy Star New Homes program?	% of Respondents (n=44)
Financial Incentives	69%
Differentiation in the market place	51%
Other	49%
Advertising Partnership	46%
Third-party inspections and recognized labels	32%
A means to achieve 2001 Title-24 compliance	3%
Do not know	-

Table 16: Motivation in Participation

Table 17 indicates whether or not builders believed the ENERGY STAR program had any impact on the sale and/or marketability of the home. None of the respondents claimed the program had a negative impact on the marketability of the homes, where as 79% indicated a positive impact on the marketability. The vast majority of builders and buyers recognize the added value of a more energy efficient home. The actual implementation of the energy efficient measures is as important as educating buyers and builders on the long-term energy savings and benefits.

How would you characterize the impact of the Energy Star label on the marketability of a home? Would you say that the Energy Star label has…	% of Respondents (n=44)
A positive impact on the marketability of homes	79%
No impact on the sale of home	21%
A negative impact on the marketability of home	-
Do not know/Not sure	-

Table 17: Impact of Program on Marketability of Homes

Table 18 reveals whether or not respondents found participation in the program to be helpful in gaining market exposure. More than half of the participant builders believed that it did increase market exposure. However, about 35% did not believe that the program helped them gain marketing exposure. It may be that these builders preferred to use their own marketing materials with their company name rather than using welcome mats or table tents with the ENERGY STAR logo. In addition, it is difficult to measure the marketing success or failure by comparing the sales of ENERGY STAR homes to non-ENERGY STAR homes since they all seem to be selling well in this market. Part of the reason is that the residential real estate market has been so strong for the past several years.

Has participation in the program helped you get more marketing exposure?	% of Respondents (n=44)
Yes	55%
No	35%
Possibly	9%
Do not know/Not sure	1%

Table 18: Market Exposure through Program Participation

Table 19 summarizes what, if any, types of marketing support respondents received. A majority of the builders (87%) did receive some type of marketing support. Point-of-sale brochures (62%), ongoing advertising support (55%) and Comfort Wise sales training and support (51%) were the highest-ranking responses. Marketing tools help educate both homebuyers and builders about the benefits of ENERGY STAR. About 13% stated that they received no marketing support.

Which of the following types of marketing support have you received from the program?	% of Respondents (n=44)
Point-of-sale brochures	62%
Ongoing advertising support	55%
ComfortWise sales training and support	51%
Model "Grand Opening" assistance by ComfortWise staff	48%
Enhanced builder image and reputation as an environmentally friendly builder	24%
Developed a reputation for quality construction and cutting-edge technology	21%
World Wide Web page with links to ComfortWise and your web site	14%
None	13%
Do not know	9%
Video	8%

Table 19: Marketing Support Received from Program

Participants were asked to rate the degree of program satisfaction from 1 to 5 with one meaning “very unsatisfied” and five meaning “very satisfied.” Table 20 summarizes the results. Respondents were most satisfied with the ‘Communication with Utility’ with an average score of 4.07. Overall program satisfaction was 3.62, which indicates satisfaction with the program is slightly above average.

Only the advertising partnership scored below average at 2.71 by participant builders. Since 13% of the respondents did not receive any advertising support, it may be that utilities must increase their outreach to support ENERGY STAR builders. Respondents who scored the advertising partnership satisfaction below a three commented that they did not receive any support or the support was not adequate in differentiating their homes.

Although the amount of incentives section received an average score of 3.08, a significant number of respondents scored it with below average satisfaction because they either felt

the amount was not sufficient to cover the additional costs or felt the program was unreliable due to its limited funding and timeline.

The respondents, who were dissatisfied, with the application documentation, third party inspections and certification process, believed that this process took too much time and slowed their construction progress. In addition, a significant number of participant respondents criticized the program for running out of money just as they met the ENERGY STAR requirements.

Program Satisfaction	Average Rating*	Standard Error	n
Amount of Incentives	3.08	*(0.40)*	43
Advertising Partnership	2.71	*(0.24)*	38
Third Party Inspections	3.44	*(0.62)*	41
Certification Process	3.64	*(0.57)*	41
Application Documentation	3.38	*(0.30)*	43
Required Margin of Compliance	4.02	*(0.41)*	42
Incentive Processing and Payment	3.19	*(0.28)*	38
Communication with Utility	4.07	*(0.16)*	42
Overall Program	3.62	*(0.33)*	43

Table 20: Statewide Program Satisfaction

* Responses provided on a scale of 1 to 5 with a 1 meaning "not very satisfied" and a 5 meaning "very satisfied." Values are weighted means, with weighted standard errors in parentheses.

RLW calculated program satisfaction average scores with its standard error in parentheses for each geographic region to better target each builder's needs based on where they built homes.

For the amount of incentives (overall average 3.08), builders in the north coastal area were least satisfied with this aspect, with an average score of 2.25. In 2002, PG&E committed all of its program funds by August 2002. Builders who found out about the program after that date had to wait until the 2003 program was funded to see whether any incentive benefits would be available. Some of the verbatim from respondents stated:

Amount is not enough.

The program ran out of money.

It costs a lot more to meet rebate and rebate is not significant enough.

The cost of energy efficient equipment is much more than the rebate.

There appears to be a misconception among builders that the incentive is supposed to cover the cost of building to ENERGY STAR requirements. The program may want to focus more on providing information to builders that educates them on all aspects of the ENERGY STAR partnership in order to overcome this participation barrier.

Advertising partnership (statewide average 2.71) scored lowest in the north coastal region with an average of 2.15. The highest score in this category was in the desert region at 3.04. It seems that most regions were marginally satisfied with the utility advertising partnership. This should be an area the utilities concentrate efforts on improving in order

to convince builders that participating in the program will lead to greater home marketability and product differentiation.

For third party inspections, the south coastal and desert regions scored their program satisfaction at 4.00 and 4.84, respectively. North coastal builders scored their satisfaction with third party inspections the lowest with 2.16. The PG&E program manager and builders indicated some frustration due to the lack of active CHEERS raters in this region of California.

In the categories of certification process, application documentation, required margin of compliance, incentive processing and payment, the north coastal builders scored below three on average. However, north coastal builders did score communication with utility and overall program satisfaction higher than the statewide average. Perhaps the low scores from the north coastal builders with respect to program incentives and required margin of compliance stem from the mild climate. Due to the low number of cooling degree days in the north coast climate zone, builders are likely required to specify a greater number of efficiency measures in order to meet the program requirements of 15% or more efficient than Title 24, than are their warmer climate zone counterparts.

Program Satisfaction	Amount of Incentives	Advertising Partnership	Third Party Inspections	Certification Process	Application Documentation	Required Margin of Compliance	Incentive Processing and Payment	Communication with Utility	Overall Program
Statewide	3.08	2.71	3.44	3.64	3.38	4.02	3.19	4.07	3.62
	(0.40)	*(0.24)*	*(0.62)*	*(0.57)*	*(0.30)*	*(0.41)*	*(0.28)*	*(0.16)*	*(0.33)*
	n=43	n=38	n=41	n=41	n=43	n=42	n=38	n=42	n=43
RMST CZ 1 (North Coastal)	2.25	2.15	2.16	2.27	2.49	2.50	2.28	4.34	4.01
	(0.76)	*(0.74)*	*(0.89)*	*(0.80)*	*(0.93)*	*(0.95)*	*(0.82)*	*(0.35)*	*(0.28)*
	n=11	n=11	n=10	n=11	n=11	n=10	n=9	n=10	n=10
RMST CZ 2 (South Coastal)	3.29	2.76	4.00	4.06	3.29	4.15	2.93	4.09	3.98
	(0.40)	*(0.33)*	*(0.55)*	*(0.56)*	*(0.39)*	*(0.52)*	*(0.29)*	*(0.10)*	*(0.07)*
	n=18	n=15	n=18	n=17	n=18	n=18	n=17	n=17	n=17
RMST CZ 3 (South Inland)	2.72	2.67	2.93	3.00	3.71	3.72	3.43	3.95	3.13
	(0.50)	*(0.35)*	*(0.57)*	*(0.65)*	*(0.25)*	*(0.22)*	*(0.23)*	*(0.33)*	*(0.59)*
	n=18	n=12	n=17	n=1+	n=17	n=17	n=16	n=17	n=18
RMST CZ 4 (Central Valley)	2.82	2.69	2.28	3.32	3.94	4.22	3.95	4.11	3.26
	(0.49)	*(0.21)*	*(0.52)*	*(0.74)*	*(0.38)*	*(0.24)*	*(0.44)*	*(0.39)*	*(0.59)*
	n=13	n=14	n=13	n=13	n=14	n=14	n=13	n=14	n=14
RMST CZ 5 (Desert)	3.93	3.04	4.84	4.86	3.12	4.85	3.10	4.03	4.02
	(0.08)	*(0.06)*	*(0.18)*	*(0.16)*	*(0.14)*	*(0.17)*	*(0.14)*	*(0.06)*	*(0.04)*
	n=7	n=5	n=6	n=6	n=6	n=6	n=6	n=6	n=7

Table 21: Program Satisfaction by each Region

* Responses provided on a scale of 1 to 5 with a 1 meaning "not very satisfied" and a 5 meaning "very satisfied." Values are weighted means, with weighted standard errors in parentheses.

Participant builders were asked whether they experienced any barriers to certifying their new homes and 48% claimed they did. Of those respondents, about 38% stated that the program timeline as a barrier to certification. Again, this response rate reinforces the previous sentiments in regards to program instability being a chief component to program dissatisfaction and program barrier to participation. About half of the verbatim responses coded as "other" also expressed frustration due to the uncertainty or funding limitations.

Have you experienced any barriers to certifying homes under the Energy Star New Homes program?	% of Respondents (n=44)
No	52%
Yes	48%
Of those who responded "yes,"	**% of Respondents**
Program Timeline	38%
Other	35%
Verfication Requirements	3%
Product Availability	3%
Inspection Costs	1%
Do not know	-

Table 22: Barriers Experienced by Participant Builders

Participants were asked to indicate their reaction to the listed statements through a score where a "1" means "completely disagree" and a "5" means "completely agree." Table 23 states the average score given for the following statements to help determine potential program barriers to participation. The following averages reflect the responses of participant builders only.[9]

Participants most strongly disagreed to the notion that energy efficient equipment is harder to find than standard equipment (1.76), that it is difficult to find qualified contractors that understand how to comply with ESH (1.60) and that the added cost of building ESH outweighs all other benefits of program participation (1.91). Participants somewhat agreed that they gained differentiation in the market place as an ESH builder (3.90).

[9] In the non-participant section, RLW asked non-participant builders to rate the same statements and compares the scores to participant builders.

Statements	Average Rating*	Standard Error	n
Staying Current on construction options to meet ENERGY STAR criteria is difficult.	2.31	*(0.48)*	44
Difficult to find qualified contractors that understand how to install and/or comply with ES.	1.60	*(0.24)*	44
Program requires measures that are not cost-effective in new home construction.	3.09	*(0.31)*	44
Most homeowners do not consider benefits of long-term energy savings.	2.51	*(0.60)*	42
Differentiation in market place as an ENERGY STAR homes builder benefited my business.	3.90	*(0.51)*	42
Homebuyer satisfaction is greater among my ENERGY STAR homebuyers than other buyers.	3.37	*(0.34)*	30
My ENERGY STAR homes sell faster than my non-ENERGY STAR homes.	3.10	*(0.41)*	28
Construction costs of ENERGY STAR homes are equal or less than those of my non-ENERGY STAR homes.	1.92	*(0.37)*	40
The added cost of building ENERGY STAR homes outweighs all other benefits of program participation.	1.91	*(0.33)*	42
Energy efficient equipment is much harder to find than standard equipment.	1.76	*(0.40)*	43

Table 23: Program Barriers

* Responses provided on a scale of 1 to 5 with a 1 meaning "completely disagree" and a 5 meaning "completely agree." Values are weighted means, with weighted standard errors in parentheses.

Non-Participant Builder Analysis

RLW also interviewed builders who did not participate in the ENERGY STAR program in order to better understand potential program barriers. Although respondents did not participate in the program, the majority, 94%, were aware of the California ENERGY STAR Homes program. One may conclude that most single family builders were not discouraged in participating because they did not know it existed.

Have you heard of the California Energy Star program?	% of Respondents (n=47)
Yes	94%
No	6%

Table 24: Program Awareness among Non-Participants

Those who were aware of the ENERGY STAR program first learned about it through various means. Fourteen percent of builders learned about the program through a utility representative, while 3% learned about it through the trade show. Of the 10% who responded "other," respondents learned of the program through other companies that they did business with and magazine advertisements.

How did you first become aware of the Energy Star Homes program?	% of Respondents (n=47)
Utility Representative	14%
Do not know	11%
Other	10%
Pamphlet	3%
Trade Show	3%
Title-24 Consultant	4%
Bill Insert	2%
Utility Website	2%
Other builder	1%
Television Commercial	1%
Radio	1%
Friend	-
EPA Website	-
Newspaper	-
Sign	-

Table 25: Awareness of ENERGY STAR Program among Non-Participants

When non-participants were asked why they did not participate in the 2002 ENERGY STAR program, they responded:

Lack of Interest, Awareness or Time

We haven't learned enough about the program. I do know that the program comes and goes and sometimes money is available and sometimes money runs out.

Just not interested.

I'm not interested at all. I'm interested in building homes, not going after rebates.

I just haven't had enough time to review the program requirements.

Company hasn't done so in the past. Not that aware of the program and that's why we don't participate. At this time, we're not in learning more about the program.

Not enough time. I haven't had time to really look into it, I don't know much about the program.

It is an issue with my boss, the company's owner, who does not want to get involved with the program.

I haven't had time to research the program. I've heard of it but don't know much about it.

We have not had the time.

It just hasn't been brought to our attention. We do not know other builders who use it - it's a very competitive market in the production builders. We don't do something unless the competition does it.

We would have participated if we were contacted about the incentive. But we are a small company and nobody seems to know about us.

High Cost and Incentive-Related Issues

It does not offer us enough incentive for participation. Our homes are built to ENERGY STAR *program requirements, but participation in the program is not worth it because of having to pay a third party for certification.*

In the past the rebates were not enough to justify participation in the program.

They became cumbersome and not user-friendly. It's time consuming and costly.

It's just one more thing to do that costs us time and money. We pride ourselves on building great homes that exceed T24 standards and in order to meet the ENERGY STAR *requirement, we would have to add equipment at a higher cost to us.*

The timing and money involved. It also takes a longer time to go through the inspections process.

Expense -there is no return on investment in participating in the program.

The outlay of money cannot be made up in sales to first-time homebuyers.

The cost to install is much greater than the rebate we would get from it.

Not enough financial return to us for the time we have to expend. Every home we build is a custom home; for every home, we would have to submit a separate plan.

Lack of Program Funding

When I went to apply for the program, I was told it is no longer available.

The cost and reliability of the program - it may be here one year then not available the next. Funding may not be available to us in the middle of a project; if that happens we can't downgrade any of our plans.

Lack of funding. We tried it in 2001 and built to ComfortWise standards then the program ran out of money. I was short-changed in the deal. I put in lots of effort, time and money only to not have the incentives available to me.

We didn't have any active projects that met the timeline for participation.

We do what the program requires anyway. I've been through the mill on the rebates programs. I increased what I was spending on equipment only to have the funding not made available to me because the program ran out of money.

Other

For most projects, PG&E does gas and Merced does the electric. In an upcoming project, I am going to recommend we participate in the program, because it will be the first time in many years that PG&E will provide both gas and electric.

It's a difficult effort with as many houses as we build. It's a nightmare, not worth it. We didn't see the benefit, though we may change our minds at some point.

Actually we will participate in the program soon, we just got a job where, due to developer requirements, we're going to have to exceed T24. Since we have to exceed T24 anyway, we figured we might as well get the money from the ENERGY STAR *program.*

Company philosophy. We always meet or exceed T24 but we are not interested in exceeding requirements to the level of ENERGY STAR.

We have custom homebuyers.

We do incorporate the concept of ENERGY STAR *requirements.*

A majority of the respondents (68%) stated that their company would benefit from training on how to cost-effectively meet the program requirements. Eighty percent of the 68% said that such training would likely increase the participation of their company or participation of other developers.

Non-participants were asked to rate several program aspects from one to five with one meaning "not a barrier" and five meaning "large barrier." Table 26 compares their weighted average of non-participant responses to participant responses.[10] On average, non-participants rated the amount of incentives at 2.60 (where one means not a barrier) and participants rated it at 2.92 (where one means very satisfied). However, the difference in the two averages is not statistically different from zero with 95% confidence.

Responses between non-participants and participants were not statistically different for third party inspections and certification process with 95% confidence. However, non-participants rated each of these aspects higher as a barrier, on average than participants. The descriptive answers to why builders did not participate commonly sited the paperwork and inspection hassles as reasons. Builders felt that in order to stay competitive, they could not afford to add in inspections to receive ENERGY STAR recognition and incur extra costs for these inspections. This sentiment may be captured in the high scores in the third party inspection and certification process categories.

Communication with utility scored above average satisfaction (1.93) by participants and slightly more of a barrier to program participation by non-participants (2.21)—an average difference of 0.27. Although the average scores are not statistically different, it may be worth noting that non-participants perceive communications with utilities as a bigger issue than it would likely be if they did participate.

[10] The response scale was reversed to correctly match the non-participant scale. For participant response averages in this section, one means "very satisfied" and five means "very unsatisfied."

Barrier to Program Participation	Avg. for Non-Participants*	Avg. for Participants[3*]
Understanding of Program	2.43	n/a
	(0.22)	*n/a*
	n=41	*n/a*
Amount of Incentives	2.60	2.92
	(0.30)	*(0.40)*
	n=39	n=43
3rd-Party Inspections	3.45	2.56
	(0.27)	*(0.62)*
	n=40	n=41
Certification Process	3.43	2.36
	(0.22)	*(0.57)*
	n=38	n=41
Program Application Documentation	2.78	2.62
	(0.32)	*(0.30)*
	n=38	n=43
Program Required Margin of Compliance	2.45	1.98
	(0.30)	*(0.41)*
	n=35	n=42
Communication with Utility	2.21	1.93
	(0.24)	*(0.16)*
	n=38	n=42

Table 26: Comparison of Program Satisfaction between Participants and Non-Participants

*Responses provided on a scale of 1 to 5 with a 1 meaning "not a barrier" and a 5 meaning "large barrier." Values are weighted means, with weighted standard errors in parentheses.

In order to better target non-participants, RLW calculated average scores and standard errors to rate program barriers for each major geographical region. In regards to the understanding of the ENERGY STAR program, all regions rated it as 'below average' or 'neutral' barrier to program participation. Although almost all non-participants had some understanding of the ENERGY STAR program and felt that understanding the program was not a significant barrier. Their verbatim responses indicate that more education and knowledge about the benefits of energy efficiency and the relatively quick turnaround with certification may alter their viewpoint on participation.

The amount of incentives, the next column in Table 27, is a larger barrier to participation. Most notably in RMST climate zone 1, where the average score is 4.28. Conversely, the south coastal zone scored the lowest barrier rating in this category, at 1.47. Builders in the remaining climate zones rated this to be somewhat of a barrier, with scores ranging between 2.4 and 2.8.

Third party inspections appear to be viewed as a participation barrier in all climate zones, where average scores ranged between 3 and 4.9. Builders may have had some bad experiences with third party inspectors, as evidenced by the highest statewide average

score (3.45). Application documentation scored the second highest score, or is the second biggest barrier according to the responding non-participant builders.

Less of a barrier is the required margin of compliance and communication with utility, with statewide average scores of 2.45 and 2.21, respectively. Other than 'understanding of the program', these two types of barriers scored the lower than the other barriers listed.

Program Satisfaction	Understanding of Program	Amount of Incentives	Third Party Inspections	Certification Process	Application Documentation	Required Margin of Compliance	Communication with Utility
Statewide	2.43	2.60	3.45	3.43	2.78	2.45	2.21
	(0.22)	*(0.30)*	*(0.27)*	*(0.22)*	*(0.32)*	*(0.30)*	*(0.24)*
	n=43	n=39	n=40	n=38	n=38	n=35	n=38
North Coastal	1.91	4.28	2.99	2.89	2.61	2.75	2.47
	(0.23)	*(0.35)*	*(0.49)*	*(0.36)*	*(0.26)*	*(0.41)*	*(0.40)*
	n=11	n=9	n=10	n=10	n=11	n=9	n=11
South Coastal	2.95	1.47	4.89	3.64	1.88	1.61	1.18
	(0.07)	*(0.37)*	*(0.14)*	*(0.32)*	*(0.30)*	*(0.45)*	*(0.16)*
	n=5	n=5	n=5	n=5	n=5	n=5	n=5
South Inland	2.46	2.39	3.70	3.27	2.21	2.41	1.93
	(0.28)	*(0.28)*	*(0.40)*	*(0.40)*	*(0.35)*	*(0.28)*	*(0.36)*
	n=16	n=16	n=16	n=14	n=13	n=14	n=15
Central Valley	2.44	2.60	3.17	3.56	3.16	2.55	2.48
	(0.37)	*(0.44)*	*(0.36)*	*(0.29)*	*(0.45)*	*(0.47)*	*(0.30)*
	n=18	n=18	n=18	n=18	n=18	n=16	n=16
Desert	2.80	2.81	4.49	3.47	1.71	1.57	2.00
	(0.27)	*(0.49)*	*(0.40)*	*(1.19)*	*(0.42)*	*(0.49)*	*(0.00)*
	n=3	n=3	n=3	n=3	n=3	n=2	n=3

Table 27: Program Satisfaction by Region

* Responses provided on a scale of 1 to 5 with a 1 meaning "not a barrier" and a 5 meaning "large barrier." Values are weighted means, with weighted standard errors in parentheses.

RLW asked non-participants to rate their level of agreement with a series of statements. Table 28 compares the average scores of non-participants to participants.

Builders were asked to respond to two general types of barriers—practical issues and cost barriers. Overall, builders felt the costs related issues to be a greater barrier than the practical issues (although the difference is not statistically different).

Based on the average response, participant builders do not find that staying current with options to meet ENERGY STAR criteria is a barrier (2.31 average). This is likely because in most cases the participant builders receive construction advice from turnkey companies that provide this as part of their service to the builders. Based on the evidence show in Table 28 builders also do not believe finding qualified contractors is a barrier to program participation. Again, because of the full range of services the turnkey companies provide, this potential barrier has likely been removed. Lastly, the ability to find energy efficient equipment does not appear to be a barrier. One might conclude from these participant responses that practical issues are not as important of issues as are cost barriers.

Table 28 lists a number of statements related to cost barriers. The fourth statement on the list suggests that builders somewhat believe that the cost of the measures to comply with ENERGY STAR standards are not cost effective (3.09). Similarly, participant builders believe, though less strongly, that the construction cost of an ENERGY STAR home is more than a non-ENERGY STAR home. All other cost barriers scored lower than 2.5, suggesting that the builders do not see the other cost statements as a barrier to participation. These

findings suggest that cost barriers related to construction material procurement and total construction costs are likely the number one barrier that deters these builders from participating in the future.

Statements*	Avg. of Non-Participants	Avg. of Participants
Practical Barriers to Program Participation		
Staying current on options to meet Energy Star criteria is difficult.	2.65	2.31
	(0.15)	*(0.48)*
	n=39	n=44
It is difficult to find qualified contractors.	2.51	1.60
	(0.23)	*(0.24)*
	n=40	n=44
Energy efficient equipment is much harder to find than standard equipment.	1.94	1.76
	(0.22)	*(0.40)*
	n=41	n=43
Cost Barriers to Program Participation		
Energy Star Homes requires measures that are not cost-effective.	3.09	3.09
	(0.20)	*(0.31)*
	n=39	n=44
Most homeowners do not consider benefits of long-term energy savings.	2.93	2.51
	(0.25)	*(0.60)*
	n=41	n=42
Construction costs of Energy Star homes are equal or less than those of my non-Energy Star homes.	2.37	1.92
	(0.36)	*(0.37)*
	n=40	n=40
The added cost of building Energy Star homes outweighs all other benefits of program participation.	3.03	1.91
	(0.24)	*(0.33)*
	n=37	n=42

Table 28: Comparison of Opinion between Participants and Non-Participants

RLW asked non-participants whether they had any suggestions or comments about the ENERGY STAR program. Their verbatim comments are summarized below:

> *It seems that lately the utility companies don't really push the programs as much. It used to be that the gas and electric companies were always there with different programs going on, pushing programs on the radio, but lately you don't hear much.*
>
> *My only suggestion would be to make it user-friendly and include as many types of equipment options as possible. That's the easiest way to comply.*
>
> *Make the requirements easier for larger homes.*
>
> *The program needs to be simplified, and more information needs to be disseminated through marketing.*
>
> *Make the program simpler. Provide us with the specification on ducting and HVAC, etc. to meet the program requirements and have HVAC contractor certify*

the work. The utility can test the HVAC contractors on an annual basis to make sure they are qualified.

Just make is simpler and easier for a builder to not necessarily comply but to implement and take advantage of the program, while still being cost-effective to the home industry. It'd be nice if they gave us a generic idea based on areas and house types.

Have representatives come in and talk to us at our office.

There should be an outreach and education program for builder and primarily for vendors.

Need more communication between directors of program and builders.

Educate builders about the program.

It is too hard to implement on the construction line.

The application needs to be simplified and the incentives must be higher.

The program can be beneficial. The subsidy should be increased to the point that it covers the cost to participate.

We would happily do it if it didn't cost so much or cause more delays. It's the third party inspections—they have to be scheduled between those we already have.

When given incentives to make an energy efficient home, they give a rebate to a builder or buyer, but contractors just increase price to offset the rebate. The market destroys rebates.

Get a representative that will work with us on it. Don't change the program start dates every year. In the past, we have applied to the program only to be told that we started building too late.

It's a good intellectual idea, but it is hard to sell to builders. There is no return for the investment of time and money put into the program.

They should try to get the rebate a little closer to the cost. I think that would be more of an incentive to get builders to work with the program.

Convince my boss that it is worth it. I'd like to participate but my boss does not think the time spent on it is worth it.

RLW finally asked non-participants whether they had any suggestions for generating more builder interest in the ENERGY STAR program. Below is a sampling of the builder comments:

Provide a list of builders who are participating in it so I could call them up and ask if it works. It's OK to put in 50% extra cost as long as you get it back. I want to be able to make sure it pays to participate.

Send out a Representative, and conduct follow-up phone calls.

Send a representative out to different builders so they can sit down and talk out all aspects of the program.

More in publications such as the builders' magazines.

Have some seminars.

Training to the building industry at the local level. Create more interest at the local level as opposed to the national level.

Educate the vendors.

Make it simple. Most builders have a Title 24 consultant anyway, so get rid of the third party process. Let's put that money into more efficient HVAC equipment. Have the utility Rep come in and check our T-24 compliance.

Educate the builders and architects about the program requirements.

I haven't heard any advertising about the program at all, so maybe it should be advertised.

Increase the amount of the incentives, to make participation in the program worthwhile.

They need to make the incentive more appealing.

I always said to Consul that marketing dollars is the best way. Marketing materials don't appeal to purchasers. We look at the bottom dollar.

If the program had a "break-even" point to the builder and also a realize-able marketing benefit, this would help the builder.

Tell them they will save money. Usually it seems too complicated to do it. We make the homes faster than we get the $800.00 incentive.

Show how it will save the homeowner money, and not cost the builders any more time or money.

Primary Decision-Maker

The following table shows the breakdown of responses given when the respondents were asked who is the primary decision-maker in their organization with regard to participation in these types of programs.

Primary Decision-Maker	% of Non-Participants
Company Owner, President	50%
VP or Director of Construction	32%
Other	18%
VP or Director of Sales/Mktg	14%
Project Manager	5%
Architect/Engineer	-
Title 24 Consultant	-

Table 29: Primary Decision-Maker

Below are some of the 'Other' responses provided:

It's a team effort - I would review it first then the construction Manager, and finally the President - and we would come to a mutual agreement.

Purchasing Manager

Superintendent

Unaware of Program

There were three non-participant builder respondents who stated that they were unaware of the program. All three stated that they are interested in learning more about the program. Of the 47 non-participants, 49% were interested in learning more about the program. When asked about their preferred method of contact, 50% of respondents stated email, while another 36% said print material by mail, and another 27% said that a phone call would be a preferred method of contact.

Single Family Builder Conclusions

The CA ENERGY STAR program certified over 10,000 single family units in 2002 as ENERGY STAR compliant. RLW asked single family builders who participated in the program and also those who did not participate to comment on the CA ENERGY STAR program. Over three-fourths of the participant builders believe the program made a positive impact on the marketability of the new homes. Over two-thirds of the participants also stated to have changed their building measures to include energy efficient building practices as a result of program participation. The overall program satisfaction scored an average of 3.62 (where 5 was the most satisfied) and the communication with utility averaged at 4.02. A significant number of builder participants stated that a greater advertising partnership would be beneficial. In regards to the cost of ENERGY STAR homes, participant builders did not generally think that it was difficult to find qualified contractors or to find energy efficient equipment. They did agree, in general, that the cost of ENERGY STAR homes was slightly higher (about 1-5%) than equivalent non-ENERGY STAR homes.

The vast majority of builders who did not participate in the 2002 ENERGY STAR program were aware of the program. Non-participants scored third party inspections and certification process as the highest barriers to program participation. In addition, some builders were not satisfied with the communication with utility aspect. These three aspects may be useful to concentrate on to gain a greater pool of builders in future program years.

Some single family builders (both participants and non-participants) stated they were ENERGY STAR compliant, but did not certify homes as ENERGY STAR due to two reasons. They either did not want to go through the documentation process due to the costs and time involved or could not participate in the program because funds were depleted. To improve builder satisfaction, the utilities should seek to have more consistent program funding availability to ensure all builders who meet the ENERGY STAR requirements may participate.

3. Multifamily Builders

RLW conducted a multifamily builder survey analysis in order to provide utilities with a broader understanding of the barriers facing builders with respect to program participation, builder satisfaction, attitudes toward the program, program awareness, and builder recommendations.

RLW developed questions for both participant and non-participant multifamily builders. Participant survey questions addressed:

- How participants heard of the program,
- The reasons for program participation,
- Program requirements,
- Measures that have been implemented resulting from the program,
- Program strengths and weaknesses, and
- Program satisfaction and recommended improvements.

Non-participant survey questions addressed:

- Awareness of the program,
- Attitudes toward program,
- Program Barriers,
- Understanding of the program, and
- Willingness to participate.

The surveys conducted with multifamily builders sought to characterize the aforementioned issues for both low-rise and high-rise multifamily projects. One of the key differences between low-rise and high-rise multifamily projects relates to Title 24 compliance. High-rise projects, 4 stories or more, are required to comply with commercial Title 24, while low-rise projects are subject to residential Title 24 standards. A qualitative analysis is provided in this section for the high-rise builders because RLW was only able to execute surveys with a limited number of high-rise builders, as Table 30 shows. Of the 60 surveys completed, only two respondents reported building high-rise exclusively, while one other respondent reported building both high-rise and low-rise, with the majority being high-rise.

Six other builder respondents also reported building high-rise projects, however the majority of their projects were reported to be low-rise. Since the projects of these six builders are dominated by low-rise construction, and because the survey instruments were not separate (i.e. low-rise/high-rise), we have included their responses to the survey within the low-rise multifamily builder analysis.

Multifamily Housing Builder Respondents	Number of Respondents
Exclusively Low-rise Construction	51
Exclusively High-rise Construction	2
High-rise and low-rise dominated by low-rise	6
High-rise and low-rise dominated by high-rise	1
Total	**60**

Table 30: Types of Multifamily Builder Respondents

RLW Analytics interviewed a total of 60 multifamily builders that built various types of housing. The majority of the builders (95%) constructed at least some low-rise housing. Of those who built low rise housing, on average, low-rise housing constituted 97% of all their multifamily housing built in 2002.

Only 14.5% of the multifamily builders surveyed had experience constructing high-rise units in 2002. Of those builders that build high-rise units, high-rise housing made up an average of 40% of each builder's projects in 2002. The remaining 60% of the projects built by high-rise builders was reported to be low-rise multifamily housing projects.

Low Rise Multifamily Housing (n=59)	% of Respondents Constructing Type of Housing	Respondents' % by Each Housing Type
For Sale/Condo/Townhouse	10%	9%
Market Rate Rental	29%	10%
Affordable/Moderate Income Rental	85%	75%
Student Housing/Single Room Occupancy	7%	4%

Table 31: Low Rise and High Rise Builders

Table 32 summarizes low-rise multifamily housing built by respondents. About 85% of all low-rise builders constructed units for affordable/moderate income rentals. Affordable/moderate income housing represents 75% of total units builders built by respondents.

Few low-rise multifamily builders (10%) concentrated the majority of their efforts on constructing condos/townhouses for immediate sale. The majority of the surveyed low-rise builders concentrated construction efforts on affordable/moderate income rental housing.

Low Rise Multifamily Housing (n=59)	% of Respondents Constructing Type of Housing	Respondents' % by Each Housing Type
For Sale/Condo/Townhouse	10%	9%
Market Rate Rental	29%	10%
Affordable/Moderate Income Rental	85%	75%
Student Housing/Single Room Occupancy	7%	4%

Table 32: Summary of Low Rise Multifamily Housing

Of the builders who constructed affordable/moderate income housing, each was asked whether or not they constructed any senior, special needs and/or family housing. Eighty-two percent of the builders responded that they have built *some* family housing. These

builders were also asked the breakdown of their projects by these categories. Family housing represented 62% of all affordable/moderate income projects by respondents.

Affordable/Moderate Income Multifamily Housing (n=50)	% of Respondents Constructing Type of Sector	Respondents' % by Each Sector
Senior Homes	68%	31%
Special Needs	24%	9%
Family Housing	82%	62%

Table 33: Summary of Affordable/Moderate Income Multifamily Housing

Multifamily Participant Builders

Title 24 Awareness and Compliance

The vast majority of participant multifamily builders who were surveyed were familiar with California's Title 24 standards.

Are you familiar with California's Title 24 Energy Code for newly constructed residential and commercial buildings?	% of Respondents (n=37)
Yes	99%
No	1%

Table 34: Familiarity with Title 24 Standards

Although builders are familiar with Title 24 standards, it is almost always the Title 24 consultant or energy consultant who typically completes compliance documentation.

Can you tell me what member of your project team typically does Title 24 compliance documentation on multifamily projects?	% of Respondents (n=37)
Title 24 Consultant or Energy Consultant	99.7%
President, Partner, Owner	0.3%
Engineer-In house	-
Other	-
Do not know	-

Table 35: Title 24 Compliance Documentation Responsibility

Of the multifamily builders who participated in the 2002 ENERGY STAR New Homes program, 56% rated the difficulty in meeting Title 24 standards as 'very easy' and about 34% of the respondents rated is as 'easy.' Less than 5% of the respondents found it to be somewhat or very difficult to meet California's Title 24 standards. These responses represent multifamily builders who participated in the ENERGY STAR program, which requires buildings to be built at a higher efficiency.

How would you rate the difficulty in meeting Title 24 standards on your new multifamily projects?	% of Respondents (n=37)
Very Easy	56%
Somewhat Easy	34%
Neutral	7%
Somewhat Difficult	3%
Very Difficult	-
Do not Know	-

Table 36: Difficulty of Meeting Title 24 Standards

RLW asked builder participants to rate the efficiency level of their newest projects, nearly 95% of the respondents stated that their most recent projects are at least 10% better than code. It may be that builders who participated in the 2002 ENERGY STAR program have continued to build better than code because of the innate benefits or because they are still participants of the ENERGY STAR program. In either case, the vast majority of builders who participated in the 2002 program claim to be building better than code requirements.

In terms of compliance margin on your newest projects, would you say that your buildings are…	% of Respondents (n=37)
Much better than code (15% or more)	69%
Better than code (10-14%)	25%
Marginally better than code (1-9% better)	1%
Just compliant (= to Code)	5%
Less efficient than code (< Code)	-

Table 37: Level of Title 24 Compliance

Participant builders were asked whether they were aware of the planned 2005 energy code changes for multifamily housing projects. Ninety percent of the respondents who participated in the 2002 ENERGY STAR program were not aware of the planned changes in the energy code for 2005.

Are you aware that the planned 2005 energy code changes are going to greatly affect Title 24 compliance for multifamily housing projects?	% of Respondents (n=37)
Yes	10%
No	90%

Table 38: Awareness of 2005 Title 24 Standards

Builder Training Attendance and Satisfaction

Of the 38 participant multifamily builders RLW surveyed, Table 39 summarizes the number of participants who attended a training session and the average rating of usefulness of the training. Builders are not required to attend Title 24 trainings or energy efficiency information sessions, but builders did find the training on Title 24 compliance and energy efficiency very useful with average scores of 4.92 and 4.04 respectively, on a

scale of 1 to 5. Two of the 38 participant builders surveyed attended the training on proper installation techniques, and they did not find the training very useful.

Training Type	# who attended of 38 Participants	Usefulness of Training[1,2]
Title 24 Compliance Training	5	4.92 *(0.09)*
Training on Energy Efficiency Options	14	4.04 *(0.43)*
Training on proper installation techniques	2	1.68 *(1.05)*

Table 39: Training Attendance and Usefulness Score

Of those who attended any of the three training sessions, about 90% were interested or very interested in attending future training sessions. The overwhelming interest in attending more training sessions may imply that builders found the training sessions to be very helpful in practice.

How interested are you in attending future training sessions similar to these?	% of Respondents (n=15)
Very interested	81%
Interested	9%
Not interested	9%
Not sure/do not know	-

Table 40: Interest in Future Training Sessions

Of those who did not attend any training sessions, 64% of the respondents claimed to rely on outside sources of information such as their architects. Because over half of the builders in RLW's survey who participated in the program relied on another source for information, it may be just as essential to train architects, as it is to train builders.

About one fifth of the participant builders who did not attend any training were not aware of the training programs. It may behoove the training administrators to more widely market their training sessions to better educate the broad multifamily builder community.

Can you provide an explanation as to why you, or your employees, have not attended any training programs?	% of Respondents (n=21)
Rely on outside sources for information	64%
Unaware of training programs	18%
Not interested/Do not need training	12%
Not offered at convenient times	6%
Not offered at convenient location	-
Not interested in training subject matter	-

Table 41: Reason for Not Attending Any Training Session

Importance of Energy Efficiency and Motivation to Participate in Program

RLW asked builders who participated in the ENERGY STAR program to rate how important they felt energy efficiency was in the design of their different types of multifamily housing on a scale of 1 to 5. Builders of senior housing rated energy efficiency design with highest

importance (4.13) in relation to other types of housing. Market rate housing builders rated energy efficiency the lowest (3.43).

It may be that moderate income multifamily and senior housing are more oriented to bringing affordable housing to a certain population, and the goal of low energy bills and energy conservancy may concur with the overall objective. On the other hand, market rate multifamily housing scored the lowest with an average of 3.43. Market rate housing is usually constructed by builders to be sold, so the main objective may be to build at lowest cost regardless of whether that includes an energy efficient design or not. Overall, builders' opinion on an energy efficiency design fared well with average ratings of about 4 (somewhat important).

How important is energy efficiency in the design of your…	Average Rating*
Affordable/moderate income housing	3.97
	(0.20)
	n=34
Market rate housing	3.43
	(0.53)
	n=15
Senior housing	4.13
	(0.31)
	n=22
Special needs housing	3.93
	(0.94)
	n=9

* Responses provided on a scale of 1 to 5 with a 1 meaning "not very important" and a 5 meaning "very important." Values are weighted means, with weighted standard errors in parentheses.

Table 42: Importance of Energy Efficiency by Housing Type of Builder

When participant builders were asked about their motivation in participating in the 2002 ENERGY STAR program, over 79% listed the financial incentives as their motivation. The second most common response was 'lower energy costs for tenants,' which 10% of the respondents listed as their motivation. About 7% said they participated in the ENERGY STAR program because it was a means to achieve 2001 Title 24 compliance.

Multifamily builders who constructed units for low-income households received tax credits if they built above Title 24 standards by 15% or more, however only 3% of the multifamily builder participants listed tax exemptions as a means for participation.

What were your motivations for participating in the 2002 California Energy Star program?	% of Respondents (n=37)
Financial Incentives	79%
Lower energy costs for tenants	10%
A means to achieve 2001 Title 24 compliance	7%
Ability to obtain tax credits or tax exempt financing	3%
Differentiation in the market place to promote the sale of housing	-
Differentiation in the market place for fundraising purposes	-
Advertising Partnership	-
Third-party inspections and recognized labels	-
Other	-
Do not know	-

Table 43: Motivation for Program Participation

Change in Practices and Attitudes after Program Participation

The ENERGY STAR program strives to change building practices to include more energy efficient measures. The most common energy efficiency measures are listed below in Table 44. Builders were asked which of them they typically install to meet ENERGY STAR standards. According to builder responses, high efficiency glazing is most commonly specified by 65% of builders who state they always specify it and 29% who sometimes install it. The second most common measure is the high efficiency furnaces, which 40% of participant builders claimed to always install and 48% claim to sometimes install in their multifamily projects. Builders have also specified increased attic/wall insulation — 41% claimed to always install and 45% claimed to sometimes install to meet ENERGY STAR standards. Over 50% of the builders who claimed to always or sometimes install the following building measures: Central DHW, high efficiency unitary DHW, high SEER air conditioning, and central space heating. Measures that were the least typically specified by multifamily builders were TXV/refrigeration heating and electric resistance heating.

To meet Energy Star standards, what measures or measure packages are you typically installing? (n=37)	% with Response:			
	Never	Sometimes	Always	Do Not Know
High Efficiency Glazing	5%	29%	65%	1%
High Efficiency Furnaces	5%	48%	40%	8%
Increased attic/wall insulation	12%	45%	40%	3%
Central DHW	29%	27%	38%	6%
High efficiency unitary DHW	37%	30%	28%	6%
High SEER AC	29%	31%	28%	12%
Central Space Heating	42%	26%	24%	7%
Central DHW with controls	49%	17%	10%	24%
Tight Ducts	37%	20%	16%	27%
Radiant barrier	40%	30%	18%	13%
Electric Resistance Heat	60%	6%	12%	22%
TXV/Refrigeration testing	63%	4%	-	33%

Table 44: Frequency of Measures Typically Installed

Tax Exemption and Finance Help for Affordable Housing Builders*

The following tables (Table 45 and Table 46) summarize responses from builders who constructed affordable to moderate-income housing. Tax credits are provided by the state of California to builders that construct affordable housing projects that exceed Title 24 by 15% or more. Therefore the ENERGY STAR Homes Program is a perfect vehicle to help builders reach higher levels of energy efficient construction and to obtain tax credits. RLW asked these builders whether the ENERGY STAR label helped them gain tax advantages and about half claimed that ENERGY STAR helped them gain credits on some or all projects.

How would you characterize the impact of Energy Star label on your ability to gain tax credits on tax exempt financing?	% of Respondents (n=36)
ES has helped us gain credits on some projects.	23%
ES has helped us gain credits on all projects.	26%
ES has not helped us gain tax credits.	43%
Do not know/Not sure	8%

Table 45: Affordable Housing Tax Exemption Credit*

RLW also asked affordable to moderate income housing builders whether program participation helped them obtain funding from outside sources and over half (60%) stated that it did not improve their fundraising ability, however nearly 30% thought the program had helped them improve the fund raising capabilities.

*Questions related to tax exemptions and increased financing opportunities were ONLY asked of affordable housing builders.

Has the Energy Star label improved your ability to obtain project funding from outside sources?	% of Respondents (n=36)
Greatly improved fundraising ability	8%
Somewhat improved fundraising ability	26%
Has not improved fundraising ability	60%
Do not know	6%

Table 46: Affordable Housing Ability to Gain Additional Project Funding*

Marketability of ENERGY STAR as Perceived by Builders**

Builders who participated in the 2002 ENERGY STAR program believed that the ENERGY STAR label had either no impact, or a positive impact on the marketability of their multifamily homes. Over 50% of the respondents believed the logo helped increase the marketability of their homes. These responses suggest that builders recognize the financial incentives are not the only benefit of constructing ENERGY STAR-certified homes, but that they also reap increased marketability benefits. Note that these questions were only asked of multifamily builders that built market rate housing.

How would you characterize the impact of the Energy Star label on the marketability of your new home sales?	% of Respondents (n=4)
No impact on the sale of home	46%
A positive impact on the marketability of the home.	54%
A negative impact on the marketability of the home.	-
Do not know	-

Table 47: Marketability of ENERGY STAR Label**

Although builders believe that the ENERGY STAR qualification has helped increase their marketability, all market rate rental builders believed that the program increased their marketability. Note only four of the surveyed participants built market rate rental units and addressed this question.

Has participation in the program helped you get more marketing exposure?	% of Respondents (n=4)
Yes	100%
No	-
Possibly	-
Do not know/Not sure	-

Table 48: Marketing Exposure Help**

All participant respondents received some type of marketing support from the utilities in the ENERGY STAR program. About 94% of the respondents received the following type of marketing support: ongoing advertising support, point-of-sale brochures, ENERGY STAR display for models, videos, and an enhanced builder image. Another 51% between

** Questions related to marketability were ONLY asked of market rate rental builders.

ENERGY STAR and builder website, and an improved reputation for quality construction and cutting-edge technology. It is important that builders are supplied with pertinent information and tools to effectively market their ENERGY STAR multifamily units to potential buyers or renters of the property. Much to the program's credit, none of the builders responding to the survey indicated that they had not received any marketing support.

Which of the following types of marketing support have you received from the program?	% of Respondents (n=4)
Ongoing Advertising Support	94%
Point-of-Sale Brochures	94%
ES Display and Video	94%
Enhanced builder image and reputation	94%
Developed reputation for quality construction	51%
Website to ES and your website	51%
Sales Training and Support	51%
Print Media Ads	43%
Model "Grand Opening" Assistance	43%
Sales/Rental Office	-

Table 49: Type of Marketing Support**

Program Satisfaction and Barriers to Participation

Multifamily builders who participated in the 2002 ENERGY STAR program were overall satisfied with the program experience. Third party inspections and the amount of incentives were the only two aspects of program satisfaction that received an average score below 4 on a scale of 1 to 5. The lowest average rating for third party inspections (3.59) may be associated with the difficulty in finding certified CHEERS raters who inspect the units to ensure ENERGY STAR compliance. The CHEERS rater section of this report further explores the challenges of the rating aspect of the ENERGY STAR program. Anecdotally, builders did report a shortage in the number of available raters willing to inspect multifamily housing projects.

Program Satisfaction	Average Rating[1,2]
Amount of Incentives	3.98
	(0.32)
	n=37
Design Assistance Incentives	4.24
	(0.29)
	n=27
Third Party Inspections	3.59
	(0.42)
	n=25
Certification Process	4.07
	(0.35)
	n=21
Application Documentation	4.16
	(0.23)
	n=36
Required Margin of Compliance	4.43
	(0.19)
	n=37
Incentive Processing and Payment	4.34
	(0.29)
	n=18
Communication with Utility	4.36
	(0.21)
	n=37
Overall Program	4.33
	(0.20)
	n=37

* Responses provided on a scale of 1 to 5 with a 1 meaning "not very satisfied" and a 5 meaning "very satisfied." Values are weighted means, with weighted standard errors in parentheses.

Table 50: Program Satisfaction Ratings

Participant builders were also asked to rate their level of agreement to a series of statement to assess possible barriers to program participation. Table 51 summarizes builder's sentiments where a "1" means they highly disagree and "5" means they highly agree with the statement. Builders on average somewhat disagreed (1.69) that there was inadequate information on energy efficiency options to meet ENERGY STAR standards. In general, participant builders felt they had adequate information and access to information in regards to energy efficiency. Builders also somewhat disagreed (1.82) that it was difficult to find contractors who were knowledgeable measures that were required ENERGY STAR. Builders highly disagreed (1.47) that it was more difficult to find energy efficient equipment than standard equipment. These findings suggest that the up-stream, or supply side, of the market is well developed and is not presenting a barrier to program participation.

Although builders previously rated third party inspections with the least satisfaction out of all the program aspects (see Table 50), program participants slightly disagreed (2.63) that it was difficult to find a CHEERS rater to conduct inspections. However, the average is not statistically different from 3 (neutral) at a 95% confidence level.

Builders of multifamily units somewhat agreed (3.89 statistically different from 3 with 95% confidence) that most homeowners did not consider long-term energy benefits. It *may be* that in the multifamily unit case, people who live in multifamily housing do not have a vested interest because they consider it a temporary living situation rather than a long-term commitment.

However, builders of multifamily units did somewhat agree (3.71 statistically different from 3 with 95% confidence) that homeowner satisfaction is greater among ENERGY STAR homebuyers than non-ENERGY STAR homebuyers.

Statements	Average Rating*
There is inadequate information on energy efficiency options to meet Energy Star criteria.	1.69
	(0.22)
	n=37
It is difficult to find qualified contractors that understand how to install and/or comply with some of the measures required to meet Energy Star.	1.82
	(0.28)
	n=37
It has been difficult to find CHEERS raters willing to conduct my third party inspections.	2.63
	(0.64)
	n=28
The design assistance incentive is inadequate considering all of the paper work requirements of Energy Star.	2.41
	(0.42)
	n=32
The added costs of inspections outweighs all other benefits of program participation.	2.15
	(0.38)
	n=31
The program's timing requirements make it difficult to participate in the program.	2.80
	(0.52)
	n=37
Energy efficient equipment is much harder to find than standard equipment.	1.47
	(0.18)
	n=37
**Most homeowners do not consider long-term costs when buying homes.	*3.89*
	(0.28)
	n=10
**The differentiation in the market place that I have realized as an Energy Star homebuilder has added value to my business.	*2.60*
	(0.46)
	n=9
**Homebuyer satisfaction is greater among my Energy Star home buyers than it is among my non-Energy Star home buyers.	3.71
	(0.24)
	n=9

**Market Rate Housing Builders Only (weighted accordingly.)

* Responses provided on a scale of 1 to 5 with a 1 meaning “highly disagree” and a 5 meaning “highly agree.” Values are weighted means, with weighted standard errors in parentheses.

Table 51: Builder Opinion in regards to Program Barriers

Non-Participant Multifamily Builder Analysis

RLW also surveyed multifamily builders who did not participate in the 2002 ENERGY STAR program in order to better understand program’s strengths and challenges.

Title 24 Awareness and Compliance

Non-participants were asked whether they were familiar with California's Title 24 energy code and over 90% of the builders were indeed familiar with it. However, 7% of the respondents were not familiar with the Title 24 standards, which is higher than the participant respondent rate. It may be that builders who participated in the ENERGY STAR program may have also indirectly educated builders about the Title 24 energy code.

Are you familiar with California's Title 24 Energy Code for newly constructed residential and commercial buildings?	% of Non-Participants (n=20)	% of Participants (n=37)
Yes	93%	99%
No	7%	1%

Table 52: Familiarity with Title 24 Standards

As was true with participant builders, the vast majority of non-participants stated that a Title 24 consultant or energy consultant as the person who typically completed Title 24 compliance documentation. However, a significant percentage listed their in-house engineer as the person who completed documentation.

Can you tell me what member of your project team typically does Title 24 compliance documentation on multifamily projects?	% of Non-Participants (n=20)	% of Participants (n=37)
Title 24 Consultant or Energy Consultant	91%	99.7%
President, Partner, Owner	-	0.3%
Engineer-In house	9%	-
Other	-	-
Do not know	-	-

Table 53: Decision Maker of Title 24 Compliance

Table 54 summarizes how non-participants rated the difficulty of meeting Title 24 standards. About 52% felt it was very easy and 23% thought it was somewhat easy. Although the percentages are somewhat lower for non-participants in comparison to participant respondents, almost none of the non-participants felt it was somewhat or very difficult to meet the minimum standards. However, the decreased percentages in non-participant responses indicate that non-participants did not find it as easy to meet Title 24 standards as the participants did. This would suggest that if the program were to bring more non-participants into the program in future years, the resulting energy savings might be greater than it was for the earlier participants. This is based on the assumption that the program would be working from a less efficient baseline, since the builders with more Title 24 compliance knowledge participated earlier in the program. This is further supported by the findings presented in Table 56, which shows the level of compliance for participant projects to be greater than it is for non-participant projects. The results presented in Table 54 may also be an indicator that the participants are realizing significant educational and design practice benefits through participating in the program, as they are finding it easier to build more efficient buildings than their non-participant counterparts.

How would you rate the difficulty in meeting Title 24 standards on your new multifamily projects?	% of Non-Participants (n=20)	% of Participants (n=37)
Very Easy	52%	56%
Somewhat Easy	23%	34%
Neutral	25%	7%
Somewhat Difficult	1%	3%
Very Difficult	-	-
Do not Know	-	-

Table 54: Difficulty of Meeting Title 24 Standards

Of the non-participants RLW surveyed, only 40% of the respondents had heard about the ENERGY STAR program. The fact that almost 60% of the respondents had not heard of the ENERGY STAR program may indicate the lack of awareness among builders about the program as a chief barrier to greater program participation. Table 234 (in Program Manager Interviews Section) summarizes how many multifamily units each utility recruited for the 2002 ENERGY STAR program. ENERGY STAR multifamily units were highly concentrated in the southern California, so it may be that multifamily builders in northern California were less aware of the program.

Have you heard of the California Energy Star New Homes program?	% of Non-Participants (n=20)
Yes	40%
No	60%

Table 55: Awareness of ENERGY STAR Program

In order to certify multifamily units as ENERGY STAR compliant, they must be built better than the Title 24 energy code. Over three-fourths of the non-participant builders claimed that they built their multifamily units much better than code (15% or more). If the builders are correctly assessing their level of compliance, then it may be that beating Title 24 standards is not an unfeasible goal seeing that 79% of non-participants are doing so already. Part of the ENERGY STAR's program goals is to encourage builders to construct more energy efficiency homes. Over 90% of the builders who did not participate in the program claim to be doing so already.

Based on the current flaws[11] in the Title 24 energy code for low-rise multifamily housing, this finding is not surprising. Codes changes that will be implemented in 2005 will strengthen multifamily code compliance and will likely reduce the ease of compliance multifamily builders now enjoy. Moreover, this finding should not be misconstrued in leading one to believe that participants are merely free-riders. Without the program, many of the participant builders would certainly have designed less efficiently and would not have had the opportunity to learn about energy efficiency design and construction practices. Perhaps the utilities should consider increasing the program's qualifying level of

[11] Flaws in the Title 24 compliance algorithms for domestic hot water and allowable fenestration area currently make compliance of low rise multifamily housing projects much easier than single-family compliance. However, high rise multifamily housing must comply to commercial building standards, so the issues for hot water and fenestration area are mitigated.

efficiency above Title 24 (currently 15%) in order to deal with these issues. Strengthening the program requirements will better prepare multifamily builders for the 2005 code changes, and since they already appear to be building to such levels of efficiency without the incentive, raising the bar seems to be a logical next step.

In terms of compliance margin on your newest projects, would you say that your buildings are…	% of Non-Participants (n=20)	% of Participants (n=37)
Much better than code (15% or more)	83%	69%
Better than code (10-14%)	6%	25%
Marginally better than code (1-9% better)	6%	1%
Just compliant (= to Code)	5%	5%
Less efficient than code (< Code)	-	-

Table 56: Level of Title 24 Compliance

Table 57 summarizes the level of awareness of the planned 2005 energy code changes as weighted percentages. However, of the 60 builders RLW interviewed, a total of 9 builders were aware of the upcoming changes and 4 of the 9 were non-participants. The weighted percentage value appears overestimated because some of the largest multifamily builders who did not participate in the ENERGY STAR program were aware of the upcoming changes.

Are you aware that the planned 2005 energy code changes are going to greatly affect Title 24 compliance for multifamily housing projects?	% of Non-Participants (n=20)	% of Participants (n=37)
Yes	42%	9.9%
No	58%	90.1%

Table 57: Awareness of Planned Changes

Builder Training Attendance and Satisfaction

Non-participants did not attend training sessions as much as participant builders. It may be that participants were more concerned about energy efficiency and thus not only built to ENERGY STAR standards but also attended any training in relation to energy efficiency in order to do so. However, the training session may have been another venue of marketing for the program. Of the builders who did attend the trainings, non-participants found it to be somewhat useful (4.05) on a scale of 1 to 5.

Training Type	# who attended of 19 Participants	Usefulness of Training[1,2]
Title 24 Compliance Training	3	4.05 *(0.32)*
Training on Energy Efficiency Options	6	4.04 *(0.22)*
Training on proper installation techniques	0	

Table 58: Training Attendance and Usefulness Score

Of the non-participant builders who did not attend any training sessions, 87% of the builders relied on outside sources for information such as architects. As was true for participant builders, it may be that it is as important to train builders about energy

efficiency as it is to train other persons such as architects and engineers who design the buildings and specify the equipment and materials.

Can you provide an explanation as to why you, or your employees, have not attended any training programs?	% of Respondents (n=12)
Rely on outside sources for information	87%
Do not know	7%
Unaware of training programs	6%
Not interested/Do not need training	-
Not offered at convenient times	-
Not offered at convenient location	-
Not interested in training subject matter	-

Table 59: Explanation for not Attending Training Sessions

On average, non-participants rated the importance of an energy efficient design slightly lower for every type of housing. However, the difference may not be statistically different with 95% confidence. Interestingly, non-participants scored market rate housing the lowest with regard to the importance of energy efficiency in design. Market rate housing is usually sold, so it may be that the first cost of construction outweighs the value of energy efficient design, when compared to other types of multifamily housing.

How important is energy efficiency in the design of your…	Avg. of Participant Respondents	Avg. of Non-Participant Respondents
Affordable/moderate income housing	3.97	4.62
	(0.20)	*(0.11)*
Market rate housing	3.43	3.87
	(0.53)	*(0.40)*
Senior housing	4.13	4.32
	(0.31)	*(0.23)*
Special needs housing	3.93	4.17
	(0.94)	*(0.50)*

* Responses provided on a scale of 1 to 5 with a 1 meaning "not very important" and a 5 meaning "very important." Values are weighted means, with weighted standard errors in parentheses.

Table 60: Importance of Energy Efficiency

Non-participant builders were asked to rate different aspects of the ENERGY STAR program, where a "5" is a large barrier, and a "1" is not a barrier to program participation. Builders rated the understanding of the program, required margin of compliance and third party inspections with averages that were not statistically different from 3 (neutral). The lowest rated aspects (that indicate the least barriers) were certification process and application documentation with averages of 1.92 and 1.98 respectively. Since none of the program aspects ranked very high as a barrier to program participation, it may be that the lack of awareness of the program and program funding certainty are the single largest barriers. However, participants were asked to rank their program satisfaction by the categories stated in Table 61 where as non-participants were asked to identify barriers to program participation. Consequently, the comparison is not one of "apples-to-apples."

Program Participation Barrier	Non-Participant Average (n=8)	Participant Average (n=37)
Understanding of program	2.93	n/a
	(0.45)	*n/a*
Amount of Incentives	3.85	3.97
	(0.38)	*(0.32)*
Third Party Inspections	2.70	3.58
	(0.64)	*(0.42)*
Certification Process	1.92	4.07
	(0.53)	*(0.35)*
Application Documentation	1.98	4.15
	(0.49)	*(0.23)*
Required Margin of Compliance	2.50	4.42
	(0.68)	*(0.19)*
Inadequate information on energy efficiency options	2.45	n/a
	(0.63)	*n/a*
Timing of program requirements conflict with timing of my project	3.44	n/a
	(0.70)	*n/a*
Communication with utility	2.38	4.36
	(0.85)	*(0.21)*

* Responses provided on a scale of 1 to 5 with a 1 meaning "not very satisfied" and a 5 meaning "very satisfied." Values are weighted means, with weighted standard errors in parentheses.

Table 61: Program Rating by Non-Participant and Participant

Table 62 summarizes the level of agreement of non-participants and participants to a series of statements. Non-participants mostly disagreed that it is difficult to find qualified contractors who are knowledgeable about energy efficient measures. Non-participants somewhat agreed that the ENERGY STAR Program's timeline make it difficult to participate in the program. The 2002 ENERGY STAR program was not approved until March 2002. Consequently, program administrators had 8-9 months to execute a one-year program. The uncertainty around future funding of the program most likely discouraged and disabled some builders from participating.

There also appears to be a mild disagreement between the participants and non-participants regarding energy efficient equipment availability and third party inspections. While participants appear to find little problem finding energy efficient equipment, non-participants are somewhat unsure whether product availability would hamper efforts to specify such equipment. There also appears to some amount of uncertainty among the non-participants regarding the added cost posed by third party inspection, as compared to participant responses. The program may want to consider providing focused training and support to help minimize these perceived barriers.

Statements	Non-Participant Average (n=8)	Participant Average (n=37)
There is inadequate information on energy efficiency options to meet Energy Star criteria.	2.55	1.68
	(0.53)	*(0.22)*
Energy Star requires measures that are not cost effective, even with the program's incentives.	2.87	n/a
	(0.80)	*n/a*
It is difficult to find qualified contractors that understand how to install and/or comply with some of the measures required to meet Energy Star.	1.47	1.81
	(0.44)	*(0.22)*
It has been difficult to find CHEERS raters willing to conduct my third party inspections.	1.69	2.63
	(0.71)	*(0.64)*
The design assistance incentive is inadequate considering all of the paper work requirements of Energy Star.	2.96	2.44
	(0.34)	*(0.42)*
The added costs of third party inspections outweighs all other benefits of program participation.	2.70	2.17
	(0.77)	*(0.38)*
The program's timing requirements make it difficult to participate in the program.	3.67	2.81
	(0.70)	*(0.52)*
Energy efficient equipment is much harder to find than standard equipment.	1.20	1.48
	(0.19)	*(0.18)*
The added cost of building to Energy Star outweighs all other benefits of program participation.	2.45	n/a
	(0.60)	*n/a*

* Responses provided on a scale of 1 to 5 with a 1 meaning "disagree" and a 5 meaning "very much agree." Values are weighted means, with weighted standard errors in parentheses.

Table 62: Builder Opinion in regards to Program Barriers CHEERS Raters

Multifamily Builder Conclusions

In 2002, the ENERGY STAR program certified over 9,000 multifamily units (over 8,000 in southern California) as ENERGY STAR-compliant. RLW interviewed 61 multifamily builders to better assess construction practices and attitudes of ENERGY STAR program participants and non-participants.

Both participants and non-participants solely depended on a Title 24 consultant or energy consultant to complete documentation for Title 24 compliance. The vast majority of both groups found it very or somewhat easy to meet Title 24 standards, although program participants seemed to rate the easiness with a higher percentage. In addition, both groups claim to be building better than code. About 94% of program participants and 89% of non-participants stated that they built at least 10% or better than code. The majority of builders were not aware of the planned 2005 energy code changes. Based on these responses, the utilities should consider increasing the Program's qualifying level of efficiency to be greater than 15% better than Title 24, at least until the 2005 energy code changes are implemented.

Participant builders rated the importance of an energy efficient design with an average score of about 4 (of out a high of 5). Non-participants voted the importance with a slightly lower average, but the difference is not statistically different with 95% confidence.

The main motivation that participants listed as their reason for joining the program was the financial incentives. Although the financial incentives help builders incur the additional

costs of building with greater energy efficiency, it is also important that builders recognize other benefits they gain from being ENERGY STAR-compliant such as the marketing support.

All participants did receive some type of marketing support. Over half of the participants stated that they received ongoing sales support, point-of-sale brochures, and ENERGY STAR displays. Overall program satisfaction ranked fairly high with an average score of 4 out of 5. RLW conducted a multifamily builder survey analysis in order to provide utilities with a broader understanding of the barriers facing builders with respect to program participation, builder satisfaction, attitudes toward the program, program awareness, and builder recommendations.

4. Title 24 Consultants

Introduction

The following chapter is an excerpt of the 2003 PG&E Residential New Construction (RNC) Study. Itron (formally RER) conducted the study under the direction of PG&E's project manager Mary Kay Gobris, also the project manager for the California ENERGY STAR New Homes Program. Due to the similarities in work scope identified between the two studies regarding Title 24 surveys, it was determined that the most cost effective approach for including Title 24 consultants in each of the studies would be to combine the efforts into one task, led by one team. Therefore Itron took leadership of this task, with RLW providing survey instrument design support. Itron was responsible for all other aspects of this phase of work, including survey design, implementation, analysis and report writing. Itron provided the remainder of this section of the report in whole; the same material is also published in the 2003 PG&E Residential New Construction (RNC) Study report.

Overview

As part of the 2003 PG&E Residential New Construction (RNC) Study, Itron conducted telephone surveys with 41 Title 24 consultants throughout California to gain an understanding of building and compliance practices of low rise single family new homes related to the current Title 24 2001 energy efficiency Standards (the Standards).[12, 13] This analysis corresponds, in part, to the survey of Title 24 consultants conducted for the previous RNC study.[14] One of the objectives of the previous study was to gain insight into the *anticipated* impact of the 2001 Standards with respect to the specification of high-efficiency measures to comply with the (then) upcoming Standards. In contrast, the survey administered for this study obtained information on the *actual* incidence of specific measures after the adoption of the 2001 Standards pursuant to AB 970, as well as consultants' insight into the level of effort required to achieve compliance of the 2001 Standards as compared to the 1998 Standards. The consultants were also questioned about their knowledge and awareness of the California ENERGY STAR New Homes program and differences in the design and construction of ENERGY STAR homes relative to non-ENERGY STAR homes.

While Title 24 consultants make recommendations to builders about strategies to meet the Standards, they do not make final decisions as to which measures are specified and installed. The previous study relied on the judgment of Title 24 consultants for the anticipated changes to construction practices resulting from the 2001 revisions to the Standards. Builders had very little knowledge of the specific changes to the Standards and, thus, were not surveyed as part of that effort.

In an effort to maintain continuity between this and the previous study, Itron initially contacted the 55 participants of the previous study. Once that list was exhausted, Itron

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[12] California Energy Commission. *2001 Energy Efficiency Standards for Residential and Nonresidential Buildings*. August 2001.

[13] The 2001 Standards were developed pursuant to California State Assembly Bill 970 (AB 970), enacted on September 6, 2000.

[14] Regional Economic Research. *Residential New Construction Study.* Prepared for Pacific Gas & Electric. September 10, 2001.

augmented the sample with 50 additional consultants specializing in analysis of residential projects obtained from the California Association of Building Energy Consultants (CABEC) roster of Certified Energy Analysts.[15] In all, 26 participants[16] of the previous study were interviewed for this study.

In addition to the telephone surveys, in-depth interviews were conducted with three "high-volume" firms who provide ENERGY STAR turnkey services and/or Title 24 compliance analysis. The interview guide used in the in-depth interviews contained a subset of key questions from the telephone survey, enabling interviewers to focus primarily on specification and design practices. Since the focus and structure of the in-depth interviews was quite different from that of the telephone surveys and results from these interviews are reported separately throughout this report.

The remainder of this report includes the following sections:

- Preview of Key Findings,
- General Title 24 Consultant Information,
- Compliance and Building Practices Relative to the 2001 Title 24 Standards,
- The California ENERGY STAR New Homes Program, and
- General Comments from Survey Respondents.

Preview of Key Findings

Title 24 consultants have a strong familiarity and understanding of energy-related characteristics of new homes as well as builder specification strategies to comply with Title 24 Standards. The surveys and in-depth interviews conducted for this study provide valuable insight into the impact of the 2001 revision to the Standards on compliance practices and the differences between homes that just meet Title 24 and those that qualify for the ENERGY STAR New Homes program. The following key findings are discussed in greater detail throughout this report.

Impact of the 2001 Standards. The 2001 Standards have had the greatest impact on building practices in the Desert and High Desert regions (CEC climate zones 14 and 15), followed by the South Inland and Central Valley regions. This result confirms expectations of earlier studies, and is not surprising since the 2001 revisions focused on reducing cooling peak demand.

Measures requiring third-party verification are specified only as last resort for Title 24 compliance. According to Title 24 consultants, the additional cost, potential disruption to the construction schedule, and potential insurance risk associated with measures requiring third party verification create a significant disincentive for specification of such measures. HERS related measures are most commonly found in the desert and high

[15] See http://www.cabec.org/directory.html.

[16] While 28 participants from the previous study were interviewed, the results for 26 participants were used. The two participants whose data was not included in the results were thrown out because the percentage of the plans that they analyzed under the Standards for residential new construction was less than 20%.

desert where the Title 24 Standards are most stringent. Additionally, some builders claim to utilize duct and building envelop sealing practices, but do not include them in the Title 24 compliance analysis specifically to avoid verification requirements.

Specification practices of ENERGY STAR homes. Interviews with high volume consultants who provide turnkey services conduct analysis for both ENERGY STAR and non-ENERGY STAR homes revealed that duct system sealing is a common upgrade for ENERGY STAR qualification. High efficiency central air conditioning, thermostatic expansion valves (TXVs) and high performance windows are also utilized in the cooling climate regions.

General Title 24 Consultant Information

The majority of consultants surveyed for this study are employed by relatively small firms employing an average of 5 consultants who conduct Title 24 analysis. Of the 41 respondents, 11 are certified HERS raters.

Residential plans account for approximately 88% of the total plans analyzed by the consultants during 2002, while commercial building plans account for the remaining 12%. Of the residential plans, 90% constituted detached single family homes and 10% constituted multifamily buildings. The consultants surveyed conducted compliance analysis on an estimated 16,053 building plans representing an estimated 55,801 detached single family buildings during 2002, which represents approximately 45% of the new homes in California. According to Construction Industry Research Board (CIRB) data, approximately 108,468 single family housing starts were reported in California in 2001.

Table 63 presents the geographic distribution of buildings analyzed (in 2002) by the respondents and the number of respondents who practice in each region. As shown, the Central Valley, North Coastal, and South Inland regions account for the majority of buildings represented by the consultants surveyed.

Region (CEC Climate Zones)	Number of Consultants	Number of Homes	% of Total	Housing Starts*	% of Total
North Coastal (1-5)	23	13,246	24%	20,041	18%
South Coastal (6-7)	12	5,103	9%	11,180	10%
South Inland (8-10)	15	10,398	19%	24,027	22%
Central Valley (11-13)	27	22,625	41%	43,666	40%
Desert (14)	5	1,778	3%	2,446	2%
High Desert (15)	5	2,120	4%	4,667	4%
Mountain (16)	15	530	1%	2,442	2%
Total	**41**	**55,800**	**51%**	**108,468**	

* Housing starts in 2001. Construction Industry Research Board.

Table 63: Geographic Distribution of Sample

Construction and Compliance Practices – New Single Family Homes

To support the baseline analysis for the RNC study, the Title 24 consultant surveys were developed specifically to obtain information regarding characteristics of homes planned during 2002 and the strategies builders and designers use to comply with the 2001

Standards. This section summarizes the compliance methods, consultants' assessments of builder attitudes toward the 2001 Standards, the incidence of high efficiency measures in new construction, and the changes in design and construction practices attributed specifically to the 2001 Standards.

Use of Performance and Prescriptive Compliance Methods

Title 24 offers builders and designers some flexibility in meeting energy efficiency requirements. The performance approach specifies the maximum allowable water heating and space conditioning energy use, enabling builders and designers (and Title 24 consultants) to specify measures and features that best suit their design practices and construction budgets. When using the performance approach, Title 24 consultants conduct compliance analysis with one of several approved computer programs, such as MICROPAS,[17] EnergyPro,[18] or CalRes.[19]

As shown below in Table 64, consultants used the performance method of compliance for the majority of their projects (99%) in 2002. Over three-fourths of these projects were evaluated with MICROPAS, and just less than one-quarter with EnergyPro.

The remaining projects were developed using a prescriptive approach. The prescriptive approach allows for specific combinations of energy-related measures and design requirements which must be utilized to achieve compliance. The 2001 Standards offer three prescriptive packages (C, D, and an alternative to D); packages A and B of the 1998 Standards are no longer allowed.[20]

[17] Enercomp, Inc. See http://www.Micropas.com/.

[18] EnergySoft LLC. See http://www.energysoft.com/.

[19] California Energy Commission. See http://www.energy.ca.gov/title24/calres_software/.

[20] California Energy Commission. *2001 Energy Efficiency Standards for Residential and Nonresidential Buildings.* August 2001. Section 151.

About what percentage of your low rise residential new construction projects were analyzed using the following compliance methods?	Average
Performance Method	99.6%
Prescriptive Package C	0.1%
Prescriptive Package D	0.1%
Prescriptive Package D-Alternative	0.3%
About what percentage of your low rise residential new construction projects were analyzed using the each of the following programs?	**Average**
Calres	0.1%
EnergyPro	22.3%
MICROPAS	76.3%
Other	1.3%

Values are weighted percentages, with weighted standard errors in parentheses.

Table 64: Compliance Approaches for Residential New Construction Projects

Attitudes toward the 2001 Standards

Overall, the consultants characterized the builders' attitude toward the 2001 Standards as one of *acceptance*. Although builders and developers generally do not welcome restrictions on construction practices, about two-thirds of the respondents stated that builders have grown accustomed to working with the Standards over the 25 years since their inception.

While about 20% of the respondents noted that the Standards are clearly more stringent than the 1998 requirements, just over 18% indicated that the 2001 revisions are not as difficult as they had anticipated. Attitudes toward the 2001 Standards compared to the 1998 Standards generally address one or more of the following three issues: cost, third party verification requirements, and maximum glazing area percentages.

- ***Cost.*** Almost 10% of the consultants indicated that the revisions to the Standards increase the cost of homes "a little bit." While cost is not a critical issue during a strong housing market, it may present a significant obstacle when the market weakens.

- ***Third Party Verification.*** Nearly half (48%) of the consultants explained that measures requiring verification are specified only if absolutely necessary to achieve compliance. The cost and level of effort associated with scheduling and potential delays in the construction schedule are commonly cited as reasons to avoid specifying measures requiring third party verification. Thus, many consultants never recommend or specify HERS certified sealed ducts or TXVs.

Duct system verification, in particular, is a point of contention among builders. One consultant, in particular, explained that the market is not developed fully enough to accommodate such a requirement. Another cited difficulty locating a contractor to conduct the testing, while two consultants explained that the building departments are not enforcing this standard. As one consultant explained, "If they want to have tight ducts, they should make it mandatory and enforce it."

To avoid the duct sealing and testing requirement, almost two-thirds of the consultants explained that many builders specify high performance windows, high efficiency HVAC equipment, or radiant barriers (in the Central Valley). (As explained below, the exception to this strategy is specification of HERS measures for ENERGY STAR qualified homes.)

- ***Maximum Glazing Area Percentages.*** Consistent with the results of the previous study, the surveys revealed that compliance strategies are a function of the maximum glazing area percentages mandated through the Standards. In general, California homebuyers demand a large number of windows; incorporating large glazing areas presents builders and Title 24 consultants with challenges in complying with the Standards – particularly in the Central Valley and other weather intense climate zones.

Despite the challenges associated with glazing percentages, 68% of the consultants explained that high performance windows (double paned, low-E, vinyl framed) are standard for many builders. One claimed that there "were such terrific advances in the energy efficiency of windows and other measures that it hasn't been too difficult to comply in any climate zone."

In addition to conducting compliance analysis and preparing documentation, Title 24 consultants provide builder education. Two consultants mentioned that educating builders about new requirements and how builders must change their practices is one of the most significant challenges Title 24 consultants face with each revision of the Standards.

Changes in Practices Due to the 2001 Residential Standards

To ascertain how the 2001 Standards affected builders, respondents were asked to characterize the level of effort required to achieve compliance under the 2001 Standards as compared to the 1998 Standards. They were then asked to comment on any changes in the design and specification practices that they felt were due specifically to the implementation of the 2001 Standards.

Table 65 presents the consultants' perceptions of the level of effort required to achieve compliance of the 2001 Standards compared to the 1998 Standards. On average, respondents rated the adjustment "very difficult" in the Desert and High Desert regions (4.5 on a scale of 1 to 5) and least difficult in the coastal climate zones (1.6 to 1.9). This is not surprising, since the focus of the 2001 changes were to decrease peak energy usage primarily by decreasing energy used for space cooling.

How would you characterize the level of effort required to achieve compliance under the 2001 Standards compared to meeting the 1998 Standards?	Average Rating *(Std. Error)* # of Respondents
North Coastal (CZ 1-5)	1.9 *(0.21)* n = 18
South Coastal (CZ 6-7)	1.6 *(0.53)* n = 6
South Inland (CZ 8-10)	3.4 *(0.32)* n = 9
Central Valley (CZ 11-13)	2.7 *(0.19)* n = 20
Desert (CZ 14)	4.6 *(1.22)* n = 2
High Desert (CZ 15)	4.6 *(0.50)* n = 2
Mountains (CZ 16)	2.4 *(0.19)* n = 10

Ratings provided on a scale of 1 to 5 with a 1 meaning "easy" and a 5 meaning "very difficult."
Values are weighted means, with weighted standard errors in parentheses.

Table 65: Adjustment to the 2001 Standards

Additional insight provided by the respondents includes the following:

- Compliance is still fairly effortless in the South Coastal region. One consultant explained that low-e glass and high efficiency central air conditioners are used to comply if necessary.
- Three consultants indicated that homes in the Central Valley are the most difficult to get to comply. One added that "a lot of high efficiency measures are needed to just meet the Standards." However, one consultant added that even though "Climate Zone 12 is the toughest in the state; it was tough before the 2001 Standards".

To gain further insight into the adjustments to building and construction practices after the implementation of the 2001 Standards, consultants were asked to comment on changes they attribute to the new Standards. Two-thirds of the consultants interviewed for this study indicated that their clients have changed their standard design and specification specifically because of the 2001 Standards, and that about 70% of the homes they analyzed in 2002 reflect such changes. Responses are summarized below.

- ***Duct system.*** While duct sealing is not commonly specified in new construction, two consultants attributed increased awareness of duct construction and "pushing contractors to provide better quality duct work" to the 2001 revisions.

- ***High performance windows.*** Six consultants attributed the increased use of low-e glass to the 2001 Standards, and that "builders have accepted vinyl-framed, low-e windows as standard." One consultant claimed the Standards have not had much of an impact on glazing "because the market is going there anyway." As revealed through other questions in the survey, the adoption of high performance windows is at least partly a response by builders, designers, and consultants to avoid HERS inspection requirements.

- ***Radiant barriers.*** One consultant stated that radiant barriers were not used in Climate Zone 15 prior to the 2001 Standards, but they are now routinely specified in that region.

- ***Thermostatic expansion valves.*** One consultant explained that "builders are more prepared to use a unit with a TXV; they were not aware of it before the 2001 Standards."

Incidence of High Efficiency Measures in Low rise Residential New Construction

To determine the incidence of various high efficiency measures specified for new single family homes, Title 24 consultants were asked how frequently builders/designers specify each measure. They were then asked to estimate the percentage of homes covered by their compliance analyses in 2002 that included each measure by geographic region.

To assess the incidence of high efficiency measures in new single family homes, survey respondents were asked to estimate the percentage of homes planned in 2002 that include each measure. Table 66 presents the percentage of non- ENERGY STAR ("standard") homes throughout California that include various high efficiency measures as reported by the Title 24 consultants interviewed.

	Overall	North Coastal	South Coastal	South Inland	Central Valley	Desert	High Desert	Mtn.
CEC climate zone		1-5	6-7	8-10	11-13	14	15	16
# 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 66: Incidence of High Efficiency Measures in "Standard" Homes

Observations with respect to these results are provided below.

- ***Thermostatic expansion valves.*** Statewide, TXVs are specified in about 25% of "standard" homes. The incidence of TXVs parallels that of central air conditioners, which are both more prevalent in areas with high cooling load. Interviews also confirmed earlier assumptions that while TXVs would be an upgrade for 10 SEER units, they are a standard feature in most 12 SEER and all 14+ SEER air conditioners. Additionally, the higher frequency of TXV installation relative to duct testing might imply that many homes are installing TXVs but not taking credit for the installation to avoid potential problems associated with verification requirements.

- ***Duct-related measures,*** including HERS certified sealed ducts, ACCA Manual D duct design, duct location, duct surface area, and R-8 duct insulation are not commonly utilized measures in "standard" residential new construction. According to respondents, R-8 duct insulation is not a practical upgrade because it does not fit into standard sized trusses. R-6 is much more common upgrade from R-4.2.

- ***Building envelope sealing.*** Building envelope sealing is not utilized in "standard" residential new construction. (Additionally, consultants indicated that builders are reluctant to conduct blower tests for fear that the home would fail an inspection, requiring additional work on the air distribution system.)

- ***High performance windows*** were specified in about 66% of "standard" homes statewide. Both builders and Title 24 consultants explained that double-paned vinyl framed windows with low-E glass are standard features of most new single family homes in California. However, aluminum framed windows are specified in some coastal homes, and even in some homes in extreme hot climates, such as Palm Springs. One consultant added that unless vinyl framed windows are installed the day of delivery to the construction site, they can warp if left in the hot sun. To avoid this risk, some builders might prefer aluminum framed windows.

- ***Radiant barriers*** are specified in about 10% of the "standard" homes statewide and are most common in extreme desert climates. Survey results indicate that the market for radiant barriers is still immature - some Title 24 consultants explained that many builders are not informed about the costs, and one mentioned the material is not available in certain areas. A few consultants mentioned that because the material is one-sided there is a considerable amount of wasted product, particularly in custom homes. Interestingly, the high volume turnkey service providers and consultants indicated that they do not specify radiant barriers at all statewide – *in either standard homes or ENERGY STAR homes*. One explained that radiant barriers are specified only when it is needed to meet Title 24.

- ***Higher efficiency water heaters*** (0.60+ EF) are commonly specified in over 90% of "standard" homes statewide. One turnkey company explained that they specify 0.60 to 0.62 EF units (40 to 75 gallon) and that 75-gallon units are more common in southern California where homes tend to be larger. Builders of large homes, however, are beginning to specify tankless, on-demand equipment.

- ***High efficiency central air conditioners.*** Overall, high efficiency air conditioners (12+ SEER) are specified in 43% of standard new homes statewide, and are more prevalent in cooling zones (11 through 16) and less prevalent in the coastal regions.

- ***High efficiency furnaces.*** As indicated by both Title 24 consultants and turnkey service providers, high efficiency furnaces are seldom specified in new construction, except in the Mountain region. Some respondents attributed this to the high cost of 90+ AFUE units. This sentiment was repeated by one of the high volume turnkey service providers interviewed for this study.

- ***Increased roof and wall insulation*** were specified in about two-thirds of "standard" homes. According to respondents, increasing insulation levels is a fairly cost-effective approach to meet Title 24. It is interesting to note that this result is inconsistent with past on-site surveys, which report that most homes possess lower levels of insulation than the prescriptive requirement. The on-sites currently being conducted for this study in homes that were built under the 2001 Standards will likely provide greater insight into whether building practices regarding insulation have changed in response to the 2001 Standards.

Specification of Measures that Would Not Meet Prescriptive Requirements

Because the performance method of compliance affords builders and designers flexibility in meeting the Title 24 Standards, some (understandably) specify measures that would not meet the prescriptive requirements. Ninety-percent of the consultants indicated that builders exceed the maximum prescriptive glazing percentage and about two-thirds indicated that builders specify less than prescriptive wall insulation.

Measure	% of Respondents
Roof insulation	25%
Wall insulation	64%
Percent glazing	90%

Table 67: Using Measures that do not meet Prescriptive Requirements

Specification Practices Not Reflected in Compliance Analysis

Interestingly, approximately 75% of the consultants indicated that builders were specifying measures for which they were not taking credit in the Title 24 compliance analysis. The most common measure not included in the compliance analysis was tight ducts. One consultant explained:

> *"We make some of the architects put notation on the plans for tight ducts but not take the credit due to possibility of inspection failure."*

Another repeated this sentiment:

> *"Some builders have standard policy to do duct testing on all their homes, but they do not want the hassle of third-party verification."*

One consultant revealed insurance issues with respect to duct sealing:

> *"[Builders] do not take credit for tight ducts since [it] requires that duct testers have professional liability insurance. It is hard to find testers with this insurance."*

Two consultants also believed that builders were specifying or installing high performance windows and not taking Title 24 credit. In fact, one of the high-volume consultants explained that they model the plans using default window values (worst-case scenario), which provides them with the flexibility to install any variety of windows for any homes in the plan.

Regional Differences in Specification Practices

The majority of respondents indicated there are differences in design and construction practices between northern and southern areas of the state and between the coastal and inland regions (94% and 95%, respectively). Few offered insight into the reasons for the differences between northern and southern regions relating to energy efficiency. However, one consultant stated that homes in northern California have increased insulation.

According to the respondents, high performance glazing is far more commonly specified in the inland regions than on the coast, followed by high efficiency central air conditioners. Two consultants also mentioned radiant barriers and increased insulation – two measures

rarely observed in the coastal areas. These sentiments reinforce the findings with respect to the incidence of high efficiency measures by climate region presented above in Table 66.

Because of the temperate climate in the coastal regions, the Standards are less stringent. Instead of upgrading cooling equipment, builders on the coast specify a TXV valve to increase cooling efficiency. One consultant explained:

> *"[A]nything works in coastal zones because there is no (space conditioning) load in coastal zones. The water heater makes the biggest difference."*

Comparing Survey Responses to the 2001 Survey

As explained above, in an effort to maintain continuity between this and the previous study, Itron surveyed participants of the previous study. Of the 41 Title 24 consultants surveyed for the 2003 study, 26 were participants of the 2001 study. Table 68 provides the average likelihood of installing high efficiency measures reported by Title 24 consultants during the 2001 and the 2003 interviews. As shown, there are noticeable differences between what consultants anticipated prior to the implementation of the 2001 Standards (pre-AB 970) and what was actually specified in 2002 (post AB 970) for five high-efficiency measures: windows, radiant barriers, water heaters, furnaces, and roof and wall insulation. The differences associated with each of these measures are discussed in further detail:

- ***High Efficiency Windows.*** As shown in Table 68, responses to the current survey indicate that consultants believe high-performance windows to be specified more often than they had anticipated previously; average ratings increased from a 3.9 to a 4.8 on a scale of 1 to 5. As explained below, consultants indicated that, overall, high-performance windows are becoming prevalent in residential new construction and that many builders use them as a standard practice.

- ***Radiant Barriers.*** Prior to the implementation of the 2001 Standards, consultants believed radiant barriers would be "somewhat likely" to be specified, or about a 3 on a scale of 1 to 5. Over a year after the implementation of the Standards, consultants indicated that radiant barriers are "not at all likely" to be specified. The most common explanation for this divergence is that the credit for radiant barriers is lower than what they anticipated, particularly in the mild climate zones.

  Additionally, one consultant explained that not utilizing radiant barriers is "a marketing choice by a lot of builders" who would rather install high efficiency space conditioning equipment because it is more cost effective and it is more easily understood by consumers. Another consultant stated that some builders specify radiant barriers but then actually forget to install them. One consultant claimed to always recommend radiant barriers but stated that his clients do not want to use them.

  Despite the fact that radiant barriers are specified much less frequently than anticipated, the few respondents who have utilized them provided very positive feedback. One consultant stated that "if builders saw a radiant barrier demo[onstrate]d, they'd want it." Another claimed that radiant barriers "provide the biggest bang for the buck."

- ***High Efficiency Water Heaters.*** Consultants' ratings of the likelihood of use of high efficiency water heaters decreased from 3.8 to 2.1 after the implementation of the 2001 Standards. In the case of water heaters, the decrease does not denote fewer high efficiency water heaters in new homes. Rather, what consultants and builders consider to be "high efficiency" seems to have changed. Since the last study, 0.60 and 0.62 EF units have become standard; high efficiency water heaters are 0.63 EF or greater.

- **High Efficiency Furnaces.** On average, high efficiency furnaces are believed to be specified less often than consultants anticipated in the previous study. As noted below, high efficiency furnaces were specified in less than one-fifth of new homes in 2002 and are rarely used to upgrade a home to the ENERGY STAR qualification.

- ***Roof and Wall Insulation.*** The average likelihood of increased roof and wall insulation also decreased since the implementation of the 2001 Standards.

Using a scale of 1 to 5 with a 1 meaning "not at all likely" and 5 meaning "very likely" how often do builders/designers specify the following measures?	**Post AB 970** *(Std. Error)* # of Respondents	**Pre-AB 970** *(Std. Error)* # of Respondents
HERS Certified sealed ducts	2.7 *(0.16)* n=40	2.7 *(0.17)* n =52
TXV /Refrigerant charge air flow test	2.2 *(0.15)* n=40	2.3 *(0.2)* n=50
High-performance windows	4.8 *(0.11)* n=40	3.9 *(0.13)* n=53
Radiant barriers	1.4 *(0.14)* n=40	3.2 *(0.18)* n=53
Higher efficiency water heater	2.5 *(0.26)* n=40	3.9 *(0.16)* n=48
Higher efficiency central air conditioner	3.3 *(0.14)* n=40	3.7 *(0.17)* n=47
Higher efficiency furnace	2.1 *(0.18)* n=40	3.5 *(0.17)* n=48
Increased wall and/or roof insulation levels	2.1 *(0.2)* n=40	3.4 *(0.16)* n=48
R-8 duct insulation	1.3 *(0.1)* n=40	*(not avail.)*

Values are weighted means, with weighted standard errors in parentheses.
Difference of means test reveals the differences between pre- and post-AB 970 responses are significantly different for all measures except HERS certified sealed ducts and TXVs.

Table 68: Likelihood of Specifying High Efficiency Measures – All Respondents

Table 69 also presents average likelihood of installing high efficiency measures reported by Title 24 consultants, but only for those respondents that participated in *both* the 2001 and 2003 surveys – pre and post AB 970. When comparing the pre and post AB970

results, they are similar to the above results for HERS certified sealed ducts, high-performance windows, radiant barriers, high efficiency water heaters, and high efficiency furnaces – meaning that if a measure is statistically different, or not, in Table 68 than it is also statistically different, or not, in Table 69. However, when comparing the results for just those Title 24 consultants that participated in both surveys, the average likelihoods for TXV valves, high efficiency central air conditioners, and roof/wall insulation, are not similar to those when comparing all respondents. These respondents reported a significantly less likelihood of using TXV valves, unlike the results of all respondents which show no significant difference between what they anticipated before AB 970 was implemented and what they have seen since AB 970 was implemented. Similarly, Table 69 shows that there is no significant difference between the pre and post AB 970 average likelihoods of specifying high efficiency air conditioners or increased roof/wall insulation.

Using a scale of 1 to 5 with a 1 meaning "not at all likely" and 5 meaning "very likely" how often do builders/designers specify the following measures?	**Post AB 970** *(Std. Error)* # of Respondents	**Pre-AB 970** *(Std. Error)* # of Respondents
HERS Certified sealed ducts	2.3 *(0.21)* n=25	2.6 *(0.30)* n=23
TXV /Refrigerant charge air flow test	1.2 *(0.11)* n=26	2.1 *(0.22)* n=24
High-performance windows	4.7 *(0.13)* n=26	4.3 *(0.18)* n=22
Radiant barriers	1.9 *(0.26)* n=26	3.3 *(0.27)* n=25
Higher efficiency water heater	3.0 *(0.23)* n=26	3.7 *(0.27)* n=22
Higher efficiency central air conditioner	3.3 *(0.11)* n=26	3.7 *(0.29)* n=21
Higher efficiency furnace	2.4 *(0.33)* n=26	3.5 *(0.28)* n=22
Increased wall and/or roof insulation levels	2.3 *(0.14)* n=24	2.8 *(0.29)* n=22

Values are weighted means, with weighted standard errors in parentheses.
The number of respondents that ranked the likelihood of specifying each measure pre- and post-AB 970 varied since not all respondents ranked the likelihood of specifying each measure.

Table 69: Likelihood of Specifying High Efficiency Measures – Participants from the Previous and Current Year Study Only

Specification Practices for California ENERGY STAR New Homes

Program Awareness and Participation

On average, Title 24 consultants indicated they are "somewhat knowledgeable" of the California ENERGY STAR New Homes program, or a 2.8 on a scale of 1 to 5. Of the 55,801 homes represented by the consultants surveyed for this study, approximately 8,690 (15%) were being designed to meet the ENERGY STAR qualification.

Observations on Specification Practices of 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.[21] 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 (Table 66 above), these "high volume" participants were asked to estimate how frequently each high efficiency measure listed Table 70 was specified in the ENERGY STAR homes that they did 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.

Table 70 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 used by builders to upgrade homes to the ENERGY STAR level. As shown in Table 70, 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 66, 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 by these consultants for ENERGY STAR qualification.

- "High volume" participants 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 the ENERGY STAR level – if the prescriptive glazing requirement is met.

[21] These consultants report to have planned approximately 7,800 California ENERGY STAR new homes in 2002. Please note that the data in Table 70 represents 7,141 homes because estimates of specific measures installed were not available for approximately 650 of the homes.

- **Increased Roof and Wall Insulation.** While increasing the roof and wall insulation in "standard" homes is reportedly being used in over three-fourths of the homes in most regions, it is being used to upgrade coastal homes to ENERGY STAR.

- Survey results do not reveal significant differences between ENERGY STAR and non-ENERGY STAR homes with respect to **water heaters**.

	Overall	North Coastal	South Coastal	South Inland	Central Valley	Desert	High Desert	Mtn.
CEC climate zone		1-5	6-7	8-10	11-13	14	15	16
# of Respondents	3	2	1	2	3	1	1	1
CA ENERGY STAR Homes represented[22]	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

Table 70: Incidence of High Efficiency Measures in ENERGY STAR Homes

When the "high volume" participants were asked to explain the additional features that a "standard" home that just meet Title 24 needs to meet ENERGY STAR, there answers were similar to the results above. Duct sealing was mentioned by all three respondents as one

[22] Please note that 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.

of the first upgrades to get homes to the ENERGY STAR level. Not only was it reported to be used by all three, but one consultant mentioned that it is the first measure used and another pointed out that duct sealing alone would get homes in some CEC climate zones to meet ENERGY STAR. Two consultants reported using high efficiency windows as an upgrade while the other consultant said that these were specified for even all of their "standard" homes.

TXVs and 12 SEER air conditioners were reported to be the next upgrades used depending on the climate zone. While two of the three "high volume" participants 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.

General Comments from Survey Respondents

About one-third of the consultants interviewed for this study took advantage of the opportunity to provide additional comments regarding the Title 24 Standards with respect to residential new construction.

- Three consultants provided comments regarding duct sealing HERS verification requirements. One stated,

  > *"[There is] not a lot of interest in HERS. [There is] not a lot of infrastructure or awareness about HERS, so [I] do not want to recommend something to clients that they are unfamiliar with."*

It is important to note here that a small percentage of organizations account for the majority of HERS inspections. This perspective seems to be representative of those who are not involved with HERS.

- Additionally, one consultant offered a suggestion for streamlining the verification process:

  > *"Ducts that can be visually inspected by a building inspector, and ducts in conditioned space, should be able to be examined by a building official rather than a third-party HERS inspector."*

- Eight consultants voiced opinions about enforcement of the Standards. While the majority expressed concern over the apparent lack of enforcement of the Standards, a few noted improvement in levels of enforcement over the years. Examples of comments are provided below.

  > *"There must be more implementation at the field inspection level to make sure that Title 24 requirements are being met."*

  > *"For Title 24 to work, city inspectors must enforce HERS inspections… Lack of enforcement makes it hard for me as a CHEERS rater."*

> *"I am thankful for the efforts I am beginning to see in building departments in enforcing Title 24. There is improved education and greater knowledge among building inspectors."*

- Finally, three consultants offered opinions regarding the availability of information with respect to the Standards. These respondents feel that the architectural community should be better informed about the Standards.

5. Evaluation Methodology

Building Characteristics Methodology

In order to analyze the building characteristics of ENERGY STAR homes, RLW devised three databases—one for single family projects (692 plans), one for low-rise multifamily projects (225 plans) and one for high rise multifamily projects (5 plans). Each database has the same structural tables that summarize information by the following categories: Building Detail, DHW (Domestic Hot Water), HVAC (heating and cooling), Fenestration, Insulation, and Zone Detail. These three databases will be delivered in MS Access format.

Queries have been set up to allow the user to analyze some key questions for each measure. All of the summary tables in this report have been obtained from queries conducted on the project database.

The following is a list of the steps that were taken to ready the databases for delivery:

- Transfer Files from Utilities
- Parsed Data from Robert Scott
- Tracking Data from Utilities and Weight Assignment
- Creation of Efficiency Categories
- Creation of Analysis Queries
- Development of Database Summarization Tool

This section contains a description of the databases and the steps taken to prepare the databases for analysis and delivery; however for a complete description of each table and query, see the appendix to this report.

Transfer Files from Utilities

A transfer file was created from every Micropas and Energy Pro file that stored the building characteristics from the Title 24 report in text format. All three utilities had the transfer files that were created for each plan in the program. RLW requested and received these transfer files from each utility along with the utility tracking data on the planned number of units to be built for each plan.

Parsed Data Files

After the transfer files were received by RLW, the files were sent to Rasent Solutions where the text was parsed into a columnar format that enabled RLW to conduct the analysis. Rasent Solutions provided the parsed information to RLW in Microsoft Excel format and RLW used SAS to import the files into MS Access where a QC process was implemented. The parsing process involved several iterations since the text files were found to be inconsistent among the different Title 24 program versions. When the text files differed, the parsing program had to be modified to adapt to the differences and the data went through the QC process again.

Tracking Data from Utilities and Weight Assignment

Once the plans were cleaned in the database, the case weights for the analysis were merged into the database in the 'FloorPlan_Projects' table under the Plan Weight variable. Each plan was given a corresponding weight that we define to be the number of units built from that plan. At the time of the evaluation, the utility tracking data did not contain enough information on each participating plan to determine the actual or planned number

of units that were going to be built from each plan. Instead, the utilities only recorded the total number of units that the builders planned to construct for each project (projects typically have more than one plan). Since RLW did not receive enough data to link the specific number of units to each plan, equal weight was given to each plan based on the total number of units in the project. These weights were used to expand the sample to the population.

Creation of Efficiency Categories

Efficiency categories were developed for each appliance type depending on the distribution of the efficiencies. When applicable, the measures were analyzed by the prescriptive requirements for the specific measure. A typical efficiency analysis would result in a summary of the percentage of units better than, equal to, or worse than prescriptive requirements.

Creation of Analysis Queries

Analysis queries for each measure were created in MS Access to analyze each measure by Utility, climate zone, or size of home. Each of the measures was analyzed by climate zone and utility. In addition, some measures were analyzed by the size of the home and the prescriptive Title 24 requirements. The square foot ranges for each unit were broken into 4 segments: less than 1500 square feet, 1500 to 2500 square feet, 2501 to 3500 square feet, and 3501 or more square feet. These analysis queries were designed specifically for the Model Bases Statistical Sampling (MBSS) program to analyze the data using ratio estimation techniques. More information on the format of each query is provided in the appendix.

Development of Database Summarization Tool

The final big challenge to the success of this project was to make the database user-friendly. To meet this challenge, we provided a variant of the analysis software developed for a CEC Nonresidential New Construction Database project and used extensively in the CBEE Nonresidential New Construction Baseline study. In these prior studies we faced the challenge of providing analysis software that would implement stratified ratio estimation using an Access database of complex building characteristics. We created a Visual Basic application of MBSS that would select one or more queries in the database, carry out the statistical calculations of stratified ratio estimation, and create tables in the database with the results desired. The application tailored for this project has the ability to:

- Calculate ratio estimates, classified by any available categorical variable such as utility, square footage bins, or climate zone.
- Calculate the underlying sample sizes
- Calculate the appropriate model-based error bounds
- Calculate proportions (i.e., proportion of all cooling units that have SEER 10 value vs. SEER 12 or above)

This software can be used to create one-way, two-way or multi-way tables categorizing the market share of specified appliances and measures by any specified dimensions. The resulting tables can be easily exported to Excel and displayed graphically. This software was used to create the graphs shown in the writing sample given in the Appendix. The software provided is fully documented in the Appendix, and a help file is available within the software if the user encounters any problems.

The following is a list of some examples of the types of weighted statistics that can be obtained from the database:

- Average Efficiency of primary HVAC and other equipment
- Percentage of Homes in Climate Zone 1-5 with Certain Type of Water Heater

This type of information can be developed for all sites, or for various classifications of residences. Using the standard queries that we provide in the database, the sites can be classified by any combination of the following variables:

- Utility Service Territory
- Climate Zone (CZ 1-16 or RMST 1-5)
- Square Footage (4 bins)

Almost all building characteristics results were presented by utility and climate zone. Much of the variance between climate zones was usually due to differing Title 24 standards and weather patterns. Results by each utility are also very informative in understanding the difference in building measure efficiency. Sometimes, RLW presented calculations by square footage bins to compare results between small and large homes.

Ex-Post Energy Saving Methodology

RLW utilized each builder's construction plans that qualified the home as ENERGY STAR to estimate the energy savings, demand reduction and therm savings. The EM&V estimates are based on Title 24 files that were obtained from each of the four utilities represented in the evaluation. The Title 24 files used were all approved ES homes by the utilities for participation in the 2002 program, and represent the utility's best approximation of what will actually be built.

For each ENERGY STAR compliant plan, the C2-R form in the Title 24 file summarizes the standard design (baseline) energy use and the proposed design (as built) energy use for space heating, space cooling, and water heating end-uses in terms of source energy (kBtu/sf-yr). Since the 2002 utility 4th quarter reports (filed May 1, 2003) presented the savings by kWh and therms, RLW also summarized the data using the same breakdown in order to compute realization rates using the utility estimates. It should be noted that while calculating the realization rates we noticed large differences in the claimed savings between the utilities. Part of the reason is that different methodologies were used by each utility to calculate 2002 energy savings results for the final AEAP filing in 2003. We discuss this issue further in the conclusions and recommendations section of the report. The remainder of this section describes the methodology RLW used to calculate the ex-post energy savings for kWh, therms, and source energy which combines both kWh and therm savings.

Allocation of End Uses

The first step in the analysis was to determine which of the three end-uses should be included in the kWh and therm calculations for each of the plans. All cooling systems utilized electricity and consequently were used in the electricity (kWh) savings calculation. Because all hot water systems in the program utilized gas as the primary energy source, hot water savings were added to the therm reduction calculation. Finally, heating systems varied by each unit; consequently, heating savings from homes that utilized a heat pump were added to electricity savings and homes with a furnace were added to therm

reductions. Standards for the three end-uses are set by Title 24 and often vary by climate zone.

Electricity Savings in kWh Calculation

AEAP energy savings were presented in units of kilowatt-hour. Therefore, in order to convert cooling energy and the electric heating energy from kBtu/sf-yr, RLW made the following conversions:

Kbtu/sqft-yr: (Δ Electricity savings) = (Std. Cooling – Prop. Cooling) + (Std. Heating – Prop. Heating)[23]

In order to differentiate electricity savings and therm reductions, RLW only utilized cooling energy use and electric heating energy use for electricity savings. RLW took the difference between the Title 24 standard for each project and the proposed (as built) estimate.

Kbtu/sqft-yr Source: Δ Source Electricity Savings = (Δ Electricity savings) / 3

The AEAP aggregate electricity savings is presented at the "source" level, which is approximately 3 times the end-use savings.

Kwh/unit: Kilowatt hour/unit= (Δ Source Electricity Savings) x square feet) / 3.413

A kilowatt-hour is approximately equal to 3.413 kBtu, so in order to convert kBtu savings into kWh savings RLW divided the difference in source electricity savings by 3.413. In addition, end-use savings is presented per square foot, so RLW multiplied each difference in energy savings by the conditioned square footage of each unit.

Total Kwh: Total Electricity Savings= $\sum_{1}^{i} \mathrm{wi} * (\mathrm{kwh/unit}$, *where* w_i= *number of units/plan.*

Finally, each unit's source electricity savings (kWh) was weighted by the number of units in each plan.

Therm Reductions Calculation

Therm reductions are end-use savings from hot water and some heating savings. All heating savings where homes that did not utilize a heatpump were added to the therm calculation in addition to hot water savings. RLW calculated therm reductions as follows:

Kbtu/sqft: (Δ Therm Reduction) = (Std. Hot Water – Prop. Hot Water) + (Std. Heating – Prop. Heating)[24]

In order to differentiate electricity savings and therm reductions, RLW only utilized hot water energy use and gas heating energy use for therm savings. RLW took the difference between the Title 24 standard for each project and the proposed (as built) estimate.

[23] Change in heating savings were only used if unit contained a heatpump.

[24] Change in heating savings were only used if unit did not contain a heat pump heating system.

Therms/unit: Therms/unit= (Δ Therm Reduction) x square feet) / 100

One therm is approximately equal to 100 kBtu, so in order to convert kBtu savings up to therms, RLW divided the difference in source therm savings by 100. In addition, end-use savings is presented per square foot, so RLW multiplied each difference in therm savings by the conditioned square footage of each unit.

Total Therms: Total Therm Reductions = $\sum_{1}^{i} \text{wi} * (\text{therms/unit})$, *where* w_i= *number of units/plan.*

Finally, each unit's therm savings (thm) was weighted by the number of units in each plan.

Realization Rate

The realization rate represents the AEAP estimate divided by the EM&V estimate. It is our understanding that each utility used a different methodology to calculate the AEAP estimate, therefore realization rates varied greatly by utility. Other measures may help compare the four utilities by a unified standard.

Savings Per Unit

RLW presents electricity and therm savings per unit that participated as an ENERGY STAR home. Essentially, this measurement tool characterizes the marginal energy efficiency value of each unit that contributes to the overall energy savings. The greater the savings per unit, the more effective and cost efficient the program is.

Savings per Unit = Total Savings / Total Number of ES Units

Cost Per Unit Recruited

The number of housing units recruited by each utility in one way signifies the level of penetration. In addition, the cost per unit recruited may also be used as a measurement of cost-effectiveness of the program. The total cost is based on IOU budgets presented in utility reports and budgets approved by the CPUC.

Cost per Unit Recruited = Total Program Budget / Total Number of ES Units

Cost Per 1,000 kBtu Saved

Cost effectiveness can also be measured by the amount of energy savings produced per dollar. RLW calculated the cost (in program dollars) of saving 1,000 kBtu (both electric and therm). The calculation is as follows:

Cost per 1,000 kBtu saved = 1,000 x (total energy savings/total program budget)

Savings Per Unit

RLW presents electricity and therm savings per unit that participated as an ENERGY STAR home. Essentially, this measurement tool characterizes the marginal energy efficiency value of each unit that contributes to the overall energy savings. The greater the savings per unit, the more effective and cost efficient the program is.

Savings per Unit = Total Savings / Total Number of ES Units

Summary

The total electricity savings and therm reduction calculations are key in presenting the total energy savings as a result of the ENERGY STAR program. Depending on the end-use (hot water, heating or cooling), saving calculations varied by the type of energy utilized. The realization rate is the EM&V estimate divided by the AEAP estimate.

Other measures that RLW utilized to measure the effectiveness of the ENERGY STAR program included: savings per unit, cost per unit recruited, and cost per 1,000 kBtu saved. One strength in these measurement tools is that the same methodology was utilized for each utility's estimation. The AEAP estimates of energy savings varied greatly by each utility, which is reflected in RLW's calculated realization rates.

6. Ex-Post Energy Savings

The most telling measurements used to evaluate the impact of the 2002 ENERGY STAR program are the overall energy savings that are produced as a result of constructing more energy efficient homes. RLW utilized each builder's Title 24 compliance files that qualified the home as ENERGY STAR to estimate the energy (i.e. gas and electric) savings. In sum, the savings is the difference between the prescriptive baseline Title 24 standard that the home must meet and the as-built level of efficiency.

After the 2002 ENERGY STAR program was complete, the utilities updated the CPUC energy savings targets with actual program savings as part of the Annual Earnings Assessment Proceeding (AEAP) filing in April 2003. At this point in time, the utilities had a concrete number of participating single family and multifamily units and possessed the Title 24 files for the majority of the program participants. Some utilities utilized the Title 24 data to adjust the original CPUC savings estimate, while other utilities elected other means in estimating post-program energy savings. RLW recommends that the utilities make an effort to utilize a common approach in estimating program energy savings so that savings may be compared more objectively.

For this report, RLW encourages readers to not only draw on the AEAP filing as an indicator of program success, but also utilize other metrics that go further than verifying AEAP claimed savings. Since program implementation budgets and numbers of participants also vary by utility, we have included additional indicators of program cost effectiveness that are perhaps equally, if not more important, as overall realization rates of savings estimates. These metrics provide further insight into the evaluation and use equivalent methodologies of calculation.

In conclusion, the EM&V of this program will seek alternative methods and data sources in order to evaluate gas and electric savings resulting from the program. Currently the EM&V team is considering a billing analysis, using a non-participant control group that is currently part of a residential new construction baseline study being conducted by Itron, and the 2002 program participants. Similarly, data from the Itron baseline study may also be used to determine what the actual construction baseline is, and how close it is to either of the two previously presented approaches. Therefore, the Phase II EM&V report will delve more deeply into this issue and will make recommendations for future EM&V methodology for this program.

Energy Savings

In this section we present a preliminary assessment of what the ENERGY STAR New Homes program will produce (upon final build out) in terms of energy savings. We present two approaches in this section for determining the fraction of kBtu savings that are gas or electric. The first approach we present is the approach the utilities selected as part of the original EM&V plan, the second approach is an alternative approach that utilizes data from a recent residential new construction analysis conducted by Itron,[25] herein referred to as "Approach A" and "Approach B," respectively.

[25] Itron presented the utilities with a study memo titled "Differences in Savings Estimates". June 2003

Approach A Evaluation Overview

Approach A methodology is based on Title 24 files that were obtained from each of the four utilities represented in the evaluation. The Title 24 files used were all approved by the utilities for participation in the 2002 program, and represent the utilities' best approximation of what will actually be built. Energy savings are based on a comparison of the "as specified"[26] home compared to the prescriptive baseline (Package D) home.

Again, using output from the Title 24 files RLW calculated the energy savings for ENERGY STAR homes by comparing the energy usage of the prescriptive baseline home to the as-specified home. For each single family residential end-use (i.e., heating, cooling and water heating), the difference in energy use was determined in units of kBtu. Depending on the fuel type of the equipment installed in the home, the kBtu savings for each end-use was converted to either gas or electric savings. Each housing plan in the program underwent this analysis before being weighted to the total number of plans represented in the program.

In California, builders can use either a performance-based method to meet Title 24 standards that use "trade-off" savings between end-use categories (cooling, heating, hot water) or a prescriptive method to meet the minimum requirements by each specified category. Builders very seldom use the prescriptive method due to its cost-ineffectiveness. For this reason we also considered an alternative approach of calculating gas and electric savings, herein referred to as "Approach B."

Approach B Evaluation Overview

The Approach B method of calculating energy savings by each fuel type accounts for differing assumptions in the baseline figures. The Approach A methodology of gas and electricity savings uses the prescriptive (Package D) based standards[27] as the baseline. In this section we utilize data from a previous Itron analysis. The Itron work sought to identify a baseline that would more accurately reflect actual construction practice in California.

Since nearly all residential Title 24 compliance is done on a performance basis, rather than a prescriptive basis, it is pertinent to identify what the performance baseline would be in order to most accurately predict gas and electric savings. However, predicting the performance baseline can be quite subjective and requires a significant amount of effort each year in order to determine what the industry is doing in terms of construction practice. The Itron study sought to identify actual baseline construction practice through surveys of builders and Title 24 consultants. Additionally, the study also sought to identify what measures, or packages of measures, builders would likely implement (by coastal and inland climate zones) in order to meet ENERGY STAR.[28] Although the utilities ultimately selected the previously presented approach for EM&V, the resulting gas and electric savings might not be an accurate representation of what is actually being saved (since the

[26] "As specified" refers to how the ENERGY STAR home is modeled in Title 24. Is most cases this is an accurate representation of the home's material and equipment characteristics. However, it is possible that the home was ultimately constructed slightly differently, which would be identified by the CHEERS rater at the time of the CHEERS inspection.

[27] The prescriptive standards refer to the specific Title 24 minimum standards in each end-use category (cooling, heating, hot water).

[28] A chapter of this report is dedicated to comparing the Title 24 consultant and builder responses to what we actually found in ENERGY STAR homes in order to determine how accurate this type of reporting is.

prescriptive baseline does not change). The primary reason the approach was selected was because according to interviews with Title 24 consultants, it would be a subjective exercise to determine what would have been built if the builder did not participate in the program. Also, subsequently, RLW found significant discrepancies for HVAC efficiencies and levels of insulation between the survey responses of both builders and Title 24 consultants compared with actual building practices.

Currently the EM&V team is considering a billing analysis, using a non-participant control group that is currently part of a single family residential new construction baseline study being conducted by Itron, and the 2002 single family participants of the ENERGY STAR New Homes Program. Similarly, data from the Itron baseline study may also be used to determine what the actual construction baseline is, and how similar it is to the results of either of the two previously presented approaches (i.e., Approach A and Approach B). Therefore, the Phase II EM&V report will delve more deeply into this issue and will make recommendations for future EM&V methodology for this program.

RLW is not confident that the Approach A approach used to measure gas and electric savings for single family accurately measures the same for multifamily housing. Multifamily new construction is a relatively new market to energy efficiency programs in California, therefore there has been less attention paid to this segment in the past, and as a result there is less secondary information to be gleaned for addressing this deficiency. Although a multifamily new construction baseline study was conducted in 2001 in California, the study was not able to gather enough representative and quantitative data to leverage for the purpose of understanding actual baseline construction practice. With little other information available, it is extremely difficult to gauge the accuracy of the Approach A approach for the same reasons as we mention in the single family discussion.

Since this market will undergo a mandated transformation in 2005 RLW is recommending continued use of the Approach A approach to evaluate energy savings in the multifamily segment. We believe the cost of conducting an in depth study in order to identify a baseline that will soon change as part of the 2005 energy code revisions is an inefficient use of ratepayer funds. Instead, we recommend leveraging the lessons learned from the single family process of identifying an EM&V method, we believe these activities will assist in determining the most cost effective and logical approach to estimating energy savings by fuel type in the multifamily new construction program.

Single Family Energy Savings in kWh – Approach A

Table 71 presents energy savings for single family homes participating in the 2002 ENERGY STAR New Homes Program. The first column of data shows each utility's 4th quarter AEAP (Annual Earnings Assessment Proceeding) filing with the CPUC on May 1, 2003 (after program execution). The AEAP filing represents the IOU's estimate of energy and therm savings. Once again, the utilities arrived at these estimates using varying approaches. The AEAP filing is followed by the EM&V (Evaluation, measurement and verification) estimate, or the amount of single family energy savings as estimated by RLW. The realization rate is the ratio of the EM&V Estimate to the AEAP-filed estimate. The realization rate is followed by the 'Housing Units' column, which contains the total number of filed housing units claimed in the AEAP. The final column, 'Savings per Unit', is the EM&V estimate of savings per housing unit claimed.

Based on the realization rate, PG&E and SoCalGas are the only utilities where the EM&V estimate exceeded the utility AEAP estimate. SoCalGas' program produced a 226% realization rate in energy savings, PG&E's single family homes program is producing a

102% realization rate, and the other utilities are less than 100%. However, when one reviews the estimated savings per unit, it is Southern California Gas that thrived with an extraordinary 1,496 kWh per housing unit saved. The reason for the high savings per unit for SoCalGas is that there were only two unique single family builder participants—one of whom constructed 396 units of senior homes in Banning (southern California inland/desert region). Because of Banning's hot climate, the high efficiency air-conditioning measures present in these homes produced significantly more electric savings than the average project. On average, the 396 single family units exceeded Title 24 requirements by 25 to 30%. Since the Banning project represents more than 90% (396 of 432 units) of SCG's total single family participant projects it is understandable why their per unit electric savings is so great compared to the other utilities.

The savings per unit recruited for the other utilities were as follows: SDG&E (173 kWh/unit), PG&E (240 kWh/unit) and SCE (392 kWh/unit). Not only did SCE produce the second best savings per unit, but they also had the highest participation rate based on the number of single family housing units participating.

SDG&E fared worst in terms of its realization rate and savings per unit. RLW's estimate is only 25% of the utility estimate. Their kilowatt-hour savings per unit were only 173 kWh per unit—less than half of SCE's result. Part of the reason for SDG&E's low electric savings may be due to the mild climate of their region and the types of measures implemented by builders to reach ENERGY STAR.

It should also be noted that RLW applied a 0.80 net-to-gross factor to the gross savings calculations. The 0.80 value was also used by the utilities and is included in their AEAP estimate. The 0.80 factor was taken from the CPUC's Energy Policy Handbook.

Utility	Energy Savings, kWh		Realization Rate	Housing Units	Savings per Unit
	AEAP Estimate	EM&VEstimate			
PG&E	829,781	846,362	102%	3,520	240
SCE	4,199,475	2,049,974	49%	5,234	392
SoCalGas	286,243	646,158	226%	432	1,496
SDG&E	1,268,170	321,698	25%	1,863	173
Overall	**6,583,669**	**3,864,192**		**11,049**	**350**

Table 71: Summary of Overall Energy Savings (kWh) – Approach A

Single Family Therm Reductions – Approach A

Therm reductions are the amount of gas energy saved due to greater efficiency produced from measures that utilize natural gas. Because all of the cooling equipment in ENERGY STAR homes was fueled by electricity, RLW only included hot water efficiency improvement (all water heaters gas-fueled) and heating efficiency improvements (not including heatpumps) to calculate the total therm savings.

Although SDG&E had the highest realization rate (1318%), actual therm savings per unit were highest for PG&E's single family projects (116 therms/unit). SoCalGas had the lowest savings per unit and a realization rate of 306%. Overall, each unit produced about 85 therms of savings in gas. SCE, an all-electric utility, did not claim any therm savings; therefore no realization rate has been calculated.

The differences in savings per unit can be explained by the various energy efficient measures that are installed. For example, if builders in PG&E's territory installed more efficient hot water heaters, while SoCalGas builders installed more energy efficient cooling

measures, then PG&E will result in greater therm reductions per unit (hot water heater fueled by gas) and SoCalGas will see more electric savings per unit (cooling fueled by electricity).

Utility	Therm Reduction		Realization Rate	Housing Units	Savings per Unit (Therm/unit)
	AEAP Estimate	EM&V Estimate			
PG&E	403,299	407,443	101%	3,520	116
SCE	n/a	395,617	n/a	5,234	76
SoCalGas	6,163	18,851	306%	432	44
SDG&E	8,988	118,434	1318%	1,863	64
Overall	**418,450**	**940,345**		**11,049**	**85**

Table 72: Summary of Overall Therm Reduction (Therms) – Approach A

Alternate Ex-Post Gas/Electricity Saving Calculation – Approach B

In California, builders can use either a performance-based method to meet Title 24 standards that use "trade-off" savings between end-use categories (cooling, heating, hot water) or a prescriptive method to meet the minimum requirements by each specified category. Builders very seldom use the prescriptive method due to its cost-ineffectiveness.

In this section RLW presents an alternative method of calculating energy savings by each fuel type in order to account for differing assumptions in the baseline figures. In our previous presentation of gas and electricity savings RLW assumed the prescriptive based standards[29] as the baseline. In this section we utilize data from a previous study done by Itron.[30] The Itron study sought to identify a baseline that would more accurately reflect actual construction practice in California.

Since nearly all residential Title 24 compliance is done on a performance basis, rather than prescriptively, it makes sense to try an identify what the performance baseline would be in order to most accurately predict gas and electric savings. However, predicting the performance baseline can be quite subjective and requires a significant amount of effort each year in order to determine what the industry is doing in terms of construction practice. The Itron study sought to identify actual baseline construction practice through surveys of builders and Title 24 consultants. Additionally, the study also sought to identify what measures, or packages of measures, builders would likely implement (by coastal and inland climate zones) in order to meet ENERGY STAR.[31] Although the utilities ultimately selected the previously presented approach for EM&V, the resulting gas and electric savings might not be an accurate representation of what is actually being saved (since the prescriptive baseline does not change). The primary reasons the approach was selected was because of the subjectivity that is removed, and because the baseline would not need to be researched each year.

Table 73 presents an example of this discussion. Take for example a standard home that prescriptively complies with Title 24 standards that allows: 5 kBtu/sqft-yr for heating, 8

[29] The prescriptive standards refer to the specific Title 24 minimum standards in each end-use category (cooling, heating, hot water).

[30] Itron presented the utilities with a study memo titled "Differences in Savings Estimates". June 2003.

[31] A chapter of this report (Comparison of Builder Survey, T24 Consultant Survey, and Building Characteristics) is dedicated to comparing the Title 24 consultant and builder responses to what we actually found in ENERGY STAR homes in order to determine how accurate this type of reporting is.

kBtu/sqft-yr for cooling, and 10 kBtu/sqft-yr for hot water. This home may have (likely) complied to Title 24 standards by constructing a home with end-uses of: 8 kBtu/sqft-yr for heating, 8 kBtu/sqft-yr for cooling, and 7 kBtu/sqft-yr for hot water because in a performance based model, builders must only meet or exceed the total energy allowance—in this case 23 kBtu/sqft-yr. Consequently, the prescriptive standard does not necessarily represent the actual allocation of end-use energy of standard homes in California. Then, depending upon the fuel type of the end-use, gas and electric savings will vary, while the kBtu savings will remain constant.

Method	Heating	Cooling	Hot Water	Total
Prescriptive Title 24 Requirement	5	8	10	23
Performance-Based Compliance	8	8	7	23
Difference	**-3**	**0**	**3**	**0**

Table 73: Performance vs. Prescriptive Compliance, kBtu/sqft-yr

Using the Itron study findings, RLW determined the fraction of kBtu savings that were either gas or electric, using only a different baseline (performance rather than prescriptive). The results of this analysis are presented in the remainder of this section.

Fuel-Type Ratio Estimates by Itron Study

In this section, RLW utilized ratios that estimate the actual proportion of savings by fuel-type, which was based on a sample of standard and ENERGY STAR homes in 2001 by Itron. Because these ratios are an estimate and housing construction practices are constantly in a state of flux, RLW reiterates that this is only an broad estimate to correct the difference in prescriptive versus performance based compliance methods. The best way to measure the true gas and electric savings produced by ENERGY STAR homes would be to compare the C2-R file if the home were built to the minimum Title 24 standards (use as standard) and the C2-R file for the actual built home to ENERGY STAR standards (use as proposed). However, since an "absent the program" C2-R does not exist we must use an alternate approach.

Table 74 presents the estimated ratios by each utility and by inland homes and coastal homes as determined by Itron. In general, more electricity savings result in inland regions (Climate zones 8-16) than in coastal regions (Climate zone 1-7). SCE had the greatest variance between regions where coastal homes had on average, electricity savings of 42% where as inland homes had an average of 87% electricity savings.[32]

The data presented in Table 74 shows what fraction of the total kBtu savings that can be attributed to each fuel type. The data presented is based on the findings of the Itron study.

Utility COASTAL	Gas (Therms)	Electricity (kWh)	Total
SCE	58%	42%	100%
PG&E	71%	29%	100%
SDG&E/SoCalGas	12%	88%	100%

Utility INLAND	Gas (Therms)	Electricity (kWh)	Total
SCE	13%	87%	100%
PG&E	58%	42%	100%
SDG&E/SoCalGas	11%	89%	100%

Table 74: Fuel-Type Ratios

RLW applied Itron's ratios between fuel-type savings to each utility's total kBtu savings in order to gain an alternative estimate of gas versus electric savings. Note this

[32] The percentages are the amount of kBtu savings for electric as apposed to gas.

methodology is only to account for the difference in gas versus electric savings, but the combined/total energy savings between the two methodologies remains equal. Table 75 summarizes the total savings by gas/electric and coastal/inland areas.

	Gas Savings (kBtu)		Electric Savings (kBtu)		
Utility	Coastal	Inland	Coastal	Inland	Total (kBtu)
PG&E	5,018,528	24,531,183	2,038,989	17,821,449	49,410,150
SCE	-	7,610,670	-	52,940,736	60,551,406
SoCalGas	58,393	875,577	414,337	7,152,814	8,501,121
SDG&E	1,090,851	687,747	7,740,270	5,618,385	15,137,253
Total	**6,167,772**	**33,705,177**	**10,193,596**	**83,533,385**	**133,599,930**

Table 75: EM&V kBtu Savings Estimates Ratio Adjusted

Table 76 presents the alternate EM&V electricity savings and presents the associated realization rates. SCE had the largest change in realization rate from 49% to 123%. Essentially, the alternative savings redistributes the total energy savings. All utilities exceed the AEAP estimate with the EM&V estimate, when this approach is applied.

	Electric Savings (kBtu)		Realization
Utility	AEAP Estimate	EM&V Estimate	Rate
PG&E	8,496,128	19,860,438	234%
SCE	42,998,425	52,940,736	123%
SoCalGas	2,930,842	7,567,151	258%
SDG&E	12,984,793	13,358,655	103%
Total	**67,410,187**	**93,726,981**	**139%**

Table 76: Approach B Electric Savings Realization Rates by Utility

Because Itron's ratios gave greater weight to electricity savings, Table 77 shows decreased realization rates in gas savings. SCE does not claim its gas savings because it is an all-electric utility. PG&E's gas AEAP estimate did not meet or exceed the alternative gas EM&V estimate, even though their electric AEAP estimate was less than half of the alternative electric EM&V estimate.

	Gas Savings (kBtu)		Realization
Utility	AEAP Estimate	EM&V Estimate	Rate
PG&E	40,329,900	29,549,712	73%
SCE	-	7,610,670	
SoCalGas	616,300	933,970	152%
SDG&E	898,800	1,778,598	198%
Total	**41,845,000**	**32,262,280**	**77%**

Table 77: Approach B Gas Savings Realization Rates by Utility

Depending on the climate zone and Title 24 end-use allotment, builders will chose different energy efficient measures based on cost, not on the prescriptive end-use values. For example, a climate zone that has a low allowance for cooling does not mean that builders will construct homes with highly efficient cooling systems to meet that specified low cooling allowance; instead, using performance based compliance they may exceed the hot water allowance and take the extra credit from hot water and use it as a trade-off in the cooling category.

Since the performance baseline is an ever moving target, it may be most productive to evaluate each program on its overall gas and electric (total energy or kBtu) savings rather than basing it on fuel-type savings. Conversely, the prescriptive baseline approach could be applied consistently since the baseline is fixed, although this methodology likely does not accurately reflect true gas and electric savings.

Single Family Combined Total Energy Savings

Table 78 combines the gas and electric savings data presented in the previous two tables. In this section we compute fuel-neutral realization rates by converting all energy savings into kBtu's. The overall average split was 70% gas savings and 30% electric savings based on the prescriptive standard values. SoCalGas' ratio between gas and electric was 22% vs. 78%, respectively.

Using the AEAP estimate we have calculated an overall single family realization rate. This realization rate does not vary by either methodology. SoCalGas has the best overall program realization rate at 240%, followed by SDG&E and PG&E produced realization rates of 109% and 101% respectively. SCE was the only utility with a realization rate below 100% with 49%. Note that RLW did not include SCE's therm reductions in the realization rate calculation since SCE did not claim any therm savings. However, in the alternate calculation of electric savings, SCE had a realization rate of 123% because it allowed them to allocate a greater portion of the total savings to electric rather than gas. Rather than attempting to guess a ratio that estimates a performance-based standard, SCE should consider claiming gas savings in order to account for the fuel-blind methods of reaching Title 24 compliance.

Utility	EM&V Therm Reductions (kBtu)	EM&V Electricity Savings (kBtu)	% of Therm Savings of Total	% Energy Savings of Total	EM&V Total Energy Savings (kBtu)	AEAP Estimate	Realization Rate
PG&E	40,744,253	8,665,896	82%	18%	49,410,150	48,826,028	101%
SCE	39,561,725	20,989,680	65%	35%	60,551,406	42,998,425	49%*
SoCalGas	1,885,105	6,616,016	22%	78%	8,501,121	3,547,142	240%
SDG&E	11,843,386	3,293,867	78%	22%	15,137,253	13,883,593	109%
Overall	**94,034,469**	**39,565,460**	**70%**	**30%**	**133,599,930**	**109,255,187**	**122%**

*Therm Reductions were not included in the total realization rate.

Table 78: Total Energy Savings and Realization Rate

In conclusion, the EM&V of this program will seek alternative methods and data sources in order to evaluate gas and electric savings resulting from the program. Currently the EM&V team is considering a billing analysis, using a non-participant control group that is currently part of a residential new construction baseline study being conducted by Itron, and the 2002 program participants. Similarly, data from the Itron baseline study may also be used to determine what the actual construction baseline is, and how close it is to either of the two previously presented approaches. Therefore, the Phase II EM&V report will delve more deeply into this issue and will make recommendations for future EM&V methodology for this program.

Cost of Total Energy Reduction (in kBtu) and Single family Unit Recruitment

RLW also computed the cost of each single family home recruited, and the total energy saved for each utility, which is summarized in Table 79.[33] The most cost effective program generates the greatest amount of energy savings (for load reduction) and unit participation (for market penetration) with the least amount of program funds.

[33] RLW included SCE's gas savings to better compare the utilities on a consistent methodology.

SDG&E had by far the lowest cost per unit recruited ($580), while SoCalGas had the highest cost for each single family unit ($1,718). SoCalGas is unique in that it had very few single family projects, which may explain part of the higher cost.

The lowest cost per 1,000 kBtu saved was by SDG&E, so by measurement of dollars spent per 1,000 kBtu saved, SDG&E excelled at $71.35. After SDG&E, SCE faired well with $81.21 per 1,000 kBtu saved, and PG&E finished with the highest cost of $89.29 to produce 1,000 kBtu of energy reduction. Interestingly, the two utilities (PG&E and SDG&E) with the best kBtu (fuel neutral) realization rates had the highest and lowest cost per kBtu saved (respectively $89.29 and $71.35).

Utility	RLW Total kBtu Reduction	2002 Single-Family Budget	Single-Family Units	Cost Per Unit Recruited	Cost per 1000 kBtu Saved
PG&E	49,410,150	$ 4,412,000	3,520	$ 1,253	$ 89.29
SCE	60,551,406	$ 4,917,183	5,234	$ 939	$ 81.21
SoCalGas	8,501,121	$ 742,000	432	$ 1,718	$ 87.28
SDG&E	15,137,253	$ 1,080,066	1,863	$ 580	$ 71.35
Overall	133,599,930	$ 11,151,249	11,049	$ 1,009	$ 83.47

Table 79: Summary of Cost of Units Recruited and Energy Saved

Table 80 and Table 81 present a breakdown of the EM&V energy savings estimates by utility and climate zone. Table 80 shows the amount of, and fraction of, energy savings in kBtu (considers both electric and gas savings). It is interesting to see the divergence of savings by utility and by end-use. PG&E's savings are dominated by heating savings, while SCE is more proportionally distributed between the three end-uses, SoCalGas is highly dominated by cooling savings, while SDG&E more closely resembles PG&E's distribution of energy savings. Interestingly, the only all-electric utility (SCE) has their greatest amount of energy savings coming from heating, which is nearly all gas savings. SCE did not claim any gas savings, only electric savings; therefore these savings remain unclaimed. Since SCE fell short of their electric savings, they may want to consider claiming the gas savings in the future in order to improve their total resource cost (TRC) test, or overall program cost effectiveness (assuming this is acceptable by the CPUC).

Approximately 80% of SDG&E's energy savings is resulting from heating and water heating measures, which are gas fuel dominated. This may explain their poor realization rate for SDG&E's electric measures.

Utility	Cooling Savings and % of Total Savings	Heating Savings and % of Total Savings	Hot Water Savings and % of Total Savings	Total Energy Savings
	8,659,799	28,054,110	12,696,241	49,410,150
PG&E	18%	57%	26%	100%
	20,792,428	25,161,947	14,597,031	60,551,406
SCE	34%	42%	24%	100%
	6,616,016	582,509	1,302,596	8,501,121
SoCalGas	78%	7%	15%	100%
	3,200,931	6,154,167	5,782,155	15,137,253
SDG&E	21%	41%	38%	100%
	39,269,174	**59,952,733**	**34,378,022**	**133,599,930**
Overall	**29%**	**45%**	**26%**	**100%**

Table 80: Energy Savings (kbtu) for Each End-Use by Utility

Table 81 presents the breakdown of savings by RMST climate zone, rather than by utility. Here the climate becomes extremely evident, as savings shift between measures as climates change. For example, CZ 1, a mild climate with little cooling requirements is dominated by heating and water heating savings. Whereas CZ 5, a hot inland zone is dominated by cooling savings. About 47% of the program's savings were achieved in CZ 3, comprising the Inland Empire, the inland areas of Orange County, and the inland areas of greater San Diego.

Climate Zone	Cooling Savings and % of Total Savings	Heating Savings and % of Total Savings	Hot Water Savings and % of Total Savings	Total Energy Savings
	1,056,075	3,483,914	2,517,528	7,057,517
RMST CZ 1	15.0%	49.4%	35.7%	100%
	2,107,739	3,599,297	3,596,814	9,303,851
RMST CZ 2	22.7%	38.7%	38.7%	100%
	20,800,876	25,777,938	15,957,398	62,536,212
RMST CZ 3	33.3%	41.2%	25.5%	100%
	7,603,724	24,570,196	10,178,712	42,352,632
RMST CZ 4	18.0%	58.0%	24.0%	100%
	7,700,760	2,521,388	2,127,569	12,349,717
RMST CZ 5	62.4%	20.4%	17.2%	100%
	39,269,174	**59,952,733**	**34,378,022**	**133,599,930**
Overall	**29.4%**	**44.9%**	**25.7%**	**100%**

Table 81: Energy Savings (kBtu) for Each End-Use by Climate Zone

Single Family Average Energy Use (kBtu/sqft-year) and Compliance Margin

Table 82 and Table 83 summarize the average energy use and average compliance margin for each category (heating, cooling, hot water) and for the total. These two tables in combination best explain the stark differences in electric and gas savings by each utility.

In essence, it shows that a high compliance margin does not always equate to high aggregate savings.

First in Table 82, the proposed number represents the level at which the builder has committed to construct the home and the standard is the Title 24 minimum requirement. The larger the raw difference between the proposed and the standard, the greater the actual energy and/or gas savings. As mentioned before, all of the cooling energy use is fueled by electricity (hence any savings will reflect in energy savings) and all of the hot water energy use is fueled by gas (hence any savings will reflect in therm reductions). Heating energy use is a mix of gas and electric saving and depends on what type of heating furnace the home carries. *Note that when analyzing aggregate energy and therm savings, one uses the actual change of energy use rather than a percentage change/compliance margin.* In the Building Characteristics Analysis section, RLW will analyze the degree to which homes exceeded Title 24 compliance measuring the percentage change from standard to proposed energy use. However, in this section, the purpose is to quantify the actual reduction of energy/gas use, which requires the use of raw numbers. *In order to maximize such a reduction, in general, the most effective strategy is to target homes that use the most energy because there is a greater potential to reduce actual energy use.*

On average, the SoCalGas projects had the total highest energy use allowed by Title 24 standards (53.9) and also had the greatest difference from the proposed total than any other utility (13.6 kbtu/sqft). Most of this energy use is allocated for cooling, which may be the reason for SoCalGas' exuberant single family energy savings (1870 kWh/unit, see Table 71 for details). Conversely, SDG&E projects show the lowest energy use allowed by Title 24, at nearly 21 kBtu/square foot-yr. Likely a result of the mild inland climate, SDG&E projects offer fewer opportunities for overall energy efficiency improvements.

PG&E's ENERGY STAR homes are allotted the highest amount of energy use for heating. On average, PG&E had the greatest difference between proposed and standard heating (4.4 kbtu/sqft). Note that the difference in heating is much less (about 1/3 less) than the reduction change in SoCalGas' territory for cooling.

For hot water energy use, the difference for all utilities between standard to proposed hot water use ranged from 1.7 to 2.3. In the Single family building characteristics analysis section, RLW will further discuss what type of water heaters each utility region employed and can compare the differences in efficiencies of the water heaters. Overall, total energy use was reduced by 6.7kBtu/square foot-yr (32.6 – 25.9) and the greatest amount of this change resulted from efficiencies made in heating energy use (2.9).

This same information can also be presented in terms of compliance margin, but tells a different part of the story. The compliance margin is the percentage by which the project exceeds the standard Title 24 requirement. One can use this measure as a way to quantify how well each project performed against its minimum required standards. As Table 83 shows, the overall compliance margin was 20%, which reflects the program's effort to encourage builders to construct at least 15 to 20% (depending on incentive) better than code.

SoCalGas builders used cooling measures in large part to help them meet the program's minimum compliance standard, by improving cooling efficiency by 30% on average. Overall, the cooling compliance margin was 25% better than proposed.

The greatest total compliance margin by any utility was seen in the SoCalGas projects, but once again, one may see this finding as an exception to the norm, as these savings are

being driven in large part by a few projects delivering high amounts of cooling savings. After SoCalGas, the other utilities compared closely, ranging between 19% and 21% compliance.

Hot water compliance was below the overall average compliance margin of 20%, at 15%. It may be that hot water efficiencies have topped out for what is a cost effective energy efficiency measure in single family new construction. The hot water end-use produced the tightest range of compliance margins (13.4 – 17.3), so it may be that builders are fairly standardized in their specification of hot water heating systems.

Utility	Proposed Total	Standard Total	Proposed Heating	Standard Heating	Proposed Hot Water	Standard Hot Water	Proposed Cooling	Standard Cooling	n
PG&E	29.7	37.6	14.5	18.9	10.3	12.5	4.9	6.3	299
SCE	25.5	31.6	7.1	9.5	10.5	12.2	8.0	10.0	251
SoCalGas	40.3	53.9	2.3	3.3	12.5	14.5	25.5	36.2	12
SDG&E	16.6	20.9	3.9	5.5	10.0	11.9	2.8	3.4	130
Overall	**25.9**	**32.6**	**8.7**	**11.6**	**10.4**	**12.3**	**6.8**	**8.7**	**692**

Table 82: Average Energy Use (kBtu/square foot-yr) by Utility

Utility	Total	Heating	Cooling	Hot Water	n
PG&E	21%	23%	22%	17%	299
SCE	19%	25%	20%	14%	251
SoCalGas	25%	31%	30%	13%	12
SDG&E	20%	29%	20%	16%	130
Overall	**20%**	**25%**	**22%**	**15%**	**692**

Table 83: Average SF Compliance Margin by Utility

RLW also analyzed the energy use by climate zone because climate zones are used by Title 24 to establish standard energy budgets. As Table 84 displays, climate zone 5 (far eastern region of California) has the highest standard and proposed energy use total than all other climate zones, which is driven entirely by the large cooling budget. As shown in Table 84 and Table 85, ENERGY STAR homes in climate zone 5 are on average 11.2 kBtu/square foot-yr (or 22%) below the standard energy use total, producing the largest amount of savings per unit than any other climate zone; however only 15 of the 692 projects were built in this region. Homes in climate zone one produced the greatest overall compliance margin of 26%, however only 49 of the 692 projects were built in this zone. The climate zone with the smallest compliance margin, climate zone three (20%), lead the program with the highest fraction of projects participating (291 of 692) in the 2002 program and the greatest amount of overall energy savings.

The lowest total energy use change was seen in climate zone 2 (south coastal), which also has the lowest total proposed and standard energy use. Sixty-five percent (11.9/18.3) of the total proposed budget in climate zone 2 is owned by the proposed hot water budget, leaving only 35% of the total budget to be affected by cooling or heating measures. Not surprisingly, the majority of the savings (39%, Table 81) in climate zone 2 resulted from hot water heating. Moreover, no other climate zone has a greater percentage of savings in this category.

Climate zone 4 (Sacramento/Central Valley) had an overall change from standard to proposed of 7.9—4.4 of which came from lower heating energy use. This also supports

the findings presented in Table 81 from above, which shows 58% of the savings in this climate zone resulting from heating.

Climate Zone	Proposed Total	Standard Total	Proposed Heating	Standard Heating	Proposed Hot Water	Standard Hot Water	Proposed Cooling	Standard Cooling	n
RMST CZ1	23.5	31.6	11.8	15.6	9.9	13.0	1.8	3.0	49
RMST CZ2	14.5	18.3	3.0	4.3	10.2	11.9	1.4	2.0	87
RMST CZ3	24.1	30.1	6.3	8.6	10.4	12.1	7.4	9.3	291
RMST CZ4	30.8	38.7	15.0	19.4	10.4	12.4	5.4	6.8	250
RMST CZ5	40.9	52.1	8.8	10.9	11.7	13.6	20.3	27.6	15
Overall	**25.9**	**32.6**	**8.7**	**11.6**	**10.4**	**12.3**	**6.8**	**8.7**	**692**

Table 84: SF Average Energy Use kBtu/square foot-yr) by Climate Zone

Climate Zone	Total	Heating	Cooling	Hot Water	n
RMST CZ1	26%	24%	40%	24%	49
RMST CZ2	20%	30%	31%	15%	87
RMST CZ3	20%	27%	20%	15%	291
RMST CZ4	20%	23%	21%	16%	250
RMST CZ5	22%	19%	26%	14%	15
Overall	**20%**	**25%**	**22%**	**15%**	**692**

Table 85: Average Compliance Margin by Climate Zone

Table 86 summarizes the percentage of total energy use in each category by each utility's ENERGY STAR units. On average, almost half of the energy use for PG&E's units was allocated to heating and over a third went to hot water. About 60% of the total energy use in SDG&E territory was expended on hot water. In the ENERGY STAR units for the SoCalGas region, 63% of the total energy use was utilized for cooling purposes and very little (6%) was used for heating. Overall, on average, participant projects statewide used 34% of total energy for heating, 26% for cooling and 40% for hot water.

It is also useful to study the various breakdowns of total energy use based on climate zones rather than utility. For example, Table 87 shows that about 70% of energy use in climate zone 2 (coastal southern California) went towards hot water and only 10% went to cooling. A good example indicating the number of cooling and heating degree days by climate zone; as heating and cooling budgets increase, so to do the number of degree days. Climate zone 1 (north coastal) requires the largest allocation of heating energy, while climate zone 5 (inland/desert/mountains) requires the largest allocation of cooling budget.

Utility	Proposed Heating	Proposed Cooling	Proposed Hot Water	n
PG&E	49%	16%	35%	299
SCE	28%	31%	41%	251
SoCalGas	6%	63%	31%	12
SDG&E	24%	17%	60%	130
Overall	**34%**	**26%**	**40%**	**692**

Table 86: SF Percent Allocation by Utility

Climate Zone	Proposed Heating	Proposed Cooling	Proposed Hot Water	n
RMST CZ1	50%	8%	42%	49
RMST CZ2	21%	10%	70%	87
RMST CZ3	26%	31%	43%	291
RMST CZ4	49%	18%	34%	250
RMST CZ5	22%	50%	29%	15
Overall	**34%**	**26%**	**40%**	**692**

Table 87: SF Percent Allocation of Energy Use by Climate Zone

Multifamily Energy Savings in kWh

The energy savings in this multifamily energy saving section consists of savings from both low rise and high-rise multifamily dwellings. The high-rise dwellings were separated from the low rise dwellings in the subsequent multifamily building characteristics section of this report. All demographic information on the high-rise dwellings is included in the high-rise multifamily building characteristics section.

The low rise multifamily energy savings are grouped into the same three categories as single family energy savings, namely space heating, space cooling, and domestic hot water. However, the high-rise multifamily includes "other" energy components in the energy savings calculation since the high-rise compliance methods are similar to commercial compliance methods. The "other" energy components are all electric and consist of energy savings from heat rejection, pumps & misc., and indoor fans.

This section summarizes aggregate energy savings of multifamily units that were built to meet or exceed Title 24 standards by 15%.

Table 88 presents by utility the AEAP filed estimate of savings and the EM&V estimate of energy savings. PG&E and SoCalGas appear to have dramatically underestimated the amount of energy savings they will achieve, while the other utilities have overestimated their kWh savings. SCE achieved the greatest savings (219 kWh/unit), which is followed closely by SoCalGas with 206 kWh/unit. SDG&E has the fewest electric savings per unit, and also the worst realization rate, which may be due to greater use of gas-fueled measures. SDG&E did have the highest number of multifamily participation, which comprised of 35% of the total number of ENERGY STAR multifamily units.

Utility	Energy Savings, kWh		Realization Rate	Housing Units	Savings per Unit (kWh/unit)
	AEAP Estimate	EM&V Estimate			
PG&E	32,401	125,422	387%	1,129	111
SCE	668,714	444,621	66%	2,030	219
SoCalGas	527,374	617,184	117%	2,994	206
SDG&E	712,002	291,128	41%	3,313	88
Overall	**1,940,491**	**1,478,355**		**9,466**	**156**

Table 88: Energy Savings for ENERGY STAR Multifamily Homes

Multifamily Therm Reduction

Table 89 presents the therm reductions for multifamily projects, including both the AEAP estimate and the EM&V estimate of savings. Here we find that SoCalGas has the highest realization rate at 122% even though PG&E projects save the most therms per project (68). SoCalGas projects saved the least amount per project with an average of 33 therms per unit. SDG&E had the second highest realization rate with 112%. While SCE did not claim any therm savings, their ENERGY STAR multifamily units save almost 83,000 therms per year.

Utility	Therm Reduction		Realization Rate	Housing Units	Savings per Unit (Therm/unit)
	AEAP Estimate	EM&V Estimate			
PG&E	88,157	77,039	87%	1,129	68
SCE	n/a	82,997	n/a	2,030	41
SoCalGas	80,442	98,539	122%	2,994	33
SDG&E	126,298	141,626	112%	3,313	43
Overall	**294,897**	**400,201**		**9,466**	**42**

Table 89: Therm Savings for Multifamily Homes

Multifamily Combined Savings

Table 90 combines the data presented in the previous two tables. Therm and kilowatt-hour savings have been converted to savings in kBtu (EM&V Total Energy Savings kBtu). Using the AEAP estimate, we have calculated an overall multifamily realization rate. PG&E has the highest realization rate of 120%, followed by PG&E at 98%, and then by SDG&E at 86%. SCE had the lowest realization rate with 66%, but RLW did not include SCE's therm reductions since they did not claim any therm savings.

Utility	EM&V Therm Reductions (thm)	EM&V Energy Savings (kWh)	EM&V Total Energy Savings (kBtu)	AEAP Estimate (kBtu)	Realization Rate
PG&E	77,039	125,422	8,988,113	9,147,454	98%
SCE*	82,997	444,621	12,852,193	6,846,963	66%*
SoCalGas	98,539	617,184	16,173,208	13,443,982	120%
SDG&E	141,626	291,128	17,143,419	19,919,988	86%
Overall	**317,203**	**1,478,355**	**55,156,933**	**41,314,187**	**133.5%**

*Therm Savings not included in the total realization rate.

Table 90: Total Energy Savings and Realization Rate (kBtu)

The following two tables present total kBtu savings (combines gas and electric savings) by utility for each Title 24 end-use (cooling, heating, water heating, other, total). Overall, the majority of the savings resulted from water heating measures (60%), which was also true for each utility. SDG&E's multifamily project water heating savings (65%) were the greatest of the four utilities, followed by SCE (64%), then by PG&E (58%), and finally by SoCalGas (52%). Overall, the cooling end-use produced the second greatest amount of savings; however cooling savings produced less than half the amount of savings of hot water heating measures. PG&E had the greatest fraction of heating savings of any utility, while SCE had almost none. At the same time PG&E had the smallest fraction of cooling savings while SoCalGas had the largest fraction. The "other savings" category reflects savings in the high-rise multifamily projects that result from three end-uses; specifically indoor fans, heat rejection, and pumps and miscellaneous comprise "other savings."

Utility	Cooling Savings and % of Total Savings	Heating Savings and % of Total Savings	Hot Water Savings and % of Total Savings	Other Savings and % of Total	Total Energy Savings
	365,800	3,461,509	5,231,670	(70,866)	8,988,113
PG&E	4%	39%	58%	-1%	100%
	3,643,870	9,723	8,362,783	835,817	12,852,193
SCE	28%	0%	65%	7%	100%
	6,009,890	1,731,600	8,431,717	-	16,173,208
SoCalGas	37%	11%	52%	-	100%
	2,521,629	3,557,253	11,064,537	-	17,143,419
SDG&E	15%	21%	65%	-	100%
	12,541,190	**8,760,086**	**33,090,707**	**764,951**	**55,156,933**
Overall	**23%**	**16%**	**60%**	**1%**	**100%**

Table 91: Total kBtu Savings by Utility

Table 92 presents similar information as above, replacing utility with climate zone. RMST climate zone 3 and 4 account for the overwhelming majority of program activity and savings. Water heating represents the majority of savings in these climate zones, in addition to RMST climate zones 1 and 2. Only in climate zone 5 is water heating not the lead end-use in terms of savings; instead cooling savings represent the greatest fraction of savings.

Climate Zone	Cooling Savings and % of Total Savings	Heating Savings and % of Total Savings	Hot Water Savings and % of Total Savings	Other Savings and % of Total	Total Energy Savings
	162,565	2,563,763	4,185,009	(70,866)	6,840,470
RMST CZ 1	2%	37%	61%	-1%	100%
	3,276,844	1,842,334	11,982,200	-	17,101,377
RMST CZ 2	19%	11%	70%	-	100%
	5,455,488	3,063,397	14,063,582	835,817	23,418,284
RMST CZ 3	23%	13%	60%	4%	100%
	600,000	1,088,652	1,419,005	-	3,107,657
RMST CZ 4	19%	35%	46%	-	100%
	3,046,294	201,940	1,440,911	-	4,689,145
RMST CZ 5	65%	4%	31%	-	100%
	12,541,190	**8,760,086**	**33,090,707**	**764,951**	**55,156,933**
Overall	**23%**	**16%**	**60%**	**1%**	**100%**

Table 92: Total kBtu Savings by Climate Zone

Cost of Energy Reduction (in kBtu) and Multifamily Unit Recruitment

Table 93 presents additional metrics to evaluate the four utilities. Recall that SDG&E had the lowest realization rate for electric savings (41%). However, to SDG&E's credit, they appear to be running the most cost effective program in terms of the cost per energy savings. As Table 93 shows, they had the lowest cost per 1,000 kBtu saved ($42.47). SCE, who had the lowest overall realization rate, had the lowest recruitment cost per unit ($248). Although PG&E had a 98% overall realization rate, by other measures, their projects demonstrated to be least cost-effective. PG&E cost per unit skyrocketed at $734 (overall average was $343, less than half of PG&E's average cost) and their cost per 1000 kBtu saved was $92.21—double of SDG&E's cost.

Utility	EM&V Total kBtu Reduction	2002Multifamily Budget	Multifamily Units	Cost Per Unit Recruited	Cost per 1000 kBtu Saved
PG&E	8,988,113	$ 828,837	1,129	$ 734	$ 92.21
SCE	12,852,193	$ 742,000	2,030	$ 248	$ 57.73
SoCalGas	16,173,208	$ 946,608	2,994	$ 286	$ 58.53
SDG&E	17,143,419	$ 728,149	3,313	$ 359	$ 42.47
Overall	**55,156,933**	**$ 3,245,594**	**9,466**	**$ 343**	**$ 58.84**

Table 93: Cost per Unit Recruited and per Unit Saved

Multifamily Average Energy Use (kBtu/sqft-year) and Compliance Margin

As stated before, over half of the total energy savings rooted from hot water energy use. Table 94 shows the average for each proposed energy use by utility. The highest energy end-use value is within standard and proposed hot water on average, which is also the energy use with the greatest difference between proposed and standard value. Although the overall compliance margins were very similar (range of 20-30%), as Table 94 shows, we know that the majority of savings resulted from hot water measures.

Utility	Proposed Total	Standard Total	Proposed Heating	Standard Heating	Proposed Hot Water	Standard Hot Water	Proposed Cooling	Standard Cooling	Proposed Other	Standard Other	n
PG&E	27.2	37.0	11.5	15.9	12.7	16.6	2.9	4.5	0.07	0.06	37
SCE	25.5	32.7	2.5	2.5	18.2	24.1	4.4	5.7	0.34	0.37	35
SoCalGas	30.2	39.0	4.0	4.8	18.3	22.2	7.8	12.1	-	-	74
SDG&E	21.8	27.9	3.5	5.1	14.8	18.5	3.4	4.3	-	-	84
Overall	**25.3**	**33.0**	**5.4**	**7.4**	**15.4**	**19.3**	**4.4**	**6.3**	**0.04**	**0.04**	**230**

Table 94: MF Average Energy Use kBtu/square foot-yr) by Utility

Utility	Total	Heating	Hot Water	Cooling	Other	n
PG&E	27%	28%	23%	35%	-12%	37
SCE	22%	0%	24%	24%	8%	35
SoCalGas	23%	16%	17%	35%	-	74
SDG&E	22%	31%	20%	21%	-	84
Overall	**23%**	**26%**	**20%**	**30%**	**1%**	**230**

Table 95: MF Compliance Margin by Utility

By climate zone, RMST 5 has the highest allocation for total energy use. Title 24 standards require that total energy use for climate zone 5 be 55.2 or below. On average, ENERGY STAR multifamily homes' total energy use was 39.1 in this zone. Overall, compliance margin for this climate zone was 29%. However this climate zone represents only 12 projects and is much greater than the overall compliance margin of 23%. While RMST climate zone 1 has a similarly high compliance margin, what should be noted is the negative savings for other (only applies to high-rise multifamily). This is likely a perfect example of builders trading measures. Since the standard other budget for this climate zone is so low, builders can easily makeup savings in other end-use categories. In this case, the makeup has occurred in both hot water and heating, putting overall compliance at 27%. However, on average the overall compliance margin is 23%.

Climate Zone	Proposed Total	Standard Total	Proposed Heating	Standard Heating	Proposed Hot Water	Standard Hot Water	Proposed Cooling	Standard Cooling	Proposed Other	Standard Other	n
RMST CZ1	26.5	36.5	12.0	16.5	11.8	15.6	2.7	4.3	0.0749	0.0667	28
RMST CZ2	20.7	26.4	3.0	3.8	15.8	19.8	1.9	2.8	-	-	89
RMST CZ3	26.9	34.3	4.3	6.0	16.7	20.7	5.8	7.6	0.065	0.071	87
RMST CZ4	32.8	41.3	6.9	9.6	18.0	21.9	7.9	9.8	-	-	14
RMST CZ5	39.1	55.2	1.1	1.8	16.2	18.7	21.8	34.6	-	-	12
Overall	**25.3**	**33.0**	**5.4**	**7.4**	**15.4**	**19.3**	**4.4**	**6.3**	**0.04**	**0.04**	**230**

Table 96: MF Average Energy Use kBtu/square foot-yr) by Climate Zone

Climate Zone	Total	Heating	Hot Water	Cooling	Other	n
RMST CZ1	27%	27%	24%	39%	-12.3%	28
RMST CZ2	22%	20%	20%	34%	-	89
RMST CZ3	22%	28%	19%	24%	8%	87
RMST CZ4	21%	27%	18%	20%	-	14
RMST CZ5	29%	39%	13%	37%	-	12
Overall	**23%**	**26%**	**20%**	**30%**	**1%**	**230**

Table 97: MF Compliance Margins by RMST Climate Zone

In Table 98 we present average HERS scores, and HERS scores by bin. A HERS score of 87 or better reflects ENERGY STAR design and construction standards in California. Table 98 clearly illustrates the fact that on average the multifamily homes meet or exceed ENERGY STAR criteria. Multifamily projects in PG&E service area scored the best with an average score of 88.6, while the other three utilities were almost equal. The data does show that a few projects did not meet the 87 minimum, although it is not clear why.

Utility	Average	Equals 86	Equals 87	Equals 88	Greater than 88	n
PG&E	88.6	4%	26%	42%	28%	37
SCE	87.6	16%	41%	5%	26%	34
SoCalGas	87.7	0%	65%	23%	12%	70
SDG&E	87.6	0%	69%	20%	11%	84
Overall	**89.1**	**5%**	**11%**	**47%**	**37%**	**225**

Table 98: Multifamily HERS Scores

Table 99 summarizes the percentage of total energy use in each category by utility. On average, more than half of SCE's, SoCalGas,' and SDG&E's energy use was allocated to water heating. SCE's cooling savings accounted for nearly 30%, more than any other utility. SoCalGas and SDG&E had similar breakouts, with the majority of total energy use in hot water heating, followed by cooling, and then by heating. Overall, on average, participant projects statewide used 22% of total energy for heating, 18% for cooling and 61% for hot water.

Utility	Proposed Heating	Proposed Cooling	Proposed Hot Water	n
PG&E	42%	11%	47%	37
SCE	10%	17%	73%	35
SoCalGas	13%	26%	61%	74
SDG&E	16%	16%	68%	84
Overall	**22%**	**18%**	**61%**	**230**

Table 99: MF Percent Allocation of Energy Use by Utility

By climate zone (Table 100), the energy use is also dominated by the hot water end-use. Only in climate zone 5,we find that hot water energy use is trumped by heating energy use. However only a limited number of projects in climate zone 5 participated in the program.

Climate Zone	Proposed Heating	Proposed Cooling	Proposed Hot Water	n
RMST CZ1	45%	10%	45%	28
RMST CZ2	15%	9%	76%	89
RMST CZ3	16%	22%	62%	87
RMST CZ4	21%	24%	55%	14
RMST CZ5	3%	56%	42%	12
Overall	**22%**	**18%**	**61%**	**230**

Table 100: MF Percent Allocation of Energy Use by Climate Zone

Energy Savings Comparison between 15% Compliance vs. 20% Compliance

Is it cost-effective to pay builders an additional incentive if they increase their single or multifamily unit compliance margin to 20 or more percent? For 2002, single family units that complied by at least 20% over Title 24 standards received almost double the incentive amount than if they had complied their units by 15% better than Title 24. The additional 5% of energy savings earned builders almost double the incentive amount. Table 101 summarizes the incentive levels for 2002.

Climate Zone	15-19.99% Compliance	20% + Compliance
CZ 1-7	$ 400	$ 700
CZ 8-16	$ 500	$ 900

Table 101: 2002 Single Family Incentive Rates per Unit

RLW compared the benefits produced from units that complied 15 to 19.99% better than Title 24 ('15% compliance') and units that complied 20% or more than Title 24 ('20% compliance') by the number of kBtu each dollar generated. Table 102 summarizes the results and also presents the Total Incentive Budget[34] (number of units multiplied by the incentive amount) and the number of ENERGY STAR units for single family builders. The kBtu per incentive dollar is essentially the total energy savings divided by the total

[34] The Total Incentive Budget does not include program administration cost because we only analyze the cost-effectiveness of the incentive.

incentive budget. In theory, builders are incentive-driven, so an increase in incentive dollars will encourage builders to construct units with greater efficiency.

Overall, 15% compliant-units produced about 21.1 kBtu per incentive dollar while 20% compliant units averaged 17.7 kBtu per incentive dollar. Note that the 15% compliant units received $400-$500 per unit while 20% compliant units received $700 to $900. The increased incentive amount was offset by the additional savings, but not to the efficiency level of 15% compliant units. Only in climate zone 6 were single family units with 20% compliance being more cost-effective than 15% compliant units. It was extremely inefficient to subsidize 20% compliance in climate zone 4, 5, 7, 11, and 12 where the "very highly" efficient homes fell short at least 5 kBtu per incentive dollar to its 15% compliant counterparts.

Single Family	15% Compliance	20% Compliance	15% Compliance	20% Compliance	15% Compliance	20% Compliance
Climate Zone	kBtu/Incentive Dollar		Total Incentive Cost		Number of Units	
Climate Zone 2	-	28.0	-	$ 50,400	-	72
Climate Zone 3	-	24.8	-	$ 135,800	-	194
Climate Zone 4	23.1	17.4	$ 34,667	$ 14,933	87	21
Climate Zone 5	20.4	15.3	$ 44,844	$ 20,222	112	29
Climate Zone 6	18.6	22.3	$ 41,933	$ 19,717	105	28
Climate Zone 7	15.7	10.9	$ 167,600	$ 499,800	419	714
Climate Zone 8	15.2	11.6	$ 170,344	$ 515,080	341	572
Climate Zone 9	17.0	14.4	$ 80,000	$ 822,600	160	914
Climate Zone 10	18.7	17.3	$ 1,049,431	$ 1,220,524	2,099	1,356
Climate Zone 11	24.0	17.5	$ 71,077	$ 484,961	142	539
Climate Zone 12	22.2	17.0	$ 408,028	$ 1,356,250	816	1,507
Climate Zone 13	-	30.4	-	$ 900	-	1
Climate Zone 14	25.3	-	$ 170,500	-	341	-
Climate Zone 15	-	22.5	-	$ 356,400	-	396
Total	**21.1**	**17.7**	**$ 2,079,618**	**$ 5,074,902**	**4,621**	**6,344**

*Yellow highlighted cells mean better savings per dollar result within climate zone category.

Table 102: Compliance Margin Comparison for Single Family Units

Incentive rates for multifamily units did not vary by climate zone, and in 2002, units that met or exceed Title 24 standards by 20% received an additional $100 to the 15% compliance rate of $150.[35]

Climate Zone	15-19.99% Compliance	20% + Compliance
CZ 1-7	$ 150	$ 250
CZ 8-16	$ 150	$ 250

Table 103: 2002 Multifamily Incentive Rates per Unit

Overall, 15% compliant units saved 29 kBtu per incentive dollar while 20% compliant units saved 36.2 kBtu per incentive dollar. So, essentially the rate of return (in kBtu) is almost equal and would justify the additional incentive rate for 20% compliance.

However, when the rate of return is analyzed by climate zone, only in one case (CZ 7) did 20% compliant units outperform 15% compliant units. In climate zone 3, 4, 10, 13 and 15, the 20% compliant units fall far below the rate of return of 15% compliant units.

As mentioned before, complying multifamily units with the 20% ENERGY STAR standard was not very challenging for low rise multifamily builders considering the Title 24 issues that

[35] The 2003 ESH program did not offer the 20% compliance incentive in any climate zone.

exist in low-rise multifamily housing compliance. It may be that once 2005 Title 24 standards take effect, it may be cost effective to offer the 20% compliance incentive.

Multifamily	15% Compliance	20% Compliance	15% Compliance	20% Compliance	15% Compliance	20% Compliance
Climate Zone	kBtu/Incentive Dollar		Total Incentive Cost		Number of Units	
Climate Zone 2	42.8	-	$ 2,100	$ -	14	-
Climate Zone 3	46.6	42.6	$ 6,300	$ 51,750	42	207
Climate Zone 4	64.7	32.6	$ 6,525	$ 117,625	44	471
Climate Zone 6	25.9	19.9	$ 130,080	$ 290,950	867	1,164
Climate Zone 7	25.4	26.4	$ 152,250	$ 154,250	1,015	617
Climate Zone 8	28.8	27.6	$ 279,600	$ 228,750	1,864	915
Climate Zone 9	26.3	23.4	$ 50,100	$ 15,750	334	63
Climate Zone 10	37.0	30.7	$ 24,900	$ 209,250	166	837
Climate Zone 12	32.3	31.3	$ 30,600	$ 37,000	204	148
Climate Zone 13	48.5	37.5	$ 7,800	$ 15,500	52	62
Climate Zone 15	75.7	54.3	$ 7,020	$ 66,050	47	264
Climate Zone 16	-	32.6	$ -	$ 17,500	-	70
Total	**29.0**	**29.0**	**$ 697,275**	**$ 1,204,375**	**4,649**	**4,818**

Table 104: Compliance Margin Comparison for Multifamily Units

Hard to Reach Market Outreach

The CPUC requires that at least 20% of direct implementation funds be directed to the Hard-to-Reach markets, which are defined in the Energy Efficiency Policy Manual[36] as:

- Language- Primary language spoken is other than English, and/or
- Income- Those customers who fall into the moderate income level (income levels less than 400% of federal poverty guidelines), and/or
- Housing Type- Multifamily and Mobile Home Tenants, and/or
- Geographic- Residents of areas other than the San Francisco Bay Area, San Diego area, Los Angeles Basin or Sacramento, and/or
- Homeownership- Renters.

Based on these criteria, each utility presented an estimate of the percent fund allocation toward the hard-to-reach market. All utilities claim to have met and exceeded the minimum requirement of 20%. However, it is difficult to track their interpretation of the mandate and methodology in their calculation. For example, SDG&E had the highest percentage (47%) of its total 2002 budget allocated for multifamily housing (i.e. Hard-to-Reach market). However, they only claimed to have allocated 37% of their funds to the hard-to-reach market. PG&E claimed that 86% of their program funds were targeted toward the hard-to-reach market, but due to the lack of concrete data, RLW cannot substantiate that information.

Table 105 summarizes total utility funds and the last column indicates the percentage of total funds allocated for multifamily housing. SDG&E and SoCalGas had the highest number of ENERGY STAR compliant multifamily units (see Table 93).

[36] Approved by the CPUC in D01-11-066, it adopts new energy efficiency policy rules and sets forth the criteria parties should use in applying for energy efficiency funding for program year (PY) 2002 and in some cases 2003.

Utility	Hard-to-Reach AEAP Estimate	Total Budget Funds	Minimum Hard-to-Reach Funds	Multifamily Budget	Part of Actual Fund Allocation
PG&E	86%	4,826,774	965,355	828,737	17%
SCE	58%	5,645,332	1,129,066	728,149	13%
SoCalGas	61%	1,484,000	296,800	742,000	50%
SDG&E	37%	2,026,674	405,335	946,608	47%
Overall	**-**	**13,982,780**	**2,796,556**	**3,245,494**	**23%**

Table 105: Utility Estimate of Hard-to-Reach Fund Allocation

7. Single family Building Characteristics

This section presents the characteristics of the single-family homes participating in the 2002 ENERGY STAR New Homes Program. RLW obtained the Title 24 files from the utilities for each project that participated in the program. Using the transfer files generated by the Title 24 runs, RLW developed a database of housing characteristics inclusive of all plans receiving ENERGY STAR status through the program. This section presents the results of the analysis that utilized this information.

Demographics

In 2002, each of the utilities reached out to single-family homebuilders to comply with ENERGY STAR standards in order to decrease electricity and gas demand and improve energy efficiency. Figure 2 displays the percentage of load each type of home appliance captures to better understand which building characteristics may have greatest influence on greatest energy savings.

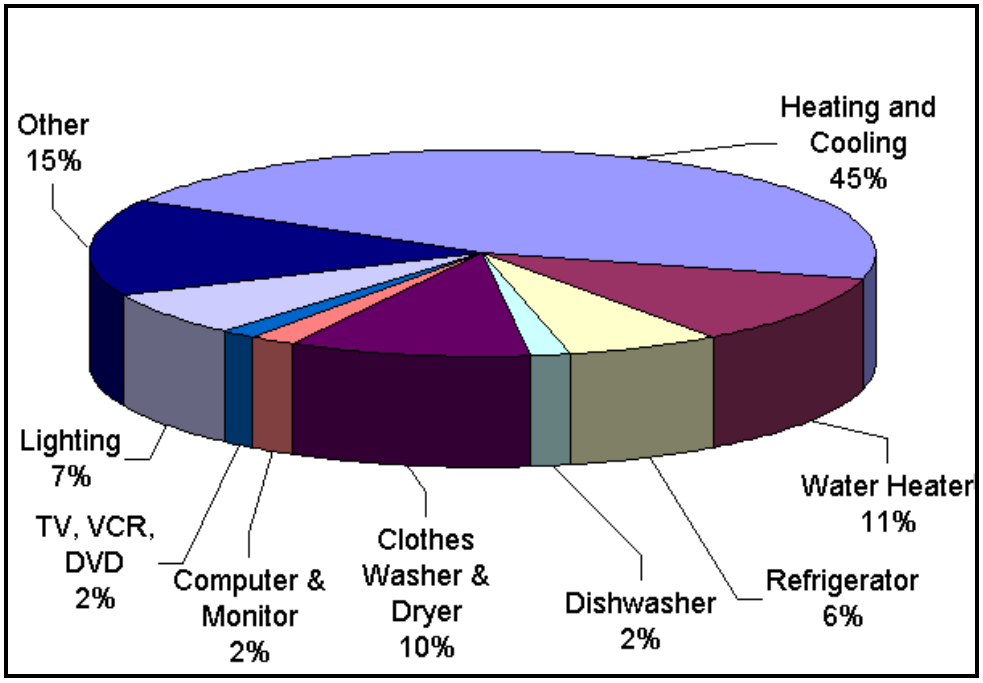

Figure 2: Average Cost Allocation of Home Energy Bill[37]

Table 106 summarizes the number of projects, plans, and units by utility service territory. Projects refer to the overall number of developments, while plans are the individual housing plans within each development. Units are the number of each plan that builders intend to construct within each project. Note that there were a total of 116 projects in the 2002 statewide program, with 692 total plans and 10,965 total units. SCE had the largest number of SF units in the program.[38]

[37] ENERGY STAR Website. Note Cost Allocation is on a nationwide basis and may vary for California.

[38] SCE filed a total of 5,234 single family units, but 80 were disqualified and do not have building characteristics data available.

Utility	Projects	Plans	Units
PG&E	42	299	3,520
SCE	51	251	5,154
SEMPRA	23	142	2,291
Total	**116**	**692**	**10,965**

Table 106: Number of Projects, Plans, and Units by Utility

Table 107 summarizes the number of plans, projects and units by climate zone. The majority of the units fell in climate zones 2, 3 and 4. Zone 2 covers the southern coastal region, zone 3 includes the northern coast and the bay area, and zone 4 extends into Sacramento and Stockton regions.

Climate Zone	Projects	Plans	Units
RMST CZ1	8	49	515
RMST CZ2	14	87	1,266
RMST CZ3	56	291	5,442
RMST CZ4	34	250	3,005
RMST CZ5	4	15	737
Total	**116**	**692**	**10,965**

Table 107: Number of Projects, Plans, and Units by Climate Zone

Table 108 shows the weighted and unweighted average square footage of ENERGY STAR homes by utility. The unweighted average overstates the true average because the number of homes per plan is not taken into account. Based on the weighted averages, SoCalGas had ENERGY STAR homes of less than 2000 square feet on average and SDG&E had the largest ENERGY STAR homes with 2651 square feet average. Part of the difference may be due to market demands in different parts of California, but another reason may be that the programs intentionally or inadvertently targeted a certain type of homes and builders.

Utility	Average Plan SqFt	Average Weighted SqFt
PG&E	2,415	2,274
SCE	2,632	2,493
SDG&E	2,813	2,651
SoCalGas	3,170	1,914
Overall	**2,581**	**2,427**

Table 108: Average Square Foot per plan and Weighted Avg. Sqft. Per Unit

Table 109 summarizes the number of plans and units by the size of the home. Over half of the units were homes of 1500 to 2500 square feet.

Square Feet	Plans	Units
< 1500 sf	27	567
1500 -2500 sf	302	5,939
2501-3500 sf	261	3,547
> 3501 sf	102	912
Total	**692**	**10,965**

Table 109: Number of Plans and Units by Square Footage

The majority of the Title-24 consultants utilized Micropas to execute the ratings; only three projects used Energy Pro, which is most commonly used for commercial compliance.

File Type	Projects	Plans	Units
Micropas	113	675	10,726
Energy Pro	3	17	239
Total	**116**	**692**	**10,965**

Table 110: Number of Projects, Plans, and Units by File Type

The following tables and description address the specific building characteristics and its relative performance to baseline standards. 98.2% of ENERGY STAR compliant homes had cooling systems and 100% were operating on dual-fuel (gas and electric) systems.

Utility	% of Plans	% of Units
PG&E	97%	94%
SCE	100%	100%
SEMPRA	100%	100%
Overall	**99%**	**98%**

Table 111: Percentage of Plans and Units with Cooling

Domestic Hot Water

Figure 3 clearly illustrates storage hot water heaters as the dominant technology type installed for hot water heating in ENERGY STAR homes. Of the 692 projects that participated as single-family ENERGY STAR homes, the vast majority (97%) made use of storage hot water heaters, while the remaining builders installed instantaneous hot water heaters. Large refers to storage hot water heaters that have an input BTU/hr greater than 75,000.

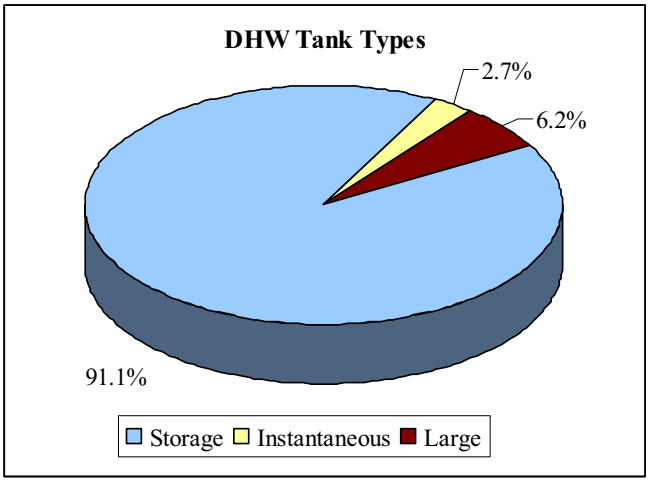

Figure 3: Percentage of Water Heater Tank Types

SDG&E had the lowest percentage of storage tanks with about 80%, but had the highest percentage (14.7%) of large water heater tanks in their territory. All large hot water heaters identified by RLW had tank sizes of 75 gallons.

Instantaneous (also known as "tankless") water heater tanks were by far the least utilized in any territory, which may due to the fact that it is a relatively new and emerging technology. Unlike traditional tank water heaters, instantaneous water heaters produce hot water only on demand. Instantaneous hot water heaters are typically more efficient than conventional storage systems because they do not suffer standby losses (or jacket losses), however the added cost and consumer uncertainty appears to be deterring wider implementation of this technology.[39]

Utility	Storage	Instantaneous	Large	n
PG&E	92%	5%	2%	299
SCE	94%	0%	6%	251
SDG&E	80%	6%	15%	130
SoCalGas	100%	0%	0%	12
Overall	**91%**	**3%**	**6%**	**692**

Table 112: Percentage of Water Heater Types by Utility

By climate zone, almost all instantaneous hot water heaters were in Zone 1 (Northern Coastal) and the majority of large hot water heaters were in Zone 2 and Zone 3 (southern coastal and inland). A possible explanation as to why instantaneous hot water heaters are found in the northern coastal zone may be that ENERGY STAR compliance is more difficult in the northern zone. The lack of cooling and heating degree-days, compared to other climate zones, limits the types and impacts of measures used by builders to meet ENERGY STAR criteria. The added energy credits that instantaneous water heaters produce above their storage water heater counterparts may have been what the builders needed to meet the program's minimum efficiency criteria.

[39] Creative Energy Technologies http://www.cetsolar.com/benefitstankless.htm

Climate Zone	Storage	Instantaneous	Large	n
RMST CZ1	63%	37%	0%	49
RMST CZ2	89%	0%	11%	87
RMST CZ3	90%	2%	9%	291
RMST CZ4	97%	0%	3%	250
RMST CZ5	100%	0%	0%	15
Overall	**91%**	**3%**	**6%**	**692**

Table 113: Percentage of Water Heater Types by Climate Zone

Tank Size

We will not be conducting a tank size analysis for instantaneous hot water heaters since they do not have a tank, like the traditional storage hot water heater does.[40] Of the 692 water heaters included in the analysis, 17 were storage hot water heaters that did not include a tank size. The 17 storage tanks that did not list a tank size were all "gas fired", as opposed to the majority of other tanks that were shown as "gas". The systems for these "gas fired" tanks were by 'A O SMITH WATER PRODUCTS' and 'AMERICAN WATER HEATER CO.'. We omitted these water heaters from the analysis due to lack of documentation.

Although "storage" and "large" water heaters both utilize a hot water storage tank, RLW has listed them separately to differentiate between large and standard size hot water heaters. Although a "large" hot water heater can have a tank larger than 75 gallons, all large water heaters in the study were found to be 75 gallons. The statewide average tank size for standard storage hot water heaters is 48.4 gallons.

Tank Type	Average Tank Size	n
Storage	48.4	580
Large	75.0	74
Instantaneous	n/a	21
Storage	missing	17
Overall	**50.1**	**692**

Table 114: Average Tank Size by Tank Type

Table 115 shows the average tank size for storage and large hot water heaters by utility service territory. While PG&E has the smallest average tank size, SDG&E has the largest average tank size. This supports the findings presented in Table 108 that homes in northern California are smaller than homes elsewhere in the state, as one characteristic used to size hot water heaters is the size of the home.

[40] RLW encountered seven input files that listed a tank size of 50 for instantaneous hot water heater systems. RLW corrected the data under the assumption that this was a modeling error.

Tank Type	Utility	Tank Size	Tank Size
Storage	PG&E	46.3	259
	SCE	48.8	226
	SDG&E	51.1	83
	SoCalGas	49.5	12
Large	PG&E	75.0	16
	SCE	74.9	24
	SDG&E	75.0	34

Table 115: Average Tank Size by Utility

This finding is even more evident in Table 116, which shows PG&E as having the highest fraction of 30 and 40-gallon hot water heaters, and the smallest fraction of 50 and 75 gallon hot water heaters.

Tank Type	Utility	Tank Size (gallons)						n
		30	40	50	74.5	75	Blank	
Storage	PG&E	0.2%	34%	58%	-	0.2%	7%	276
	SCE	1%	17%	78%	-	3%	-	226
	SDG&E	-	3%	92%	-	5%	-	83
	SoCalGas	-	5%	95%	-	-	-	12
	Overall	**1%**	**20%**	**74%**	**-**	**2%**	**2%**	**597**
Large	PG&E	-	-	-	-	100%	-	16
	SCE	-	-	-	21%	79%	-	24
	SDG&E	-	-	-	-	100%	-	34
	Overall	**-**	**-**	**-**	**10%**	**90%**	**-**	**74**

Table 116: Percentage of Water Heater Tank Sizes by Utility

Tank Type	Climate Zone	Tank Size (gallons)						n
		30	40	50	74.5	75	Blank	
Storage	RMST CZ1	2%	0%	22%	-	2%	74%	42
	RMST CZ2	-	5%	88%	-	7%	-	74
	RMST CZ3	1%	15%	80%	-	3%	-	232
	RMST CZ4	-	38%	62%	-	-	-	234
	RMST CZ5	-	13%	87%	-	-	-	15
	Overall	**1%**	**20%**	**74%**	**-**	**2%**	**2%**	**597**
Large	RMST CZ2	-	-	-	-	100%	-	13
	RMST CZ3	-	-	-	15%	85%	-	45
	RMST CZ4	-	-	-	-	100%	-	16
	Overall	**-**	**-**	**-**	**10%**	**90%**	**-**	**74**

Table 117: Percentage of Water Heater Tank Sizes by Climate Zone

Storage Hot Water Heater Energy Factor

The efficiency of a storage water heater is indicated by its energy factor (EF). This number includes both the conversion of the fuel source to hot water and the standby losses - heat lost through the tank surfaces. In general, smaller water tanks are more efficient than larger ones because there is less standby loss. Table 118 indicates the average energy

factor by tank size. The energy factor combines tank volume, internal insulation, recovery efficiency and standby loss. The higher the energy factor the more efficient the water heater. The majority of the ENERGY STAR homes had either a 40 or 50-gallon tank, average energy factors for these water heaters was .62 and .61, respectively. These average efficiencies bode well when compared to the minimum national appliance efficiency standards of .53 for 50-gallon tanks and .54 for 40-gallon tanks.[41]

Tank Size (gallons)	Energy Factor	n
30	0.62	13
40	0.62	150
50	0.61	386
75	0.49	31
Blank	0.60	17
Overall	**0.61**	**597**

Table 118: Average Energy Factor by Tank Size

The average energy factor varied from 0.60 to 0.62 for each of the utilities, with PG&E having the highest average energy factor, at 0.62. This follows logic, since PG&E had the higher proportion of smaller tank sizes, and since smaller size units are more efficient than larger units, one might expect see higher efficiency water heaters in the PG&E service territory. Table 119 also shows that builders in each utilities service area are exceeding the minimum national appliance efficiency standards.

Utility	Average Energy Factor	n
PG&E	0.62	276
SCE	0.61	226
SDG&E	0.60	83
SoCalGas	0.60	12

Table 119: Average Energy Factor by Utility

By RMST, climate zone 4 has the most efficient water heaters. This also makes sense since the majority of this area is served by PG&E. Climate zone 1, the north coastal zone, appears to have the lowest average energy factor for storage hot water heaters. However this finding may be misleading since a large number of the water heaters in this area did not list the tank size or energy factor.

[41] The Gas Research Institute (GRI)
http://www.gru.com/YourHome/Conservation/Energy/WaterHeaters/efficency.jsp

Climate Zone	Average Energy Factor	n
RMST CZ1	0.60	42
RMST CZ2	0.60	74
RMST CZ3	0.61	232
RMST CZ4	0.62	234
RMST CZ5	0.61	15

Table 120: Average Energy Factor by Climate Zone

Table 121 shows that the worst energy factors resulted from the largest tanks—75 gallons. However, the majority of the hot water heaters in the ENERGY STAR program had energy factors ranging from 0.60 to 0.62.

Energy Factor	Overall	Tank Size (gallons)				
		30	40	50	75	Blank
48	1%	-	-	-	50%	-
50	1%	-	-	-	50%	-
59	0%	-	-	0%	-	-
60	34%	11%	9%	41%	-	94%
61	0.1%	-	0%	0%	-	-
62	63%	89%	91%	59%	-	6%
n	**597**	**13**	**150**	**386**	**31**	**17**

Table 121: Energy Factor Bins by Tank Size

Distribution Credits

Title 24 allows builders to claim additional water heating credits when specifying various distribution credits. These credits reduce energy consumption through the use of various technologies aimed at reducing energy losses associated with water distribution. The credits builders can take are as follows:

- Pipe insulation
- Recirculation controls, time and temperature
- Recirculation controls, timer controlled
- Recirculation controls, temperature controlled
- Recirculation controls, demand controlled

Overall, distribution credits are not widely used, as is evident in Table 122. Storage water heaters, which comprise the majority of water heater types in the program, utilized very few credits. The most widely used credit was pipe insulation, which was used mostly by PG&E builders for both storage and large water heaters. Homes with large water heaters were more likely to take credit for recirculation controls, lead by time and temperature recirculation credits, at 21%. Seven instantaneous water heaters were installed by PG&E builders, all received pipe insulation credits.

Tank Type	Utility	Standard	Pipe Insulation	Recirc/ TimeTemp	Recirc/ Timer	Recirc/ Temp	Recirc/ Demand	n
Storage	PG&E	85%	15%	0.2%	-	-	-	276
	SCE	99%	0.3%	-	0.2%	-	-	226
	SDG&E	85%	8%	-	-	-	7%	83
	SoCalGas	92%	-	-	-	-	8%	12
	Overall	**92%**	**6%**	**0.1%**	**0.1%**	**-**	**1%**	**597**
Large	PG&E	48%	19%	27%	-	1%	4%	16
	SCE	44%	-	15%	27%	14%	-	24
	SDG&E	73%	-	27%	-	-	-	34
	Overall	**56%**	**2%**	**21%**	**13%**	**7%**	**1%**	**74**
Instant.	PG&E	-	100%	-	-	-	-	7
	SCE	100%	-	-	-	-	-	1
	SDG&E	100%	-	-	-	-	-	13
	Overall	**35%**	**65%**	**-**	**-**	**-**	**-**	**21**

Table 122: Water Heating Distribution Credits Utilized

Heating and Cooling Equipment

Heating and cooling equipment costs the average US homeowner about $600 a year to operate—nearly half the home's total energy bill. [42] Consequently, the efficiency of a home can significantly increase energy savings through efficient heating and cooling systems.

HVAC (heating, ventilation, air conditioning) can also impact the air quality of the home due to ventilation. The air tightening of the building envelope can help minimize air leakage, which also reduces energy costs.

RLW reviewed heating and cooling systems for all single-family ENERGY STAR homes and analyzed the level of efficiency of the equipment by utility, climate zone and size of home.

Heating Equipment

The efficiency of a furnace is measured by its AFUE (annual fuel utilization efficiency). The federal appliance standards require that furnaces have a minimum rating of 0.78 (at least 78% efficient).[43] Furnaces with an AFUE of 0.90 or better qualify for the ENERGY STAR label (on the furnace) and can use 10 to 20% less energy than federal standard efficiency models, which can save up to $80 per year through heating bills.

Furnace Heating Efficiency

The overall average AFUE in 2002 ENERGY STAR new single-family homes was 0.82, which is slightly above California's minimum efficiency standard (dictated by Title 24). Note SCE and SDG&E both had an average of 0.80—which is slightly above the minimum. Bear in mind that these territories do not require much heating so an efficient furnace will not greatly impact the energy savings of the home since they would not be utilized very often. SoCalGas had two projects; one of them was in Banning (where

[42] Department of Energy and ENERGY STAR website. Also see Figure 2.

[43] ENERGY STAR Program Website, www.energystar.gov

temperatures drop to low 40 degree Fahrenheit during winter months), which had the highest AFUE average at 0.88, while many of the homes had furnaces with 0.90 or greater efficiencies. The majority of PG&E's energy savings came by way of heating savings (see Table 71), which is explained by the greater than average AFUE of 0.84.

Utility	Average AFUE	n
PG&E	0.84	289
SCE	0.80	248
SDG&E	0.80	127
SoCalGas	0.88	12
Overall	**0.82**	**676**

Table 123: Average AFUE by Utility

By climate zone, climate zone 3 to 10 almost always used furnaces with minimum requirement efficiencies. Climate zone 11 to 13 had higher AFUE averages ranging from 0.82 to 0.90. These zones are mainly located in the central valley, where temperatures can be very low in the winter, so it benefits homeowners, who will be utilizing the furnace frequently, to own one with greater efficiency.

Climate Zone	Average AFUE	n
2	0.92	4
3	0.80	8
4	0.80	16
5	0.80	11
6	0.80	15
7	0.80	70
8	0.82	61
9	0.80	46
10	0.80	180
11	0.82	52
12	0.85	197
13	0.90	1
14	0.80	12
15	0.90	3
Overall	**0.82**	**676**

Table 124: Average AFUE by Climate Zone

When analyzing the AFUE of furnaces by the size of the home, the most efficient furnaces were found in the smallest homes (less then 1500 square feet) with an AFUE average of 0.86. Although not very many ENERGY STAR homes were built at this size, it is likely to be more cost effective and efficient to install efficient furnaces in larger homes since more energy is consumed than in small homes. In the other three categories of home size, the average stayed slightly above the California minimum standard.

Square Footage	Average AFUE	n
< 1500 sf	0.86	30
1500 -2500 sf	0.82	89
2501-3500 sf	0.82	298
> 3501 sf	0.81	259
Overall	**0.82**	**676**

Table 125: Average AFUE by Size of Home

The majority of furnaces with 0.90 or greater (which qualify as ENERGY STAR compliant) were in PG&E and SoCalGas territory. About 35% of PG&E's ENERGY STAR homes had a furnace with 90% or greater efficiency installed while 84% of SoCalGas' ENERGY STAR homes had such a furnace installed.

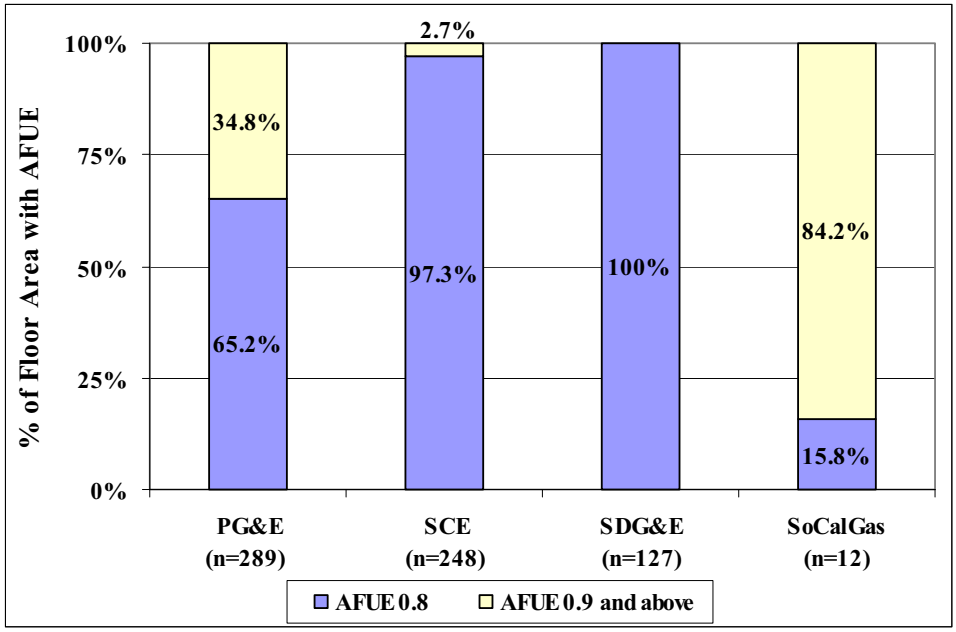

Figure 4: Percentage of Homes with Energy-Star Qualified Furnaces by Utility

Climate zone 2 (100%), 8 (15%), climate zone 11 (13%), climate zone 12 (14%), climate zone 13 and 15 (100%) had very efficient furnaces with an AFUE of 0.90 or greater. Because heating can take up a significant portion of an energy bill in these climate zones, and as a result have greater impacts on Title 24, it makes sense that builders are specifying high efficiency heaters in these areas.

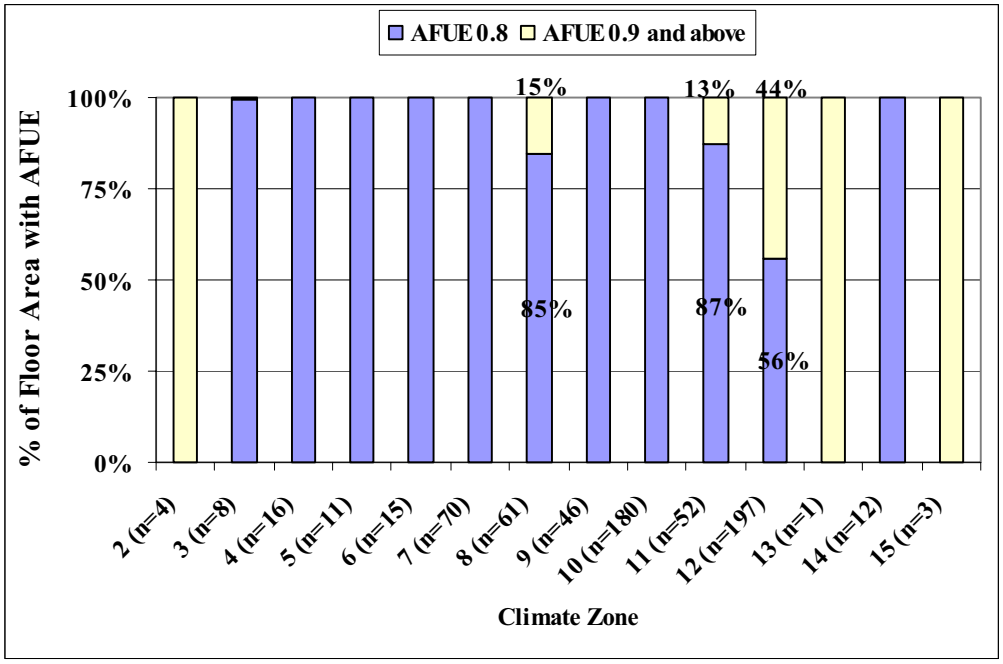

Figure 5: Percentage of Homes with Energy-Star Qualified Furnaces by Climate Zone

Heatpumps

Heatpumps are unique from furnaces because they require electricity rather than gas for heating purposes. Overall, only 1.3% of ENERGY STAR compliant single-family homes installed a heat pump in place of a natural gas furnace. The majority of these heat pumps were installed in SDG&E's territory, followed by SCE, then PG&E.

Utility	Heat Pump	Furnace	n
PG&E	0.1%	99.9%	299
SCE	2%	98%	251
SDG&E	3%	97%	130
SoCalGas	-	100%	12
Overall	**1%**	**99%**	**692**

Table 126: Type of Heating System by Utility

Heatpumps were installed in climate zones 4, 8, 9 and 10. These climate zones are all mild temperature areas, which heatpumps work the best in.

Climate Zone	Heat Pump	Furnace	n
Climate Zone 2	0%	100%	4
Climate Zone 3	0%	100%	8
Climate Zone 4	5%	95%	26
Climate Zone 5	0%	100%	11
Climate Zone 6	0%	100%	15
Climate Zone 7	3%	97%	72
Climate Zone 8	4%	96%	63
Climate Zone 9	4%	96%	47
Climate Zone 10	1%	99%	181
Climate Zone 11	0%	100%	52
Climate Zone 12	0%	100%	197
Climate Zone 13	0%	100%	1
Climate Zone 14	0%	100%	12
Climate Zone 15	0%	100%	3
Overall	**1%**	**99%**	**692**

Table 127: Heating Type by Climate Zone

Cooling Equipment

Key to building energy efficient homes is that builders select the correct size of a cooling system based on the size of the home, level of insulation, and window size and performance characteristics, often referred to as "integrated design" or "right sizing". Sometimes, builders may install a larger capacity air-conditioning system than is necessary to ensure homes receive adequate cooling capacity. This practice can lead to humidity problems in the home, and also causes excessive energy use and peak demand. Besides right-sizing the air conditioner, one also reduces energy use by purchasing a high efficiency air conditioner. ENERGY STAR qualifies cooling equipment that has a SEER rating of 12 or above. ENERGY STAR qualified cooling equipment will save 20 to 40% of energy than standard equipment.[44]

Type of Cooling Equipment

According to the building characteristics data we received on ENERGY STAR homes in California, 97% of all homes install some type of cooling equipment. Sixty-two percent of the AC systems are AC Split with 10 SEER, and the remaining 35% are AC Split with SEER greater than 10. Unfortunately these findings are not entirely accurate because of a problem that relates to the way homes without cooling systems are modeled in Micropas.

New homes that do not specify air conditioning systems require a "dummy" cooling system in the Title 24 model. This "dummy" system is held energy neutral, or in other words is a standard efficiency (10 SEER) air conditioner. Incidentally, both certification software tools (EnergyPro and Micropas) used to document Title 24 compliance assume the home has a standard efficiency air conditioner regardless if one is installed or not. Unless the consultant indicates "no cooling" in the name of the heating and cooling system it is

[44] ENERGY STAR website.

difficult to ascertain if there is actually cooling when the unit is a standard 10 SEER air-conditioning system. Therefore, we found it necessary to review houses with 10 SEER air-conditioning units to determine if the home actually installed air-conditioning.

RLW was able to identify "dummy" systems in homes that used EnergyPro documentation since the user can indicate a zero cooling capacity. RLW reviewed the EnergyPro files and discovered that three of five single-family projects indicating 10 SEER Split DX actually have zero cooling capacity output. Therefore, even though the document shows Split DX, there is no cooling as is verified with no cooling output. Consultants using Micropas don't have the option of inputting a cooling capacity and should indicate "no cooling" as the system name. However, Micropas users often bypass the "no cooling" naming convention and instead indicate a SplitDX system with 10 SEER (baseline system) since the program will inherently make the assumption. Therefore, for homes with 10 SEER Split DX systems that were certified with Micropas, there is a degree of uncertainty whether or not there is actually cooling or not.

Based on this information, while reading this section we recommend using caution when drawing conclusions regarding cooling equipment saturation estimates, cooling equipment types, and efficiencies. A recent report showed that on a statewide basis new single-family homes (non-ENERGY STAR) had an 86% saturation of cooling systems.[45] Assuming Itron did not encounter the same problem as RLW has identified, the findings we show of 97% saturation (Table 128) may be around 10% high. However in another study previous to the aforementioned study, Itron identified an 80% saturation of cooling systems in residential new construction in California.[46] These finding suggest an upward trend in cooling saturation in this particular market segment, demonstrating that the likely saturation among ENERGY STAR Homes to be somewhere between 86% and 97%. Of course this assumes ENERGY STAR homes are homogenous to non-ENERGY STAR new homes, which we believe to be true.

[45] "Baseline Study for Residential New Construction -- Year 2" Itron, September 26, 2002. (Homes that were constructed between July 1 1999 and July 1 2000)

[46] "Baseline Study for Residential New Construction -- Year 1" Itron, September 10, 2001. (Homes that were constructed between July 1 1998 and July 1 1999)

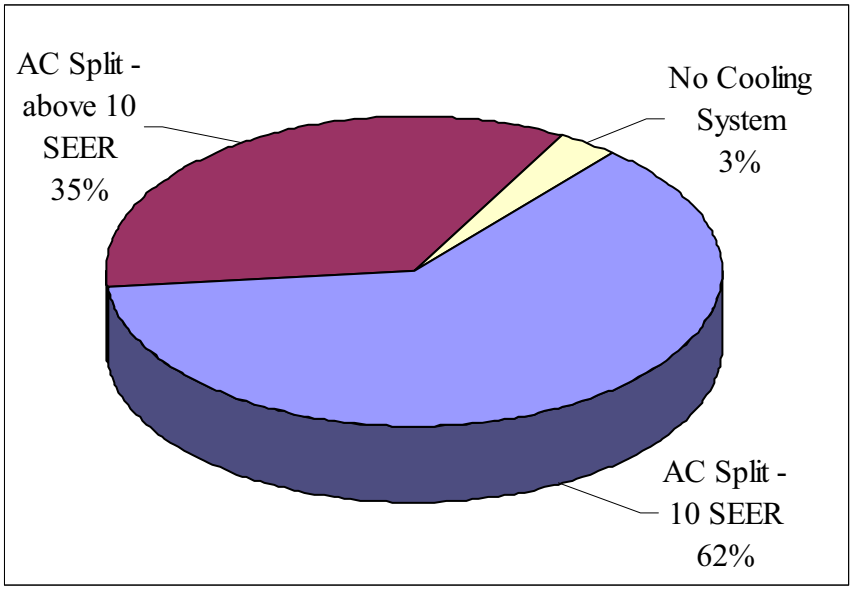

Figure 6: Cooling System Types

All of the cooling equipment installed in participating homes were split system air-conditioners. Ten percent of the homes in PG&E territory were not cooled.

Utility	AC Split	No Cooling System	n
PG&E	90%	10%	299
SCE	100%	-	251
SDG&E	100%	-	130
SoCalGas	100%	-	12
Overall	**97%**	**3%**	**692**

Table 128: Type of Cooling System by Utility

When studying the distribution of various cooling equipment by climate zone, one can see that only ENERGY STAR homes in climate zones 3 and 5 installed no cooling systems. All new homes within the San Francisco area and Central Coast did not require an air conditioner, which can be explained by the sparse cooling degree-days in those regions.

Climate Zone	AC Split	No Cooling System	n
Climate Zone 2	100%	-	4
Climate Zone 3	-	100%	8
Climate Zone 4	100%	-	26
Climate Zone 5	-	100%	11
Climate Zone 6	100%	-	15
Climate Zone 7	100%	-	72
Climate Zone 8	100%	-	63
Climate Zone 9	100%	-	47
Climate Zone 10	100%	-	181
Climate Zone 11	100%	-	52
Climate Zone 12	100%	-	197
Climate Zone 13	100%	-	1
Climate Zone 14	100%	-	12
Climate Zone 15	100%	-	3
Overall	**97%**	**3%**	**692**

Table 129: Presence of Cooling System by Climate Zone

Split Systems with Thermostatic Expansion Valves (TXV)

Of the ENERGY STAR homes with cooling equipment, a significant percentage (47%) had a Thermastatic expansion valve (TXV) installed. TXV technology helps the cooling system when it falls below its maximum efficiency refrigerant levels. In theory, the TXV may never come into use if the cooling equipment maintains proper refrigerant charge. Consequently, thermostatic expansion valves are reported to help increase the time an air conditioner functions at its peak efficiency, even when the refrigerant charge is incorrect.

Over 90% of the split air conditioners had TXVs in SoCalGas's territory, and over 80% did so in PG&E's territory. On the other hand, SCE and SGG&E ENERGY STAR homes had less than 30% of the homes installed with TXV's. It may that builders of these homes installed the technology, but did not claim the credit on their ENERGY STAR/Title 24 rating report due to added testing costs. Therefore it is difficult to tell how many systems actually had TXVs.

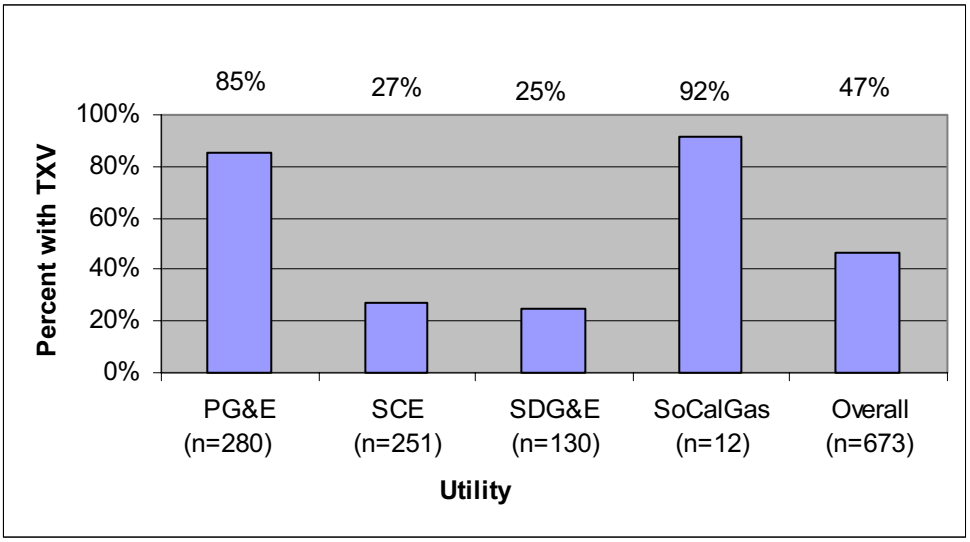

Figure 7: Percentage of AC Split Systems with TXV by Utility

All split air conditioners had a TXV in the following climate zones: Climate zone 1, climate zone 13, and climate zone 15. Note that southern California regions had more TXVs accompany the split air conditioning systems than northern California, which is also where temperature can be warmer.

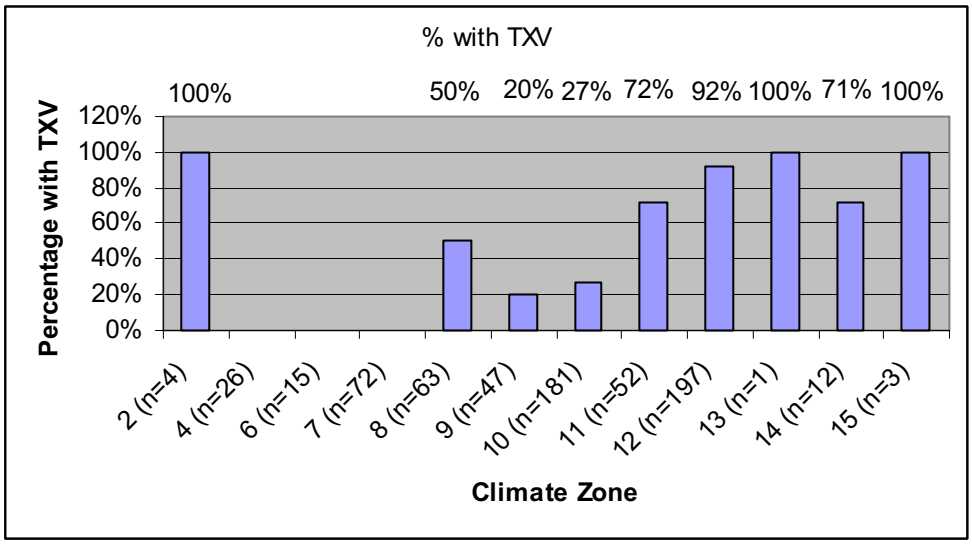

Figure 8: Cooling Systems with TXV by Climate Zone

SEER Efficiency Rating

Air conditioning efficiency is measured by SEER—the greater the value the better the efficiency. The minimum requirement is a 10 SEER. As shown by Table 130, PG&E had the most efficient air conditioners (12.0) in ENERGY STAR homes in 2002, followed very closely by SoCalGas (11.7). The overall average was 10.8.

Utility	SEER Average	n
PG&E	12.0	280
SCE	10.2	251
SDG&E	10.4	130
SoCalGas	11.7	12
Overall	**10.8**	**673**

Table 130: SEER Average by Utility

Climate zone 2 and climate zone 13 had the most efficient SEER averages, with 13.7 and 14.0 respectively. However, both regions combined for only five projects. Most climate zones had averages of 10 or slightly above. Climate zones 11, 12, and 15 had averages of around 12, which implies these regions may benefit more from cooling credits than others climate zones would.

Climate Zone	SEER Average	n
Climate Zone 2	13.7	4
Climate Zone 4	10.0	26
Climate Zone 6	10.0	15
Climate Zone 7	10.0	72
Climate Zone 8	10.8	63
Climate Zone 9	10.0	47
Climate Zone 10	10.2	181
Climate Zone 11	12.2	52
Climate Zone 12	11.9	197
Climate Zone 13	14.0	1
Climate Zone 14	11.0	12
Climate Zone 15	12.0	3
Overall	**10.8**	**673**

Table 131: SEER Average by Climate Zone

Although PG&E had the highest percentage of homes with SEER averages 13 and above, SoCalGas had the highest percentage of a SEER average of 12. Both SCE and SDG&E had the majority of the ENERGY STAR homes equipped with SEER 10 air conditioners.

Utility	SEER 10	SEER 11	SEER 12	SEER 13 or Above	n
PG&E	17%	2%	51%	30%	280
SCE	87%	3%	9%	0%	251
SDG&E	82%	-	18%	-	130
SoCalGas	16%	-	84%	-	12
Overall	**64%**	**2%**	**25%**	**9%**	**673**

Table 132: SEER Rating by Utility

The breakdown of SEER percentage bins by climate zone clearly indicates that climate zones 11, 12 and 13 had the most efficient cooling equipment installed by measurement of a SEER rating. These climate zones represent California's Central Valley, an area of the

state the experiences extreme high temperatures. Climate zone 2, 14 and 15 also had a high percentage of air conditioners with high SEER rating; however, the number of projects in those regions was minimal.

Climate Zone	SEER 10	SEER 11	SEER 12	SEER 13 or Above	n
Climate Zone 2	-	-	-	100%	4
Climate Zone 4	100%	-	-	-	26
Climate Zone 6	100%	-	-	-	15
Climate Zone 7	100%	-	-	-	72
Climate Zone 8	55%	10%	35%	-	63
Climate Zone 9	100%	-	0%	-	47
Climate Zone 10	87%	2%	10%	0%	181
Climate Zone 11	-	-	80%	20%	52
Climate Zone 12	19%	2%	47%	32%	197
Climate Zone 13	-	-	-	100%	1
Climate Zone 14	48%	-	52%	-	12
Climate Zone 15	-	-	100%	-	3
Overall	**64%**	**2%**	**25%**	**9%**	**673**

Table 133: SEER Rating by Climate Zone Radiant Barrier

Radiant barriers are materials that are installed in buildings to reduce summer heat gain and winter heat loss, thereby reducing building heating and cooling energy usage. The potential benefit of attic radiant barriers is primarily in reducing air-conditioning cooling loads in warm or hot climates. Radiant barriers usually consist of a thin sheet or coating of a highly reflective material (usually aluminum), which is applied to one or both sides of a number of substrate materials. A radiant barrier is a C-HERS measure that can be used by builders to gain additional compliance credits.

Table 134 shows the percentage of conditioned area in participating homes utilizing a radiant barrier. PG&E has the highest fraction (9%) of household square footage utilizing radiant barrier measures. Edison has the next highest amount of square footage utilizing radiant barriers, while SDG&E and SCG builders did not utilize radiant barriers at all. Overall, radiant barriers were only installed in 5% of the floor area of ENERGY STAR Homes.

Utility	% of Area with Radiant Barrier	n
PG&E	9%	299
SCE	5%	251
SDG&E	-	130
SoCalGas	-	12
Overall	**5%**	**692**

Table 134: Percent of Conditioned Floor Area with Radiant Barrier by Utility

Interestingly, climate zone 1 had the highest utilization rate (34%) of radiant barriers, even though this climate zone is not exceptionally hot, where this technology performs the best. Not surprisingly radiant barriers were not used in climate zone 2, which has the mildest climate of the five zones.

Climate Zone	% of Area with Radiant Barrier	n
RMST CZ1	34%	49
RMST CZ2	-	87
RMST CZ3	2%	291
RMST CZ4	5%	250
RMST CZ5	19%	15
Overall	**5%**	**692**

Table 135: Percent of Conditioned Floor Area with Radiant Barrier by Climate Zone

Fenestration

The fenestration aspect (windows, doors and skylights) of an efficient home largely results from a whole-building design approach.[47] Efficient windows, doors and skylights deliver not only lower energy bills (from reduced heating, cooling and lighting) up to 15%, but also benefit the homeowner through increased comfort, noise reduction, and protection against sun damage to carpet, wood floors, furniture, fabrics and artwork in your home. If all homes in the US utilized ENERGY STAR-qualifying windows, the nation would save $134 billion in energy costs alone.[48]

Window to Floor Area Ratio

Part of the integrated-design approach may include minimizing the window to floor area ratio in order to maximize energy efficiency. The California Energy Commission sets both maximum U-values and maximum area ratios in Title 24 standards. Table 136 summarizes the standards (manual D), which 2002 ENERGY STAR home participants exceeded by at least 15%.

[47] Whole-Building Design Approach, also referred to as integrated design, is when the building HVAC system has been sized according to the load requirements as determined by a computer simulation model, rather than only basing the size of the HVAC system on building size or rule of thumb procedures.

[48] ENERGY STAR Website: www.energystar.gov

Climate Zone	RMST CZ	U-Value	SHGC	Max Area
1	1	0.65	NA	16%
2	1	0.65	0.4	16%
3	1	0.75	NA	20%
4	1	0.75	0.4	20%
5	1	0.75	NA	16%
6	2	0.75	NA	20%
7	2	0.75	0.4	20%
8	3	0.75	0.4	20%
9	3	0.75	0.4	20%
10	3	0.65	0.4	20%
11	4	0.65	0.4	16%
12	4	0.65	0.4	16%
13	4	0.65	0.4	16%
14	5	0.65	0.4	16%
15	5	0.65	0.4	16%
16	5	0.65	NA	16%

Table 136: Summary of 2001 Title 24 Standards for Fenestration

On average for the 2002 ENERGY STAR homes, overall, the window to floor area ratio was about 17%. The highest average window to floor area ratio was in homes with less than 1500 square feet. The lowest ratio was in middle-size ranges of 1500-2500 square feet and 2500-3500 square feet—both of about 17%.

Square Footage	Window to Floor Area	n
< 1500 sf	19%	44
1500 - 2500 sf	17%	299
2501 - 3500 sf	17%	260
> 3501 sf	18%	89
Overall	**17%**	**692**

Table 137: Window to Floor Area by Square Footage

When comparing homes by utility service territory, SCE's homes maintained the lowest window to floor area at 16% and SDG&E's was the highest at 19%. Recall that SCE's overall energy savings were highest per unit recruited[49] and part of that reason is likely due to lower window to floor area ratios.

SoCalGas and SDG&E had homes in climate zones with more stringent standards (16% ratio and 0.65 or less U-value) and less stringent standards (20% and 0.75 U-value), but their overall window to floor ratio was 18% and 19% respectively.

There was no clear pattern throughout all utilities in the size of the home and level of efficiency. In PG&E's and SoCalGas' region, the larger homes had lower window to floor ratios. The other two utilities showed no absolute trends. This likely reflects the diversity of climate zones served by each of the utilities.

[49] See Table 71.

Utility	Square Footage	Window to Floor Area	n
PG&E	< 1500 sf	19%	28
	1500 -2500 sf	18%	144
	2501-3500 sf	17%	100
	> 3501 sf	17%	27
	Overall	**18%**	**299**
SCE	< 1500 sf	18%	10
	1500 -2500 sf	15%	111
	2501-3500 sf	16%	99
	> 3501 sf	18%	31
	Overall	**16%**	**251**
SDG&E	< 1500 sf	23%	5
	1500 -2500 sf	19%	38
	2501-3500 sf	19%	59
	> 3501 sf	20%	28
	Overall	**19%**	**130**
SoCalGas	< 1500 sf	21%	1
	1500 -2500 sf	18%	6
	2501-3500 sf	16%	2
	> 3501 sf	16%	3
	Overall	**18%**	**12**

Table 138: Window to Floor Area by Square Footage and Utility

Studying the window to floor ratios by climate zone is more telling since one can compare them to the standards in each region. Table 139 indicates that RMST climate zone 3 (CZ 9 and 10) and climate zone 5 (CZ 14 to 16) had the best ratios at 16%. That may be due to the stricter requirements in those regions.[50]

RMST Climate zone 1 and 2 showed the worst window to floor area ratio with an overall average of 19% and homes smaller than 1500 square feet with an average of 22% and 23%. The mild climate of this region will allow builders the flexibility to have greater amounts of glass area with less negative impacts on the energy budget, as evidenced by the lower ratios in all other zones.

When homes do not comply with a Title 24 prescriptive requirement on a certain measure like fenestration, tradeoffs with other measures may be taken in order to meet overall compliance standards. Because of the aesthetics associated with windows, builders often will trade higher window to floor area ratios for other energy efficient measures. However, it appears as though ENERGY STAR builders are staying within the Title 24's prescriptive values for window to floor area. Only in RMST CZ1 does it appear as though builders may be exceeding the prescriptive values, as shown in Table 136.

[50] See Table 136 for standard requirements by climate zone.

Climate Zone	Square Footage	Window to Floor Area	n
RMST CZ1	< 1500 sf	22%	13
	1500 -2500 sf	19%	21
	2501-3500 sf	17%	15
	Overall	**19%**	**49**
RMST CZ2	< 1500 sf	23%	2
	1500 -2500 sf	19%	17
	2501-3500 sf	19%	46
	> 3501 sf	19%	22
	Overall	**19%**	**87**
RMST CZ3	< 1500 sf	19%	13
	1500 -2500 sf	15%	127
	2501-3500 sf	17%	111
	> 3501 sf	19%	40
	Overall	**16%**	**291**
RMST CZ4	< 1500 sf	18%	15
	1500 -2500 sf	18%	123
	2501-3500 sf	17%	85
	> 3501 sf	17%	27
	Overall	**17%**	**250**
RMST CZ5	< 1500 sf	21%	1
	1500 -2500 sf	16%	11
	2501-3500 sf	15%	3
	Overall	**16%**	**15**

Table 139: Window to Floor Area by Square Footage

Average U-Value and SHGC

Fenestration has a U-value and solar heat gain coefficient (SHGC) that measures the rate of heat loss and how well a product prevents heat from entering. The U-value ratings generally fall between 0.20 and 1.20. The lower the u-factor, the greater a product's resistance to heat flow and the better its insulating value is. The SHGC measures how well a product blocks heat caused by sunlight. The SHGC is expressed as a number between 0 and 1. The lower the SHGC, the less solar heat it transmits. Some manufacturers apply a low-E (low-emittance) coating to glazing surfaces; these windows are commonly referred to as "low e- windows" by builders, as was observed in the Builder Analysis section of the report.

Table 140 summarizes average U-values and SHGC for doors, windows and skylights by each utility.

For windows, SoCalGas and SDG&E had the most efficient windows (0.35/0.36 U-value and 0.34 SHGC value) and SCE had the least efficient average (0.42 U-value and 0.36 SHGC). The difference in the averages between utility service areas is minimal; therefore little can be said about differences between them.

Utility	Average U-value	Average SHGC	n
PG&E	0.37	0.35	299
SCE	0.42	0.36	251
SDG&E	0.36	0.34	130
SoCalGas	0.35	0.34	12
Overall	**0.39**	**0.35**	**692**

Table 140: Average Window U-value and SHGC by Utility

Bear in mind that high performance windows perform the best in very warm or very cold climates. Table 141 shows window performance values by climate zone. By climate zone, zones 2, 4 and 5 have the most efficient windows by U-value (0.35 and 0.36) and by SHGC (0.34 and 0.36). The least efficient windows were found in climate zone 1 (northern coastal) with average U-value of 0.43 and SHGC of 0.46. Not surprisingly, since this zone is the mildest of the five.

Climate Zone	Average U-value	Average SHGC	n
RMST CZ1	0.43	0.46	49
RMST CZ2	0.36	0.34	87
RMST CZ3	0.41	0.36	291
RMST CZ4	0.36	0.33	250
RMST CZ5	0.35	0.34	15
Overall	**0.39**	**0.35**	**692**

Table 141: Average U-Value and SHGC by Fenestration Type and Utility

Overall, the average U-value and SHGC were well below Title 24 prescriptive standards. The skylight were the least efficient of the three types of fenestration, however, they were also the least common type of fenestration installed.

Fenestration Type	Average U-value	Average SHGC	n
Door	0.43	0.42	656
Skylight	0.57	0.42	41
Window	0.39	0.35	692

Table 142: Average U-Value and SHGC by Fenestration Type

ENERGY STAR Rating for Fenestration

The Department of Energy (DOE) also has a program that allows fenestration to qualify as ENERGY STAR and place the logo on their product. The requirements have recently been modified in August 2003 to a higher standard. However, the California utilities were enforcing the new standard even though the US Department of Energy qualified less efficient windows as ENERGY STAR.

Fenestration Type	Current U-Value	Previous U-Value	Current SHGC	Previous SHGC
Door/Windows	0.40	0.35 to 0.75	0.40	0.40 to 0.55
Skylights	0.60	0.45 to 0.75		

Table 143: DOE Requirement to Qualify for ENERGY STAR Fenestration Rating[51]

The following tables summarize what percentage of windows meet or exceed each listed U-value. The vast majority of all fenestration types in all utilities met or exceeded a U-value of 0.60. The lowest percentage of windows that either met, or exceeded 0.45, are SCE's ENERGY STAR homes. SoCalGas had the highest percentage of windows that met or exceeded 0.35, but also had the lowest sample size of 12.

If the 2002 ENERGY STAR homes were held to today's fenestration standard of 0.40 for windows, then overall, over 80% of the window area would qualify for an ENERGY STAR rating.

Utility	U-Value of % that Meet or Exceed Value				
	0.35	**0.40**	**0.45**	**0.60**	**n**
PG&E	47%	94%	94%	100%	299
SCE	36%	68%	70%	100%	251
SDG&E	64%	98%	98%	100%	130
SoCalGas	97%	100%	100%	100%	12
Overall	**47%**	**83%**	**84%**	**100%**	**692**

Table 144: Percentage of Windows that Meet or Exceed U-value by Utility

Table 145 summarizes windows that meets or exceeds U-values by climate zone. Again, results are very pleasing. However, climate zone 10 should be noted as one of the only zones with a substantial sample size where only 54% of the windows met or exceeded 0.45 (overall average is 84%). Obviously builders found other (possibly more cost effective) measures in this climate zone to meet the programs 15% standard.

[51] Previous values refer to requirements prior to August 2003 and current values are thereafter. All information is public on the ENERGY STAR website.

Climate Zone	U-Value of % that Meet or Exceed Value				2001 T24 Std U-Value	n
	0.35	0.40	0.45	0.60		
2	16%	100%	100%	100%	0.65	4
3	-	100%	100%	100%	0.75	8
4	11%	11%	11%	100%	0.75	26
5	3%	21%	21%	100%	0.75	11
6	93%	98%	98%	100%	0.75	15
7	76%	97%	97%	100%	0.75	72
8	48%	94%	99%	99%	0.75	63
9	35%	97%	97%	100%	0.75	47
10	30%	53%	54%	100%	0.65	181
11	83%	100%	100%	100%	0.65	52
12	46%	98%	98%	100%	0.65	197
13	100%	100%	100%	100%	0.65	1
14	68%	100%	100%	100%	0.65	12
15	100%	100%	100%	100%	0.65	3
Overall	**47%**	**83%**	**84%**	**100%**		**692**

Table 145: Percentage of Windows that Meet or Exceed U-value by Climate Zone

Opaque Surface Insulation

The insulation level of exterior opaque surfaces has profound effects on the energy efficiency and comfort of a home. The prevailing residential construction in California is a wood frame home with fiberglass batt insulation in the cavities of the frame for walls and floors. Ceiling/roof assemblies are also insulated with blown-in "rock wool" type insulation. The "R-value" of an insulation material is a measure the level of thermal resistance of the material. The higher the R-value of a material, the greater is its ability to resist heat flow.

Insulation R-Value

The participant data included the R-value of the material that was used to insulate opaque surfaces. Table 146 summarizes the average resistance values for each opaque surface insulating material (roof and wall) by utility. PG&E had the highest average insulation in each category and SoCalGas had the least insulation, on average. Average roof R-values were higher, which ranged from 22.0 to 34.0. Average wall insulation material R-values had little variation (13.0 to 13.6).

Utility	Roof	n	Wall	n
PG&E	34.0	283	13.6	282
SCE	30.9	251	13.1	251
SDG&E	26.9	130	13.1	130
SoCalGas	22.0	12	13.0	12
Overall	**30.8**	**676**	**13.2**	**675**

Table 146: Average R-Value by Utility and Surface Type by Utility

Table 147 shows the average insulation material R-value by climate zone. One can see that climate zone 2 and 10 had the highest R-value for floors R-19.0, while climate zones 4 and 5 had the lowest floor R-values. Average roof insulation was greatest in climate

zone 1 (36.4). Average wall insulation varied little, as was the case when analyzing by utility.

Climate Zone	Roof	n	Wall	n
Climate Zone 2	38.0	4	13.0	4
Climate Zone 3	36.0	8	13.0	8
Climate Zone 4	20.4	20	13.0	20
Climate Zone 5	30.0	1		0
Climate Zone 6	27.5	15	13.0	15
Climate Zone 7	25.0	72	13.0	72
Climate Zone 8	30.4	63	13.2	63
Climate Zone 9	31.0	47	13.2	47
Climate Zone 10	30.5	181	13.1	181
Climate Zone 11	34.8	52	13.6	52
Climate Zone 12	33.6	197	13.7	197
Climate Zone 13	38	1	13.2	1
Climate Zone 14	34.5	12	13.0	12
Climate Zone 15	22	3	13	3
Overall	**30.8**	**676**	**13.2**	**675**

Table 147: Average R-Value by Surface Type and Climate Zone

The Title 24 Package D prescriptive requirement for ceiling insulation is either R-30 or R-38 depending on which CEC climate zone the home is located. However the mandatory minimum is R-19 for all climate zones. Table 148 shows the proportion of homes that have ceiling\roof insulation above the R-19, R-30 and R-38 thresholds. Overall, 87% of homes have ceiling insulation equal or greater than R-30 and 27% have ceiling insulation equal or greater than R-38. RMST climate zone 1 has the greatest proportion of ceiling insulation R-38 and above, 50%.

Utility	Roof: R19 Min	Roof: R30 Min	Roof: R38 Min	n
PG&E	100%	95%	56%	299
SCE	100%	98%	15%	251
SDG&E	100%	66%	8%	130
SoCalGas	100%	92%	0%	12
Overall	**100%**	**87%**	**27%**	**692**

Climate Zone	Roof: R19 Min	Roof: R30 Min	Roof: R38 Min	n
RMST CZ1	100%	97%	50%	49
RMST CZ2	100%	56%	3%	87
RMST CZ3	100%	95%	13%	291
RMST CZ4	100%	94%	57%	250
RMST CZ5	100%	46%	28%	15
Overall	**100%**	**87%**	**27%**	**692**

Table 148: Percentage of Homes that Meet or Exceed Roof R-Value by Utility and RMST Climate Zone

The Title 24 package D prescriptive requirement for wall insulation is R-13, R-19 or R-21 depending on which CEC climate zone the home is located. The mandatory minimum for the entire state is R-13. Table 149 shows that very few walls, 5% of the total, are insulated with R-19 and above. This indicates that builders that are willing to go below the baseline prescriptive requirement in order to avoid the added cost 2x6 framed walls that could accommodate R-19 batt insulation. Based on these findings, one can conclude that nearly 10% of ENERGY STAR homes in PG&E's territory use 2x6 framing, a much higher fraction than builders in the other service areas. Since the PG&E service territory serves a

greater proportion of the cooler climate zones (i.e., those with greater numbers of heating degree days) it makes sense that PG&E builders are installing higher levels of insulation.

Utility	Wall: R13 Min	Wall: R19 Min	n
PG&E	100%	13%	299
SCE	100%	2%	251
SDG&E	100%	1%	130
SoCalGas	100%	0%	12
Overall	**100%**	**5%**	**692**

Climate Zone	Wall: R13 Min	Wall: R19 Min	n
RMST CZ1	100%	23%	49
RMST CZ2	100%	0%	87
RMST CZ3	100%	2%	291
RMST CZ4	100%	11%	250
RMST CZ5	100%	0%	15
Overall	**100%**	**5%**	**692**

Table 149: Percentage of Homes that Meet or Exceed Wall R-Value by Utility and Climate Zone

Assembly Insulation U-Value

While the above analysis was for the insulation material, the insulating performance of an opaque surface for the entire assembly needs to consider all of the assembly components such as framing and sheathing. The conductivity, rated as a "U-value" of an opaque surface is the simply the inverse of the overall R-value of the surface that considers all components of the assembly. The units for U-value are BTU /(hour-square foot-degree F), the lower values represent greater insulation. Table 150 presents average U-values for each surface type by RMST climate zone. RMST climate zone 4 opaque surfaces have the best-insulated surfaces.

Climate Zone	Floor	n	Roof	n	Wall	n
RMST CZ 1	0.053	47	0.029	49	0.070	49
RMST CZ 2	0.061	78	0.036	87	0.087	87
RMST CZ 3	0.056	211	0.031	291	0.087	291
RMST CZ 4	0.045	149	0.028	250	0.070	250
RMST CZ 5	0.055	4	0.035	15	0.087	15
Overall	**0.05**	**489**	**0.030**	**692**	**0.081**	**692**

Table 150: Average U-Value for each Surface Type by Climate Zone

Table 151 shows the percentage of homes that have U-values equal to or less than standard values. 0.065 represents the U-value for a wood frame raised floor with R-13 cavity insulation, the mandatory minimum. Similarly, 0.049 represents a U-value of a standard wood frame raised floor with R-19 with no crawlspace and 0.037 is the U-value for the same floor with a crawlspace.

Although the standards of floor insulation are consistent throughout the state, PG&E has considerably greater floor insulation than other utilities.

Utility	Floor: U-Value 0.037	Floor: U-Value 0.049	Floor: U-Value 0.065
PG&E	14%	86%	99%
SCE	0%	24%	100%
SDG&E	4%	25%	100%
SoCalGas	-	-	100%
Overall	**6%**	**47%**	**100%**

Climate Zone	Floor: U-Value 0.037	Floor: U-Value 0.049	Floor: U-Value 0.065
RMST CZ1	-	73%	98%
RMST CZ2	-	3%	100%
RMST CZ3	2%	30%	100%
RMST CZ4	21%	93%	100%
RMST CZ5	-	34%	100%
Overall	**6%**	**47%**	**100%**

Table 151: Percentage of homes that Meet or Exceed Floor U-Value by Utility and Climate Zone

The U-values 0.028, 0.034 and 0.051 represent U-values for standard wood frame ceiling and/or roof with R-38, R-30, and R-19 cavity insulation. The majority of roofs had u-values of 0.034 or better. By utility, PG&E performed best, where over half of the roofs had U-values of 0.028 or better. Some of PG&E's territory has higher package D prescriptive requirements for roofs, which would explain the higher level of insulation when compared with the other utilities.

Utility	Roof: U-Value 0.028	Roof: U-Value 0.034	Roof: U-Value 0.051
PG&E	56%	95%	96%
SCE	15%	93%	100%
SDG&E	8%	66%	100%
SoCalGas	-	1%	100%
Overall	**27%**	**85%**	**99%**

Climate Zone	Roof: U-Value 0.028	Roof: U-Value 0.034	Roof: U-Value 0.051
RMST CZ1	50%	97%	100%
RMST CZ2	3%	55%	100%
RMST CZ3	13%	92%	100%
RMST CZ4	57%	94%	96%
RMST CZ5	28%	46%	100%
Overall	**27%**	**85%**	**99%**

Table 152: Percentage of homes that Meet or Exceed Roof U-Value by Utility and Climate Zone

The U-values 0.059, 0.065 and 0.0088 represent U-values for standard wood frame wall with R-21, R-19, and R-13 cavity insulation. The vast majority (99%) of wall U-values were in the minimum requirement of 0.088 or better category. PG&E had the most high performance wall assemblies. The lack of high performance wall is Southern California seems to indicate market domination of 2x4 wall framing in the region.

Utility	Wall: U-Value 0.059	Wall: U-Value 0.065	Wall: U-Value 0.088
PG&E	27%	56%	97%
SCE	-	2%	100%
SDG&E	-	1%	100%
SoCalGas	-	-	100%
Overall	**8%**	**18%**	**99%**

Climate Zone	Wall: U-Value 0.059	Wall: U-Value 0.065	Wall: U-Value 0.088
RMST CZ1	35%	58%	89%
RMST CZ2	-	-	100%
RMST CZ3	-	2%	100%
RMST CZ4	26%	55%	98%
RMST CZ5	-	0.3%	100%
Overall	**8%**	**18%**	**99%**

Table 153: Percentage of homes that Meet or Exceed Wall U-Value by Utility and Climate Zone

Ducting

Excessive duct leakage, especially duct leakage into unconditioned attics is a preventable waste of heating and cooling energy. To address this issue, credit toward attaining an ENERGY STAR home rating is given to homebuilders that assure tight duct construction, below 6% of full flow rate through duct leakage testing. Taking this credit requires that a C-HERS inspector perform duct leakage testing with duct pressurization equipment.

Additional credit is given for homes that achieve greater ducting efficiency by designing the ducting systems of their homes to the Air Conditioning Contractors of America (ACCA) Manual D standards. ACCA Manual D standards insure that optimal design is achieved such that airflow through the ductwork is not restricted without overcompensating by over sizing the ductwork. Oversized ducting loses efficiency because of excessive surface area that leads to heat losses, while restricted airflow leads to greater fan energy in order to condition the home. A C-HERS inspector must review the duct design if this credit is taken.

Table 154 summarizes the program homes that have taken credit for duct leakage testing and ACCA Manual D duct design by utility. Duct leakage is a more popular measure, especially for the PG&E and SCE programs. ACCA Manual D is a commonly used program measure, notably in SCE territory, but is less popular than duct leakage testing.

Utility	% of homes that Tested Duct Leakage	% with ACCA Manual D	n
PG&E	96%	21%	299
SCE	96%	89%	251
SDG&E	63%	45%	130
SoCalGas	0%	-	12
Overall	**87%**	**56%**	**692**

Table 154: Percentage of Single-family Homes that tested Duct Leakage and Percentage that Complied with ACCA Manual D by Utility

Table 155 shows the homes that have taken ducting credits by RMST climate zone. RMST Climate zones 3 and 4 have the greatest proportion of homes taking duct-testing credits. The majority of homes in RMST climate zones 2 and 3 used the ACCA Manual D duct design credit.

Climate Zone	% of homes that Tested Duct Leakage	% with ACCA Manual D	n
RMST CZ1	73%	39%	49
RMST CZ2	61%	61%	87
RMST CZ3	92%	80%	291
RMST CZ4	100%	17%	250
RMST CZ5	46%	46%	15
Overall	**87%**	**56%**	**692**

Table 155: Percentage of Single-family Homes that tested Duct Leakage and Percentage that Complied with ACCA Manual D by Climate Zone

Infiltration

Credit towards receiving an ENERGY STAR rating is given to homes that have low infiltration rate, essentially a "tight" home credit. For homes that do not claim an infiltration credit, the assumption is a specific leakage area (SLA) of 4.9 for homes with ducted conditioning systems. SLA is the aggregate leakage area of the home expressed as a fraction of floor area times 10,000. Installation of approved house infiltration retarding wrap (i.e. Tyvek) achieves a credit of 0.5 SLA, and duct leakage testing achieves a further credit of 0.5 SLA. Alternatively credit may be taken for an infiltration or "blower door" test. When taking infiltration test credit, a target SLA must be selected by the analyst and input into the

simulation program. This establishes a maximum leakage value that must achieved when the blower door test is performed in order to pass.

Table 156 shows the SLA as modeled for the participant homes by utility. A specified leakage area of 3.8 is a popular target SLA as selected by analysts, and is used by the majority of homes in the SCE program. A specified leakage area of 4.9 is the most common SLA for homes in PG&E, SDG&E and SoCalGas as it represents homes that have taken no infiltration credit.

	Specified Leakage Area								
Utility	3.0	3.1	3.5	3.6	3.8	4.2	4.4	4.9	n
PG&E	28%	-	2%	-	11%	1%	0.4%	58%	299
SCE	0.3%	1%	12%	1%	78%	-	0.02%	8%	251
SDG&E	-	4%	-	-	45%	-	-	51%	130
SoCalGas	-	-	-	-	-	-	-	100%	12
Overall	**9%**	**1%**	**6%**	**0%**	**48%**	**0.2%**	**0.1%**	**35%**	**692**

Table 156: Modeled SLA by Utility

Table 157 shows the modeled SLA by RMST climate zone. Interestingly, we found very few homes taking credit for infiltration retarding wrap (i.e., Tyvek), which is normally installed on all homes. The SLA value of 4.4 represents the builders that took the 0.5 credit for infiltration retarding wrap. It is possible that the majority of Title 24 analysts are not aware of this credit that could likely be taken on most homes.

Climate	Specified Leakage Area								
Zone	3.0	3.1	3.5	3.6	3.8	4.2	4.4	4.9	n
RMST CZ1	-	-	-	-	39%	-	0.2%	60%	49
RMST CZ2	-	-	-	-	61%	-	-	39%	87
RMST CZ3	0.3%	2%	10%	1%	70%	-	0.0%	17%	291
RMST CZ4	33%	-	2%	-	6%	1%	0.5%	57%	250
RMST CZ5	-	-	10%	-	36%	-	-	54%	15
Overall	**9%**	**1%**	**6%**	**0.5%**	**48%**	**0.2%**	**0.1%**	**35%**	**692**

Table 157:Modeled SLA by RMST Climate Zone

8. Multifamily Building Characteristics

The following section describes the building characteristics of the 2002 ENERGY STAR-compliant low rise multifamily projects in California. RLW obtained the Title 24 files from the utilities for each project known to have participated in the program. Using the transfer files generated by the Title 24 runs, RLW developed a database of housing characteristics inclusive of all plans receiving ENERGY STAR status through the program. This section presents the results of the analysis that utilized this information.

Demographics

Table 158 summarizes the number of projects, plans, and units by utility service territory. Projects refer to the overall number of developments, while plans are the individual housing plans within each development. Units are the number of each plan that builders intend to construct within each project. Note that there were a total of 56 projects in the 2002 statewide program, with 225 total plans and 8,865 total units. SDG&E had the largest number of multifamily units in the program, followed closely by SoCalGas.

Utility	Projects	Plans	Units
PG&E	12	36	1087
SCE	10	31	1471
SDG&E	19	84	3313
SoCalGas	15	74	2994
Total	**56**	**225**	**8,865**

Table 158: Number of Projects, Plans, and Units by Utility

Table 107 summarizes the number of plans, projects and units by climate zone. The majority of the units fell in climate zones 2 and 3. Zone 2 covers the southern coastal region and zone 3 includes the southern inland area (SCE and SDG&E).

Climate Zone	Projects	Plans	Units
RMST CZ1	10	27	735
RMST CZ2	20	89	3,663
RMST CZ3	18	83	3,620
RMST CZ4	4	14	466
RMST CZ5	4	12	381
Total	**56**	**225**	**8,865**

Table 159: Number of Projects, Plans, and Units by Climate Zone

The majority of the Title-24 consultants utilized Micropas to execute the ratings. Because low rise dwellings must meet residential standards, raters may use either Energy Pro or Micropas to comply units. Since Micropas can only be used for residential compliance, all high-rise multifamily projects utilized Energy Pro since it is approved for both commercial and residential compliance. There were only five high-rise projects, they are discussed separately following the multifamily building characteristics section.

File Type	Projects	Plans	Units
Energy Pro	17	59	2,337
Micropas	39	166	6,528
Total	**56**	**225**	**8,865**

Table 160: Number of Projects, Plans, and Units by File Type

The following tables and description address the specific building characteristics and their relative performance to baseline standards.

Domestic Hot Water

Figure 9 clearly illustrates storage hot water heaters as the dominant technology type installed for hot water heating in multifamily ENERGY STAR homes. About 82% of the multifamily units received their hot water from a storage water heater, while the remaining builders installed central instantaneous and central boiler systems.

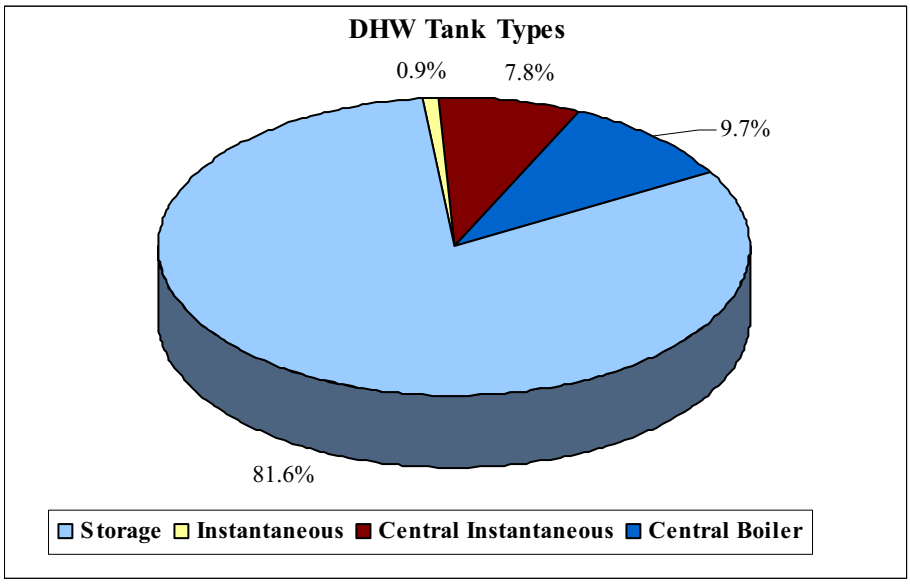

Figure 9: Tank Types Utilized by Multifamily Units

By utility territory, over 95% of water tanks were storage for the SDG&E and SoCalGas multifamily units. Less than half of the water tanks in PG&E's and SCE's territory were of storage tank type. Central instantaneous systems were the second most common hot water heating system in SCE's territory where 37% of the units utilized this technology type. Over 40% of PG&E's multifamily units employed a central boiler tank type.

Utility	Storage	Instantaneous	Central Instantaneous	Central Boiler	n
PG&E	49%	7%	3%	41%	36
SCE	41%	-	37%	22%	31
SDG&E	96%	-	4%	-	84
SoCalGas	97%	-	-	3%	74
Overall	**82%**	**1%**	**8%**	**10%**	**225**

Table 161: Hot Water Tank Type by Utility

RMST climate zones 1 and 5 had the lowest fractions of storage tank water heaters, and the greatest fraction of central hot water systems serving multifamily units. Climate zones 2, 3, and 4 were dominated by storage tank systems.

Climate Zone	Storage	Instantaneous	Central Instantaneous	Central Boiler	n
RMST CZ1	24%	11%	5%	60%	27
RMST CZ2	95%	-	-	5%	89
RMST CZ3	79%	-	18%	2%	83
RMST CZ4	100%	-	-	-	14
RMST CZ5	62%	-	-	38%	12
Overall	**82%**	**1%**	**8%**	**10%**	**225**

Table 162: Hot Water Tank Type by Climate Zone

Storage Tank Size

Storage and central boiler hot water system types have a tank associated with the water hot system, whereas instantaneous systems function on demand and do not store water. Therefore, projects utilizing instantaneous type systems have been excluded from the following analysis of tank size. Table 161 presents the average tank size for storage hot water heating systems, considering unitary and central systems as unique. Larger tank sizes are associated with central boilers, which are indicated by the overall average of 246 gallons, while unitary storage tanks averaged 47 gallons. This suggests that the majority of unitary hot water heaters are likely 50-gallon tank systems, as apposed to the next most common size of 40 gallons. Note that the sample size of central boilers (15) is much smaller than the sample of storage tanks (193). PG&E had the largest average tank size for both storage and central boiler systems with an average of 50 and 371 gallons respectively.

As we will show in the heating section, the reason the average hot water heater tank size is so large in multifamily dwellings is due to the heating type. The most common heating system type is hydronic heat, and the hot water heater located in the dwelling unit services the majority of these systems. Since the hot water heater is required to provide water for both space heating and service hot water these tanks are sized larger than if they were only providing service hot water. This explains why the average tank size for smaller square footage multifamily dwellings is on equal footing with the tank sizes associated with larger single family dwellings.

Tank Type	Utility	Average Tank Size	n
Storage	PG&E	50.2	16
	SCE	47.4	85
	SDG&E	47.1	68
	SoCalGas	40.0	14
	Overall	**47.0**	**193**
Central Boiler	PG&E	371.3	5
	SCE	111.1	6
	SoCalGas	119.0	4
	Overall	**246.4**	**15**

Table 163: Average Tank Size (gallons) by Utility

The majority of tank sizes for storage were less than 100 gallons (89%) and the majority tank sizes for central boiler systems were over 100 gallons (87%). Of the storage systems, about 55% were 50 gallon systems and another 31% were 40 gallon systems or less. Multifamily units within SoCalGas territory with storage systems, where all less than 100 gallons, about 74% were 50 gallons tank size, while about 20% were 40 gallons or less. About 40% of the multifamily units within PG&E's territory that had a storage hot water system were 100 gallons or greater. These systems may also be providing hot water to more than one dwelling units.

As mentioned before, multifamily units with central boiler systems have greater tank sizes associated with them, even though roughly 30% of SCE's multifamily units were less than 100 gallons. These systems are likely systems that serve a small number of dwelling units, and may not be considered true central systems as is normally defined by large boilers or large capacity instantaneous systems. The Title 24 author defines the system types (i.e. storage and central boiler) that we are presenting, and because compliance software allows for some discretion on this entry it is difficult to have a true "apples to apples" comparison.

Tank Type	Utility	Tank Size (gallons)						n
		Blank	40 or Less	50	65 to 99	Less than 100	100 or Greater	
Storage	PG&E	3%	41%	14%	2%	57%	40%	36
	SCE	37%	38%	28%	7%	72%	16%	31
	SDG&E	4%	35%	65%	0%	100%	0%	84
	SoCalGas	0%	20%	74%	3%	97%	3%	74
	Overall	**8%**	**31%**	**55%**	**2%**	**89%**	**8%**	**225**
Central Boiler	PG&E	-	-	-	3%	3%	97%	5
	SCE	-	-	-	29%	29%	71%	6
	SDG&E	-	-	-	0%	0%	100%	4
	Overall	**-**	**-**	**-**	**13%**	**13%**	**87%**	**15**

Table 164: Tank Size Bins by Utility

RMST climate zones one and three had the majority of central systems with tank sizes of 100 gallons or greater, although this only represents nine projects. Again, the majority of hot water system types were defined as storage systems, which were most heavily dominated by 50-gallon tank systems. RMST climate zone one was the only climate zone that had a greater proportion of 100 gallon or greater systems than 100 gallon or less

systems. Again, these are likely storage systems that are serving both hot water service needs and heating requirements for a hydronic heating system.

Tank Type	Climate Zone	Tank Size (gallons)						n
		Blank	40 or Less	50	65 to 99	Less than 100	100 or Greater	
Storage	RMST CZ1	5%	13%	20%	3%	36%	59%	27
	RMST CZ2	0%	30%	63%	3%	96%	4%	89
	RMST CZ3	18%	31%	62%	0%	93%	2%	83
	RMST CZ4	0%	100%	0%	0%	100%	0%	14
	RMST CZ5	0%	0%	62%	18%	80%	20%	12
	Overall	**8%**	**31%**	**55%**	**2%**	**89%**	**8%**	**225**
Central Boiler	RMST CZ1	-	-	-	3%	3%	97%	5
	RMST CZ2	-	-	-	15%	15%	85%	4
	RMST CZ3	-	-	-	0%	0%	100%	4
	RMST CZ5				48%	48%	52%	2
	Overall	**-**	**-**	**-**	**13%**	**13%**	**87%**	**15**

Table 165: Tank Size Bins by Climate Zone

Storage Tank Energy Factor

The energy factor is a measure of efficiency of water tanks—the lower the energy factor, the greater the efficiency of the water tank. The overall average of multifamily water tanks was 0.61, but SCE's average was slightly lower at 0.60.

Utility	Average Energy Factor	n
PG&E	0.61	25
SCE	0.60	16
SDG&E	0.61	82
SoCalGas	0.61	70
Overall	**0.61**	**193**

Table 166: Average Energy Factor by Utility

The average energy factor varied more by climate zone. The lowest (and most efficient) energy factor was found in climate zone 5, which had an average of 0.57. The highest energy factor average was in climate zone 4. The majority of the water tanks were found in climate zone 2 and 3 where the average energy factor was 0.60 and 0.61 respectively.

Climate Zone	Average Energy Factor	n
RMST CZ1	0.59	16
RMST CZ2	0.60	85
RMST CZ3	0.61	68
RMST CZ4	0.62	14
RMST CZ5	0.57	10
Overall	**0.61**	**193**

Table 167: Average Energy Factor by Climate Zone

Instantaneous and Central Boiler System Recovery Factor Efficiency

The recovery factor is the efficiency associated with central boilers and instantaneous hot water systems. The lowest average recovery factor is found in central boilers, with an average of 0.80. Central boiler systems in SoCalGas area had the lowest recovery factor average of 0.75 and central instantaneous systems in SCE's territory had the highest recovery factor average (0.84).

Tank Type	Utility	Average Recovery Factor	n
Central Boiler	PG&E	0.79	5
	SCE	0.83	6
	SoCalGas	0.75	4
	Overall	**0.80**	**15**
Central Instantaneous	PG&E	0.83	1
	SCE	0.84	9
	SoCalGas	0.80	2
	Overall	**0.83**	**12**
Instantaneous	PG&E	0.82	5
	SCE	-	-
	SoCalGas	-	-
	Overall	**0.82**	**5**

Table 168: Average Recovery Factor by Utility

All central instantaneous and instantaneous systems had recovery factors that ranged from 0.80 to 0.85. Twenty-three percent of SCE multifamily units had central boilers with 0.91 recovery factors, which was the highest of all multifamily central systems. SoCalGas had no central instantaneous or unitary instantaneous water tanks, and all of its central boilers had recovery factors between 0.75 and 0.79.

Tank Type	Utility	Recovery Factor			
		0.75 to 0.79	0.8 to 0.85	0.91	n
Central Boiler	PG&E	41%	59%	0%	5
	SCE	0%	77%	23%	6
	SoCalGas	100%	0%	0%	4
	Overall	**31%**	**60%**	**9%**	**15**
Cemtral Inst.	PG&E	-	100%	-	1
	SCE	-	100%	-	9
	SDG&E	-	100%	-	2
	Overall	**-**	**100%**	**-**	**12**
Instant.	PG&E	-	100%	-	5
	Overall	**-**	**100%**	**-**	**5**

Table 169: Recovery Factor by Tank Type and Utility

Only climate zone 5 had recovery factors of 0.91; half of climate zone 5 had central boilers with recovery factors of 0.91. Climate zone 2 had all of its central boilers with recovery

factors ranging from 0.8 to 0.85, while all of the central boilers in climate zone 3 had recovery factors below 0.80. Note that the sample size of these tank types is fairly small, proving that most of the multifamily units participating in the program utilized a storage tank type.

Tank Type	Climate Zone	Recovery Factor			
		0.75 to 0.79	0.8 to 0.85	0.91	n
Central Boiler	RMST CZ1	41%	59%	-	5
	RMST CZ2	0%	100%	-	4
	RMST CZ3	100%	0%	-	4
	RMST CZ5	0%	48%	52%	2
	Overall	**31%**	**60%**	**9%**	**15**
Central Inst.	RMST CZ1	-	100%	-	1
	RMST CZ3	-	100%	-	11
	Overall	**-**	**100%**	**-**	**12**
Instant.	RMST CZ1	-	100%	-	5
	Overall	**-**	**100%**	**-**	**5**

Table 170: Recovery Factor Percentage by Tank Type and Climate Zone

Hot Water Distribution Credits

Title 24 allows builders to claim additional water heating credits when specifying various distribution methods. These credits reduce energy consumption through the use of various technologies aimed at reducing energy losses associated with water distribution. The credits builders can take are as follows:

- Pipe insulation
- Recirculation controls, time and temperature
- Recirculation controls, timer controlled
- Recirculation controls, temperature controlled
- Recirculation controls, demand controlled

Overall, distribution credits are not widely used, as is evident in Table 171. Storage water heaters, which comprise the majority of water heater types in the program, utilized very few credits (the column header “Standard” indicates no credits). About 14% utilized pipe insulation with storage type systems, while slightly more (about 18%) of the multifamily units in SDG&E’s territory took credit for pipe insulation.

Builders installing central systems were most likely to take distribution credits, which were dominated by temperature controlled recirculation (the lowest cost control credit). PG&E builders most commonly received credit for pipe insulation with instantaneous water heaters. Projects with central boilers were more likely to take credit for recirculation controls; about 51% utilized recirculation with temperature controls, about 19% took credits for recirculation with no controls and another 18% took credit for demand-controlled recirculation with pipe insulation. Five instantaneous water heaters were installed by PG&E builders, four of which received pipe insulation credits.

Tank Type	Utility	Standard	Pipe Insulation	Recirc/Temp	Recirc/ DemPipelns	n
Storage	PG&E	98%	-	2%	-	25
	SCE	94%	6%	-	-	16
	SDG&E	82%	18%	-	-	82
	SoCalGas	85%	15%	-	-	70
	Overall	**85%**	**14%**	**0%**	**-**	**193**
Instant.	PG&E	20%	80%	-	-	5
	SCE	-	-	-	-	0
	SDG&E	-	-	-	-	
	Overall	**20%**	**80%**	**-**	**-**	**5**
Central Instant.	PG&E					0
	SCE	78%	-	-	22%	9
	SDG&E	100%	-	-	-	2
	Overall	**82%**	**-**	**-**	**18%**	**11**
Central Boiler	PG&E	18%	-	82%	-	5
	SCE	8%	23%	21%	47%	6
	SoCalGas	100%	-	-	-	4
	Overall	**22%**	**9%**	**51%**	**18%**	**15**

Table 171: Distribution Type by Utility and Water System Type

Unitary instantaneous systems were only installed in RMST climate zone one, all of which received credit for pipe insulation. Central instantaneous systems were only installed in RMST climate zone three, nearly 18% of these systems also received credit for added pipe insulation. All central boilers installed in climate zone two received credit for temperature controls.

Tank Type	Climate Zone	Standard	Pipe Insulation	Recirc/Temp	Recirc/ DemPipelns	n
Storage	RMST CZ1	93.2%	-	6.8%	-	16
	RMST CZ2	79%	21%	-	-	85
	RMST CZ3	89%	11%	-	-	68
	RMST CZ4	100%	-	-	-	14
	RMST CZ5	100%	-	-	-	10
	Overall	**85%**	**14%**	**0.2%**	**-**	**193**
Instant.	RMST CZ1	20%	80%	-	-	5
	Overall	20%	80%	-	-	**5**
Central Instant.	RMST CZ3	82%	-	-	18%	11
	Overall	82%	-	-	18%	**11**
Central Boiler	RMST CZ1	-	-	82%	-	5
	RMST CZ2	15%	-	-	85%	4
	RMST CZ3	100%	-	-	-	4
	RMST CZ5	-	52%	48%	-	2
	Overall	22%	9%	51%	18%	**15**

Table 172: Distribution Type by Climate Zone and Water System Type

Heating and Cooling Equipment

The efficiency of a home can be significantly increased through efficient heating and cooling systems. HVAC (heating, ventilation, air conditioning) can also impact the air quality of the home due to ventilation. Reducing air-leakage associated with the building envelope can help minimize heating and cooling system usage, which also reduces energy costs.

RLW reviewed heating and cooling systems for all multifamily ENERGY STAR homes and analyzed the level of efficiency of the equipment by utility, climate zone and size of home.

Heating Equipment

ENERGY STAR multifamily units utilized a variety of heating systems; about 60% installed a hydronic heating system, about 21% utilized a heatpump, and 3 of the 225 projects installed an electric resistance heating system (less than 1%). While furnaces dominate single family construction practice, only 19% of the multifamily projects utilized a furnace system. Common construction practice in multifamily housing often utilizes hot water for heating requirements, which is serviced from either a central boiler or a unitary hot water heater. If cooling exists, these systems are most often coupled with a unitary split system air-conditioner or heatpump. This type of fan coil arrangement is popular in multifamily housing because of lower first cost and space issues. Furnaces cost more than these systems, they are more expensive to install, and they require more space than hydronic systems.

Overall, heatpumps and furnaces share fairly equal market share in multifamily housing projects participating in the program. Over half of the units in SCE's territory utilized a heat

pump and over half of SDG&E's and SoCalGas' units installed a hydronic system. Gas furnaces were most common in PG&E's and SDG&E's service territories.

Utility	Heat Pump	Furnace	Hydronic	Electricity	n
PG&E	31%	31%	36%	2%	36
SCE	52%	8%	40%	-	31
SDG&E	11%	30%	59%	-	84
SoCalGas	14%	7%	79%	-	74
Overall	**21%**	**19%**	**60%**	**0.3%**	**225**

Table 173: Percentage of Heating System Types by Utility

RMST climate zone one had the highest percentage of furnaces than any other utility where 46% of the units used a furnace. Over 75% of units in climate zone four utilized a hydronic system while none in climate zone one had a hydronic system.

Demand of one type of heating system over another seems to be closely tied to geographic regions. The least efficiency system type, electric, was only installed in climate zone one, the climate zone with one of the mildest heating climates of the five. Regardless, these systems did produce negative savings for heating which was compensated by more efficient hot water heating systems.

Climate Zone	Heat Pump	Furnace	Hydronic	Electricity	n
RMST CZ 1	46%	46%	5%	3%	27
RMST CZ 2	12%	19%	68%	-	89
RMST CZ 3	28%	10%	62%	-	83
RMST CZ 4	-	24%	76%	-	14
RMST CZ 5	18%	36%	45%	-	12
Overall	**21%**	**19%**	**60%**	**0.3%**	**225**

Table 174: Percentage of Heating System Types by Climate Zone

Cooling Equipment

Only 4% of all 2002 ENERGY STAR multifamily units did not have cooling systems[52]; most of which are found in PG&E's territory. Overall, about 88% of all projects with cooling systems were split air conditioners. In PG&E's territory, 21% of the units did not have cooling systems and about sixty percent utilized a split system air-conditioner. SCE projects had the highest fraction of packaged terminal air-conditioners (PTAC or "through the wall" systems), followed by PG&E, the only utilities with PTAC systems. Central (chiller) air-conditioning systems comprised only a small fraction of the cooling systems installed, which were found in 3% of the projects in California.

[52] The same issue applies to multifamily as does single family. Title 24 authors that complied projects using Micropas (the majority) may not have selected "no cooling" when they should have. Dummy cooling systems are required for Micropas models to run, therefore if "no cooling" was not selected by the compliance author, and in fact that the project has no cooling, then it will show up in the data as a project with cooling. As a result one should be aware that the cooling saturation tables and cooling efficiency tables likely do not accurately reflect what was actually installed in ENERGY STAR multifamily Homes. Note that this is not an issue for projects that complied using EnergyPro (~35%).

Utility	Projects with Cooling Systems	n
PG&E	79%	36
SCE	92%	31
SDG&E	100%	84
SoCalGas	99%	74
Overall	**96%**	**225**

Table 175: Percentage of Projects with Cooling Systems by Utility

Utility	Split AC	Packaged AC	Room PTAC	HP Package	Chiller	No Cooling System	n
PG&E	62%	-	9%	7%	-	21%	36
SCE	73%	7%	12%	-	-	8%	31
SDG&E	100%	-	0%	-	-	-	84
SoCalGas	91%	-	0%	-	8%	1%	74
Overall	**88%**	**1%**	**3%**	**1%**	**3%**	**4%**	**225**

Table 176: Type of Cooling Equipment by Utility

In climate zone one, over one fourth of the units did not have a cooling system. Cooling systems in RMST climate zones 2, 3, and 4 were dominated by AC split systems. Twenty percent of the cooling systems in RMST climate zone 5 were packaged AC, where as the overall average was only 1% for packaged AC. However the 20% of package units in climate zone 5 represents the climate zone with the fewest number of projects.

Climate Zone	Split AC	Packaged AC	Room PTAC	HP Package	Chiller	No Cooling System	n
RMST CZ1	44%	-	-	11%	-	31%	27
RMST CZ2	89%	-	-	-	6%	4%	89
RMST CZ3	94%	1%	5%	-	-	-	83
RMST CZ4	100%	-	-	-	-	-	14
RMST CZ5	80%	20%	-	-	-	-	12
Overall	**88%**	**1%**	**3%**	**1%**	**3%**	**4%**	**225**

Table 177: Type of Cooling Equipment by Climate Zone

Cooling Equipment Efficiency

A SEER score measures the efficiency of cooling systems. SEER averages did not vary greatly, except for HP package systems. HP packages were only found in PG&E's multifamily units with a SEER average of 12.5. Overall, the SEER average for AC split systems was 10.3.

Utility	AC Split	Packaged AC	Room PTAC	HP Package	n
PG&E	10.8	-	-	12.5	25
SCE	10.3	10.0	11.2	-	23
SDG&E	10.1	-	-	-	84
SoCalGas	10.2	-	-	-	65
Overall	**10.3**	**10.0**	**11.0**	**12.5**	**198**

Table 178: SEER Average of Cooling Equipment by Utility

Notwithstanding package systems, SEER average was much higher than average in RMST climate zone 5, where average of AC splits was 12.0. Projects in this area are driven by cooling savings because of the hot desert climate, so it makes sense that builders installed high SEER equipment in order to take advantage of the savings.

Utility	AC Split	Packaged AC	Room PTAC	HP Package	n
RMST CZ1	11.0	-	10.7	12.5	17
RMST CZ2	10.1	-	-	-	72
RMST CZ3	10.1	9.8	11.2	-	83
RMST CZ4	10.2	-	-	-	14
RMST CZ5	12.0	10.0	-	-	12
Overall	**10.3**	**10.0**	**11.0**	**12.5**	**198**

Table 179: SEER Average of Cooling Equipment by Climate Zone

Overall, 77% of all cooling systems had an average of 10 or less[53]. None of the systems had a SEER average of 13 or more in any of the multifamily units.[54] SDG&E had the highest percentage (93%) of cooling systems with a SEER rating of 10 or less. PG&E had the highest percentage (13%) of units with a SEER rating of 12 or more, and the fewest number of units with a SEER of 10 or less.

Utility	SEER 10 or Less	SEER 11-11.99	SEER 12-12.99	n
PG&E	32%	55%	13%	26
SCE	72%	18%	9%	23
SDG&E	93%	-	7%	84
SoCalGas	92%	0%	7%	73
Overall	**77%**	**14%**	**9%**	**206**

Table 180: SEER Rating by Utility

RMST climate zone 5 had the most efficient cooling equipment by measurement of SEER ratings. About 61% of the units in climate zone 5 utilized cooling equipment with SEER ratings of 12 or better. Only 39% of the units had systems with SEER 10 or less, whereas

[53] Although 10 SEER is baseline, one projects installed PTAC units with SEER values of 9.7 and one project showed package units with SEER of 9.8, both lower than code.

[54] In ENERGY STAR single family units, overall, 8.4% had SEER averages of 13 or more. In PG&E's territory, 29% of its single family units had a SEER average of 13 or more.

the overall average was 77% for SEER 10 or less. RMST climate zone 1 ranked second best where about 14% of systems had SEER 12 or better and 24% of the units had a system with SEER 10 or less.

Climate Zone	SEER 10 or Less	SEER 11-11.99	SEER 12-12.99	n
RMST CZ 1	24%	62%	14%	17
RMST CZ 2	96%	-	4%	80
RMST CZ 3	86%	10%	4%	83
RMST CZ 4	88%	6%	6%	14
RMST CZ 5	39%	-	61%	12
Overall	**77%**	**14%**	**9%**	**206**

Table 181: SEER Rating by Climate Zone

Radiant Barriers

Builders may install radiant barriers in the attic space in order to receive heating and cooling credits in Title 24. Installation of this measure requires an inspection, as do many of the other measures used by builders to meet or exceed ENERGY STAR program metrics. Overall, only 9% of the attic area received radiant barrier credit. However, since this is a relatively new measure, 10% saturation may be better than expected. The measure dominates in SCE's territory, which shows more than 30% of the attic space using radiant barrier. Due to SCE's warmer climate, radiant barriers may be more cost effective as a mechanism to exceed Title 24.

Utility	% of Area with Radiant Barrier	n
PG&E	12%	36
SCE	31%	31
SDG&E	1%	84
SoCalGas	10%	74
Overall	9%	**225**

Table 182: Percentage with Radiant Barrier by Utility

While the percent of area utilizing radiant barriers is dominated by RMST climate zones one and five (17% and 70%), the number of projects in these zones is far fewer than those in climate zones two and three. Therefore, one should not overlook the fact that the majority of square footage utilizing radiant barriers is in climate zone 2, which incidentally is served for the most part by SCE.

Climate Zone	% of Area with Radiant Barrier	n
RMST CZ1	17%	27
RMST CZ2	9%	89
RMST CZ3	1%	83
RMST CZ4	0%	14
RMST CZ5	70%	12
Overall	**9%**	**225**

Table 183: Percentage with Radiant Barrier by Climate Zone

Fenestration

The fenestration analysis for multifamily is limited to floor ratio and window U-value and solar heat gain coefficient.

Window to Floor Area Ratio

Table 184 summarizes the multifamily average window to floor area ratio by each utility. Ratios varied only slightly across utilities, 11% to 13%.

Utility	Window to Floor Area	n
PG&E	12%	36
SCE	11%	31
SDG&E	12%	84
SoCalGas	13%	74
Overall	**12%**	**225**

Table 184: Window to Floor Area Ratio by Utility

RMST climate zone 5 had the lowest window to floor area ratio of 8%, whereas RMST climate zone 3 had the highest window to floor area ratio of 13%.

Climate Zone	Window to Floor Area	n
RMST CZ 1	12%	27
RMST CZ 2	11%	89
RMST CZ 3	13%	83
RMST CZ 4	9%	14
RMST CZ 5	8%	12
Overall	**12%**	**225**

Table 185: Window to Floor Area Ratio by Climate Zone

U-Value and SHGC

Table 186 summarizes average U-values and SHGC for windows in each utility. SoCalGas had the best performing glazing on average, 0.47 U-value and 0.0.47 SHGC value. The difference in the averages is partially explained by the varying prescriptive

requirements across the state. Projects in Edison's service area show the worst glazing characteristics, however they also represent the fewest multifamily projects.

Utility	Average U-value	Average SHGC	n
PG&E	0.47	0.49	36
SCE	0.73	0.62	31
SDG&E	0.50	0.48	84
SoCalGas	0.47	0.47	74
Overall	**0.51**	**0.49**	**225**

Table 186: Average Multifamily Window U-value and SHGC by Utility

Table 187 shows average multifamily window U-value and SHGC compared with the package D prescriptive requirement. Overall most average U-values meet the prescriptive requirement. CEC climate zones 3, 6 and 16 have no requirement for SHGC. Of the other CEC climate zones, only 2 and 12 have average SHGC that exceeds the prescriptive requirement. This indicates that many multifamily builders are not using low-e glazing even where it is appropriate. They appear to be willing to take a penalty for using non low-e glass, preferring to make it up in other end-uses, most likely water heating.

Climate Zone	Average U-value	Average SHGC	2001 T24 Std U-Value	2001 T24 Std SHGC	n
2	0.39	0.35	0.65	.40	2
3	0.51	0.67	0.75	NA	7
4	0.61	0.82	0.75	.40	18
6	0.61	0.57	0.75	NA	50
7	0.58	0.53	0.75	.40	39
8	0.54	0.60	0.75	.40	43
9	0.54	0.49	0.75	.40	21
10	0.55	0.46	0.65	.40	19
12	0.33	0.32	0.65	.40	9
13	0.50	0.44	0.65	.40	5
15	0.61	0.42	0.65	.40	11
16	1.00	0.74	0.65	NA	1
Overall	**0.51**	**0.49**			**225**

Table 187: U-Value and SHGC Average by Climate Zone

Overall 37% of multifamily glazing had a U-value of 0.40 or better with 93% having a U-value of 0.65 or better.

Utility	U-Value of % that Meet or Exceed Value			
	0.35	0.40	0.65	n
PG&E	10%	63%	93%	36
SCE	0%	0%	60%	31
SDG&E	10%	35%	96%	84
SoCalGas	14%	43%	99%	74
Overall	**10%**	**37%**	**93%**	**225**

Table 188: Percentage of Windows that Met or Exceeded U-value by Utility

Table 189 summarizes multifamily glazing U-values by CEC climate zones. The prescriptive requirement is listed in the column listed as "T24 Min". The climate zone with the most projects, climate zone 6, shows about one fourth of the glass having a U-value of 0.4 or better.

Climate Zone	U-Value of % that Meet or Exceed Value				
	0.35	0.40	0.65	T24 Min	n
2	0%	100%	100%	0.65	2
3	0%	71%	100%	0.75	7
4	3%	49%	87%	0.75	18
6	0%	24%	83%	0.75	50
7	3%	21%	98%	0.75	39
8	16%	53%	95%	0.75	43
9	54%	54%	100%	0.75	21
10	24%	32%	100%	0.65	19
12	54%	100%	100%	0.65	9
13	0%	43%	96%	0.65	5
15	0%	0%	100%	0.65	11
Overall	**10%**	**37%**	**93%**		**225**

Table 189: Percentage of each Fenestration Type that Met U-value by Climate Zone

Opaque Surface Insulation

The insulation level of a home greatly affects the energy efficiency and comfort of a home. As was the case with single family, the prevailing multifamily construction in California is a wood frame home with fiberglass batt insulation in the cavities of the frame for walls and floors.

Insulation R-Value

The participant data included the R-value of the material that was used to insulate opaque surfaces. Table 190 summarizes the average resistance values for each multifamily opaque surface insulating material (floor, roof and wall) by utility. The overall R-value for raised floors was 17.7, while SDG&E's R-value was much higher at 20.3. For roof R-values, the overall average was 22.4, with PG&E builders having the most roof insulation which on average was 26.7. Wall insulation R-values did not vary much across utilities.

Insulation R-Value	Floor	n	Roof	n	Wall	n
PG&E	11.9	21	26.7	33	13.0	36
SCE	14.0	5	17.4	31	13.3	31
SDG&E	20.3	38	23.9	64	13.3	67
SoCalGas	18.0	22	20.7	64	13.9	66
Overall	**17.7**	**86**	**22.4**	**192**	**13.4**	**200**

Table 190: Average R-Value by Utility and Surface Type

Raised floor R-values were highest in RMST climate zone 3 on average, roof R-values and wall R-values were highest in RMST climate zone 5. RMST Climate zone 1 had the lowest R-value average for floors and walls in 2002 ENERGY STAR multifamily units. Lowest average R-value for roofs was in climate zone 3.

Insulation R-Value	Floor	n	Roof	n	Wall	n
RMST CZ 1	11.9	21	29.9	24	13.0	27
RMST CZ 2	17.1	28	20.9	79	13.2	80
RMST CZ 3	20.4	30	20.2	67	13.3	69
RMST CZ 4	18.7	7	23.8	12	13.8	14
RMST CZ 5	17.7	86	34.6	10	18.2	10
Overall	**17.7**	**86**	**22.4**	**192**	**13.4**	**200**

Table 191: Average R-Value by Climate Zone and Surface Type

2001 Title 24 standards require that floor R-values in climate zones 1 and 16 have a minimum of 19, while the remaining climate zones have 11 as a minimum. By utility, SoCalGas' builders met the R19 standard in greatest percentage—82.5%. However, very few builders in PG&E's territory met the R19 minimum standard, where as the majority of the multifamily units in the other territories did.

Utility	Floor: R11 Min	Floor: R19 Min	n
PG&E	76%	1%	21
SCE	67%	66%	5
SDG&E	100%	81%	38
SoCalGas	100%	83%	22
Overall	**94%**	**66%**	**86**

Table 192: Multifamily Raised Floor R-Value Minimum by Utility

RMST climate zone 1 complied least with the R19 minimum. On the other hand, 94.5% of the units in climate zone 5 had floor R-values of 19 or better. About 94% of all multifamily units met the R11 minimum.

Climate Zone	Floor: R11 Min	Floor: R19 Min	n
RMST CZ1	76%	1%	21
RMST CZ2	97%	74%	28
RMST CZ3	100%	86%	30
RMST CZ5	100%	94%	7
Overall	**94%**	**66%**	**86**

Table 193: Multifamily Raised Floor R-Value Minimum by Climate Zone

Table 194 summarizes the percentage of multifamily units with roof insulation at or above R19 and R30. All PG&E multifamily units have at least R19 roof insulation minimum and 58% have at least R30 minimum.

Utility	Roof: R19 Min	Roof: R30 Min	n
PG&E	100%	58%	33
SCE	42%	24%	31
SDG&E	67%	56%	64
SoCalGas	50%	37%	64
Overall	**63%**	**46%**	**192**

Table 194: Multifamily Roof R-value Minimums by Utility

Climate zone 3 had the fewest number of multifamily units with less than R19 roof insulation. Climate zone 1, 4 and 5 multifamily units all met the R19 minimum requirements and climate zone 1 and 5 had about 82% of the units with R30 or above.

Climate Zone	Roof: R19 Min	Roof: R30 Min	n
RMST CZ1	100%	82%	24
RMST CZ2	63%	44%	79
RMST CZ3	41%	37%	67
RMST CZ4	100%	25%	12
RMST CZ5	100%	82%	10
Overall	**63%**	**46%**	**192**

Table 195: Multifamily Roof R-value Minimums by Climate Zone

Minimum R-values for walls vary by climate zone from 11 to 19 in California as shown in Table 196. All ENERGY STAR multifamily units had a minimum of R13 wall insulation, but very few met or exceeded R19. This indicates the predominance of 2x4 construction in multifamily construction, as was the case in single family.

Utility	Wall: R13 Min	Wall: R19 Min	n
PG&E	100%	-	36
SCE	100%	2.6%	31
SDG&E	100%	3.6%	67
SoCalGas	100%	8.8%	66
Overall	**100%**	**4.5%**	**200**

Table 196: Multifamily Wall R-value by Utility

By RMST climate zone, the majority (86%) of climate zone 5 multifamily units met or exceeded the R19 wall insulation, while all other zones had few or no R19 insulated walls.

Climate Zone	Wall: R13 Min	Wall: R19 Min	n
RMST CZ1	100%	-	27
RMST CZ2	100%	-	80
RMST CZ3	100%	4%	69
RMST CZ4	100%	-	14
RMST CZ5	100%	86%	10
Overall	**100%**	**4%**	**200**

Table 197: Multifamily Wall R-value by Climate Zone

Ducting

Like single family homes, multifamily dwellings can also receive Title 24 credits for tested duct leakage, and or ACCA manual D duct design. However very few multifamily projects took credit for these measures, as is indicated in Table 198 and Table 199. This is not surprising considering the ease of compliance multifamily projects now enjoy. Once Title 24 low rise multifamily energy code is strengthened as part of the 2005 standards there will likely be an increase in the use of these credits, possibly similar to what we see in single family construction. Projects completed in PG&E's service area were by far more likely to implement these measures than were projects in any other service area.

Utility	% of homes that Tested Duct Leakage	% with ACCA Manual D	n
PG&E	26%	24%	34
SCE	-	-	28
SDG&E	7%	-	81
SoCalGas	3%	-	66
Overall	**7%**	**3%**	**209**

Table 198: Percentage of Multifamily Homes that tested Duct Leakage and Percentage that Complied with ACCA Manual D by Utility

The highest percentage of projects in RMST climate zone 1 implemented both tested duct leakage and ACCA manual D duct design, however this represents a small proportion of the total projects since the majority of all projects were completed in climate zone 2 and 3.

Climate Zone	% of homes that Tested Duct Leakage	% with ACCA Manual D	n
RMST CZ1	40%	37%	25
RMST CZ2	-	-	80
RMST CZ3	6%	-	82
RMST CZ4	10%	-	11
RMST CZ5	15%	-	11
Overall	**7%**	**3%**	**209**

Table 199: Percentage of Multifamily Homes that tested Duct Leakage and Percentage that Complied with ACCA Manual D by Climate Zone

Infiltration

Only 20% of multifamily units took infiltration credit and all of those were in the PG&E program and RMST climate zone 1. This is not surprising since infiltration credits trigger a blower door test and attaining a multifamily ENERGY STAR rating can be attained relatively easily without infiltration credits. As can be seen in Table 200 and Table 201, all of the multifamily units taking infiltration credits were in PG&E territory and RMST climate zone 1. Additionally, all multifamily homes that took an infiltration credit selected 3.8% as an infiltration target.

	Specified Leakage Area		
Utility	No	3.8	n
PG&E	15%	85%	36
SCE	100%	-	31
SDG&E	100%	-	84
SoCalGas	100%	-	74
Overall	**80%**	**20%**	**225**

Table 200: Modeled Multifamily SLA by Utility

	Specified Leakage Area		
Climate Zone	No	3.8	n
RMST CZ1	5%	95%	49
RMST CZ2	100%	-	87
RMST CZ3	100%	-	291
RMST CZ4	100%	-	250
RMST CZ5	100%	-	15
Overall	**80%**	**20%**	**225**

Table 201: Modeled Multifamily SLA by Utility

High-Rise Multifamily Residential Building Characteristics

There were three projects with five plans in the 2002 ESH program that qualified as high-rise. High-rise residential construction is defined as all residential dwellings that are 4 stories or higher. The high-rise projects were **not** included in the low rise multifamily

building characteristics section of this report since the standards differ between them. Low rise residential Title-24 is the same as single family standards, whereas high-rise standards are similar to non-residential standards. In this section of the report we summarize the building characteristics of the high-rise units in the ESH program.

Demographics

One of the 3 high-rise projects was in PG&E territory, and the remaining two were in SCE territory. The PG&E project was located in climate zone three, and both SCE projects were in climate zone eight. The PG&E high-rise project consisted of 42 dwelling units (hereafter named project 1 and plan 1). The first SCE project had 240 dwelling units (hereafter named project 2 and plan 2), while the second SCE project had 3 plans, of which two of three buildings had 112 dwelling units and one of the three buildings had 95 dwelling units (hereafter named project 3 and plans 3,4, and 5 respectively). Table 202 summarizes the general characteristics of the 5 plans.

The 5 plans account for 601 total housing units, 7% of which were PG&E projects (and CZ 3) and 93% of which were SCE (and CZ 8). There were 8,865 low rise units built, therefore high-rise accounts for 6.3% of all multifamily units in the program. The average building size was 150,139 square feet and the average unit size was 1,145 square feet. All 5 plans were complied using EnergyPro.

Project #	**1**	**2**	**3**		
Plan #	**1**	**2**	**3**	**4**	**5**
Utility	PG&E	SCE	SCE	SCE	SCE
Total Units	42	240	112	112	95
% of Total Units	7%	40%	19%	19%	16%
Climate Zone	3	8	8	8	8
Floor Area	44,514	378,628	108,078	116,871	102,605
% of Floor Area	6%	50%	14%	16%	14%
Average Floor Area	1,060	1,578	965	1,043	1,080
Stories	4	18	4	4	4

Table 202: High-Rise Residential Demographics

Domestic Hot Water

All three projects used different water heating system types. Project 1 used three central boilers with recovery factors of 0.957 and 0.94. Project 2 also used a central boiler, but their boiler had a recovery factor of 0.85. Project 3 used 50-gallon storage tank water heaters for each unit with energy factors of 0.62.

Title 24 allows builders to claim additional water heating credits when specifying various distribution methods. These credits reduce energy consumption through the use of various technologies aimed at reducing energy losses associated with water distribution. Projects 1 and 3 used standard distribution and received no distribution credit. Project 2 was credited for a recirculating system with demand control and pipe insulation.

Space Conditioning

All three projects were heated with fan coil units using combined hydronic heating with the same equipment used for their hot water service. Project 1 had no cooling. Project 2 had a central cooling plant. Project 3 used split system direct expansion cooling with individual units. Plans 3 and 5 used 10.0 SEER units and plan 4 used 10.7 SEER units.

Fenestration

Window to Floor Area Ratio

The overall window to floor area ratio in project 1 was 11%, while projects 2 and 3 had an overall window to floor area ratio of 18%.

Utility	Window to Floor Area	n
PG&E	11%	1
SCE	18%	4
Overall	**18%**	**5**

Table 203: High-Rise Average Window to Floor Area

U-Value and SHGC Average

The fenestration data in the Energy Pro files only included windows. There were no skylights or doors as in single family and low rise multifamily. The average u-value for projects 1 and 2 met the prescriptive requirements. However, project 3 windows were all worse than prescriptive requirements, with u-values ranging from 0.58 to 0.59.

Utility	Average U-value	Average SHGC	n
PG&E	0.35	0.36	1
SCE	0.51	0.31	4
Overall	0.51	0.32	5
Prescriptive	**0.49**	*	-

*the prescriptive SHGC values vary by climate zone, orientation (north/non-north), and window to wall ratio.

Table 204: High-Rise Average U-Value and SHGC

Opaque Surface Insulation

Insulation R-Value

Project 1 used concrete floors that had insulation r-values of 4.5. Project 2 used insulated raised concrete floors with r-values of 20, while project 3 used uninsulated raised slab floors. The prescriptive r-value requirement for raised concrete floors in climate zone 8 is 0, and project 2 exceeds the standard.

All projects exceed the prescriptive r-value for roofs and walls.

Insulation R-Value	Roof	n	Metal Wall	n	Wood Wall	n
PG&E	29.9	1	19.0	1	19.0	1
SCE	19.2	4	12.0	1	13.0	3
Overall	20.3	5	12.1	2	13.8	4
Prescriptive R-Value	**19**	**-**	**11**	**-**	**11**	**-**

Table 205: High-Rise Average Insulation R-Value

Assembly U-value

Project 1 concrete floors had a U-Value of 0.12. Project 2 had raised, insulated concrete slab flooring with U-Values of 0.043. The uninsulated raised slab floors at project 3 had U-Values of 0.242. Project 2 had metal walls that were less insulated than package D prescriptive requirements.

Assembly U-Value	Roof	n	Metal Wall	n	Wood Wall	n
PG&E	0.035	1	0.128	1	0.062	1
SCE	0.050	4	0.273	1	0.088	3
Overall	0.048	5	0.270	2	0.083	4
Prescriptive U-Value	**0.051**	**-**	**0.181**	**-**	**0.092**	**-**

Table 206: High-Rise Average Assembly U-Value

No radiant barriers were used to gain additional compliance credits.

Ducting

Additional credit is given for homes that achieve greater ducting efficiency by designing the ducting systems of their homes to the Air Conditioning Contractors of America (ACCA) Manual D standards. The only high-rise project that claimed ACCA Manual D as a measure was project 2 with the chiller, which constitutes 40% of the high-rise units in the program and 50% of the floor area.

Infiltration

None of the 5 high-rise plans included infiltration credits. For homes that do not claim an infiltration credit, the assumption is a specific leakage area (SLA) of 4.9 for homes with ducted conditioning systems.

9. Comparison of Builder Survey, T24 Consultant Survey, and Building Characteristics

The following section compares three sections of this report: Single family builder's surveys, Itron's SF Title 24 consultant survey results, and single family building characteristics of ENERGY STAR participant homes. The goal is to see how closely the builder and Title 24 consultant responses to the telephone survey questions match the actual building measures specified in the compliance model input files for ENERGY STAR homes.

For the analysis of the single family homes, we compared the analysis from questions in the builder survey. The results are shown below in Table 207. The builder survey analysis generated the results by weighting the survey responses by the number of homes in the program that the respondent had constructed. Therefore, if the builder's responses accurately assess the situation, the results should correspond to the program population characteristics.

What measures does your company specify to meet the California Energy Star Homes requirements compared to homes that are designed to just meet Title 24?	% of Respondents (n=44)
Low e-glass	88%
Insulation	84%
Duct Sealing	41%
HVAC	38%
Other	4%

Table 207: Measures Utilized by Builders to Meet ENERGY STAR Requirements

Similar to the builders' survey, non-participating Title 24 consultants were asked about measures they specified for their standard homes, and Title 24 consultants that complied ENERGY STAR homes were asked which measures they would specify in order to reach ENERGY STAR qualification. Table 208 summarizes these findings, which are presented in greater detail in the Title 24 Consultant section of this report.

Title 24 Consultant Survey	Standard Practice	ENERGY STAR	% Differential
# of Respondents	40	3	
Homes represented	55,801	7,141	
High-performance windows	66%	95%	+29%
Increased roof/wall insulation	66%	76%	+10%
HERS cert. sealed ducts	16%	88%	+72%
Higher efficiency AC	43%	67%	+24%
Higher efficiency furnace	13%	8%	-5%
Radiant barriers	10%	7%	-3%
ACCA Manual D duct design	3%	37%	+34%
Higher efficiency water heater	91%	97%	+6%
Bldg. envelope sealing (Blower Door)	0%	55%	+55%
TXV / Ref charge air flow test	25%	79%	+54%

Table 208: Measures Utilized by Title 24 Consultants to Meet ENERGY STAR Requirements

Keep in mind that the builder and consultant analyses utilized different methodologies. The builders were asked directly how their ENERGY STAR homes deviated from standard homes. Alternatively, the consultant analysis inferred the deviation of measure frequency from the responses of the two groups of Title 24 consultants, standard and ENERGY STAR consultants. Furthermore, since the performance method gives builders options for differing characteristics of a standard home, the concept of what exactly constitutes a standard home may deviate greatly among the survey respondents.

Fenestration

Title 24 consultants indicated that high performance glazing would be modeled in 95% of the ENERGY STAR homes and in 66% of the standard homes. The best indicator of glazing performance is Solar Heat Gain Coefficient or SHGC. Table 209 shows that high performance glazing[55] is installed in 98% of participating single family homes. The majority of the glazing is below 0.35 and almost all is 0.45 or below. (In climate zones where there is a Package D requirement (i.e., all zones except 1,3,5,6) the minimum SHGC is 0.4.)

[55] High performance glazing is defined as less than 0.45 in this analysis since a Low E coating is necessary in order to have an SHGC less than 0.46.

SHGC Range	Percentage
0.3 and Below	21%
0.31-0.35	39%
0.36-0.4	25%
0.41-0.45	12%
0.46-0.50	0%
0.51-0.60	1%
0.61-0.7	1%

Table 209 ESH Single Family Glazing SHGC Distribution

The result of the builder's survey indicated that 88% of ENERGY STAR single family glazing would be higher performance than glazing in the baseline home. This implies that the single family builders believe that few standard homes use high performance glazing even though it is considered baseline for most of the state under Package D requirements. As Table 209 shows, 60% of the glazing (< 0.35) is significantly better than the Package D requirement for the single family program participants. The fact that not all participating builders consider high performance glazing typical in standard home construction may account for the deviation.

These findings suggest that the Title 24 consultants more closely identified building practice for participant homes, compared to builders. This may be because Title 24 consultants, on average, have a better understanding of what constitutes high performance glazing.

Insulation

Builder responses indicated that 84% of ENERGY STAR homes would have increased insulation levels when compared to baseline homes.

On the other hand, Title 24 consultant surveys indicated 66% of standard homes would have wall and attic insulation above baseline, whereas 76% of participating homes would have increased wall and roof insulation, a 10% increase.

Table 210 shows the distribution of roof/ceiling R-value by CEC climate zone compared with the respective Package D prescriptive requirement. It appears that both the builder and consultant survey analyses overestimate the insulation level of single family ENERGY STAR homes. According to the model input files, there is nearly three times more roof area under baseline than over baseline in the program, considering package D prescriptive requirement as baseline.

Climate Zone	R19	R30	R38	R49	Package D Baseline	Under Baseline	At Baseline	Above Baseline
Climate Zone 2	0%	0%	100%	0%	30	0%	0%	100%
Climate Zone 3	7%	9%	84%	0%	30	7%	9%	84%
Climate Zone 4	4%	83%	13%	0%	30	4%	83%	13%
Climate Zone 5	0%	100%	0%	0%	30	0%	100%	0%
Climate Zone 6	22%	78%	0%	0%	30	22%	78%	0%
Climate Zone 7	48%	49%	3%	0%	30	48%	49%	3%
Climate Zone 8	15%	61%	24%	0%	30	15%	61%	24%
Climate Zone 9	2%	82%	15%	0%	30	2%	82%	15%
Climate Zone 10	3%	88%	10%	0%	30	3%	88%	10%
Climate Zone 11	0%	39%	60%	1%	38	39%	60%	1%
Climate Zone 12	7%	37%	56%	0%	38	44%	56%	0%
Climate Zone 13	0%	0%	100%	0%	38	0%	100%	0%
Climate Zone 14	2%	39%	59%	0%	38	41%	59%	0%
Climate Zone 15	100%	0%	0%	0%	38	100%	0%	0%
Overall	**13%**	**60%**	**26%**	**1%**	**-**	**25%**	**67%**	**9%**

Table 210: Single Family Participant Ceiling Insulation R-Values

Table 211 shows the same distribution and comparison for wall R-values. The results from the input models show even a greater percentage of program wall insulated under the prescriptive baseline than ceilings. All of the walls under baseline are located in Climate zones with R19 as a baseline. This indicates that builders are more willing to build 2 x 4 wall assemblies and compensate for under baseline wall insulation with other measures, rather than using R-19 with 2 x 6 wall assemblies that conventional R19 fiberglass batt insulation requires.

Climate Zone	R13 -R-15	R-19	Package D Baseline	Under	At	Better
Climate Zone 2	0%	100%	13	0%	100%	0%
Climate Zone 3	0%	100%	13	0%	100%	0%
Climate Zone 4	0%	100%	13	0%	100%	0%
Climate Zone 5	90%	10%	13	0%	10%	90%
Climate Zone 6	0%	100%	13	0%	100%	0%
Climate Zone 7	0%	100%	13	0%	100%	0%
Climate Zone 8	4%	96%	13	0%	96%	4%
Climate Zone 9	4%	96%	13	0%	96%	4%
Climate Zone 10	1%	99%	13	0%	99%	1%
Climate Zone 11	10%	90%	19	90%	10%	0%
Climate Zone 12	11%	89%	19	89%	11%	0%
Climate Zone 13	4%	96%	19	96%	4%	0%
Climate Zone 14	1%	99%	21	99%	1%	0%
Climate Zone 15	0%	100%	21	100%	0%	0%
Overall	**5%**	**95%**	**-**	**27%**	**71%**	**2%**

Table 211 Single Family Participant Wall Insulation R-Values

In summary, neither the builders or the Title 24 consultants were able to assess the level of insulation participating projects would utilize relative to baseline.

HVAC Systems

The Title 24 consultants' responses indicated that 43% of standard homes were modeled with higher efficiency AC systems, and 67% in single family participant homes, a 24% increase. Alternatively, high efficiency furnaces would be modeled slightly less often in participating homes than in standard homes.

Builders stated that they would have higher efficiencies HVAC systems in 38% of the homes. The building characteristics from the ESH input files show that 36% of cooling systems are above baseline (10 SEER) and 14% of heating systems are above baseline (0.80 AFUE).

Utility	AFUE 0.8	AFUE 0.9 and above	n
Overall	86%	14%	676

Utility	SEER 10	SEER 11	SEER 12 or Above	n
Overall	64%	2%	34%	673

Table 212: HVAC Building Characteristic Percent Bins

This shows the Title 24 consultants had greatly overestimated high-efficiency cooling equipment installation, while the builder survey estimate was much more in line with the compliance model input files.

Builder responses indicated that 41% of the participant homes would use duct sealing measures in order to meet ENERGY STAR standards. However, the compliance model data shows that, overall, 87% of the units had been tested for duct leakage. The percentage varied greatly by utility; for example, none of SoCalGas' units tested for duct leakage, but 96% of PG&E's and SCE's single family participant homes were tested. The Title 24 consultant responses indicated that about 88% of all ENERGY STAR homes were tested while only 16% of the standard homes tested for duct leakage. The Title 24 consultant surveys were much closer with the estimate of sealed duct measure among participants.

Utility	% of homes that Tested Duct Leakage	n
PG&E	96%	299
SCE	96%	251
SDG&E	63%	130
SoCalGas	-	12
Overall	**87%**	**692**

Table 213: Duct Sealing Measure Distribution

Other Measures

Table 214 shows a comparison between the consultant survey results and measure adoption among single family participants of the ENERGY STAR program. These measures were not specifically discussed in the builder's survey, therefore we cannot comment on them.

	Title 24 Consultant Survey	ES Program Single Family
Measure	**ENERGY STAR**	**Installation%**
Radiant barriers	7%	5%
ACCA Manual D duct design	37%	56%
Higher efficiency water heater	97%	98%
Bldg. envelope sealing (Blower Door)	55%	65%
TXV / Ref charge air flow test	79%	47%

Table 214 Consultant Survey and Model Input File Comparison

The Title 24 consultant survey analysis closely estimated the usage of radiant barriers and high efficiency hot water heaters that would be used to reach ENERGY STAR. The consultants significantly under predicted the ACCA manual D duct design credits taken and the amount of homes that would receive credit for envelop sealing measures. Title 24 consultants then over predicted the number of TXV/Refrigerant charge and air flow testing credits that builders would utilize.

Conclusions

This comparison shows that although builders and title 24 consultants are often quite knowledgeable in general, they may not have perspective of how all of their homes' features compare against baseline.

Table 215 summarizes some of the key measures used to increase the energy efficiency of homes. Builders, Title 24 consultants and the building characteristics files agreed that window fenestration efficiency was highly utilized in ENERGY STAR homes. However, insulation of a home was not prevalent in the files as both builders and Title 24 consultants indicated when asked. For HVAC systems, builders were closest to the building files that indicated the prevalence at about 14% for furnaces and 34% for AC systems. Title 24 consultants overestimated the occurrence of energy efficient HVAC systems. Builders were not directly asked whether they conducted a duct leakage test, but 4% indicated they used "other" measures to increase efficiency. However, Title 24 consultants were much closer in estimating the building files estimate of duct leakage test.

Even though some characteristics were in agreement, the fact that the model input file analysis and survey results deviated widely in their assessment of HVAC efficiency and insulation level indicates some level of disconnect on the part of the survey respondents. Either they consider their home's features more efficient that they truly are or they believe that baselines and standards are more lenient than they are. If the latter is the case, a possible solution is to ask what is level of equipment efficiency or feature performance is typically installed in the homes rather than asking if their home features and equipment are "efficient" or "high performance."

Measure	Builder Response	T24 Response	Building Characteristic
Low e-glass	88%	95%	97%
Insulation	84%	76%	9%
HVAC (Cooling/Heating)	38%	67 / 8%	34 / 14%
Duct Leakge Test	4%	88%	87%

Table 215: Overall Summary of Measure Comparison

10. Turnkey Service Provider Interviews

Interviews with Key Market Actors

As part of the ENERGY STAR New Homes Program, RLW conducted in person interviews with three key market actors. Interviews were held with two turnkey service providers, private companies that provide the bulk of the CHEERS ratings, plan check services, and builder participation documentation. RLW also interviewed the contractor hired by CHEERS to train inspectors and conduct quality assurance on CHEERS raters. For the purposes of this evaluation, the business names and persons interviewed will remain unnamed.

Turnkey Service Provider Interviews

As part of the evaluation scope of work RLW conducted in-person interviews with two turnkey companies, considered major market actors in California's residential new construction market. RLW Analytics interviewed the principals of the two companies on October 28th, 2003. Each of these companies provides "turn-key" services to builders that participate in the ENERGY STAR New Homes Program. Services provided by the two companies include nearly all aspects of program participation, including application documentation, design services, Title-24, CHEERS inspections, and to some extent incentive filing. Perhaps the most notable difference between the two companies is that one company is a sub-contractor to Southern California Edison, while the other is not. As a subcontractor to SCE, this particular company is conducting "plan check" on all single family homes participating in SCE's ENERGY STAR New Homes Program. "Plan Check" refers to the final review of the Title 24 project file before it is uploaded to the CHEERS registry.

These two companies conduct the overwhelming majority of Title 24 and third-party inspections on behalf of builders participating in the ENERGY STAR Homes Program, as a result these companies are also the most frequent users of the CHEERS registry. Based on the roles these two market actors play, interviews were determined to be an important aspect of this evaluation report.

Between the two companies there is a combined 35 years of experience in providing services to new home builders. Both serve California and Nevada, and each has their own new homes program that builders can participate in. Their programs provide builders in California and Nevada with a variety of services including: HVAC layout and design; full energy code and lender documentation; field training; inspections and diagnostic testing; and sales and marketing support, including regional advertising, point-of-sale brochures and web connections.

Builders participating in the ComfortWise® program are contenders for the 2002 ENERGY STAR, since both ComfortWise® and the California ENERGY STAR New Homes Program achieve a minimum savings of 15% less energy than Title 24. Like ENERGY STAR Homes, ComfortWise® homes also require third party inspections. The difference being that all ComfortWise® homes require an inspection, while only one in seven ENERGY STAR Homes require a CHEERS inspection.

Both companies characterized their relationships with the utilities as good, based on many years of working together on Residential New Construction program design and implementation. One of the companies has benefited from their experience, utility relationships, and knowledge of Residential New Construction by becoming the sole

agency that conducts plan check on all single family SCE ENERGY STAR New Homes projects, even including projects that manage for their own participating builders. Unfortunately this creates a potential conflict of interest. The conflict arises when one of their builders participates in the ENERGY STAR homes program, thereby making them responsible for all key aspects of program participation, including program application filing, Title 24 documentation, plan check, and third party inspections. While this arrangement could lead to gaming, they contend that any potential conflict of interest is thwarted through rigorous internal and external procedures, including:

- The person responsible for the Title 24 documentation does not do plan check, the Title 24 Compliance Manager normally completes the plan check.
- A sampling of their ENERGY STAR Homes Title 24 input files are sent to an independent plan check agency
- The CHEERS analyst and rater are never the same person.
- There is little communication needed or actually initiated between the analysts and the raters.

RLW inquired about homes failing CHEERS inspections, and what reasons lead to failures. Both companies reported very few, if any homes having failed CHEERS inspections because "they take care of failures in the field". The most common reasons cited for potential failures were duct leakage tests, insulation installation quality (a ComfortWise® measure), and window installation discrepancies. Problems, such as these mentioned, are handled in the field, passing only when compliance with program requirements is met. If a builder chooses not to fix the problems then they remove the builder from the program. In some rare instances homes require new Title 24 because slightly different equipment is installed than was specified.

RLW interviewed the two companies with regard to various aspects of CHEERS, including CHEERS inspector training, use of the CHEERS registry, and responsiveness of the CHEERS staff to questions and problems. The following sections summarize their general feelings and attitudes regarding these aspects of CHEERS.

Interestingly, both reported the CHEERS training as not being adequate for their needs and standards. A newly certified CHEERS rater would not be put into the field alone without having one or two months of added field training by a senior CHEERS rater employed by their respective company. Some of the added training one company requires is driven by the fact that ComfortWise® homes require more intensive inspection processes, including insulation installation quality and window testing.

One company reported to not use the CHEERS "to do" list. Through efforts related to the ComfortWise® program they have developed their own version of the "to do" list that is used in the field to verify measure installations. They require their own "to do list" because ComfortWise® requires added inspection requirements above and beyond ENERGY STAR. One problem noted is that the CHEERS "to do list" only shows the first HVAC system listed in the transfer (*.trf) file, therefore if there are multiple systems only the first will show on the list for inspection. However, this is not viewed as a major problem because they use a more comprehensive (in-house generated) list of verification measures. Even though the CHEERS "to do list" may disregard systems, the registry does allow verification data to be input for as many systems as there were required inspections.

The other company provided a similar analysis of their interaction and use of the CHEERS "to do list". They use the list in conjunction with a list they generate themselves, much like

the aforementioned agency. These findings suggest that an improvement to the CHEERS "to do list" would increase usability and user satisfaction with this aspect of CHEERS. However, because these companies have so many of their own processes in place, as a result of the numerous numbers of ratings they complete, it is not clear whether changes made by CHEERS would even be implemented within these agencies. However, these changes would likely have a positive benefit to CHEERS rating companies not affiliated with the two turn-key agencies, who likely do not have the benefit of in-house developed rating lists.

Regarding the CHEERS quality assurance (QA) contractor, one company reported very little interaction between themselves and the QA consultant. To the interviewee's knowledge, CHEERS QA staff did not accompany any of their new raters on the first few ratings, which is supposed to be the final step of CHEERS rater training. It should be noted however, that it is the duty of the CHEERS rater to notify the QA consultant of when they plan to conduct the first few ratings, so that the QA contractor can plan to accompany the rater – and we suspect this is not happening.

In general, both companies reported struggling with the CHEERS registry, working with CHEERS on problem solving, and managing the file upload and editing process. They characterized the CHEERS database as "not user friendly", and CHEERS response time and attitude toward dealing with these issues as both adequate and inadequate. The biggest problem noted by both agencies, among other smaller problems discussed, is their inability to edit the information that is uploaded to the registry.

In terms of satisfaction with CHEERS, both agencies shared similar experiences, with overall satisfaction being relatively low. They both shared the opinion that communication could be improved greatly with the CHEERS director, while communication with their CHEERS representative was good, so long as their CHEERS representative was available. Moreover, for the amount of money these agencies spend on CHEERS fees, they believe the overall services provided are fairly weak.

CHEERS Training and Quality Control Contractor

CHEERS has a private subcontractor who performs two important roles related to CHEERS business activities. The CHEERS subcontractor is responsible for training CHEERS raters and conducting quality assurance (QA) activities. This section summarizes an interview that was held with this subcontractor.

Rater Training

The QA contractor was asked if the CHEERS training adequately prepared CHEERS raters for field activities. They believe the training does adequately prepare raters, so long as 1.) they begin conducting ratings soon after the training, essentially applying the knowledge gained during the training right away, and 2.) the rater also requests on-site training by CHEERS training subcontractor on the first two or three projects they inspect. They reported that approximately 50% of raters notify them of their first couple of ratings and ask for field assistance, which is supposed to be a requirement of the training. The other 50% that do not contact them do not get this added training. It is important to note that it is the responsibility of the rater to contact them for the final training procedures; otherwise they are unaware of when the raters will be conducting field inspections. CHEERS does not ask their subcontractor to follow up with raters that don't contact them for this training, which could potentially be done at the end of each month when they receive the CHEERS list of ratings completed during the month.

We asked if they felt CHEERS raters should have a recertification requirement on a regular basis, since currently there is no such requirement. They felt that some sort of retraining/recertification process would be a good idea, but they were not sure what sort of regularity should be considered. They added that recertification should be based on industry changes that would affect a rater's ability to conduct all aspects of an inspection. As an example, raters that were certified in the late 1990's would not have received training on Manual D duct design, whereas this is now part of the CHEERS rater training. Major changes like these should spark the need for added training for raters that underwent training prior to new requirements.

Quality Assurance

A series of questions related to QA procedures, including various aspects of the CHEERS registry as they relate to this process were discussed. The following discussion summarizes our findings related to this topic.

First it is important to understand the QA procedures currently being implemented by this contractor. QA is conducted at the time of the inspection. Essentially, a CHEERS subcontractor representative accompanies the rater, verifying and overseeing the procedures and practices implemented in the field. While in the field the QA contractor records the readings and measurements taken by the rater, these readings and measurements are later compared to the CHEERS registry inputs made by the rater to ensure data accuracy.

According to CHEERS subcontractor, the QA inspections can be fairly difficult to schedule and coordinate. Although recent communication improvements have been made with the larger ("Big 3") companies, he reported some communications barriers continue to exist. It was also reported that the smaller raters were more difficult to schedule QA with than the "Big 3," primarily because they are not rating nearly the volume of homes, or are they rating homes as regularly, as are the Big 3.

The 2003 CHEERS T-24 Quality Assurance Report found a 96% level where the field data collected with the rater matched with the data in the Registry. This method of QA assures that the data entry is 96% accurate, but it does not verify whether the collection of data by raters is accurately conducted when not in the presence of the QA contractor. To certify such information, CHEERS should conduct random independent inspections of homes rated by its raters.

When asked how multifamily inspections differ from single family inspections the following observations were provided. First, the CHEERS "to do" list is rarely, if ever, populated correctly. This appears to be the most significant problem when conducting multifamily inspections. The other observation was simply the speed at which multifamily housing projects can be rated, when compared to single family homes. Apparently, because multifamily units are closer in vicinity and in physical structure, ratings can be done at a much faster pace than single family dwellings. It is worth noting that the multifamily side of the CHEERS registry was not developed until 2003, while the single family side has been under development for several years. Since the multifamily side of the registry is new, it is understandable that more errors exist with this side of the registry. CHEERS will likely need to focus more attention on fixing these problems due to the growing number of multifamily projects that the ENERGY STAR Homes program is now able to serve.

CHEERS QA subcontractor was asked what the most common discrepancies were between the "to do list" and as-built conditions. They identified window areas,[56] window types, and conditioned square footage as the most common discrepancy. However, they also reported that these issues rarely lead to an inspection failure. During this conversation a few specific projects were discussed where large discrepancies were found during the inspections, causing the projects to fail. RLW intends to investigate these projects to determine what happened. QA findings at these particular projects that failed found problems with the installed window types and with non-existent thermal expansion valves (TXVs).

During the inspections, CHEERS raters use a "to do list" that is generated by the CHEERS registry based on the number C-HERS measures that are installed in the home. We asked how easy they felt it was for raters to work with the "to do list." They believed that using the list was easy, however the bigger issue was that in many cases inspection items that were included in the Title 24 would not show up on the list, or visa versa. Specific measures where this problem is occurring include ducts in conditioned space, TXVs, and secondary systems. They added that some of the problems related to the "to do list" are a result of the different programs being used for compliance and the file parsing process that is used to extract data from Micropas and EnergyPro. The information provided by CHEERS subcontractor supports previous evidence RLW has obtained suggesting that CHEERS has not been able to develop protocols that accurately parse transfer file data. They added that this might be the single largest problem related to developing accurate "to do lists." Furthermore, the issue is not only compounded by the two different programs and resulting transfer file formats, but also by the differences between single family and multifamily modeling protocols and transfer file output.

Finally, we asked what they thought could be done to improve the CHEERS registry and the interaction processes CHEERS raters and analysts have with it. The first recommendation was to improve the transfer file parsing process. Next they thought there should be improvements made to the "to do list", which would be a natural result if improvements were made to the file parsing process, although more work would likely still be required. They also felt CHEERS should work on improving CHEERS generated reports, "completion reports" were specifically mentioned. These reports are used by builders and builders' agents to review the status of their projects. According to the QA contractor, the single family report works fairly well, while the multifamily report does not work at all. The multifamily problems likely stem from the fact that the multifamily side of the registry is new, as mentioned earlier in this section.

[56] The subcontractor allows 5% latitude on window areas when comparing as-built to CHEERS registry data.

11. CHEERS Rater Surveys

Survey Methodology

The CA Statewide ENERGY STAR® New Home Program requires each builder to hire an independent CHEERS Certified New Construction Rater to field-verify that all C-HERS measures have been properly installed. To become a CHEERS Certified New Construction Rater, the individual must attend and pass a 3-day training class, in addition to adhering to a strict business and professional codes of ethics.

Since the CHEERS database is the foundation for our analysis, we decided to survey a sample of the raters that were responsible for populating the database with their field-verified data. We obtained the list of raters from the CHEERS website (http://www.cheers.org/cheers_raters.php), which has a total of 261 analysts and raters listed. The website provides contact information and the services that each rater/analyst offers. CHEERS Certified New Construction Raters are a small population, 156 of whom are listed on the CHEERS website. Each individual rater may be a private business and CHEERS puts forth no effort to standardize the rates the raters charge for inspection services. The builder, or the builder's agent, incurs the cost of the ratings in all cases.

The survey topics included information on how the raters view the program, training adequacy, construction trends, experiences from the field, ease of use of the CHEERS registry, and costs for the inspections.

Many participant builders use turnkey service providers for Title 24 compliance documentation, program participation requirements, and CHEERS ratings and inspections. RLW interviewed the turnkey providers and these findings are presented in the previous chapter of this report. The findings in this section mostly reflect the responses of non-turnkey raters; although one or two of the respondents were raters at the turnkey agencies.

Respondent Profile

The CHEERS rater survey began by asking all 46 respondents what their primary reason was for becoming a certified CHEERS rater. The majority of the respondents (48%) stated that they were interested in increasing their business and thought that becoming a rater was a good opportunity to do this. The second most common response (17%) was that they wanted to provide this service to meet their customers' needs. Another 13% of respondents stated that they were interested in learning about the current residential energy requirements, and CHEERS training was a good way to become informed. Twelve percent of respondents were concerned about the environment, and 11% stated other reasons, such as "*To be prepared to make energy efficient mortgage loans".* Another 6.5% of respondents were CHEERS analysts, but were not certified CHEERS raters. We did not include responses from the CHEERS analysts in the survey analysis since analysts are not actively involved in the inspection process.

What was your primary reason for becoming a certified CHEERS rater?	% of Respondents
Business Opportunity	47.8%
To Meet Customer Needs	17.4%
Interested in Current Energy Requirements	13.0%
Environment	10.9%
Other	6.5%
No Answer	4.3%
Total	100.0%

Table 216: Reason for Becoming a CHEERS Rater

CHEERS was founded in 1990 and began to certify raters in 1997. The respondents were asked to list the year they received their certification. Eighty-four percent of the survey respondents received their certification 2000 or after. Only about 30% of the respondents have been certified for more than three years. The CA ENERGY STAR New Homes program, which began in 2002, requires a CHEERS inspection. As a result the program has likely increased the demand for CHEERS inspections and certifications. This may be the reason why the survey respondents are more representative of those that recently have became certified.

In what year did you receive your CHEERS Rater certification?	% of Respondents
1997	6.5%
1999	6.5%
2000	15.2%
2001	28.3%
2002	23.9%
2003	17.4%
No Answer	2.2%
Total	100.0%

Table 217: Year of Rater Certification

Just less than half, 43%, of the respondents who were active conducted less than 10 ratings in 2002. Raters who are not very active (less than 10 ratings per year) are not in this business line full-time. Consequently, this may affect their level of expertise and comfort with conducting CHEERS ratings and using the CHEERS registry. About 30% of the active respondents stated that they conducted more than 100 ratings in 2002.

Number of SF CHEERS Ratings Conducted in 2002	% of Respondents
1 - 10	43.5%
11 - 100	13.0%
101 - 500	17.4%
> 500	13.0%
Don't Know	13.0%
Total	100.0%

Table 218: Number of Ratings by CHEERS Raters

Of the 46 survey respondents, only 50% had rated homes in 2002 and 2003. Half of the survey respondents were inactive. In reality, the proportion of inactive raters may be even higher due to the nature of self-selection bias, which suggests that raters who did not respond to the survey are more likely to be inactive raters. The percentage of raters who conducted multifamily home inspections is minimal. In 2002, 8.7% of the respondents conducted multifamily home inspections, and in 2003 it increased to 13%.

(n=46)	2002		2003	
	SF Ratings	MF Ratings	SF Ratings	MF Ratings
Yes	50.0%	8.7%	50.0%	13.0%
No	50.0%	91.3%	50.0%	87.0%

Table 219: Single Family & Multifamily Home Ratings Conducted in '02 and '03

A significantly high number of CHEERS raters do not rate multifamily homes. The most commonly stated reason for that by raters was that there were no requests or business to conduct multifamily ratings. About 50% stated that a lack of demand for such ratings deterred them from rating multifamily housing projects. The second most common response, which comprised about 38.5% of the respondents, was that the rater or the rater's company had a specialized focus on single family homes (either due to business connections or personal expertise) and did not choose to expand to multifamily homes.

Why have you not conducted multifamily CHEERS ratings?	% of Respondents
No requests or business in area	50.0%
Focus on single family due to personal or company relation	38.5%
Other	11.5%
Total	100.0%

Table 220: Reason for No Multifamily Rating

Cheers Registry Satisfaction

RLW asked CHEERS raters to assess the functionality of CHEERS' registry and support from CHEERS staff. The results are summarized in Table 221 and Table 222.

The CHEERS registry received best marks for its staff related activities such as user support and technical assistance. Over 80% of the respondents were very or somewhat satisfied with CHEERS' user support. However, responses to the CHEERS registry's portion of the survey received a less satisfied group of responses. The CHEERS registry did not receive very high ratings for its ease of input, data extraction and user-friendliness. Each of these areas scored below 'neutral' or average from CHEERS raters. About 48% of the respondents stated they were very or somewhat dissatisfied with the data input and about 50% were somewhat or very dissatisfied with extraction component of the CHEERS registry.

Rating	Ease of Data Input	Ease of Data Extraction	User-Friendliness	User Support
Very Satisfied	12.0%	6.3%	33.3%	55.6%
Somewhat Satisfied	16.0%	6.3%	16.7%	25.9%
Neutral	24.0%	25.0%	29.2%	7.4%
Somewhat Dissatisfied	24.0%	18.8%	12.5%	11.1%
Very Dissatisfied	24.0%	31.3%	0.0%	0
Don't Know	0	12.5%	4.2%	0

Table 221: CHEERS Registry Assessment (Responses by Percentage)

Over 72% of CHEERS rater respondents felt either good or very good about the overall technical assistance provided by CHEERS staff.

Technical Assistance	Average Rating
Very Good	36.2%
Good	36.2%
Neutral	16.0%
Poor	11.7%
Very Poor	0.0%
Total	100.0%

Table 222: Technical Assistance Satisfaction

Recommendations to Improve CHEERS Registry

When raters were asked for suggestions as to how to improve the CHEERS registry, the most common response was to make it more user-friendly. Raters appear to be frustrated with the registry's inability to accept changes or modifications. Many times, raters must call in to the CHEERS to ask for changes to be made to data already inputted in the registry.

A few respondents believed that the CHEERS registry was not capable of handling large volumes of data. For example, one rater stated that the registry only allow one to upload six plans at a time and it would be more convenient to be able to do more.

Cheers Training

CHEERS provides training for its raters before they go into the field. The program includes in-class preparation as well as feedback on their first few ratings. Overall, about 75% of the respondents felt CHEERS training was somewhat or very effective. Over 80% of the respondents also found the inspection training to be somewhat or very effective. However, about 11% did think the inspection training was somewhat ineffective.

CHEERS also trains raters on the use of the CHEERS registry. None of the respondents felt that component of the training was very effective. About 45% of the respondents stated it to be somewhat effective, while over 35% of the respondents stated the training on the use of the CHEERS registry was somewhat or very *ineffective*. This reaction to the registry training may be related with previous poor satisfaction with the ease of data input and extraction.

Rating	Training	Inspection Training	Use of CHEERS Registry
Very Effective	34.8%	54.8%	0.0%
Somewhat Effective	40.0%	25.2%	44.7%
Neutral	20.0%	9.6%	19.3%
Somewhat Ineffective	0.9%	10.4%	23.7%
Very Ineffective	4.3%	0	11.4%
Don't know	0	0	0.9%
Total	100.0%	100.0%	100.0%

Table 223: Overall CHEERS Training

After raters attend the training and pass the CHEERS inspector test, raters are asked to notify CHEERS of when they plan to conduct their first couple of ratings so that a CHEERS representative can accompany them in the field to oversee the rating activities and provide corrective guidance. The majority (70%) of the respondents were not accompanied on their first few ratings by CHEERS staff, suggesting that the raters are either not notifying CHEERS of their field activities, or that CHEERS was notified but chose not to accompany them. RLW believes the later is likely not the case more often than not, and that the problem is likely that the raters are not notifying CHEERS. It may be useful for raters to receive some guidance while actually inspecting homes because not all new raters may be completely competent after the training. RLW would recommend a more stringent process of identifying when raters are conducting initial visits, and accompanying them on these site inspections. CHEERS could consider holding back final certification until the rater has been accompanied on at least two projects.

Did CHEERS staff accompany you on your first few ratings?	% of Respondents
Yes, at least 3 ratings	18.2%
Yes, on less than 3 ratings	10.0%
No	70.0%
Not Applicable	1.8%
Total	100.0%

Table 224: CHEERS Field Training

CHEERS conducts randomized quality control inspections in order to verify the rater's work. Over half (56.5%) of the respondents stated that CHEERS staff contacted them to inform them about the quality control inspection.

After you conducted your first few ratings, did the CHEERS staff contact you regarding the quality control inspections?	Percent (n=27)
Yes	56.5%
No	32.2%
Not Applicable	1.7%
Don't Know	9.6%
Total	100.0%

Table 225: Quality Control Inspection Awareness

However, only 15% said that CHEERS *shared any feedback* to the quality control inspections. It is unfortunate and unproductive that CHEERS does not share its quality control findings with its inspectors because if CHEERS raters are not given feedback on their work, they have not the ability to improve their inspection practices.

Of those who did receive feedback, the majority received it in a timely manner. It is important that feedback is dispatched in a timely fashion so that any erroneous practices may be corrected as soon as possible.

Answer	Has CHEERS shared any feedback with you regarding the quality control inspections?	Did CHEERS provide timely feedback?
Yes	30.4%	75.0%
No	65.2%	25.0%
Not Applicable	3.5%	0.0%
Don't Know	0.9%	0.0%
Total	100.0%	100.0%

Table 226: CHEERS Feedback

The CHEERS three-day preparation course may not provide enough rater preparation in order to conduct a thorough inspection. Almost 40% of the respondents did encounter situations where they did not feel prepared for the inspection. Proper learning and training does not end after a three-day course. Feedback on work and follow-up training sessions, where new information and updates are presented, may improve the rater's quality of work and productivity. It is the responsibility of CHEERS to ensure that each CHEERS rater is equally qualified to do its job since the rater's work is not re-verified by an independent third party inspector.

While conducting a CHEERS inspection, hae you ever encountered a situation that the training did not prepare you for?	% of Respondents
Yes, all the time.	0.0%
Yes, sometimes.	39.1%
No	48.7%
Don't know	11.3%
Refused	0.9%

Table 227: CHEERS Inspector Preparedness

Recommendations for CHEERS Training and Feedback

In reviewing the survey results, the majority indicated a need for improving the training program. Below is a list of respondent verbatim suggestions:

Do more hands on training.

Spend time reviewing data entry process into the registry.

More coverage on ENERGY STAR *inspections and protocols.*

Spend less time on basic energy principles and more time on actual program rules.

Based on these suggestions and responses on previous questions, the CHEERS training program may benefit from spending more time reviewing the data input and extraction processes related to the CHEERS registry. More stringent adherence to the in-field accompaniment of new raters, in addition to on-going training updates, may be the best way to minimize having unprepared raters in the field. The training would also benefit from having a section cover the ENERGY STAR Homes program guidelines and participation requirements.

ENERGY STAR New Homes Evaluation

CHEERS raters are certified to inspect homes that use C-HERS measures to comply with Title 24 or ENERGY STAR requirements. ENERGY STAR homes exceed Title 24 standards by at least 15%. About 95% of the respondents stated they were familiar with the CA ENERGY STAR New Homes program.

Are you familiar with the CA Energy Star New Homes Program?	% of Respondents
Yes	94.8%
No	2.6%
Don't know/ Not sure	2.6%

Table 228: Familiarity with CA ENERGY STAR New Homes Program

About 75% of the CHEERS raters who responded to the survey indicated that they have conducted ratings for ENERGY STAR homes. Table 229 summarizes the results and Table 230 indicates the rate of satisfaction in providing rating services to ENERGY STAR homes. Overall, raters seem to be satisfied with providing services to builders that participate in the ENERGY STAR New Homes Program.

Have you done any Energy Star Home ratings for builders participating in the CA utility sponsored new construction program?	% of Respondents
Yes	71.3%
No	14.8%
Don't know/Not Sure	8.7%

Table 229: ENERGY STAR Inspections Conducted by Raters

About 85% of the raters felt very or somewhat satisfied with the services they provided to ENERGY STAR homebuilders. Rater approval of its services is important to the ENERGY STAR Program because it could potentially be a significant obstacle to program success if the majority of raters were not satisfied in providing rating services in this market.

How satisfied are you with providing rating services for builders for the CA Energy Star Home program?	% of Respondents
Very Satisfied	62.5%
Somewhat Satisfied	22.2%
Neutral	1.4%
Somewhat Dissatisfied	6.9%
Very Dissatisfied	100.0%
Don't know	6.9%

Table 230: Rater Satisfaction in providing ENERGY STAR Compliance Inspection

A certified CHEERS rater performs residential inspections for two types of reasons; the first, are homes that require inspection for Title-24 compliance, and the second, are homes that require inspections to comply with ENERGY STAR requirements.

A certified CHEERS analyst works with builders on the design of the builder's projects to ensure they comply with Title 24, or with ENERGY STAR requirements, depending upon the type of project[57]. Once a design is finalized, the CHEERS analyst inputs the Title 24 information into the CHEERS registry. Once the home is built, a CHEERS rater is hired to verify the C-HERS measures that have been specified by the analyst. The CHEERS registry produces a "to do list", which is used by the CHEERS rater during the inspection process. The "to do list" calls out each C-HERS measure utilized by the builder to meet Title 24, or to meet ENERGY STAR, which ever applies to the given project.

CHEERS will allow persons to certify as both the CHEERS analyst (the person who inputs the initial construction plans into the registry) and also the rater (the person who verifies the actual C-HERS measures). In RLW's sample of respondents, only 7.2% (about 9 people) stated they were certified both as CHEERS analysts and as raters. A potential conflict of interest could arise if the CHEERS analyst and the CHEERS rater were the same person on the same project. Based on these findings, and on our interviews with the turnkey agencies, it does not appear as though this potential conflict is occurring.

[57] In order to complete Title 24 documentation for ENERGY STAR Homes, the final Title 24 author must be a certified CHEERS Analyst.

In addition to being a certified CHEERS rater, are you also a certified CHEERS analyst?	% of Respondents
Yes, I do approximately equal numbers of each.	0.0%
Yes, however I do more ratings than I do Energy Star Title 24.	6.1%
Yes, however I do more Energy Star/Title 24 than I do ratings.	1.2%
No.	92.7%

Table 231: CHEERS Rater and Analyst

Cheers Inactive Raters

More than half of the respondents did not conduct any ratings in 2002 and 2003. Some builders and utility project managers for ENERGY STAR have commented on the lack of active CHEERS raters. RLW asked inactive raters a few questions to better understand whether these raters are aware of the program, and whether or not they would be interested in knowing more about it.

Although these CHEERS raters had not conducted any ratings in 2002 and 2003, 82% stated they were familiar with the CA ENERGY STAR Homes program.

Are you familiar with the CA Energy Star New Homes Program?	Percent (n=22)
Yes	81.8%
No	13.6%
Don't Know	4.5%
Total	100.0%

Table 232: Familiarity with ENERGY STAR New Homes Program

When inactive raters were asked whether they wanted the utilities to contact them about the ENERGY STAR program, 60% of the respondents stated they were not interested. This response rate may indicate that many of them are permanently out of the rating business and have no interest in being contacted about possibly opportunities. If this is the case, CHEERS should remove the raters from the contact list so that builders and utility managers can more effectively locate and contact active raters.

Are you interested in learning more about the CA Energy Star New Homes Program?	Have Previously Performed CHEERS Ratings	Have Not Performed CHEERS Ratings
Yes	100%	40%
No	0%	60%
Total	100%	100%

Table 233: Interest in Learning about ENERGY STAR New Homes Program

12. Program Manager Interviews

This section summarizes interviews RLW conducted with the ENERGY STAR New Homes Program Managers. The following staff members were interviewed:

a. PG&E – Cece Barros

b. SCE – Michelle Thomas

c. Sempra Energy Utilities, SoCalGas & SDG&E – David Blanke

Program Implementation and Marketing Strategy

Although funding for this energy efficiency program was not approved until March 2002, speculative marketing efforts for this program began earlier in order to ensure a successful program. The utilities heavily depended on their pre-existing relationships with builders in their territory to begin outreach. In addition, the IOUs collaboratively participated in the PCBC (Pacific Coast Builder's Conference) at the Moscone Center in June 2002, which was attended by about 70,000 to 80,000 building industry professionals. Although each IOU executed the program for its own territory, the application and requirements are uniform. The goal was to ensure customers knew that they were eligible for the same incentives and services in all parts of California. Each IOU provided information about the program and the EPA also supplied information on their website for more market support. The EPA provided some literature to support the utilities' efforts in reaching more builders, but according to the IOUs, their role was mostly passive.

The overall marketing goal is to garner participation in the program in order to affect construction practices to include energy efficiency goals. The program strategy is to alter a builder's view on building new homes. Changing builders' views will impact how homes are built in the long run, which is thought to be the most cost effective approach to sustainable long-term energy savings. In order to achieve the greatest program impact, the utilities focused the majority of their marketing activities on medium to large production builders.

Table 234 shows a summary of each utility's outreach to single family and multifamily new homes in 2002. As a result of the outreach efforts, overall, the utilities approved 11,049 single family units and 9,466 multifamily units as ENERGY STAR compliant in 2002. Almost half of the single family units and about 22% of the multifamily units were built in SCE's territory with about 28.5% of total program funds. SoCalGas and SDG&E (administered by the same utility program manager) fared well in its first year. With combined funds of about $3.5 million (25% of total program funds), they approved 2,295 single family units (21% of all single family units) and 6,307 multifamily units (67% of all multifamily units) as ENERGY STAR compliant. PG&E received the largest portion of program funds with $6.5 million (46% of total funds). They reached 3,545 single family units and 1,023 multifamily units.

Utility	SCE	SoCalGas	SDG&E	PG&E	Total
Single-Family	5,234	432	1,863	3,520	11,049
Multifamily	2,030	2,994	3,313	1,129	9,466
Total Approved Funds	*$4,000,000*	$ 1,484,000	$ 2,026,674	*$6,520,000*	$ 10,030,674

Table 234: Utility Outreach Efforts by Home Type

The following utility specific summaries discuss the steps and measures each utility took to implement the program and penetrate the market.

SDG&E and SoCalGas

Prior to the implementation of the ENERGY STAR program, SDG&E and SoCalGas had a strong ongoing relationship with about 200 builders (medium to large) in their service territory, which is maintained directly by the account executives. The account executives were already familiar with the new construction industry and were able to use their knowledge base to further promote energy efficiency measures that could be incorporated into the design and construction of the projects to achieve the source energy reduction necessary to reach the ENERGY STAR level. The incorporation of these measures was supported by the incentives offered by the ENERGY STAR program. Account executives were provided with analyses of specific measures that summarized the benefits of installing the measure.

SDG&E's and SoCalGas's database of builders were all informed about the ENERGY STAR program. About 20% of these builders participated in the program, which ultimately accounted for approximately 1,700 multifamily units and 4,400 single family units.

In addition to contacting builders, SDG&E and SoCalGas targeted other market players such as Title 24 consultants, CHEERS raters, Architects, Mechanical Engineers and HVAC contractors.

Pacific Gas & Electric

PG&E also utilized their existing contacts with builders through their account executives. All builders in their database were sent letters and information about the ENERGY STAR homes program. Like SoCalGas and SDG&E, PG&E also sent informational packets to Title-24 consultants and CHEERS raters in order to build awareness among the other key upstream market actors. PG&E also advertised in builder-oriented publications, which reached about 40,000 people.

PG&E also provided marketing tools to ENERGY STAR homebuilders that advertised the ENERGY STAR logo and explained the benefits of an ENERGY STAR to the potential buyer. PG&E noted that ENERGY STAR homes could be sold at up to $5,000 more than a comparable home without the energy efficient measures and design even though the added cost of the measures was about $1,200 (before the rebates). Once the builders' homes were certified as ENERGY STAR homes, PG&E offered to provide the builder's contact information and a map to the new development on the utility website for consumers looking for new homes to refer. In addition, the builders were supplied with brochures to pass on to prospective buyers so they could learn more about the benefits of an energy efficient home. In 2002, at least 50% of the qualified ENERGY STAR homebuilders participated in this advertising partnership.

Southern California Edison

Like the other utilities, SCE also relied heavily on its established builder contact list to market the ENERGY STAR homes program. SCE reported receiving an excellent response to their marketing efforts despite having such a short timeline to market the program. In some ways they were surprised by the excellent response rate they received because Title 24's residential building code had recently been strengthened as a result of AB 970. At the time, the SCE Program Manager feared that the revised code would discourage builders from wanting to build to even higher standards. Fortunately this was not as large of a barrier as it was originally perceived to be. Similar to its sister utilities, SCE informed

its database of about 100 builders and 600 other industry representatives about the termination of the Comfort Wise program, while at the same time introducing the new replacement program, the California ENERGY STAR New Homes Program. In June 2002, SCE also participated in the PCBC Conference. SCE found that the in-person contacts with the builders made by their representatives at the conference was the most effective way to market and recruit builders into the program.

Outreach to Non-Participant Builders

In the ENERGY STAR new homes program, the hard-to-reach community could easily be expanded to include small and custom builders.[58] However, if the overall goal of this program is to change building practices, then the small builders will most likely make the least amount of difference to overall building practices in the industry (unless they comprise of a large percentage of the new homes market.) Moreover, the cost of communicating with this group is much higher ($/new homes built) than reaching medium to large builders, since so many more would need to be contacted to equal just one production builder. Because the utilities are required to implement the energy efficiency programs in the most cost-effective manner, the utilities targeted builders who would bring the best return (i.e. greatest energy savings and lasting impact on building practices). However it should be noted that there are equity concerns for small custom builders; as a result no small builder is turned away or discouraged to participate, and complete access to program information and materials are available to the smaller builder, in the same way they are for large builders. Although the utilities do provide information for any builder to apply for incentives online on their websites, the marketing tools are mainly catered to medium to large builders.

In theory, energy efficiency funds would be maximized if only builders who were influenced by the program (i.e. financial incentives, energy efficiency classes, evaluation, etc.) were to participate, while not allowing any builder to participate who would have built to ENERGY STAR standards without the program. In practice however, the utilities do not differentiate their marketing strategy but rather employ general outreach mechanisms targeting all market actors. Although they are able to educate many and gain a great number of participants, it is not clear through this evaluation what fraction of the savings are naturally occurring, and what fraction of savings are program induced.

That said, we also recognize the importance of maintaining client relationships and participation among builders that may be free-riders. These early adopters can also become marketing leverage for the utilities in convincing other less interested builders to participate. Moreover, maintaining the client relationship will make future market transformation efforts easier as the utilities will already have the will of the builder on their side. This becomes particularly important as codes and standards and program metrics are increased over time.

RLW Analytics recommends that all four utilities conduct a study and research how to target non-participant builders in future years in order to maximize program benefits. Reviewing the mix of participants in future program years, compared to the 2002 program participants, can easily assess the effectiveness of these efforts. Furthermore, a comparison of the ENERGY STAR Homes building characteristics to Itron's Statewide Single

[58] Hard-to-reach as defined by the CPUC Energy Efficiency Policy Manual does not refer to the difficulty in reaching builders, but rather, the intent is to capture end-use consumers of the hard-to-reach market. This section intends to reach builders that may be more difficult to reach.

Family Homes Baseline Study building characteristics will provide further insight into the amount of program induced savings. RLW plans to conduct this analysis as part of the Phase II 2002 ENERGY STAR Homes Evaluation.

Builder Reactions to the Program

Program managers from each utility were asked to comment what they felt were the greatest obstacles for builders to participate in the program and which type of builders participated the most.

Program managers were also questioned as to whether or not they thought the ENERGY STAR logo label helped support the sale of homes for builders and the consensus is that it is unclear. Because the real estate market is booming, it is difficult to single out the effect of the logo. However, in general, it is believed to aid builders in marketing the homes. Recognition of the symbol will increase as the program continues in 2003 and beyond.

SDG&E and SoCalGas

The program manager for SDG&E and SoCalGas expressed the time frame of the program to be one of the main barriers impeding builders from participating in the program. Some builders could not meet the deadline to submit paperwork due to the timeframe of the program funding. The ENERGY STAR new homes program is currently funded by the CPUC on an annual basis; therefore all applications must be received before the program expires. Since construction cycles are not likely to be timed by the utility funding cycle for their program, many builders have been forced out of participating in the program.

Another expressed view from builders was that financial incentives were not high enough to cover all of the costs of installation. One solution may be to increase financial incentives. An alternative (and less costly) way may be to increase the awareness among builders and homebuyers of the benefits the program provides to the end-user, thereby increasing demand for ENERGY STAR homes. If the market players are aware and accept the added value of energy efficiency, the marginal cost of the energy efficient constructed may be justified.

PG&E

PG&E also expressed frustrations with the short timeframe to implement such a large program. The ENERGY STAR homes program is somewhat unique from other financial incentive programs in that the time between recruiting a participant and implementing the measures is much longer than compared to other energy efficiency programs.

Nonetheless, PG&E was still able to reach enough builders to deplete all of the program funds by November 2002 (program officially funded until 12/31/02.) Due to the program's popularity and high demand, one year's funding was capitalized in about seven months. PG&E was compelled to turn away interested customers after funding terminated and until further decisions were made by the PUC to extend funding for an additional year. Due to this break, PG&E's customers may have lost some confidence in the ENERGY STAR program and become more reluctant to participate in the program.

SCE

Overall, SCE was able to meet and exceed its allocated fund expectations by over-committing themselves by 30% in the first year. The over commitment was a tactical maneuver, as SCE anticipated a drop out rate resulting from build-out time constraints, mid-construction ownership/management turnover, and builders' budget constraints.

However, SCE program manager did feel that not all builders were participating because of their innate interest in energy efficiency, but rather, because of the incentives offered.

Weaknesses of the Program Implementation Strategy

The biggest challenge for program managers in the ENERGY STAR new homes program was rolling out a one-year program in about eight to nine months. Managers felt the program was brought to the market too quickly and did not allow for maximum returns.

As mentioned before, it is not clear whether the utilities made a conceded effort to reach out to builders who specifically would, or needed to, alter their building design due to program participation. Because builders in California vary so much in size, knowledge of energy efficiency, goals, and other factors, it is important to assess which builders are least likely to implement energy efficiency practices, analyze the reasons and then target that population. However, since multifamily construction is a very new market segment to energy efficiency programs, one could conclude that most multifamily builders in California would likely benefit from the education and financial support the ENERGY STAR program provides. However, if the utilities are educating and subsidizing single family builders who already believe in the value of energy efficiency, then the ENERGY STAR program is not being utilized to its fullest potential.

One example of this scenario is builders that participated in the ComfortWise® program[59] offered by one of the turnkey companies. The company reported that some of their ComfortWise® builders would have built to ENERGY STAR level with or without the program's incentives because it is now their standard practice – due to the market differentiation and customer satisfaction they have enjoyed since becoming ComfortWise® partners. Since all Californian ComfortWise® builders may also participate in the ENERGY STAR Homes Program, some may be program free-riders. However, it is important to note that some of these builders only build to higher energy efficient standards due to continued incentive support. In this context the ENERGY STAR program may be considered a springboard to participation in the ComfortWise® program. Once the builder recognizes the value and benefits of participation incentives may no longer be needed to sustain the level of building efficiency advocated by the ENERGY STAR program. While consideration could be given to limiting program incentives to return builders, this approach could backfire. As we have heard earlier in the builder interviews, builders become disenfranchised by program uncertainties, such as program timeframes and incentive availability. Therefore, if incentives were disallowed for return builders it may be very difficult to encourage them to participate in future programs.

Future marketing activities should look to attract builders that have not already learned from and realized the benefits of energy efficient design and construction. This can be assessed in future evaluations by comparing the mix of participant builders to previous program years. Since equity is important, along with maintaining existing relationships, the utilities may consider limiting financial incentives to builders that have previously participated so that incentive funds would remain available for attracting new builders. This recommendation is founded on the program strategy reported by the program managers, which emphasizes changing construction practices through education, training

[59] The ComfortWise® Program is an energy efficient new homes program that does not have participation incentives. Prior to the ENERGY STAR program, ComfortWise® was SCE's residential new construction program that did have an incentive component. Many ComfortWise® builders qualify for ENERGY STAR rebates.

and incentives – which RLW does believe the program is accomplishing. If the program implementation strategy is truly successful in educating builders about energy efficiency, then these builders will continue to build energy efficiency housing without program subsidies, therefore making room for builders that have not previously participated.

CHEERS and Raters

CHEERS (California Home Energy Efficiency Rating System) provides certified Home Energy Rating System (HERS) raters to the building industry, and a database for inputting C-HERS inspection data. It is the sole provider of this service in California.[60]

The overall relationship between the utilities and CHEERS has been less than adequate. SDG&E and SoCalGas program manager found the data entry to be satisfactory and data extractions to be problematic, but found CHEERS staff to be responsive and helpful. PG&E has been very unsatisfied with CHEERS due to the lack of responsiveness, inadequate number of active raters in its territory, and complications in tracking data in the registry. SCE expressed a need for better communication between CHEERS and the utilities. Although the SCE program manager sees great potential and work in progress in CHEERS services, the poor quality of data extractions must be improved if the relationship is to improve.

The utilities do not audit the CHEERS raters. This is due primarily to the fact that HERS providers supporting the CESNHP must be state-certified. The California Energy Commission has established criteria for HERS providers (including the requirement of QA). Therefore, the IOUs are relying on the CEC's expertise and established certification procedures as an "audit" of the HERS provider.

SDG&E and SoCalGas offered verification assistance to multifamily builders only. At the start of the program it was realized that there were not enough raters available to perform verifications for Energy Star elements only. Most raters preferred to deal with projects that had diagnostic testing, such as ducts. To assist builders and ensure that the projects would continue through the verification process, SoCalGas and SDG&E had all of the account executives certified as HERS Raters. Their function was to perform the visual inspections necessary for Energy Star certification only. If a diagnostic measure were used to meet the program requirements the builder would need to hire an independent rater. This process has worked extremely well throughout 2002 and 2003 program years.

The purpose of a rater is not solely an inspector for compliance. The rater functions as a consultant to the builder and the trades, advising on construction practices and ensuring the installation of specified measures. Many spend a considerable amount of time on site, observing practices and advising. The final inspection and subsequent entry into the registry is merely the closure of this process.

Planned Changes for Future Programs

SDG&E and SoCalGas did not change the 2003 program greatly from the 2002 program. They were satisfied with the 2002 results and feel that utilizing its existing relationships with industry builders is the most cost-effective way to implement the ENERGY STAR program.

[60] In late 2003 RLW learned of another CEC certified entity, CAL-CERTS, providing a C-HERS registry services. They are not included in this evaluation because too little information was available at the time of the evaluation.

PG&E did add some improvements to its 2003 ENERGY STAR program. They modified their websites so that the Comfort Homes program would not so easily be confused with the ENERGY STAR program. PG&E also increased its direct mailings by adding information in ad coupons and also targeted more consumers with homebuyer kits, which included an array of coupons for home improvements and information on ENERGY STAR homes. In collaboration with EPA and the other utilities, PG&E asked the EPA whether they could create a unique ENERGY STAR logo for California. After some drafts and revisions, the EPA approved a California-specific logo on 3/1/03.

All of the IOUs eliminated the incentive for multifamily builders constructing homes that exceed Title 24 standards by 20% with a new incentive that offered builders a $50 credit to hire a HERS rater and a $40 incentive to hire a design assistant for the multifamily program only. In the IOUs' experience, they found the former incentive to be less effective, while there was a greater demand for design and rating incentives. Some builders were discouraged to participate because they did not want to pay someone to inspect their work in order to qualify as an ENERGY STAR home, but this was primarily a multifamily issue. The rater incentive will hopefully mitigate such discouragement. The 20% tier was uniformly eliminated by all four utilities for all multifamily projects and coastal single family projects. The 20% tier was retained, at the request of the CPUC, for single family inland projects only. The Design assistance/verification incentives are independent of that decision. SoCalGas and SDG&E do not offer the design assistance incentive because this function is performed by the program management staff, and is available for both single and multifamily projects. Verification assistance is supported by the account executives and is offered to multifamily projects only when visual inspections are only required.

13. Conclusion and Recommendations

The 2002 ENERGY STAR New Homes program was overall a tremendous success in California. Although some builders felt the incentives were not enough to cover the added cost of energy efficient construction, demand for participation overwhelmed all four utility implementers. In junction with US Environmental Protection Agency, RLW applauds the efforts of the utilities to educate and improve building practices in new residential construction.

The following recommendations are devised into two sections—Program Administration and Improving Data Tracking and Evaluation. The program administration section addresses issues essential to the improvement of future ENERGY STAR programs. The data tracking and evaluation section concentrates on the CHEERS Registry and transfer files provided to the utilities to evaluate the actual participating homes. Although the second section is not directly under the utilities' jurisdiction, we feel it is crucial that the data collection problems are addressed and resolved by appropriate parties in order to ensure accuracy of program compliance and energy savings.

I. Program Administration

Ex Post Savings

With over 11,000 single family ENERGY STAR homes and over 9,400 multifamily units, the program generated a total electricity savings of 5,342,547 kWh, therm reduction of 1,340,545 therms, and total energy savings of 180,457,140 kBtu in 2002.

For single family homes, SoCalGas had the best returns per unit and per dollar, but results were not reflective of typical program results. Of the other three utilities, SCE had the lowest cost per unit of energy savings, while SDG&E had the highest cost per unit of energy savings. The overall compliance margin for the single family program is 21% and the multifamily compliance margin is 23%, which reflects the program's 15 to 20% better than code requirement. PG&E appears to have the most accurate formula[61] for estimating program impacts, evidenced by their 101% and 98% realization rate for electric and gas fuels, respectively.

For multifamily ENERGY STAR homes, SCE had the highest savings per unit (219 kwh/unit) for electricity and PG&E had the highest savings per unit (68 therms/unit) for gas savings.

Uniform Energy Savings Estimates

RLW obtained the utility estimate of savings from the 2002 AEAP filings in order to compute the realization rate presented in the ex-post energy savings section. While we calculated the realization rates, we noticed some large differences in the claimed savings per project between the utilities. For example, the claimed single family energy savings for SCE were 4,199,475 kWh and 829,781 kWh for PG&E. The number of single family housing units incented by SCE was 5,234 while PG&E incented 3,520 units. That equates to a claimed kWh savings per single family unit of 802 kWh for SCE and 236 kWh for PG&E. RLW estimated the average savings per unit was 350 kWh. There appears to be

[61] When using Approach A, PG&E has the most accurate formula.

inconsistencies in how the program performance estimates are derived for the filed estimates. RLW recommends that the utilities agree upon a common method to estimate savings.

Program Coordination

The ENERGY STAR program has been successful in establishing awareness about energy efficient building measures. In collaboration with the EPA, the ENERGY STAR logo is a recognized symbol of quality and energy efficient homes. The collaboration between the utilities established uniform services offered to customers. In addition, it allowed for an opportunity to exchange ideas and to combine efforts.

Timeline and Implementation

Even considering that the utilities did not have a full 12 months to implement the 2002 program, the demand for the ENERGY STAR program was tremendous. Some of the utilities exhausted their program funding before the year ended. In order to avoid the problems associated with the timeline and implementation, RLW recommends that this statewide program be approved on time by the CPUC to allow for the full amount of time to execute and to extend the program from one year to at least two years. By extending the program duration, the utilities will have sufficient time to target its key group of builders through various marketing strategies and the builders will have sufficient time to learn, adopt and gain incentives for energy efficient measures.

In order to avoid insufficient funds for the ENERGY STAR program, the utilities ought to work on better targeting its key builders who would most gain from program participation. For example, they could limit their general marketing mechanisms such as television ads[62] (which can be costly), general ad publications and focus their marketing on groups through community organizations and local governments (which may be more economical) and is currently being done through SCE's Local Government Initiative and the Community Energy Efficiency Program (CEEP). The aim would not be to exclude any type of builder, but rather to use a limited amount of marketing and outreach funds towards builders who are the most incentive and program participation-driven. Key to the success of this solution is that the utilities have sufficient funds through the program timeline so that potential builder participants are not discouraged and plagued with funding uncertainties. The utilities may also consider enlarging the program's pool of incentives to further combat problems associated with builder uncertainty related to program funding.

Multifamily Compliance Requirements

The 2002 program offered two tiers of incentive levels, projects that exceeded Title 24 by 15% met the level one tier, while projects that exceeded Title 24 by 20% met the second tier. The ability to meet the Energy Code utilizing the performance methodology is structured by the algorithms developed by the California Energy Commission. The California Energy Star New Homes Program incorporated multifamily because it wanted to address all residential construction. In meetings with the EPA and others it was felt that the 15% threshold made sense from an initial starting point. However, the 2002 multifamily projects demonstrated how much easier it was to meet the 15% threshold in multifamily units than it was in single family units with no or little design changes made to their existing design practice, due to the way Title 24 standards are designed for

[62] Television ads were only conducted by PG&E.

multifamily units. In the PG&E service area, 70% of the multifamily projects met the 20% threshold, while only 47% of single family homes did. Clear evidence that 20% efficiency above Title 24 is easier for multifamily projects than it is for single family projects. Moreover, if one were to compare a 20% better single family home to a 20% better multi family home, they would find many more efficient measures in the single family project than in the multifamily project.

For example, a project in San Francisco can install dual pane windows, electric resistance heating, standard central water heating, standard insulation levels, and standard window to floor ratios and exceed Title 24 by more than 30%. This is compared to the less than 5% of the single family homes in the program that were more than 30% better than code. All of which were required to incorporate significant numbers of measures that were above standard practice in order to meet this threshold.

Although the 2005 standards, which will be implemented sometime in 2006, will manage the majority of the Title 24 multifamily compliance issues, it seems inconsistent to hold multifamily projects to the same performance criteria as single family homes, since program compliance is leaps and bounds easier for multifamily than it is for single family. RLW strongly recommends the utilities consider raising the compliance margin above 15% (the 2003 program dropped the 20% tier) for multifamily projects in 2004 and 2005. Doing so will likely improve the cost effectiveness of the multifamily program. In addition it will better prepare multifamily builders for the upcoming code changes, which will certainly reduce the ease of compliance that they now enjoy.

RLW would also recommend disallowing multifamily projects that have negative energy savings in any one end-use.[63] The nature of using the performance compliance method is to allow builders the ability to make trade-offs between end-uses. For example, a builder may elect to install electric resistance heating, which will produce negative heating savings because the baseline for this end-use is more efficient. However for hot water heating they may elect to install a central system with controls, which is more efficient than the hot water heating baseline. In some cases the efficiency gained through hot water heating measures compensates for the negative heating savings. In most cases, again due to the Title 24 control issues, the compensation is enough to lift the project above the 15% program compliance level. Fortunately the 2005 codes and standards changes will fix the water heating and fenestration issues, which will likely alleviate this issue. However, in the mean time (until 2005 codes are adopted), disallowing negative savings is a good insurance policy for ensuring that multifamily buildings are designed efficiently in all end-use categories.

ENERGY STAR Home Inspections

On-site inspections, or other means of verification may be prudent due to current issues and areas of program design identified by the evaluation. Previously in this section we discussed potential issues with multifamily compliance that could lead to projects not being built with the energy efficient characteristics reported by program implementers. For example, we have discussed:

- The ability to easily modify a transfer file prior to uploading the data to the registry.

[63] SCE, beginning in 2003, and PG&E starting in 2004, require positive electric energy savings at the project level

- CHEERS Quality assurance (QA) being conducting along side the rater, rather than as an independent verification of the rater's activities.
- Less than adequate "to do lists" resulting from poorly parsed transfer files. Particularly an issue relating to multifamily inspections.
- Potential conflict of interest when the same agency is a.) The builders agent for program participation requirements, b.) Responsible for authoring the Title 24 documentation, c.) Responsible for conducting the CHEERS inspections, and d.) Conducts the final plan check and uploads the transfer files.

Based on these findings, and also because the ENERGY STAR New Homes Program is still in its infancy, we suggest that utilities consider conducting on-site inspections by a third party to verify the measures being installed are in fact the same measures that make the project compliant. These activities may be most suitable for the EM&V contractor early on, and may only be needed until the aforementioned issues have been resolved.

The inspections may require significant effort considering the types of measures that require verification, the timing of such activities, and the willingness of either the builder or the homeowner to agree to such activities. Even considering these complications, we believe that a representative sample of buildings could be cost effectively verified. The findings of these activities will either provide a greater level of certainty that the claimed savings are in fact being achieved, or the findings will identify program flaws, which will only improve future program results.

Plan Check

SCE should consider outsourcing plan check activities to an agency less active with the program participants. The agency responsible for the great majority of SCE and PG&E's ENERGY STAR Home Title 24, CHEERS inspections, and builder compliance documentation is also responsible for all of SCE's single family home plan check activities. Though we did not find any specific instances (or have specific evidence to believe they exist) of program gaming, the potential is certainly possible due to the inherent conflict of interest this formula creates. Although we understand that SCE implemented a quality assurance approach that samples projects for plan check by a different agency, this seems redundant. RLW would recommend that all plan check agencies be disconnected from the activities of the turnkey agencies.

II. Improving Data Tracking and Evaluation

Hard-to-Reach Market

In Decision 02-03-056, the CPUC required that 20% of all funds allocated to the ESH program be reserved for units constructed for hard-to-reach customers, as defined in the Energy Efficiency Policy Manual. In the Decision, the CPUC said that HTR includes any combination of the following housing types:

- Housing for senior citizens
- Housing for individuals with special needs
- Housing for lower-to-moderate income households
- Rental units

The CPUC Energy Efficiency Policy Manual defines residential hard-to-reach customers as those who do not have easy access to program information or generally do not

participate in energy efficiency programs due to a language, income, housing type, geographic, or home ownership barrier.

We would recommend that the utilities add another field into the tracking data that indicates whether each project is claimed as hard-to-reach. We also recommend a second field that classifies the hard-to-reach projects by the type of customer sector that they are serving. These two fields would allow the EM&V contractors to calculate more precise estimates of the savings allocated to hard-to-reach segments.

Tracking Data

In order to project the energy savings and building characteristics data to the population, the EM&V contractor will need the number of units that will be built from each plan for all future evaluations. The proposed number of units built for each plan was collected on the program application, and the utilities were able to provide those data to RLW in electronic format for this preliminary PY 2002 evaluation. However, to complete a final energy savings estimate for the 2002 program, RLW needs the actual number of units built out for each plan type instead of the proposed number of units built for each plan.

Since the program allows for a two-year build out period, the utilities have found that many builders do not know how many homes/buildings of each plan they will build when they submit their application and thus do not require this information. The builder is confident about the total number of homes to be built, but the specific models that are constructed are dependent on the homebuyers. The energy savings vary from plan to plan within the same project, therefore to more accurately estimate savings we will need the final number of units built for each project.

Additionally, RLW recommends that the utilities standardize their tracking data methods. There was much difficulty involved in obtaining the final tracking data for the 2002 program due to the fact that some projects had dropped from the program and were not identified in the tracking data. We also had problems reconciling the transfer files with the tracking data we received. We recommend that the tracking data contain the following fields in addition to the administrative fields relating to dates and payments:

- Project ID
- Project Name
- Project Location (Address, City, Zip)
- Builder ID
- Builder Name and Location
- Hard-to-Reach Housing Type, if applicable.
- Plan ID (Application Number or ID for Model)
- Plan Name
- Proposed Number of Units for each Plan
- Actual Number of Units Built for each Plan and Plan Option
- Square Footage of Conditioned area of Each Unit
- Program Year
- Check Issue Date

- Project Completion Date
- Micropas or EnergyPro file name

Tracking Data Link to CHEERS Registry

RLW found that there is no clear link between the utility tracking data and the CHEERS registry. We needed to link the registry to the tracking data in order to assign the appropriate weighting (units built from the tracking data) to the energy savings for each plan in the registry. When RLW tried to link the tracking data to the registry, we found that the plan names in the tracking data did not provide sufficient detail to allow us to link it to the matching file in the registry. Therefore for this preliminary evaluation, RLW aggregated the proposed number of units built for each plan to the project level and equally distributed the number of units built out for the project among the individual plans with energy savings.

We recommend that the registry allow for the input of a plan ID that is the same as what is used in the utility tracking data. We also recommend a standard naming convention for the Title-24 transfer files that are uploaded into the registry. An example would be: 'Utility-Builder ID -Project ID-Plan ID.'

Consider as an example the Irvine Company project named 'Turtle Ridge Apartment Homes' in SoCalGas territory. This project had 6 plans labeled 1-6. The recommended transfer file name for the first plan would be 'SCG-1-1-1' if the Irvine Company were builder 1 and 'Turtle Ridge Apartment Homes' was project 1 for the Irvine Company. The second plan in that project would thus be 'SCG-1-1-2'. As a second example, consider the Barratt Homes project named 'Surrey Farm at Ladera Ranch' which has 12 plans named from 1A, 1B, to 3X. The recommended transfer file name for the first plan would be 'SCG-2-1-1A' if Barratt Homes were builder 2 and 'Surrey Farm at Ladera Ranch' was project 1 for Barratt Homes.

CHEERS Quality Assurance Protocols

Through the course of the evaluation activities RLW has identified some discrepancies between the way some of the utility program managers understood the quality assurance protocols, and the way in which they are actually conducted. RLW would recommend that the utilities review with CHEERS the quality assurance activities and protocols and come to an agreement on how these activities should be conducted for homes participating in the program. RLW further recommends that the utilities encourage CHEERS to have the QA procedures take on more of an independent assessment of quality assurance, rather than an oversight assessment, which is the current structure. While a more independent formula of quality assurance would certainly require added resources, structure, and coordination amongst builders, the resulting benefits would provide a higher level of quality assurance and program quality control.

Parsing Transfer Files

Problems occurring due to poorly parsed transfer files must be eliminated as soon as possible. Transfer files, the text file output created by Micropas and EnergyPro for the CHEERS registry, must be parsed in order to be uploaded into the registry. Detailed review of the CHEERS registry by RLW showed that the file parsing programs used by CHEERS for this process were not adequately parsing single family or multifamily transfer file data. The utilities have been aware of this problem for some time and have been working with CHEERS to correct the data parsing program. While we noticed only limited

issues with parsed single family transfer file data, the bigger problem is associated with parsing of multifamily transfer file data. While we recognize multifamily to be a new requirement for CHEERS to manage, the complications and issues created by this ineffective process are creating several complications.

The first complication is that the data being uploaded into the CHEERS registry is not being store correctly. Because of the inherent differences between single family and multifamily projects, the parsing is not the same. Resulting from the poorly parsed files are poorly populated CHEERS "to-do-lists." CHEERS inspectors use these lists during their inspections in order to verify C-HERS measures. Considering the number of multifamily projects going through the program, it is reasonable to expect CHEERS to have a functional data parsing system for all types of projects that participate in the program.

RLW (along with the utilities) anticipated using the CHEERS registry to serve as the foundation of data for many tasks required by the evaluation. As a result of CHEERS inability to correctly parse transfer files, and store transfer file data in the Registry, the evaluation team was forced to redesign the plan for evaluating the ENERGY STAR Homes Program. Using a file-parsing program developed by a third party, RLW was able to build a database similar to the CHEERS registry. This database created by RLW was used extensively as the primary data source for many chapters in this report.

Until CHEERS is able to resolve the major problems with the registry and its related processes, this less efficient means (recreation of the CHEERS registry data) of program evaluation will be required. In addition to addressing file-parsing problems, a complete set of database documentation and user protocols should be developed so that a uniform understanding of the user processes and stored data can be established.

Transfer File Protection

A database control issue exists in the program process that could allow significant gaming of the system. Once an ENERGY STAR home is approved by the plan check agency the "transfer" file is exported from the software (i.e. Micropas, EnergyPro) and is uploaded to the CHEERS registry. The transfer file is a text file. Since the file is easily editable, the person responsible for uploading the data to the registry could easily change any number of building characteristics or efficiency values, while at the same time leaving unchanged the energy budgets and compliance margins. This type of gaming would go completely undetected, since the existing CHEERS infrastructure has no mechanism in place to detect falsified transfer files.

We strongly recommend that the utilities and CHEERS encourage and work with the Title 24 software vendors to address this issue. One possible way to alleviate this data collection issue would be to modify the format of the transfer file from text (.txt) based to an encrypted type file. We have talked to one of the vendors of Title 24 software, who felt this would be an easy step to take.

Title-24 Modeling issues and Transfer File Protocols

RLW encountered some inconsistencies in the naming conventions of systems within the Energy Pro and Micropas Title-24 building characteristics data we received. Title-24 documentation authors use different names for the same systems in HVAC and DHW, which makes the analysis by system type more difficult. For example, three different names are used in the single family files for gas furnaces, namely 'gas,' 'furnace,' and 'central furnace.' A similar trend was observed in cooling systems, where split air

conditioners were named 'ACSplit' and 'Split Air Conditioner.' In the DHW data, we found instantaneous systems with tank sizes specified as 50 gallons. In the multifamily data we found that attached single family dwellings were designated as 'SingleAttached,' 'Single Fam Attached,' and 'MultiFamily.' The central boilers in the multifamily DHW data were difficult to identify since some authors called the system by its model number, while others named the boiler 'WATER HEATER, DHWCentral,' and others named them "Large" systems. We ended up deducing the true water heater type by comparing the text provided to the recovery factors and energy factors.

A similar problem, related to the way Title 24 authors document projects, relates to cooling. The estimates of cooling system saturation and cooling efficiency are misleading in this report. This is because of the way Title 24 consultants are modeling homes without cooling systems. In Micropas, the most common software program for conducting single family compliance, there is a way to indicate "no cooling" in the model. However, because homes without cooling must have a baseline (SEER 10) system installed,[64] most Title 24 consultants simply model a baseline system rather than indicating "no cooling" in the appropriate place in the software program. By not indicating "no cooling," it is impossible to know which homes have and do not have cooling systems installed.

It may be useful for the utilities to develop protocols for the plan check process. Protocols could easily eliminate many of the frustrations associated with the data that is created by the transfer file. Although this recommendation is not a critical aspect of program delivery or meeting savings goals, the data resulting from the program data is valuable from the standpoint of understanding characteristics of the population. These changes then would be most useful to program implementers as they would refine the data that serves as a tool for program planning. Moreover, simple steps or protocols that plan check would follow would not only improve the data, but would result in less costly analysis of the transfer file information (i.e. EM&V activities).

[64] The software programs must assume a baseline efficiency system (currently 10 SEER) because it is assumed that if the homeowner puts one in after construction that it will be minimum efficiency, therefore the home would still comply with the standards.