Raising the Bar: The Effect of the California 2005 Energy Efficiency Standards on Residential New Construction Program Design

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ABSTRACT

In response to the energy crisis, the California Energy Commission adopted two code changes (2001 and 2005 Building Energy Efficiency Standards (Standards)), designed to reduce peak demand for electricity in new homes. The combined effect of the code changes has had very little impact on coastal builders and a severe impact on the inland builders. These code changes have impacted all aspects of California new home construction and pose new challenges for program designers. This paper shows how the results from the Residential New Construction (RNC) baseline study and the RNC potential study provided insight into 1) the baseline conditions of residential new construction, 2) the remaining energy efficiency potential after two rounds of aggressive code changes, and 3) how the program should evolve to maximize energy efficiency after two rounds of code changes have been implemented. Each will focus on the differences between coastal and inland builders.

This paper details the analysis used to guide program managers in effective program design of the 2006-2008 Energy Efficiency Programs targeted at residential new construction. Additionally, this paper shows how the results were used to distinguish which levels of energy efficiency potential are economically achievable. Finally, findings will be used to guide future policy regarding gross and net energy savings verification for RNC programs in California, an area of program evaluation that has not been rigorously studied in many years.

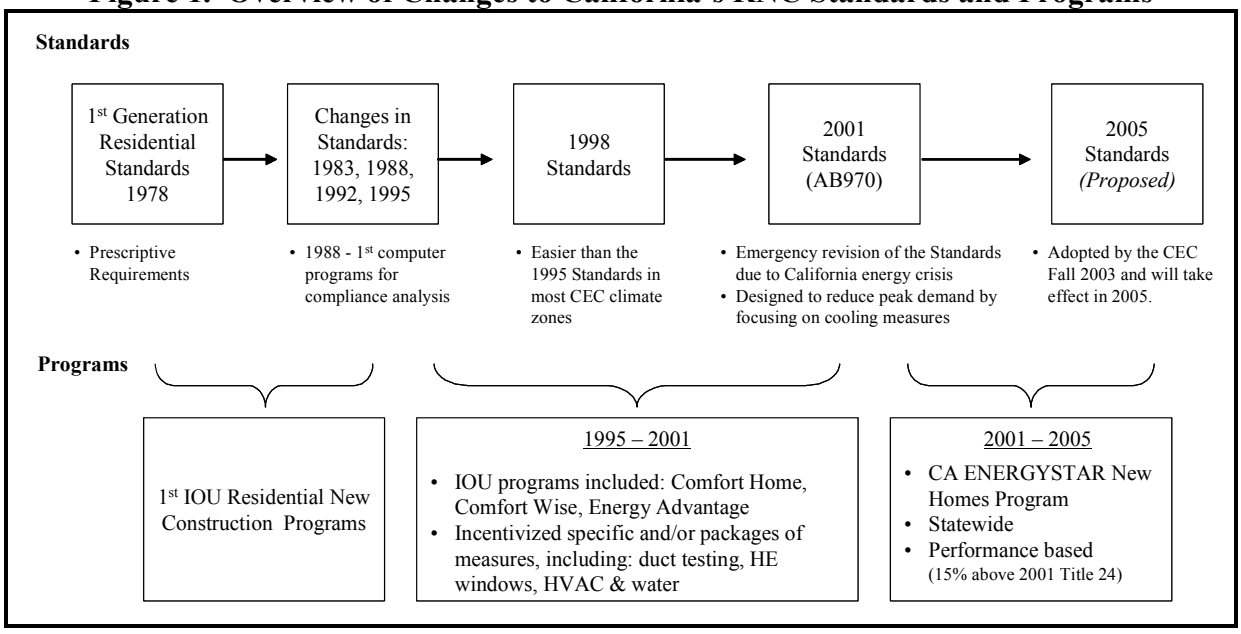
Introduction

Changes made to the Building Energy Efficiency Standards in 2005 have introduced new challenges to both builders and investor-owned utility (IOU) Program Managers. The 2005 Standards make it more difficult for builders to build homes that comply with code in the inland regions of the state, but do not require many, if any, changes in construction practices for builders along the coast. The more stringent requirements for the inland regions also make program design more difficult. The 2004/2005 Statewide ENERGY STAR® New Homes Program required homes to be at least 15% more efficient than the 2001 Standards. This level was already difficult for builders to reach in some regions. With the 2005 Standards, would it be impossible for builders to build ENERGY STAR homes if the program continued to require 15% over the new Standards? If so, how should the program(s) be changed? The remainder of this paper attempts to answer these questions by first giving an overview of California's Title 24 Standards and past IOU RNC programs, and then reviews the results of two recent RNC studies. *(Note: While the two recent studies were conducted for both single family and multifamily buildings, this paper focuses on detached single family homes.)*

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

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

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



California's Low-Rise Residential Standards

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

1995 and 1998 Standards. The overarching objective for revising the Standards is to increase the energy efficiency of newly constructed homes. One would expect that a home built under the 1995 Standards would not be efficient enough to be built under the 1998 Standards. However,

analysis conducted as part of the Residential New Construction Study (RER 2002) shows that the 1998 Standards were actually less stringent than the 1995 Standards for homes in most CEC climate zones (RER 2001; RER 2002). Changes in the water heating component and, for some climate zones, in the space heating component contributed to the 1998 Standards being easier.

2001 Standards. In response to what the State of California described as "growth trends in electricity peak demand that have strained the adequacy and reliability of California's electricity system," the State passed Assembly Bill 970 (AB 970) in September 2000 (CEC 2000). *Under these Standards, statewide annual source energy savings are estimated at 14% from the 1998 Standards, which includes a 39% or 155 MW reduction in cooling energy use on a statewide basis* (CEC 2000). The major change to the Standards is that radiant barriers,[1] low solar heat gain fenestration,[2] duct sealing,[3] and TXV valves[4] for air conditioners (certified by a Home Energy Rating System (HERS) provider/rater) are now part of the prescriptive component of the Standards for some climate zones. These added features also affected performance calculations and made it more difficult to achieve compliance.

2005 Standards. The 2005 Building Energy Efficiency Standards took effect in October 2005. The primary objectives for these new revisions are to respond to California's energy crisis to reduce energy bills, increase the reliability of the energy system, and contribute to an improvement in California's economic condition (CEC 2003). The revisions to the low-rise residential Standards include the following (Eley 2003).

- Time-dependent valuation replaced source energy in determining compliance using the performance method. In other words, high efficiency measures that reduce peak energy (i.e., air conditioners) are favored over those that reduce non-peak energy (i.e., furnaces).
- The standard energy factor for 50-gallon gas water heaters increases from 0.53 to 0.58 EF.
- R-6 and R-8 duct insulation is required in some CEC climate zones.
- Third party verification protocols and procedures encourage quality installation.

California's Residential New Construction Programs

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

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

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

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

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

Throughout the 1990s, RNC programs adopted strategies to increase energy efficiency in the short run and make sustainable changes in building practices in the long run. In addition to financial incentives, the ComfortHome, ComfortWise, and Energy Advantage Home Programs provided design assistance, marketing and advertising support, homebuyer education, and training. Program offerings targeted not only builders, but also others involved in critical aspects of design, specification, and construction, including architects, energy consultants, and engineers.

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

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

2004-2005 New Construction Program – California ENERGY STAR New Homes Program

The basic premise of California's current statewide ENERGY STAR New Homes Program (CESNHP) is to stimulate the energy efficient design and construction practices for single and multifamily new construction. The program targets various professionals involved in all aspects of the residential new construction market—builders/developers, architects, energy consultants, and others—with education, design assistance, and financial incentives.

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

Baseline RNC Study and RNC Potential Study

Over the past five years, Itron has conducted three RNC baseline studies, analyzing homes built under the 1995, 1998, and 2001 Standards, and the residential portion of the NC Potential Study. These studies use data from over 2,000 detailed on-site surveys conducted on newly constructed homes to develop saturations of energy efficient equipment installed, to determine compliance with the Standards, and to estimate how builders could reach levels above the Standards. The results of these studies are discussed in more detail below.

RNC Baseline Study – 2003

The primary objective of this study was to examine the status of Title 24 compliance for a representative sample of California residences as constructed (as-built) using the MICROPAS Title 24 computer compliance tool and using on-site survey data of 600 newly constructed single family homes. The study results were used as a baseline to determine the average building practices in the residential new construction sector by region.

The RNC Interface was used to conduct the compliance analysis for 575 detached single family homes contained in the RNC Study on-site database. The RNC Interface was first developed in 2000, during the first year of the Statewide RNC Baseline Study. The primary purpose of the RNC Interface is to generate MICROPAS[5] compliance runs, which are then used to examine the compliance status for each residential building and to explore the energy conservation potential of some key energy saving technologies. Since the RNC Interface was initially developed, it has been updated and upgraded during the two subsequent RNC baseline studies and for various other works relating to California's Title 24 Low-Rise Residential Energy Standards, the California ENERGY STAR New Homes Program, and the statewide energy savings potential in constructing more energy efficient residential buildings. The % compliance margin was determined as follows:

$$\%\,Compliance\,Margin_i = \frac{Standard\,Design_i - Proposed\,Design_i}{Standard\,Design_i}$$

where

Standard Design = Total energy use (space heating, space cooling, and water heating) for a home with Prescriptive Package D features (standard design.

Proposed Design = Total energy use (space heating, space cooling, and water heating) for home *i* with proposed construction plan features (proposed design).

Regional Compliance Results. The following summarizes the compliance results by RNC climate zone. In addition, Table 1 shows the average % compliance margin for each RNC climate zone.

- **RNC Climate Zone 1** (North Coast) tends to be the most compliant with an average % compliance margin of approximately 19%. Of the sites in RMST Climate Zone 1, only 8% are either indeterminate or non-compliant.
- **RNC Climate Zone 2** (South Coast) is the second most compliant of the RMST climate zones with an average % compliance margin of 16%. Only 1% of the sites fall in the non-compliant group and 6% fall in the indeterminate group.
- **RNC Climate Zone 3** (South Inland) tends to be compliant, as evidenced by an average % compliance margin of 9%. Approximately 17% of the sites fall in the high efficiency group, while 11% fall in the non-compliant group.

[5] MICROPAS was chosen as the compliance tool because it is the tool of choice among energy consultants for performing low-rise residential compliance analysis. Interviews with MICROPAS developers indicate that more than 75% of energy professionals use their product. Further, two subsequent studies by Itron indicate that more than 90% of energy compliance documentation was completed using MICROPAS.

- **RNC Climate Zone 4** (Central Valley) tends to be non-compliant, which is evidenced by an average % compliance margin of -3%. In RMST Climate Zone 4, 42% of sites fall in the non-compliant group and 41% are indeterminate.
- **RNC Climate Zone 5** (Desert/Mountain) is the least compliant of the RMST climate zones with an average % compliance margin of -6%. In fact, 55% of sites fall in the non-compliant group and 28% are indeterminate. The main reason that RMST Climate Zones 4 and 5 are the least compliant is because the Standards are more stringent in these climate zones.

Table 1. Average Compliance Margins by RMST Climate Zone

	Overall	RMST CZ1	RMST CZ2	RMST CZ3	RMST CZ4	RMST CZ5
Average % Compliance Margin	3.8%	19.2%	16.0%	9.4%	-2.9%	-5.7%

Why are coastal homes so compliant? As shown above, homes in RMST Climate Zones 1 and 2 (CEC Climate Zones 1-7) are, on average, overly compliant. In fact, of the homes surveyed along the coast, approximately 58% would have qualified for the California ENERGY STAR New Homes Program. This may seem surprising, however as predicted in previous reports, the 2001 Standards did not make it much, if any, harder to comply along the coast. Instead, since the new Standards were focused on reducing peak demand, typically air conditioner loads, homes in the inland regions have found it much tougher to comply.

In the 2001-2002 RNC study, homes built under the 1998 Standards were analyzed under both the 1998 and 2001 Standards. Results showed that these homes had an average compliance margin of approximately 12% when analyzed under the 1998 Standards and approximately 6% when analyzed under the 2001 Standards. While these results show that the 2001 Standards did become somewhat more stringent along the coast, the average home built in 2000 would have complied with the new Standards without changing any building practices.

However, average building practices along the coast did change between 2000 and 2003. The most dramatic change in the average building characteristics of coastal homes was the saturation of low-E windows. Over the last few years, builders across the state have started installing more low-E windows. During the interviews with builders, two reasons for this were discovered: 1) the incremental cost of low-E windows compared to clear glass windows has gone down, and 2) since builders need to install low-E windows in some inland areas in order to comply, they install the same windows in their coastal homes as well. Other changes in building characteristics in RMST Climate Zone 1 include the average AFUE increasing from 81% to 85% and the saturation of radiant barriers increasing from 0% to 14%. These changes in building practices have resulted in the average % compliance margin being even higher.

Another possible reason for coastal homes being overly compliant could be due to the California ENERGY STAR Program. Builders who were program participants for other projects built many of the nonparticipant homes surveyed. Some builders might not have been able to have more projects participate because the program was so successful that Program Year (PY) 2002 funds ran out before the end of the year. Therefore, there could have been a spillover effect. Also, interviews have shown that being a program participant changes building practices for homes that did not qualify for the program. In the evaluation of the PY 2002 program, approximately two-thirds of builders said that they had changed construction practices as a result of participating in the program.

RNC Potential Study

As part of the New Construction Potential study, Itron was charged with estimating the potential energy savings from constructing low-rise residential buildings in California that are higher than code (i.e., ENERGY STAR Homes). The first and most important part of the study was to find the costs and savings for low-rise buildings to reach 15% and 25% above the 2001 Standards. This information was then used to create packages of high efficiency measures. The 2003 Statewide RNC Baseline Study, which consists of data from homes built under the 2001 Standards, was used since this is the most recent baseline data for new single family homes.

Homes built under 2001 Standards. The first step was to develop a base case one-story and two-story home for each RMST climate zone. These base case (prototype) homes were developed by first finding homes that matched closely with the average building shell characteristics (such as floor area and glazing area) of each CEC climate zone. Once the best matching site was selected for each climate zone and story, the efficiency of the measures installed (HVAC, water heating, wall/roof insulations, window types) were adjusted. The first adjustment was made so that the measures in the prototypes more accurately reflect the average building practices in each climate zone found in the 2003 Statewide RNC Baseline Study.

After the preliminary prototypes were developed, each was run under the 2001 Standards using MICROPAS 6.0. Next, the % compliance margin for each prototype was compared to the average % compliance margin found in each CEC climate zone during the 2003 study (baseline). This was done because it is important that each prototype not only reflects the average building characteristics of its respective CEC climate zone, but also closely matches the average compliance margin of homes. In cases where the % compliance margins of the prototype were not close to the baseline compliance margins, the efficiencies of the measures in the prototype were adjusted slightly and then reanalyzed using MICROPAS.

Incremental costs. Table 2 presents the incremental cost for each high efficiency measure included in the analysis. The incremental costs were originally taken from the Incremental Costs study conducted by Itron in 2003. However, due to changes in the window industry, the incremental costs of high efficiency windows were decreased. Moreover, a couple of measures were added because the previous list of measures did not enable all of the prototypes to reach the desired targets. In June of 2005, after a re-examination of the market, the costs of roof insulation and radiant barriers were decreased to better reflect current pricing. Also, note that there are two costs given for each of the central air conditioning units due to the change in the federal minimum efficiencies beginning in 2006. (For example, from 2003 to 2005 the incremental cost for moving from a 10 SEER unit to a 14 SEER unit is $900; however, beginning in 2006, the incremental cost to move from a 13 SEER to a 14 SEER is $350.)

Table 2. Summary of Proposed Incremental Measure Costs (2003-2005)

Measure	Efficiency	Total Cost	
Central Air Conditioning	12 SEER	$400/N/A	Per Unit
	14 SEER	$900/$350	Per Unit
	15 SEER	$1,200/$600	Per Unit
Furnace	92% AFUE	$700	Per Unit
Water Heater	0.63 EF	$50	Per Unit
Radiant Barrier	Yes	$0.12	Per Sq. Ft. (Roof)
Roof Insulation	R-38	$0.08	Per Sq. Ft. (Roof)
	R-49	$0.20	Per Sq. Ft. (Roof)
Wall Insulation	R-19	$0.06	Per Sq. Ft. (Wall)
Insulation Credit	Yes	$50	Per House
House Wrap	Yes	$0.25	Per Sq. Ft. (Wall)
Windows	2-Pane Vinyl Low-E	$0.50	Per Sq. Ft. (Glazing)
	2-Pane Vinyl Spectral Low-E	$0.75	Per Sq. Ft. (Glazing)
Duct Insulation	R-8.0	$350	Per House
HERS Certified Sealed Ducts	Yes	$163	Per House
ACCA Duct Design	Yes	$131	Per House
Infiltration Testing	Yes	$150 + cost of House Wrap	Per House
TXV	Yes	$0	Per Unit

Developing the packages. After the prototypes were finalized, the prototype homes were used as the base cases to which the high efficiency packages were added. The packages were designed according to common builder practices found in the 2003 Statewide RNC Baseline Study. From these commonly found efficiency measures, 71 combinations of measures were constructed. These 71 packages were then added to each base case home and simulated using MICROPAS. The least-cost packages that reached a compliance margin of at least 15% and 25% above the 2001 Standards and 10% and 15% above the 2005 Standards were used to calculate energy savings per year for each prototype.

Table 3. Example of Packages

PackageNum	Roof38	Roof49	Wall19	TightDucts	DuctDesign	InfilTest	HouseWrap	TXV	Clear	SpecLowE	LowE	SEER12	WaterHeaters	SEER14	SEER15	SEER16	EER13	EER14	EER15	InsCredit_05	AFUE90	AFUE92	RadBar	DuctInsul	DuctinCond	SuperLowE	InstantWH	BaseEER	EER12
64		X		X	X			X			X		X		X					X		X	X	X						
65		X		X	X	X		X			X		X		X								X	X					
66		X		X	X		X	X			X	X	X							X		X	X	X					
67		X		X	X		X	X			X		X							X		X	X	X					
68		X	X	X	X	X		X		X			X		X					X		X	X	X					
69		X	X	X	X		X	X			X	X	X							X		X	X	X					
70		X	X	X	X	X		X		X			X	X								X	X	X					
71				X		X		X			X	X	X											X					

Least-cost package results. Lastly, the savings in therms and watts per year were calculated for the least-cost package of each CEC climate zone. Energy savings per year were derived by subtracting the proposed energy usage of the upgraded home per year from the base case

proposed energy usage per year (for space heating, cooling, and water heating). The following presents the cost and savings for reaching the targets under the 2001 Standards and the 2005 Standards separately.

Table 4 summarizes the cost and savings results stemming from upgrading the base case home with the least-cost package for each to reach 15% above the 2001 Standards. As shown, it would cost approximately $763 to upgrade the base case prototype in CEC Climate Zone 14 from -2.1% to 17.1% and would result in a savings of 67 therms and 1,015kWh per year.

Table 4. Savings by CEC Climate Zone – 15% Above 2001 Standards – SFD Homes

CEC_CZ	Story	FlArea	Base Compliance	Package Compliance	Cost	Space Heat Savings (Therms)	Space Cool Savings (kWh)	DHW Savings (Therms)
01	1	2,400	7.7%	16.2%	$513	57	0	4
02	1	2,400	10.4%	16.5%	$640	11	382	4
03	1	2,400	15.4%	15.4%	$0	0	0	0
04	1	2,400	11.6%	16.0%	$400	0	256	4
05	1	2,400	16.8%	16.8%	$0	0	0	0
06	1	2,450	21.7%	21.7%	$0	0	0	0
07	1	2,450	12.9%	21.0%	$207	-12	433	0
08	1	2,150	11.9%	19.9%	$450	7	206	11
09	1	2,150	13.8%	16.8%	$76	1	164	0
10	1	2,150	6.9%	17.8%	$450	10	549	11
11	1	1,800	11.8%	15.8%	$230	7	113	11
12	1	1,800	0.6%	15.2%	$827	37	521	11
13	1	1,800	-8.1%	15.9%	$1,027	23	1,462	11
14	1	2,000	-2.1%	17.1%	$763	56	1,015	11
15	1	2,000	-10.1%	18.9%	$763	5	2,747	11
16	1	2,000	1.0%	15.1%	$513	140	12	3
01	2	2,450	7.8%	15.7%	$513	59	0	4
02	2	2,450	12.1%	17.4%	$600	-10	589	4
03	2	2,450	16.6%	16.6%	$0	0	0	0
04	2	2,450	13.9%	15.4%	$112	-14	256	0
05	2	2,450	19.2%	19.2%	$0	0	0	0
06	2	2,900	13.2%	15.9%	$650	0	14	11
07	2	2,900	18.9%	18.9%	$0	0	0	0
08	2	2,900	13.5%	19.5%	$650	0	252	11
09	2	2,900	15.0%	15.6%	$115	-10	150	0
10	2	2,900	7.3%	16.0%	$650	0	661	11
11	2	2,900	7.7%	18.6%	$563	51	513	11
12	2	2,900	-3.4%	17.0%	$1,812	107	819	11
13	2	2,900	-9.4%	15.9%	$2,072	43	2,129	11
14	2	2,800	-4.1%	15.9%	$965	71	1,623	11
15	2	2,800	-12.6%	16.4%	$863	-11	3,917	11
16	2	2,800	-0.3%	15.0%	$1,055	220	104	4

Homes built under 2005 Standards. While the 2001 base case prototypes were developed using the average building characteristics of newly constructed single family detached homes, because the 2005 Standards did not take affect until October 2005, it is impossible to know how builders will reach the new Standards. Therefore, each of the packages was added to the prototypes and run under the 2005 Standards. The least-cost package that caused each prototype to just comply with the 2005 Standards was chosen as the 2005 base case prototype. Of the 32 single family detached prototypes, nine have same 2005 base case as the 2001 base case. Each is along the coast, which is not surprising given that the 2005 Standards, like the 2001 Standards, were developed to be more stringent in the inland regions.

Table 5 summarizes the cost and savings results caused by upgrading the base case home with the least-cost package for each to reach 10% above the 2005 Standards. As shown, it would cost just $157 to upgrade the one-story base case prototype in CEC Climate Zone 7 from 4.1% to 15.3% and would result in a savings of 273 kWh per year; however, installing this package of measures results in the prototype using more therms for both water heating and space heating. While installing a different package could result in positive gas savings, this was the least-cost package that brings this prototype to the goal.

Table 5. Savings by CEC Climate Zone – 10% Above 2005 Standards – SFD Homes

CEC_CZ	Story	FlArea	Base Compliance	Package Compliance	Cost	Space Heat Savings (Therms)	Space Cool Savings (kWh)	DHW Savings (Therms)
01	1	2,400	2.8%	6.2%	$993	25	0	0
02	1	2,400	2.6%	11.4%	$273	70	47	0
03	1	2,400	3.7%	14.0%	$513	60	0	4
04	1	2,400	0.1%	10.3%	$465	61	42	0
05	1	2,400	10.9%	10.9%	$0	0	0	0
06	1	2,450	13.5%	13.5%	$0	0	0	0
07	1	2,450	4.1%	15.1%	$157	-6	273	-12
08	1	2,150	0.1%	12.5%	$735	26	111	12
09	1	2,150	2.3%	11.5%	$470	25	137	0
10	1	2,150	2.3%	13.2%	$506	0	427	0
11	1	1,800	4.9%	11.2%	$208	0	257	0
12	1	1,800	0.9%	10.4%	$1,004	33	158	0
13	1	1,800	2.4%	10.2%	$1,445	73	0	0
14	1	2,000	1.5%	11.3%	$1,271	50	260	0
15	1	2,000	1.5%	10.9%	$400	3	743	0
16	1	2,000	-1.5%	11.3%	$44	140	2	0
01	2	2,450	-1.8%	16.1%	$539	149	0	0
02	2	2,450	1.5%	13.9%	$513	97	189	4
03	2	2,450	8.7%	10.4%	$125	7	10	4
04	2	2,450	2.5%	13.1%	$513	75	50	4
05	2	2,450	21.0%	21.0%	$0	0	0	0
06	2	2,900	4.3%	13.9%	$563	33	3	12
07	2	2,900	7.4%	11.2%	$287	-11	62	12
08	2	2,900	2.5%	11.5%	$563	36	68	12
09	2	2,900	0.1%	10.4%	$513	39	218	0
10	2	2,900	3.6%	13.1%	$517	-2	573	0
11	2	2,900	3.2%	11.9%	$461	-2	621	0
12	2	2,900	0.4%	18.9%	$1,382	147	315	0
13	2	2,900	0.9%	13.4%	$1,107	117	366	0
14	2	2,800	2.4%	11.2%	$1,290	81	296	0
15	2	2,800	1.6%	10.2%	$2,980	20	944	0
16	2	2,800	-4.3%	10.2%	$211	231	57	0

Remaining Potential for New Homes – Compared to Current Baseline

The objectives of the New Construction Potential (NC Potential) Study included finding the saving potential for residential buildings that would approximate the building of ENERGY STAR homes under the new standards (reaching 10 and 15% above the 2005 Residential Title 24 Building Standards) by Title 24 climate zone (as shown in Figure 2) in order to help Program Managers design the 2006-2008 RNC programs. The analysis estimated the energy savings potential and participation under the assumption that the future RNC programs would provide builders with incentives to construct homes that would use 10% and 15% less energy than allowed by the Title 24 Standards (using the performance method).

This section presents a brief summary of the estimates of residential new construction energy efficiency potential resulting from the NC Potential Study. (While the study included analysis of multifamily and single family attached buildings, this paper focuses only on the analysis and results of single family detached homes.) Estimated technical, economic and market potential were developed for the period 2003 through 2016. Market potential was estimated for two program incentive funding levels: 1) the current utility program incentive level, and 2) program incentives covering full incremental costs.

Description of the Model Used

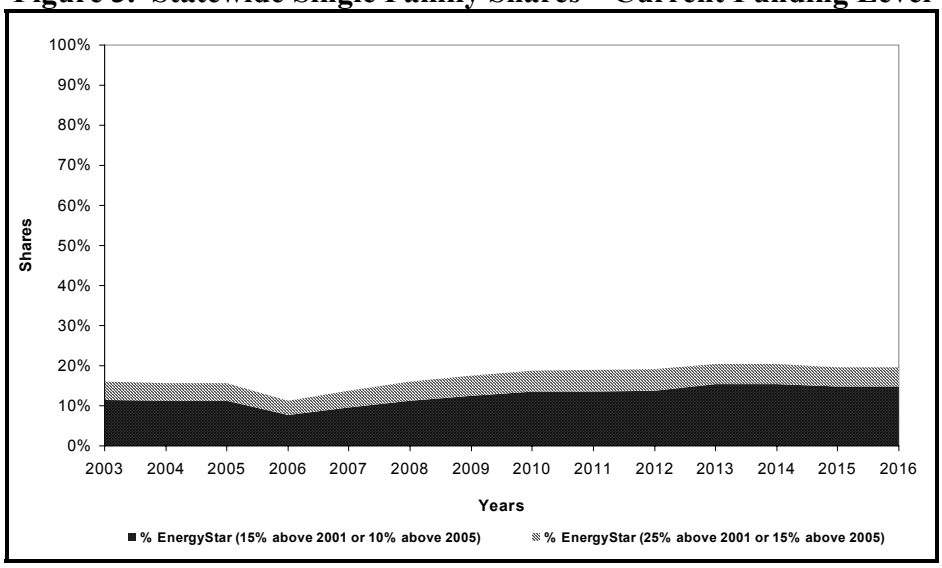
The NC Potential study used the ASSET model to estimate the technical, economic, and market potential for the IOU energy efficiency programs. The ASSET model is founded on a stock accounting algorithm incorporated with customer decision logic that is used to track and model adoptions of specific technologies. The ASSET program models technology adoptions by

combining data about customer characteristics, utility costs, rates, program incentives and accomplishments, technology costs, lifetimes, saturations, densities, and impacts with models of customer behavior. Using these inputs, the program forecasts the costs, energy impacts, and adoptions of alternative scenarios. A more detailed discussion of the benefits of using ASSET, as well as a detailed documentation of the model, can be found in the full report for this study, which will be available in May 2006.

Estimated Shares of High Efficiency New Homes

Figure 3 presents the estimated share of homes that reach 10% and 15% above the 2005 Standards. Since the 2005 Standards did not go into effect until October 2005, the first year where the new Standards impact the potential savings, and shares, is 2006. As shown, the shares of high efficiency homes are forecasted to dip temporarily in 2006 due to the changes in Standards, but then increase over time; this is due in part to increases in anticipated awareness levels.

Figure 3. Statewide Single Family Shares – Current Funding Level



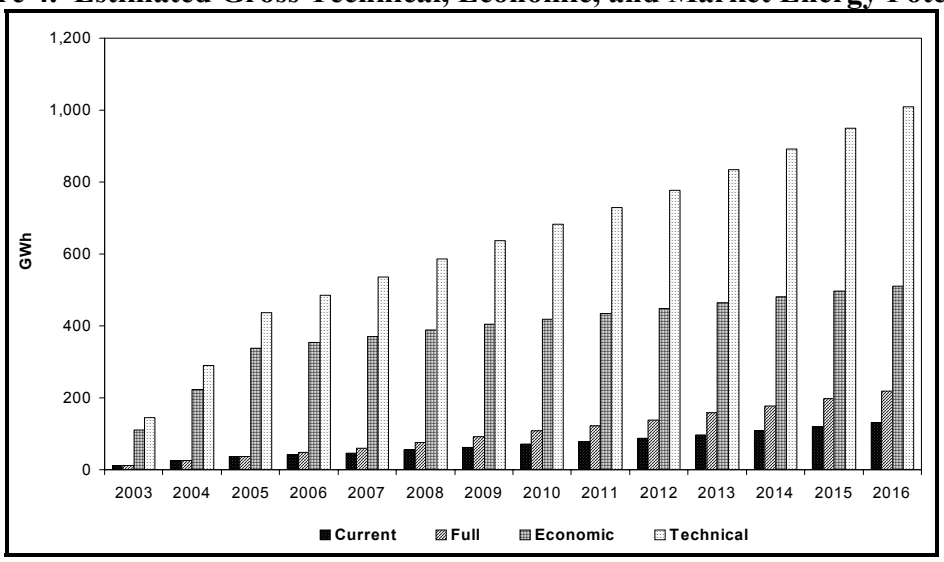
Estimated Energy Savings Potential of High Efficiency New Homes

Figures 4 and 5 present the estimated potential in terms of GWH and MW respectively for each of the four scenarios:

- **Technical Potential** is savings potential where installation of an energy-efficient measure is considered applicable and feasible regardless of cost or acceptability to the customer.
- **Economic Potential** includes the further consideration of measure costs. Avoided costs, measure costs, and program costs are used in this study to conduct a total resource cost test from the utility perspective.
- **Market Potential** relates to the impacts that can be expected to occur within a specified period and with a specified level of utility program activity. It takes into

account a variety of factors such as customer cost-effectiveness, awareness, and willingness to adopt (which depends on various market barriers like risk perceptions, split incentives, limited rationality, etc.). To estimate market potential, the ASSET model estimates market outcomes under alternative market conditions and program configurations. The model also incorporates barriers to adoption due to information costs, technology awareness, and customer perceptions about performance. This study used two incentive scenarios (current and full). The incentive used in the full-cost scenario run does not equal the full incremental measure cost. Instead, the weighted average of the incremental costs (by IOU, inland vs. coastal, and building type) was used as the *Full Incentive*.[6]

Figure 4. Estimated Gross Technical, Economic, and Market Energy Potential



[6] Incentives were developed by building type (SFD, SFA, MF), by performance level (15% and 25% above 2001 Standards, 25%, 10% and 15% above 2005 Standards.), and by region (North Coastal (CEC CZs 1-5), South Coastal (CEC CZs 6-7), Warm Inland (CEC CZs 8-10 and 16), and Hot Inland (CEC CZs 11-15).

Figure 5. Estimated Gross Technical, Economic, and Market Demand Potential

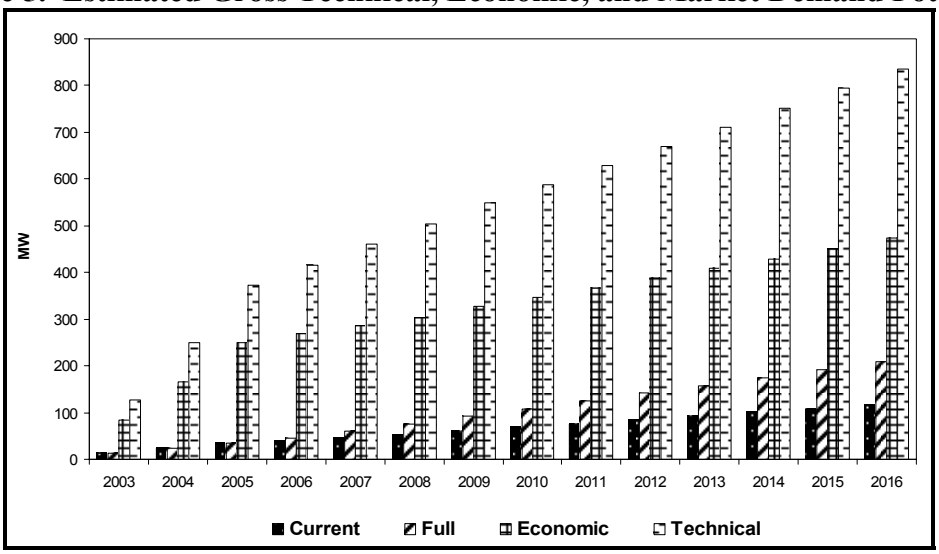
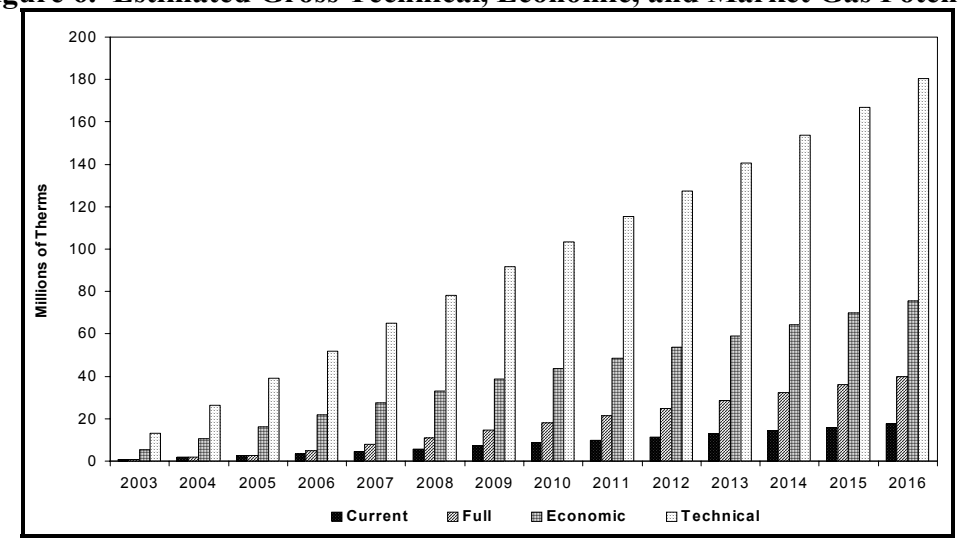


Figure 6. Estimated Gross Technical, Economic, and Market Gas Potential



Cost and Benefit Results

As shown in Table 6, the TRC tests under both the "current" and "full" incentive runs are less than 1.0. However, RNC Programs are likely to have a high degree of spillover. The RNC Programs have educated builders about energy efficiency in general and have introduced them to a wide variety of new and upcoming energy efficiency measures. The increased demand for these high efficiency measures has sometimes helped market transformation and has helped to drive new Title 24 Standards.

Table 6. Single Family New Construction Market Potential Cost and Benefit Results – 2016 – by Incentive Level

Item	SF - Current	SF - Full
Program Costs	$26,756,820	$49,833,247
Net Measure Costs	$132,549,582	$299,649,419
Gross Incentives	$132,396,597	$460,647,520
Avoided Cost Benefit	$143,572,071	$279,128,789
Program TRC	**0.90**	**0.80**

Table 7 presents the TRC test results by IOU and region (coastal versus inland). As shown, in Southern California (San Diego Gas & Electric, Southern California Edison, and Southern California Gas), the TRC results for the coastal region are poor—0.38 and 0.13 respectively. The two reasons for these low TRC results are 1) nonparticipant homes built along the south coast (CEC Climate Zones 6-7) are already energy efficient (the average compliance margin under the 2001 Standards is 16%, which means, on average, they meet the threshold required to be an California ENERGY STAR New Home), and 2) the 2005 Standards did not affect the south coast as much as the more extreme climates of California.

Table 7. Single Family New Construction Market Potential Cost and Benefit Results – 2016 – Current Incentives – by Region

	SDG&E		PG&E		SCE/SCG	
Item	Inland	Coastal	Inland	Coastal	Inland	Coastal
Program Costs	$649,527	$898,202	$13,309,463	$767,459	$10,986,664	$145,505
Net Measure Costs	$4,818,369	$5,872,503	$78,799,039	$3,093,669	$38,831,774	$1,134,229
Gross Incentives	$5,152,699	$6,584,600	$72,207,486	$2,879,994	$44,824,232	$747,586
Avoided Cost Benefit	$5,681,036	$2,605,604	$84,998,199	$3,203,553	$46,915,704	$167,975
Program TRC	1.04	0.38	0.92	0.83	0.94	0.13

Conclusion

Designing energy efficiency programs requires not only thorough knowledge of the market and the potential for change, but also the challenges the market would face and the base from which the market will be moved. The residential new construction market for both single and multifamily housing has long been recognized as a potential lost opportunity for long-term energy savings. Constructing homes and apartments that are more energy-efficient than the State Energy Code has far greater impact than purely resource conservation. The economic impact of energy efficiency is a potential reduction in utility costs. This reduction can reduce the financial impact on the segment of the population least able to withstand increases in energy costs. Low-income, senior housing, and other members of the hard-to-reach market greatly benefit from programs that create long-term energy savings. The California ENERGY STAR New Homes Program promotes and assists builders in increasing the energy efficiency of their housing to produce these energy savings in California.

In 2005, the program managers began the process of evaluating the direction for the next program cycle, which would encompass three years (2006-2008). Two important elements were necessary for this process: an understanding of the current baseline of home construction in California and the potential impact the changes in the Standards would have on builders meeting the minimum energy requirements. The studies conducted by Itron served as guidance on both. The results of the studies demonstrated that, while a challenge in some climate zones, continuation of a performance-based program in California could be maintained at the new levels set by the Standards, and further, following discussions with the Environmental Protection Agency, an ENERGY STAR Homes Program could be continued. This affords the IOUs the opportunity to continue the current program's character and prevent disengaging the current's program momentum. To this end, the incentives for program participation would remain unchanged with the exception of inland multifamily. To address this market more specifically, a separate incentive was developed. This incentive brings the multifamily program component more in line with the single family component, which had always addressed the different construction challenges facing the inland builder.

It is important that utility programs grow, evolve, and address new issues in the construction venue. Recognizing this need, beginning in 2006 the utilities will explore directly, or as consultant, a new direction in programs. Titled the Advanced Home Demonstration Projects, this program promotes a comprehensive residential new construction concept with a cross-cutting focus to sustainable design and construction, green building practices, and emerging technologies. Through a combination of education, design assistance, and financial support, the program will work with the building and related industries to significantly exceed code compliance, prepare builders for future changes in the Standards, and create future pathways to go beyond compliance and traditional energy savings objectives. This will be accomplished through demonstration pilot projects throughout Southern California.

Program design must take into consideration a number of factors, the most significant being the potential for the market to make changes in construction practices and the implications of such changes. Working closely together as the studies were developed, Itron and the IOUs were able to steer the needs of the study in the direction most beneficial to the utilities. For example, recognizing that the increased costs for some projects may prohibit the project from participation, the IOU program managers determined that additional features needed to be included in the program to afford increased participation opportunities, explore new code measures, and allow for more program flexibility. Beginning in 2006, the residential new construction programs include a prescriptive component. Separate from the performance-based ENERGY STAR Program, the measures contained in this component allow builders to explore two new compliance measures: Maximum Cooling Capacity and Quality Insulation Installation. The IOUs also expanded upon the prescriptive element in an effort to customize the offering to specific construction issues in their regions.

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