Residential
Market Effects Study

SCG Study ID No. 3702
SDG&E Study ID No. 3904

Volume 1

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Southern California Gas Company
555 West Fifth Street
Los Angeles, California 90013

and

San Diego Gas & Electric Company
8306 Century Park Court
San Diego, California 92123

Prepared by

Regional Economic Research, Inc.
11236 El Camino Real
San Diego, California 92130
(858) 481-0081

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Executive Summary

ES.1 Overview

This Executive Summary provides an overview of the Residential Market Effects Study (SoCalGas Study ID No. 3702, SDG&E Study ID No. 3904) conducted by Regional Economic Research Inc. (RER) under contract with the Southern California Gas Company. The following sections present background information on market transformation issues in California, enumerate study objectives, summarize the methodology used in the study, and provide a preview of the study' s results and conclusions.

ES.2 Background and Objectives

California' s restructuring plan calls for continued attempts to stimulate the market for demand-side management (DSM) activities. DSM promotion will take place under a revised administrative structure overseen by the Independent Energy Efficiency Board and financed through competitive transition charges (CTCs). However, these promotional activities will be reevaluated in the year 2002 when DSM might be relegated to the competitive market. Given the presumption that public DSM programs will be phased out over time, it is imperative that these programs focus on market transformation.

In the context of this study, market transformation denotes a long-lasting change in the market, or at least one that lasts beyond the life of DSM programs. Market transformation is typically characterized as the removal of market barriers that prevent the achievement of socially optimal levels of DSM activity. A taxonomy of these barriers has been developed in a recent report by Eto, Prahl, and Schlegel (1996).

Unfortunately, relatively little is known about market transformation attributable to DSM programs. Much of the work in this area has been conceptual rather than empirical. This study enhances our understanding of the market transformation effects of residential new construction (RNC) programs and focuses on the San Diego Gas & Electric (SDG&E) and Southern California Gas (SoCalGas) service areas. The study was designed to address five key questions:

- What changes in the market shares of the covered technologies have taken place over recent years?

- To what extent have utility programs influenced these changes in market shares?
- To what extent are these impacts of program stimuli long lasting?
- What market barriers were diminished by the programs in question?
- Which program features contributed to the mitigation of market barriers?
- To what extent are these impacts of program stimuli long lasting?

ES.3 Methodology

Accomplishment of the objectives presented above required the completion of three major study elements.

- The development of efficiency baselines for the measures covered by the study: gas space heating, gas water heating, and windows, ceiling insulation and wall insulation.
- The characterization of the residential new construction market, including a full description of the relationships among market actors.
- Interviews with a variety of market actors and the use of these interview results to test a series of hypotheses about the market transformation effects of RNC programs.

The first objective above required the development of a database of gas equipment and shell measure efficiency levels installed in residential new construction prior to, during, and after RNC program implementation. A historical series of efficiency levels of installed equipment and shell measures in new residential construction was used to characterize the market shares for each of these measures. These historical data are referred to as *measure baselines*. These baselines take the form of average observed efficiency levels, rather than "without program" baselines.

RER reviewed and utilized a wide variety of data sources to develop the measure baselines. Ultimately, the baselines were developed from four primary sources including:

- The California Energy Commission' s (CEC) Post-Occupancy Residential Survey project,
- SDG&E and SoCalGas residential new construction DSM program records,
- The RER Study Database from the analysis of the 1994 Southern California Gas Company (The Gas Company) Energy Advantage Home Program, and
- Title 24 compliance forms obtained from building departments throughout the SDG&E and SoCalGas service areas.

The majority of information required characterization of the market and assessment of market effects was obtained through in-depth interviews with market actors in the three areas covered by this study: the San Diego Gas & Electric Company service area, the SoCalGas service area, and a comparison area. The collection effort entailed two methods of data collection: in-depth telephone interviews and structured telephone and mail surveys.

Table 1 presents the total number of completed surveys and interviews with each market actor for each of the study areas. Market data from manufacturers, developers, HVAC contractors, distributors, lenders, building inspectors, government staff, and Title 24 consultants were collected through the open-ended interview medium. Because the level of influence of sales and real estate agents on the specification of equipment and measure efficiency levels was considered to be secondary in comparison to that of the other market actors, and that the information desired from these individuals could be solicited predominantly with close-ended questions, sales and real estate agents were interviewed with a more structured, quantitative phone survey format. Finally, data from residential gas customers (program participants and nonparticipants) from both areas were collected with a combined mail and telephone survey. RER developed a total of 28 unique interview guides and surveys for the in-depth interviews, surveys, and the consumer mail surveys.

Table 1: Target and Actual Complete Samples

Market Actor	SoCalGas	SDG&E	Control	Total
Gas Heating Manufacturers	na	na	na	5
Gas Water Heater Manufacturers	na	na	na	5
Window Manufacturers	na	na	na	4
Gas Heating Distributors	na	na	na	5
Gas Water Heating Distributors	na	na	na	5
Window Distributors	na	na	na	5
HVAC Contractors	4	4	4	13
Plumbing Contractor	1	3	2	6
Architects	6	3	5	14
Title 24 Consultants	7	2	2	12
Builders and Developers	15	15	15	45
Building Inspectors	7	2	2	12
Real Estate Agents	1	9	0	10
Sales Agents	16	14	15	45
Lenders	5	5	5	15
Government Staff	na	na	na	12
Consumers - Participants	460	96	na	556
Consumers - Nonparticipants	425	183	301	909

The qualitative and quantitative information obtained from the interviews and surveys enabled RER to characterize the RNC market and to identify key decision makers and decision influences with respect to the energy efficiency levels of gas equipment and shell measures installed in new homes.

ES.4 Results

The following sections present the results for the three major elements of this study, which include:

- A characterization of the residential new construction market and key market actors,
- Measure efficiency baselines, and
- Tests of market effects hypotheses.

Characterization of the Residential New Construction Market and Key Market Actors

One of the primary products of this research effort was an in-depth characterization of the key market actors and their interactions in the residential new construction market. The market for shell measures and high efficiency gas equipment consists of exchange transactions between a variety of actors, some acting as suppliers to the market and others acting to create demand for these products.

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The following industry participants are considered to be key market actors:

- Equipment manufacturers,
- Equipment distributors and wholesalers,
- Builders,
- Architects,
- Title 24/energy consultants,
- HVAC contractors,
- Plumbing contractors,
- Building inspectors,
- Sales and real estate agents,
- Lenders,
- Consumers, and
- Government and nongovernment agencies.

Each industry participant exerts some influence on decisions relating to market transactions, including decisions ranging from production, stocking, distribution, and pricing of the products to decisions pertaining to home design, equipment and measure specification, cost effectiveness, regulatory requirements, and consumer preferences.

Figure 1 depicts the general structure of the residential new construction market and the links and interactions among key market actors. The *supply side* of the market consists of equipment manufacturers and distributors and wholesalers. The government has a substantial influence on equipment manufacturing through the implementation of federal equipment manufacturing standards. Manufacturers sell product to distributors and sometimes directly to the contractors who install the equipment. Manufacturers' primary links to contractors and builders (those that demand the product), however, are through equipment advertising and marketing. Manufacturers influence these market actors through many channels of

communication, including in-person contact, trade literature, and trade shows and conferences.

As shown in Figure 1, the *demand side* is comprised of the remaining market participants, including builders, HVAC and plumbing contractors, architects, Title 24 energy consultants, building inspectors, real estate and sales agents, lending institutions, and, of course, residential consumers. It is quite obvious from the diagram that builders are linked to nearly every key market actor, and, as will be discussed in subsequent sections, are the primary decision makers in most aspects of residential new construction. With respect to the specific focus of this study, builders have the most influence and make nearly all final decisions pertaining to the energy efficiency levels of equipment and shell measures of new homes.

The builder works with the architect(s) during the project planning and design phase of construction. After the basic plans of the house are finalized, the plans are "elevated" to include all other specifications, including HVAC and plumbing system design and specification, and the specification of all shell measures. At this point, there is a great deal of interaction that occurs between the HVAC contractor, the builder, and the Title 24 consultant until the builder approves of all specifications and until the plans meet all building code and Title 24 requirements. A building plans examiner reviews the plans and Title 24 documents and issues the necessary building permits upon approval. [1]

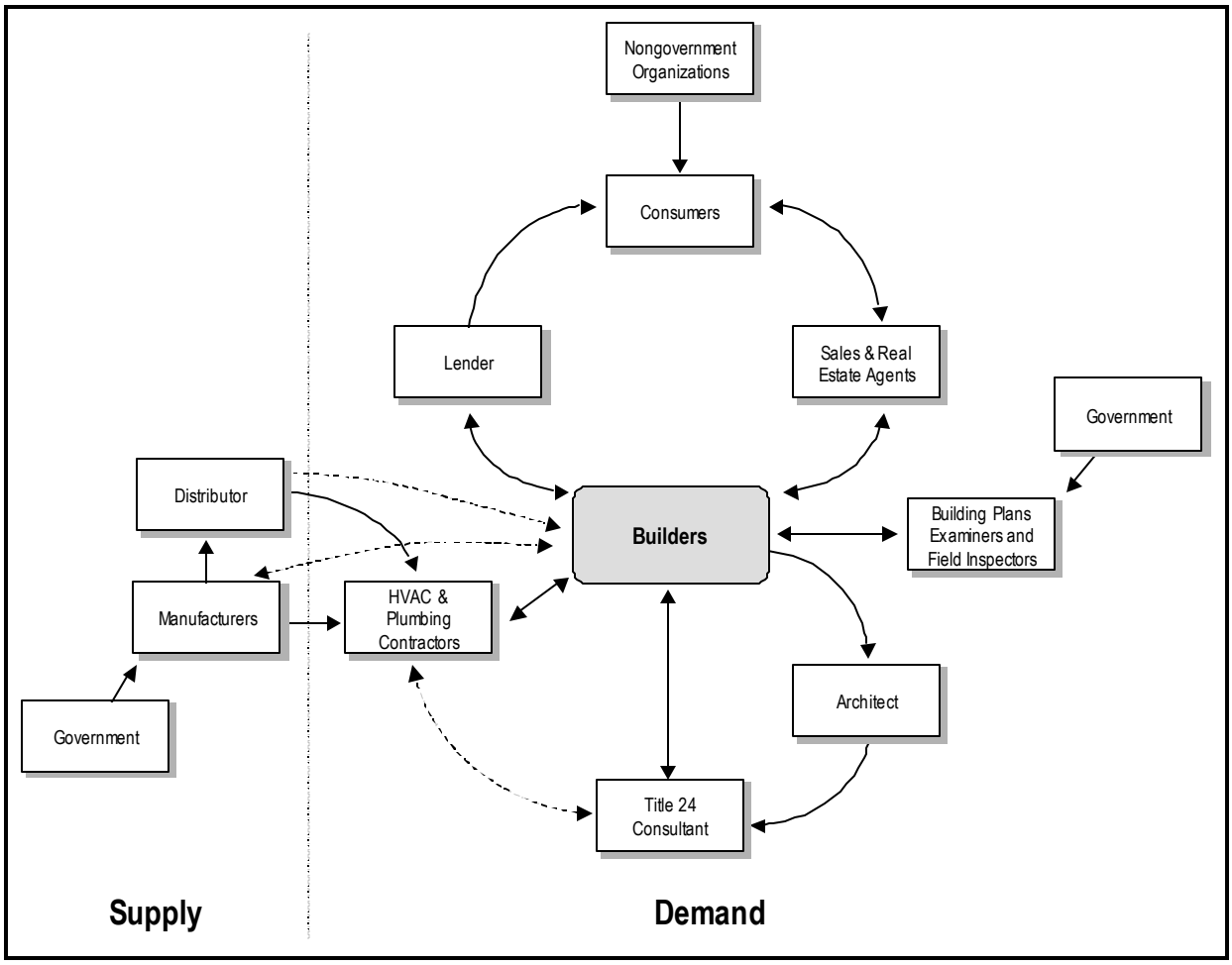
The builder solicits bids for various aspects of construction, including HVAC and plumbing equipment installations, based upon the final specifications. The contractor awarded with the bid is responsible for purchasing and installing all equipment and materials as per the building plans. Building inspection occurs at various stages of construction to ensure that all material and equipment coincide with the building plans and that all equipment has been installed according to the manufacturers' guidelines.

Sales and real estate agents are responsible for selling the property to consumers. They not only work with consumers in finding homes that are compatible with their lifestyles and needs, but also relay homebuyer preferences to the builder during project planning and market research. Note that the sales agents are the most direct link between the builder and consumers.

Finally, Figure 1 reveals that government agencies and nongovernment organizations interact with several market actors. As explained in the following sections, the roles of government and nongovernment agencies involve implementing standards and regulations in the market, as well as supplying information to key market actors.

[1] It is interesting to note that all of the intermediaries are state licensed except for the Title 24/energy consultant, for whom no license is required.

Figure 1: General Structure and Market Interactions



Key results relating to key market actors are summarized below.

Supply-Side Market Actors

- Gas space and water heating *equipment manufacturers* are sensitive to demand from market actors downstream, mainly distributors and builders. The efficiency levels of the equipment they produce are most strongly influenced by equipment efficiency standards mandated by government agencies and by competition among manufacturers.
- *Equipment distributors* have little influence in the market and are not a primary source of information for other market actors.
- The strongest link between the supply- and demand-side market actors is the information flow from manufacturers to builders, contractors, and other industry participants.

Demand-Side Market Actors

- *Builders* are the primary and central decision makers in all aspects of product development, including specification of energy efficiency levels of gas space heating equipment and shell measures. Because tract developers' objectives are to minimize construction costs subject to building code compliance, tract homes rarely exceed the minimum Title 24 requirements.
- Builders rely on the expertise of other market actors in the decision-making process. During the specification stage of product development, *architects*, *Title 24 energy consultants*, and *HVAC contractors* participate in and influence the builder' s decisions regarding equipment and shell measure specification. In some cases, these market actors might make the final decision regarding energy efficiency levels. However, decisions made by other market actors must be made within the builder' s parameters, such as the project' s budget.
- Builders' *sales agents* are the only link between builders (the central decision maker) and consumers. They not only work with consumers in finding a home that satisfies their lifestyle, but provide input to builders regarding consumer preferences during the preliminary stages of development as well.
- The extent to which sales agents provide information to consumers on energy efficiency levels of new homes is limited by the builders' willingness to train the agents and supply such information as well as consumers' interest in energy efficiency levels of new homes.
- Sales agents are very influential in helping consumers purchase homes that exceed minimum energy efficiency standards, but not very influential in helping builders develop homes that exceed the minimum energy efficiency standards.
- *Lenders* play no meaningful role at all in influencing efficiency choices. They do not generally consider efficiency levels in the process of qualifying buyers for loans, and do not feel qualified to provide advice on efficiency.
- *Consumers* expect homes to be energy efficient, and tend to think that if a home meets building code requirements then the home is as energy efficient as possible. Consumers rarely opt to upgrade the energy efficiency levels of a new home. (It is also important to note that builders rarely offer upgrades of energy-related equipment and features.)
- Consumers have little influence on the energy efficiency levels of new homes. Even though consumers indicated that energy efficiency is more important now than in the past, consumers have little influence on the energy efficiency levels of new homes. The flip side of this point is that most builders do not give consumers the opportunity to choose the efficiency of the equipment installed in their new home. Most builders explained that while they offer upgrades to the consumers, these upgrades rarely pertain to energy-related features, especially gas space and water heating equipment. (Most energy upgrades offered by builders are for air conditioning units with a higher SEER rating.) Even though builders explained

that they are willing to build anything the consumer wants, homebuyers rarely request energy efficiency upgrades, even for insulation or more efficient windows.

Government Agencies and Nongovernment Organizations

- The quality and extensiveness of building plan review and field inspection varies among municipalities. Interviews with building departments throughout Southern California revealed that the "quality" or extensiveness of plan review and inspection varies. For example, one department explained that all Title 24 calculations are thoroughly inspected, while another merely looks at the signature on the compliance forms. If the signature is recognizable and the preparer is a reputable firm or consultant, the compliance package is not reviewed more thoroughly. The same inconsistencies are also evident in building field inspections.
- Although RNC programs could potential influence building energy code revisions, builders typically have a strong presence in energy efficiency code revision processes and generally lobby for the maintenance and simplification of standards.
- Nongovernment organizations provide informational services to consumers and other market actors about the energy efficiency of residential buildings. These organizations are reactive rather than proactive. In particular, their strategy is to "fit into" the market mechanism (i.e., the home purchasing process), rather than target a specific market actor. As such, they respond to questions and requests for information rather than disseminate information to industry participants.

While the discussion points presented above are generalizations about the residential new construction market, and the residential tract development market in particular, it is important to understand that market features differ by project type, project value, residence type and consumer type. First, unlike tract developments, for instance, the consumer is the primary decision maker in custom home projects and relies heavily on the expertise of other market actors in decisions related to energy equipment and measures. Second, homes of higher value are more likely to be specified with high efficiency features than those of lower value (sometimes for energy conservation purposes and sometimes for other reasons, such as aesthetics, noise mitigation, and just for "higher quality"). Third, the goals and objectives of multi-family housing regarding energy-related features are often different than those of single family homes. Fourth, , there are differences between first-time homes buyer and repeat buyer preferences for energy efficiency. First-time homebuyers generally do not consider the operating costs of a new home, while repeat buyers are more likely to conceptualize (or have experienced) the benefits of high efficiency equipment. Repeat buyers are also more likely to ask sales agents questions about the energy-related features of a home. Such inquiries send signals to the sales agents (and therefore the builder) that homebuyers are interested in energy efficiency.

Measure Baselines

Overall Efficiency Histories

Measure baselines were derived for gas furnaces, gas water heaters, and ceiling and wall insulation. Gathering historical data on the efficiency levels of installed equipment and shell measures in residential new construction was the most difficult challenge of this study. The measure baselines developed for this study were derived from four primary information sources, including the following:

- The California Energy Commission' s Post-Occupancy Residential survey project,
- SDG&E and SoCalGas residential new construction DSM program records,
- The RER Study Database from the analysis of the 1994 Southern California Gas Company Energy Advantage Home Program, and
- Title 24 compliance forms obtained from building departments throughout the SDG&E and SoCalGas service areas.

In general, these sources provided an adequate historical gas furnace, water heater, and shell insulation efficiency level data. However, historical data from existing sources on high efficiency windows (U-values) were sparse, at best.

The measure baselines for gas space and water heating equipment, windows, and wall and ceiling insulation reveal the following trends:

- The average gas furnace annual fuel utilization efficiency rating (AFUE) steadily increased from the late 1980s and early 1990s, with a sharp increase observed in 1993 due to the increase in the AFUE standard to 78%. The AFUE peaked at just above 80% in 1995 and has decreased slightly since then.
- The average gas water heater energy factors (EF) has been historically well above the national standard of .54. The average EF has increased from .58 in 1989 to .61 in 1997.
- The average wall insulation R-value ranged from 13.11 in 1989 to 13.04 in 1997. Aside from a noticeable dip from 1993 to 1994, efficiency levels of wall insulation have remained somewhat constant over the past nine years.
- The average ceiling insulation R-value ranged from 29.74 in 1989 to 29.81 in 1997. Efficiency levels dropped significantly between 1989 and 1990, increased and peaked at 32.07 in 1994, then decreased again.

As this effort is the first attempt to integrate baseline data from several sources, it is imperative that efforts continue to derive more accurate measure baselines. The most logical options for data collection are to either continue gathering data from Title 24 compliance forms, or from building inspectors. There are several advantages in having building

inspectors collect measure baseline data. First, building inspectors are the most "neutral" market actor in the industry and have no influence during equipment specification decisions. Second, recording data on installed equipment avoids the problems of accounting for discrepancies between the efficiency levels specified in Title 24 compliance forms and those of equipment actually installed. Third, requiring building inspectors to record efficiency level data might also increase the quality and consistency of inspections. If this route is taken, the approach should be simple (i.e., a short and simple survey form) to minimize the inspectors' already burdensome workloads.

Program Influences on the Market

One application of the efficiency histories is the assessment of overall effects of the RNC programs on efficiency levels. First-year impact studies have been done for both of the programs in question, and we made no attempt to replicate these evaluations. Instead, we focused on the more central question relating to the *permanence* of these program impacts, the characteristic that distinguishes market transformation programs from their traditional predecessors. There are two ways to attempt to address this fundamental question. First, we can attempt to correlate changes in efficiency levels with the absence/presence of the program. In this approach, we essentially attempt to observe directly whether or not lasting changes in market shares have occurred. Second, we can look for some intermediate indicators that programs have changed basic attitudes, perceptions and behaviors in a way that can be assumed to have lasting impacts. This approach is often called the analysis of market effects. These market effects will be considered below in the next section. Here, we focus on the observed changes in overall market efficiency over time.

While the true test of market transformation is a more or less permanent change in the efficiency levels targeted by a program, it is difficult to observe such changes directly. Unfortunately, the data for non-program years is insufficient to support any definitive conclusions on the impacts of the RNC programs. However, changes in efficiency levels since the end of 1995 may offer some insights with respect to permanence, insofar as the SDG&E program was converted to a maintenance program and the SoCalGas program was changed to an information only program at that time. The following changes occurred after 1995:

- ***Gas Furnaces.*** Gas furnace AFUEs peaked in 1995 and have diminished slightly each year since then. While these AFUEs have not yet returned to their mandated minimum, there does appear to be some attrition in the program impacts over time. Clearly, though, more data need to be collected before this slight trend can be interpreted more clearly.
- ***Gas Water Heaters.*** Average water heater efficiencies (EFs) continued to rise in 1996, then fell slightly in 1997. They continue to remain considerably higher than the standard, but it is unclear that this is a long-lasting situation or that it

attributable to the programs in question. Again, more data need to be collected over time before we will be able to see a clearer picture.

- ***High Efficiency Windows.*** Given the problems of collecting adequate data on window U-values, there are no measure baselines for this measure. Considerably more work needs to be done to collect sufficient data to track historic and subsequent years' data. On the other hand, our interviews with manufacturers and builders did suggest that significant improvements in window U values have occurred. Moreover, some respondents indicated that these impacts were at least partly attributable to DSM programs in general, and that the improvements are probably more or less permanent.
- ***Wall Insulation.*** The wall insulation baselines suggest that wall insulation has never exceeded standards significantly. The overall average R-value has stayed very close to R-13, the minimum requirement in most weather zones. This should not be surprising, given that the installation of greater R-values would most likely involve the use of considerably more expensive 2×6 studs or expensive sheathing. When given the option, builders typically find other less costly ways to increase efficiency.
- ***Ceiling Insulation.*** Ceiling insulation levels appear to have dipped in 1996 but to have risen in 1997. No clear tendencies have emerged to suggest that program effects have been short-lived. Again, more data will have to be collected to ascertain any such tendencies.

It should be noted that all of these trend analyses are complicated not only by the short period of post-program experience, but also by the inherent variability in the distribution of construction across CEC weather zones. Moreover, comparisons across years are also complicated by the variation in market conditions over this period. Further, construction activity started to pick up in 1997 and may have influenced efficiency choices.

Tests of Market Effects Hypotheses

As noted above, another means of assessing the market transformation effects stimulated by RNC programs is to examine induced changes in market barriers, or market effects. While these effects are only intermediate indicators of program success, they nonetheless offer useful insights into the permanence of program impacts as well as the mechanism through which permanent impacts are promoted. The market barriers investigated in this study include product unavailability, organizational practices, performance uncertainties, information costs, hassle costs, bounded rationality, and split or misplaced incentives. Impacts on these barriers were assessed using information obtained from surveys completed by consumers, and in-depth interviews with builders, manufacturers, distributors, sales agents, and a variety of other market actors. Surveys were conducted in three areas: the SDG&E service area, the SoCalGas service area, and a control area consisting of the Austin/San Antonio corridor.

Our conclusions with respect to the effects of the RNC programs on these barriers are not particularly positive. They are presented below, organized by major classes of market actors as well as specific hypotheses.

Effects on Manufacturers

- ***Hypothesis 1a:*** RNC Programs increase production of affected measures and improve product availability.

  Conclusion: This hypothesis is not generally supported by the manufacturer interviews. While the efficiency mixes of both water heaters and furnaces have improved considerably over time, these improvements are primarily attributable to standards rather than DSM programs. Manufacturers also report fairly dramatic improvements in window efficiencies, but they attribute these changes to "competition among manufacturers." On the other hand, the fact that efficiency is perceived as a competitive tool may indicate that efficiency programs have been somewhat responsible for this trend. If programs have been partly responsible for improvements in windows, though, there is no guarantee that these improvements will be permanent. Interviewees emphasized that the demand for high efficiency products must be sustained in order for manufacturers to continue to offer them.

- ***Hypothesis 1b:*** RNC programs change manufacturing practices and stimulate retooling, thus leading to higher efficiency levels in the product mix.

  Conclusion: This hypothesis is not strongly supported by the data. For the most part, changes in manufacturing practices are ongoing and reportedly attributable to the manufacturers' long-term outlooks and competition in the industry, rather than to DSM programs. Manufacturing changes are made to develop better products, to achieve cost reductions, and to be more competitive. However, it is possible that some changes in practices relating to gas heaters and windows could be attributed to DSM programs in general.

Effects on Builders and Other Decision Influencers

- ***Hypothesis 2a:*** RNC programs increase the effective product availability by increasing builders' and other decision influencers' product awareness.

  Conclusion: These programs do seem to have increased builders' awareness of efficiency options. Southern California participants appear to be significantly more aware of these options than Southern California nonparticipants and (with a couple of exceptions) builders in the control area. The programs also seem to have increased awareness levels of architects. There is no evidence to suggest that programs have made HVAC contractors more aware, but comparisons with the control area were confounded by differences in weather conditions between Southern California and the control area.

- ***Hypothesis 2b:*** RNC programs affect the business strategies and standard organizational practices of builders, architects, distributors, and other decision influencers.

  Conclusion: Participation in the RNC programs does seem to have affected some organizational practices of builders and HVAC contractors.

- ***Hypothesis 2c:*** RNC programs lead to lower effective DSM prices by lowering information and hassle costs incurred by builders, distributors and other industry participants.

  Conclusion: The results do not support this hypothesis. Participating builders are generally no less likely than either nonparticipating builders or control area builders to consider lack of information, unavailability of products, difficulty of choosing among options, or hassle costs important. HVAC contractors in Southern California are also more likely to consider these barriers important than their counterparts in the control area. Results for architects are mixed.

- ***Hypothesis 2d:*** RNC programs stimulate changes in the promotional practices used by contractors and distributors.

  Conclusion: Again, we find no real support for this hypothesis. Participating builders are actually less likely than nonparticipants to market high efficiency homes differently than homes that just meet code. On the other hand, both participants and nonparticipants from Southern California are more likely than control area builders to do so. Nearly all builders expressed the opinion that energy efficiency is "low down on the [consumer' s] list of reasons to buy [a home]."

Effects on Customers:

- ***Hypothesis 3a:*** RNC programs increase customers' awareness of and knowledge about energy-efficient appliances. This lowers information and hassle costs and diminishes asymmetric information barriers.

  Conclusion: The customer survey results suggest that participants are only slightly more aware of energy efficiency standards than Southern California nonparticipants, but considerably more aware of efficiency standards on gas equipment than control area respondents. They are also only marginally more aware of energy efficiency options than nonparticipants. In comparison to control area respondents, California participants are considerably more aware of differences in available efficiency levels for gas furnaces, but less aware of differences in window efficiencies. This latter result is undoubtedly related to the importance of window integrities for cooling requirements in the control area.

- ***Hypothesis 3b:*** To the extent that energy-efficient appliances perform well, promotion of their use should improve customers' satisfaction with these products and diminish performance uncertainties.

  Conclusion: While the data are somewhat mixed on this issue, we conclude in general that the RNC programs have had limited effects on consumers'

perceptions. First, households in participating homes are only slightly more likely to think their homes are energy efficiency than households in nonparticipating homes. Second, perceptions of energy savings are relatively modest. Third, participating and nonparticipating consumers express very similar intentions to purchase energy efficiency in their next homes.

- ***Hypothesis 3c:*** RNC programs influence customers' decision-making processes relating to the choices of energy efficiency. This might take the form of reductions in bounded rationality.
- ***Conclusion:*** Again, the survey data reveal no evidence that consumers' decision-making processes have been affected by the programs.

Effects on Split Incentives

- ***Hypothesis 4a:*** Program promotions make consumers aware of the energy savings associated with shell and equipment efficiencies, and increase the prices these customers are willing to pay.

  Conclusions: At best, the evidence offers only weak support for this hypothesis. Households now living in participating homes are actually less likely to be willing to pay for increased energy efficiency in their next home, although those who are willing express greater willingness to pay. Moreover, builders (especially participating firms) are very skeptical of consumers' willingness to pay for a significant portion of the cost of efficiency.

- ***Hypothesis 4b:*** Program participation makes customers more aware of the benefits of efficiency, and makes them more likely to opt for high efficiency levels when they purchase another home.

  Conclusions: The data do not support this hypothesis. Participating and nonparticipating consumers express roughly equal willingness to purchase opt for high efficiency when they purchase their next home.

Effects on Government:

- ***Hypothesis 5a:*** RNC programs lead to improvements in appliance efficiency standards and building codes.

  Conclusions: This hypothesis is weakly supported. Assuming that RNC programs increase baseline efficiency levels of equipment and shell measures in the marketplace, RNC programs could influence energy efficiency standards to the extent that market conditions are accounted for in the revision process.

- ***Hypothesis 5b:*** RNC programs encourage greater compliance and enforcement of appliance and building energy efficiency codes.

  Conclusions: Again, this hypothesis is weakly supported. While RNC programs can encourage compliance by offering performance-based and prescriptive-base (for shell measures) incentives, the extent of the influence depends upon whether

the programs induce long-lasting market transformation. There is no evidence that RNC programs encourage enforcement of energy codes.

ES.5 General Conclusions

Our conclusions with respect to transformation are not particularly positive. Although there is some evidence of partial market transformation attributable to these RNC programs, the overall transformation effects of the programs appear to have been minimal. It is important to recognize, however, that these RNC programs were not designed for market transformation *per se*, and they were designed primarily to influence builders. While focusing on builders may have been the most effective means of inducing significant changes in installed efficiencies during the program period, long-term market transformation will clearly require significant changes in the perceptions and behavior of other market actors.

The more distant market actors are from the targeted decision point, the less likely they are to be aware of the program and the less likely they are to be affected by it. While builders (and probably HVAC contractors) exhibited some potentially long-lasting changes in behavior as a result of participation in these programs, other actors do not seem to have been influenced in any significant way. The most significant and notable permanent affects attributed to the programs pertained to duct sealing practices. Some of the HVAC contractors interviewed for this study recognized the importance of improved duct sealing methods and the use of high quality sealing materials in helping homes become more energy efficient. Regardless, even the observed changes in builder and HVAC contractor awareness and organizational practices are unlikely to be strong enough to sustain the effects of these programs on efficiency levels. Only a handful of participating builders reported that they continued to install high efficiency measures after program participation ended.

It seems clear that programs designed specifically for market transformation should target all market participants driving demand for high efficiency features in the market. It is especially important that these programs focus on the consumer, whose behavior tends to drive the actions of all other actors. Split incentives and asymmetric information are almost certainly the most significant (and the most difficult to mitigate) market barriers to the installation of high efficiency equipment and shell measures in residential new construction. These barriers exist primarily because builders (the primary decision maker) and consumers (the primary market driver) have different incentives in their market transactions and have different levels of and sources for information. As such, these barriers will be difficult to reduce. Because they are the only direct link between builders and consumers, and because they are fairly influential with consumers with respect to energy-related features in new homes, sales agents could play a pivotal role in future programs.

Market transformation may be particularly difficult to induce in Southern California, where weather conditions are mild. The majority of builders, architects, HVAC contractors, building plans examiners, and other market participants cited the moderate climate in Southern California as a major reason for complacency toward increasing energy efficiency, and the reason why consumers do not appear to be more concerned. While the measures covered by this study have been shown to be cost-effective in Southern California, their returns to consumers reflect local weather conditions.

A comparison of attitudes toward energy efficiency of market actors in Southern California and those in the control region illustrates this point. The greater cooling requirements in the control area seem to have fostered a proactive environment for increased energy efficiency in residential buildings. Overall, market actors in the control region reported being more aware of high efficiency technologies relating to air conditioning (windows and insulation). Results also imply that the market barriers that are somewhat substantial in the Southern California market are considered fairly insignificant in the control area market. In particular, decision makers and influencers in the control region indicated that information costs, hassle costs, product unavailability, and difficulty in choosing among options were not important reasons for building homes that do not exceed energy codes. Essentially, market actors in the control region—including, perhaps most importantly, consumers—better recognize the *need* for energy efficiency than their counterparts in Southern California, because the need is greater. This does not mean that it is not important to reduce barriers in Southern California, but rather that the lower returns to efficiency will require more significant reductions in these barriers than would otherwise be the case.

1

Introduction

1.1 Overview

This report presents the final results of the Residential Market Effects Study (SoCalGas Study ID No. 3702, SDG&E Study ID No. 3904). Regional Economic Research Inc. (RER) conducted this analysis under contract with the Southern California Gas Company. The reminder of this section presents background information on market transformation issues in California, enumerates the study objectives, provides a preview of results, and previews the remainder of the report.

1.2 Background and Objectives

California' s restructuring plan calls for continued attempts to stimulate the market for demand-side management (DSM) activities. DSM promotion will take place under a revised administrative structure overseen by the Independent Energy Efficiency Board and financed through competitive transition charges (CTCs). However, these promotional activities will be reevaluated in the year 2002 when DSM might be relegated to the competitive market. Given the presumption that public DSM programs will be phased out over time, it is imperative that these programs focus on market transformation.

In the context of this study, market transformation denotes a long-lasting change in the market, or at least one that lasts beyond the life of DSM programs. Market transformation is typically characterized as the removal of market barriers that prevent the achievement of socially optimal levels of DSM activity. A taxonomy of these barriers has been developed in a recent report by Eto, Prahl, and Schlegel (1996).

Unfortunately, relatively little is known about market transformation attributable to DSM programs. Much of the work in this area has been conceptual rather than empirical. This study enhances our understanding of the market transformation effects of residential new construction (RNC) programs and focuses on the San Diego Gas & Electric (SDG&E) and Southern California Gas (SoCalGas) service areas. Moreover, it focuses on gas equipment and shell efficiencies, both of which were promoted by the SDG&E and SoCalGas programs. A similar study of the transformation effects of the RNC programs operated by Pacific Gas &

Electric and Southern California Edison was conducted recently by Barakat & Chamberlin (1997). In keeping with the design of those programs, the Barakat and Chamberlin study focused on electric equipment and thermal shell efficiencies.

This study' s specific objectives included the following:

1. To characterize the demand for energy-efficient gas equipment and building shells in residential new construction market.
2. To characterize the RNC market structure and to identify key RNC market participants, decision-making processes, and influences in the RNC market.
3. To identify market barriers to more energy-efficient residential building design, thermal shell measures, and/or gas space and water heating equipment.
4. To assess the extent to which RNC programs have reduced or eliminated market barriers and the sustainability of these effects in the future.

The methodology to address these objectives and a preview of results are summarized below.

1.3 Methodology

Accomplishment of the objectives presented above required the completion of three major study elements.

- The development of baselines for the measures covered by the study: gas space heating, gas water heating, and windows, ceiling insulation and wall insulation.
- The characterization of the market for residential new construction market, including a full description of the relationships among market actors.
- Interviews with a variety of market actors and the use of these interview results to test a series of hypotheses about the market transformation effects of RNC programs.

The first objective above required the development of a database of gas equipment and shell measure efficiency levels installed in residential new construction prior to, during, and after RNC program implementation. A historical series of efficiency levels of installed equipment and shell measures in new residential construction was used to characterize the market shares for each of these measures. These historical data are referred to as *measure baselines*.

RER reviewed and utilized a wide variety of data sources to develop the measure baselines. Ultimately, the baselines were developed from four primary sources including:

- The California Energy Commission' s (CEC) Post-Occupancy Residential Survey project,

- SDG&E and SoCalGas residential new construction DSM program records,
- The RER Study Database from the analysis of the 1994 Southern California Gas Company (The Gas Company) Energy Advantage Home Program, and
- Title 24 compliance forms obtained from building departments throughout the SDG&E and SoCalGas service areas.

Data to address the later two study elements were collected during in-depth interviews and surveys with the following supply and demand side market participants:

- Equipment manufacturers,
- Equipment distributors,
- Builders and developers,
- Title 24 energy consultants,
- Architects,
- HVAC and plumbing contractors,
- Building plans examiners and field inspectors,
- Lenders,
- Real estate and sales agents,
- Government agencies and nongovernment organizations, and
- Consumers.

The qualitative and quantitative information obtained from the interviews and surveys enabled RER to characterize the RNC market and to identify key decision makers and decision influences with respect to the energy efficiency levels of gas equipment and shell measures installed in new homes.

In addition to the development of the RNC market characterization, the information obtained during the in-depth interviews and from consumer surveys enabled RER to assess the existence of barriers to efficiency in the RNC market and the extent to which the RNC programs reduced these barriers.

1.4 Preview of Results

This study focused only on market transformation induced by the SDG&E and SoCalGas RNC programs, not on their current year impacts on adoptions. These latter impacts have already been assessed by first-year load impact studies, and we have made no attempt to replicate or assess these studies. Our conclusions with respect to transformation are not particularly positive. Although there is some evidence of partial market transformation attributable to these RNC programs, the overall transformation effects of the programs appear to have been quite modest. It is important to recognize, however, that these RNC

programs were not designed for market transformation *per se*, and they were designed primarily to influence builders.

The study' s key findings relate to roles of and interactions among key market actors; changes in efficiency levels over time; and tests of several market effects hypotheses. The most important findings in these areas are summarized below.

Roles of Market Actors

Supply Side. The residential new construction market consists of both supply-side and demand-side actors. Supply-side actors include equipment manufacturers and distributors. Gas space and Gas space and water heating *equipment manufacturers* are sensitive to demand from market actors downstream, mainly distributors and builders. The efficiency levels of the equipment they produce are most strongly influenced by equipment efficiency standards mandated by government agencies and by competition among manufacturers. *Equipment distributors* have little influence in the market and are not a primary source of information for other market actors. The strongest link between the supply- and demand-side market actors is the information flow from manufacturers to builders, contractors, and other industry participants.

Demand Side. On the demand side, *builders* are the primary and central decision makers in all aspects of product development, including specification of energy efficiency levels of gas space heating equipment and shell measures. Builders rely on the expertise of other market actors in the decision-making process. During the specification stage of product development, *architects*, *Title 24 energy consultants*, and *HVAC contractors* participate in and influence the builder' s decisions regarding equipment and shell measure specification. Builders' *sales agents* are the only link between builders (the central decision maker) and consumers. Sales agents can be very influential in helping consumers purchase homes that exceed minimum energy efficiency standards, but not very influential in helping builders develop homes that exceed the minimum energy efficiency standards. *Lenders* currently play no meaningful role at all in influencing efficiency choices.

Consumers expect homes to be energy efficient, and tend to think that if a home meets building code requirements it is energy efficient. Consumers rarely opt to upgrade the energy efficiency levels of a new home. (It is also important to note that builders rarely offer upgrades of energy-related equipment and features.) Even though consumers indicated that energy efficiency is more important now than in the past, consumers have little influence on the energy efficiency levels of new homes, partly because most builders do not give consumers the opportunity to choose the efficiency of the equipment installed in their new home.

Measure Baselines

Measure baselines were derived for gas furnaces, gas water heaters, and ceiling and wall insulation. They showed that:

- The average gas furnace annual fuel utilization efficiency rating (AFUE) steadily increased from the late 1980s and early 1990s, with a sharp increase observed in 1993 due to the increase in the AFUE standard to 78%.
- The average gas water heater energy factors (EF) has increased from .58 in 1989 to .61 in 1997.
- Average wall and ceiling insulation R-values been virtually flat from 1989 through 1997.

While the true test of market transformation is a more or less permanent change in the efficiency levels targeted by a program, it is difficult to observe such changes directly from historical averages. As this effort is the first attempt to integrate baseline data from several sources, it is imperative that efforts continue to derive more accurate measure baselines.

Tests of Market Effects Hypotheses

As noted above, another means of assessing the market transformation effects stimulated by RNC programs is to examine induced changes in market barriers, or market effects. While these effects are only intermediate indicators of program success, they nonetheless offer useful insights into the permanence of program impacts as well as the mechanism through which permanent impacts are promoted. Our conclusions with respect to the effects of the RNC programs on these barriers are not particularly positive. Key findings are as follows:

- While manufacturers' efficiency mixes of both water heaters and furnaces have improved considerably over time, these improvements are primarily attributable to standards rather than DSM programs. Moreover, for the most part, changes in manufacturing practices are ongoing and reportedly attributable to the manufacturers' long-term outlooks and competition in the industry, rather than to DSM programs.
- These programs do seem to have increased builders' awareness of efficiency options. The programs also seem to have increased awareness levels of architects.
- Participation in the RNC programs does seem to have increased builders' reliance on recommendations of HVAC contractors. Perhaps most importantly, they also appear to have significantly influenced HVAC contractors' practices with respect to duct sealing. This probably stems from the strong emphasis on duct testing in these programs.
- RNC programs do not seem to have lead to lower effective DSM prices by lowering information and hassle costs incurred by builders, distributors and other industry participants.

- RNC programs do not seem to have stimulated changes in the promotional practices used by contractors and distributors. Participating builders are actually less likely than nonparticipants to market high efficiency homes differently than homes that just meet code.
- The evidence does not suggest that RNC programs increase customers' awareness of and knowledge about energy-efficient appliances
- While the data are somewhat mixed, we conclude in general that the RNC programs have had limited effects on consumers' perceptions of energy efficiency. Households in participating homes are only slightly more likely to think their homes are energy efficiency than households in nonparticipating homes, and their perceptions of energy savings are relatively modest. Participating and nonparticipating consumers express very similar intentions to purchase energy efficiency in their next homes.
- Again, the survey data reveal no evidence that living in a high-efficiency home causes consumers to be more likely to take energy efficiency into account in the purchase of a new home.
- The programs do not seem to have reduced the barrier of split incentives, which is arguably the most important barrier in this market. Households now living in participating homes are actually less likely to be willing to pay for increased energy efficiency in their next home, although those who are willing express greater willingness to pay. Moreover, builders (especially participating firms) are very skeptical of consumers' willingness to pay for a significant portion of the cost of efficiency.
- Participating and nonparticipating consumers express roughly equal willingness to purchase opt for high efficiency when they purchase their next home.
- RNC programs could have effects on appliance efficiency standards and building codes, but any such effect is likely to be very indirect.
- While RNC programs can encourage code compliance by offering performance-based and prescriptive-base (for shell measures) incentives, the sustainability of this effect is questionable. There is no evidence that RNC programs encourage enforcement of energy codes.

In general, this study suggests that the more distant market actors are from the targeted decision point, the less likely they are to be aware of the program and the less likely they are to be affected by it. While builders (and probably HVAC contractors) exhibited some potentially long-lasting changes in behavior as a result of participation in these programs, other actors do not seem to have been influenced in any significant way. It seems clear that programs designed specifically for market transformation should target all market participants driving demand for high efficiency features in the market. It is especially important that these programs focus on the consumer, whose behavior tends to drive the actions of all other actors. Split incentives and asymmetric information are almost certainly

the most significant (and the most difficult to mitigate) market barriers to the installation of high efficiency equipment and shell measures in residential new construction. These barriers exist primarily because builders (the primary decision maker) and consumers (the primary market driver) have different incentives in their market transactions and have different levels of and sources for information.

1.5 Report Organization

The remainder of this interim report is organized as follows:

- Section 2 describes the two Residential New Construction Programs covered by this study and characterizes the new home construction market in Southern California.
- Section 3 provides a conceptual framework for the discussion of market transformation.
- Section 4 summarizes the survey design and implementation.
- Section 5 presents an in-depth characterization of the RNC market, the roles of key market actors, and decision channels and influences.
- Section 6 presents the baselines of measures covered by RNC programs.
- Section 7 discusses the barriers that are relevant to increases in energy efficiency in the RNC market, DSM program stimuli, and RNC program market effects hypotheses.
- Finally, Section 8 provides a summary and conclusions of key study findings.
- Appendix A provides a list of general references.
- Appendix B provides a listing of trade associations and related organizations.
- Appendices C through R detail the sampling and interview protocols, and contain copies of interview guides and surveys.

2

Residential New Construction in Southern California: Programs, Market Size, and Standards

2.1 Introduction

This study's primary focus is to enhance our understanding of the market transformation effects of residential new construction (RNC) programs in the Southern California Gas Company (SoCalGas) and San Diego Gas & Electric (SDG&E) service territories.[1] This section provides some background information to be used in the evaluation of program market transformation impacts. Subsection 2.2 describes the evolution of these programs over the last several years, highlighting changes in program offerings. Subsection 2.3 presents a general description of construction activity in these service areas since the programs were conceived. Subsection 2.4 presents estimates of new residential customers for both utility service areas, and Subsection 2.5 discusses national and state appliance and building efficiency standards.

2.2 Program Descriptions

SDG&E Residential New Construction

SDG&E's Residential New Construction Program targeted new home builders. Through the use of financial incentives and an advertising campaign, builders were encouraged to install energy-efficient measures and appliances that exceeded Title 24 building standards by a minimum of 5%. These incentives targeted space heating, space cooling, and water heating. In addition, builders were encouraged to utilize advanced building technologies. Incentives were also considered for utilization of cost-effective measures outside of Title 24 standards.

The program began during the latter part of 1990. Builders were allowed to participate in two ways: on a performance basis or a prescriptive basis. The performance participation allowed incentives to be paid based on engineering estimates of energy savings for installing ceiling insulation, high efficiency water heaters, and high efficiency furnaces. The prescriptive participation allowed

[1] SDG&E serves customers in San Diego County. SoCalGas serves customers in Fresno, Imperial, Kern, Kings, Los Angeles, Orange, Riverside, Santa Barbara, San Bernadino, San Luis Obispo, Tulane, and Ventura counties.

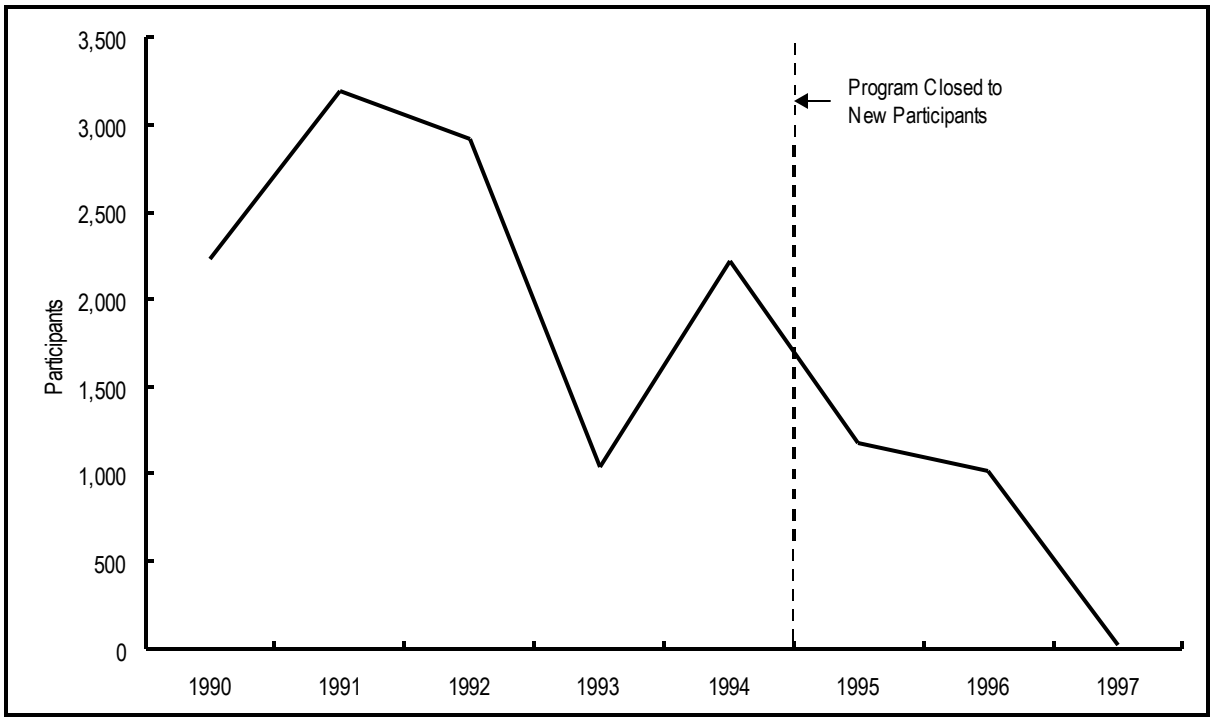
incentives for the installation of high efficiency air conditioning, double pane windows, R-19 wall insulation, and compact fluorescent light bulbs.

In 1991, an aggressive promotional campaign targeted builders through direct mail, trade and professional journals, and presentations to building trade associations. In 1993, new housing starts were particularly low due to a slow economy and building permits declined by more than 20%. In 1994, SDG&E determined that the RNC program was not cost effective and terminated the program at the end of that year. The program continued in 1995, 1996, and 1997, in maintenance mode only, to fulfill outstanding obligations with builders.

An advertising campaign was evaluated and enhanced during the term of the program. Targeting new homeowners, the campaign sought to educate consumers on the benefits of energy-efficient homes and to recognize and promote the builders participating in the program.

Figure 2-1 depicts the history of program participation levels. Note that participants in 1995 and 1996 were actually the result of commitments made under the 1994 program. This illustrates the sometimes significant lag between commitments and completions.

Figure 2-1: SDG&E RNC Program Participation



SoCalGas Residential New Construction

SoCalGas' High Efficiency New Home Program began in 1990 and continued through 1993. The program provided incentives to builders for constructing homes that exceeded Title 24 standards. Measures specifically targeted in 1992 and 1993 included the following:

- Furnaces (78% - 87.9% AFUE),
- Furnaces (88% - 100% AFUE),
- Single and multi-family water heaters (.60 + EF),
- Central water heaters (80% - 100% TE), and
- Wall insulation (R11 - R15, sq. ft.).

In 1994, a residential new construction program was marketed as the Energy Advantage Home Program. In addition to financial incentives, the program included informational and training workshops for builders. The targeted measures were as follows:

- Furnaces (88% + AFUE),
- Water heaters (.60 - .69 EF),
- Water heaters (.70 + EF),
- High efficiency combination system (.58 EF),
- Multi-family space heating (78% AFUE),
- Gas ovens,
- Duct testing,
- Duct insulation (R-4.2 to R-8),
- Heat traps for individual water heaters,
- Central water heater microprocessor-based recirculation controls,
- Manufactured housing water heaters (.60 EF),
- Manufactured housing furnaces (80 - 87% AFUE), and
- Manufactured housing furnaces (88% + AFUE).

In 1995, SoCalGas dropped the financial incentive portion of the program and continued only the information portion. The program promoted duct testing, upgrading of water heaters, upgrading of furnaces, and high efficiency combination hydronics. A major media campaign focused on the benefits of energy-efficient appliances, increased quality of homes with duct testing, and environmental benefits of energy conservation. Efforts focused on informing buyers, lenders, and real estate brokers of the California Home Energy Efficiency Rating System (CHEERS) and the availability of energy-efficient mortgages.

The program continued in 1996, but advertising was shifted away from television and toward radio and print in an effort to save money. In addition, SoCalGas expanded the amounts and variety of

informational materials. Some builders offered discounts on energy-efficient mortgages in return for being part of a builder referral service operated by SoCalGas.

Figure 2-2 shows the history of EAH household participation levels. AS shown, participation has actually grown over the past three years, after hitting a low in 1994. Figure 2-3 displays the number of furnaces and high efficiency water heaters (.60 EF and above) installed for 1992 through 1994, the last three years during which incentives were offered. Estimates of installation rates for subsequent years are not available from program records.

Figure 2-2: SoCalGas EAH Program Participation

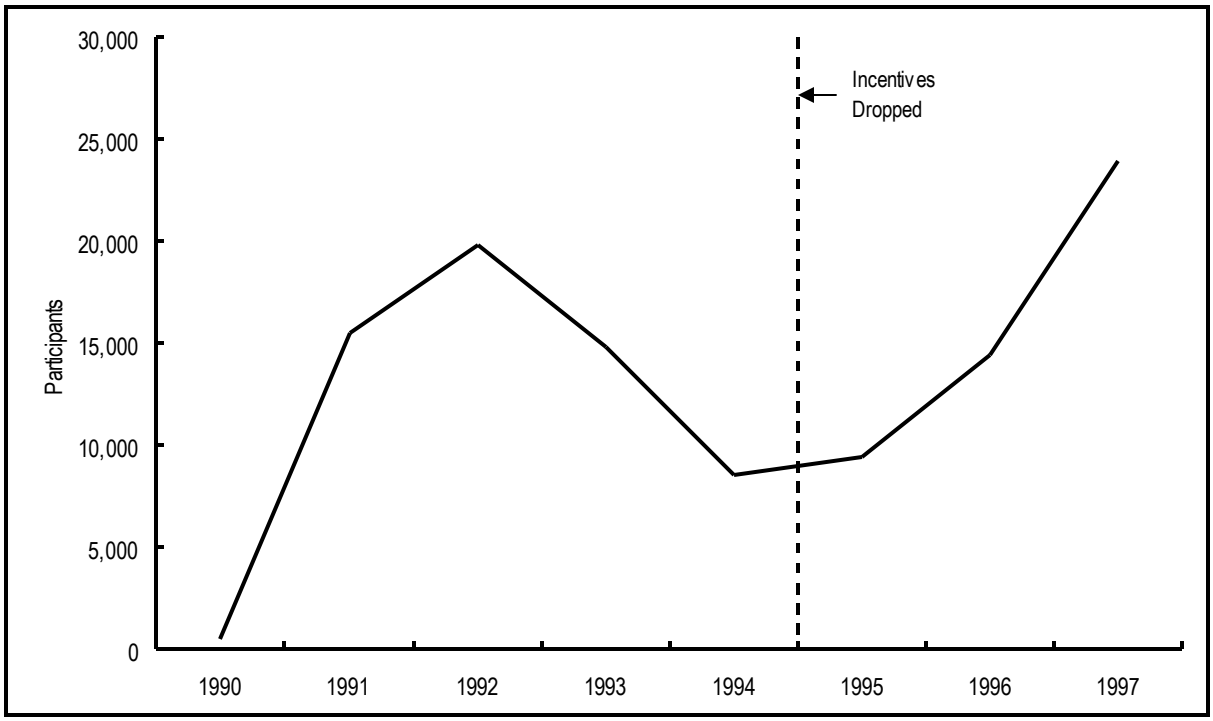
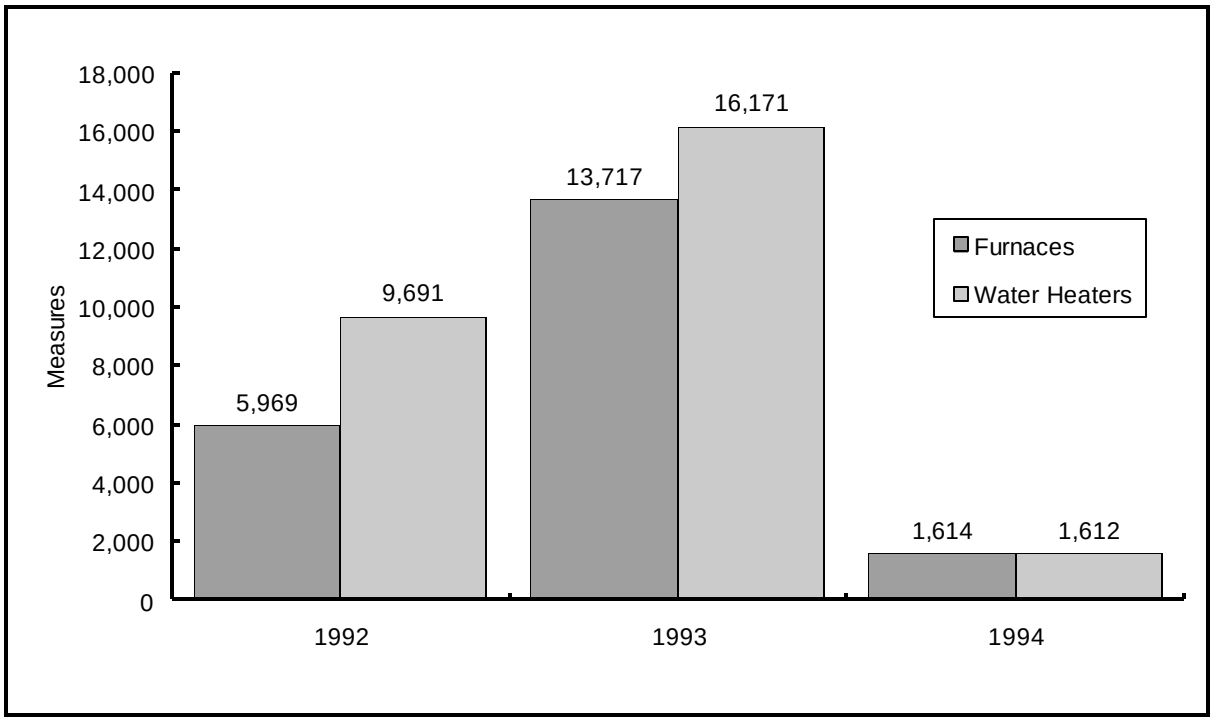


Figure 2-3: SoCalGas EAH Program Measures



2.3 Residential New Construction in Southern California

Primary Focus

In assessing the impacts of the SDG&E and SoCalGas residential new construction programs, it is useful to understand the recent history of residential construction in these service areas. These trends could affect the willingness of developers to incorporate energy efficiency into their offerings, and influence both baseline efficiency levels and the impacts of utility programs. This section reviews the volume of housing starts over the life of the RNC programs. For this study, the Southern California marketplace is defined to be the counties served by SDG&E and SoCalGas.

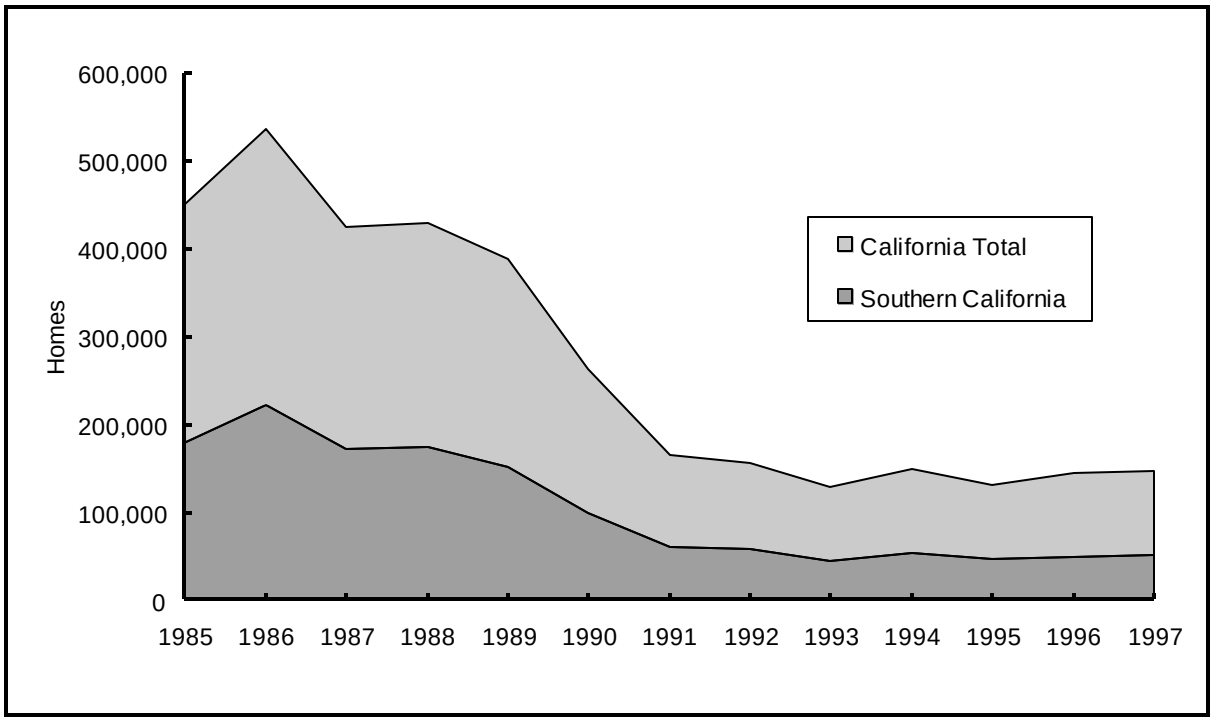
Statewide Perspective

Figure 2-4 presents the number of new housing starts for California and Southern California from 1985 to 1997.[2] As illustrated, Southern California accounts for an average of 60% of the total California new housing construction market over this period. New housing starts declined significantly from 1986 through 1991. In Southern California particularly, about 221,930 permits were issued in 1986, compared to 60,290 in 1991. This represents an average annual decline of 23,610 permits, or roughly 22.9%. This compares to a state average decline of 19.6% annually. In

[2] New housing starts are developed from data on building permits issued by the Construction Industry Research Board, Burbank, CA.

the period since 1991, new home housing starts remained relatively stable at around 94,000 for the state, and 52,000 for Southern California. Single family statewide permits declined from almost 146,570 permits to 73,810 permits, representing an annual rate of decline of 12.8%. Multi-family state-level permits fell by 28% annually since 1991. All supporting values are presented at the end of this subsection in Table 2-1.

Figure 2-4: Total New Housing Units - California Comparison



The Southern California Region

Figure 2-5 depicts total permits in the SoCalGas and SDG&E service territories and Figure 2-6 focuses on single family permits. As shown, single family Southern California housing permits declined from around 92,150 to 39,680 for the period of 1986 through 1991, an average annual rate of 15.5%. The largest decline occurred between 1989 and 1991 when Southern California single family permits dropped from 97,340 to 39,680. Single family new construction has since stabilized over the last six years at around 40,000 per year.

Figure 2-5: Southern California Total New Housing Units

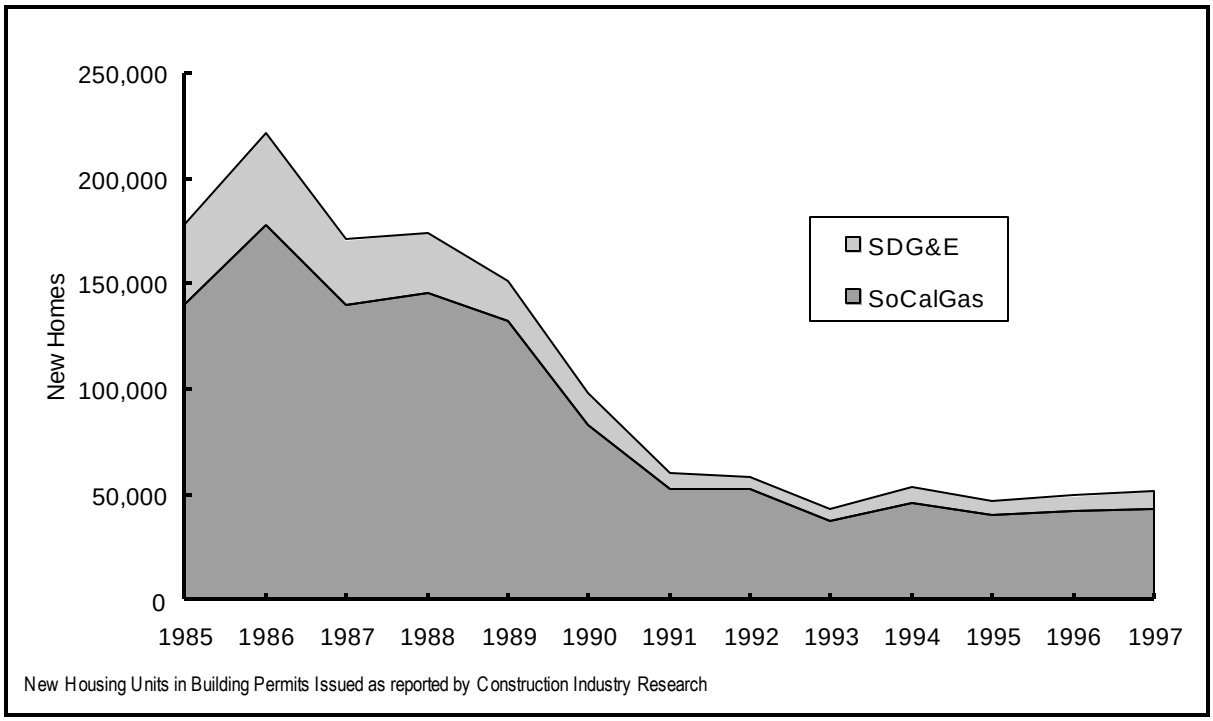
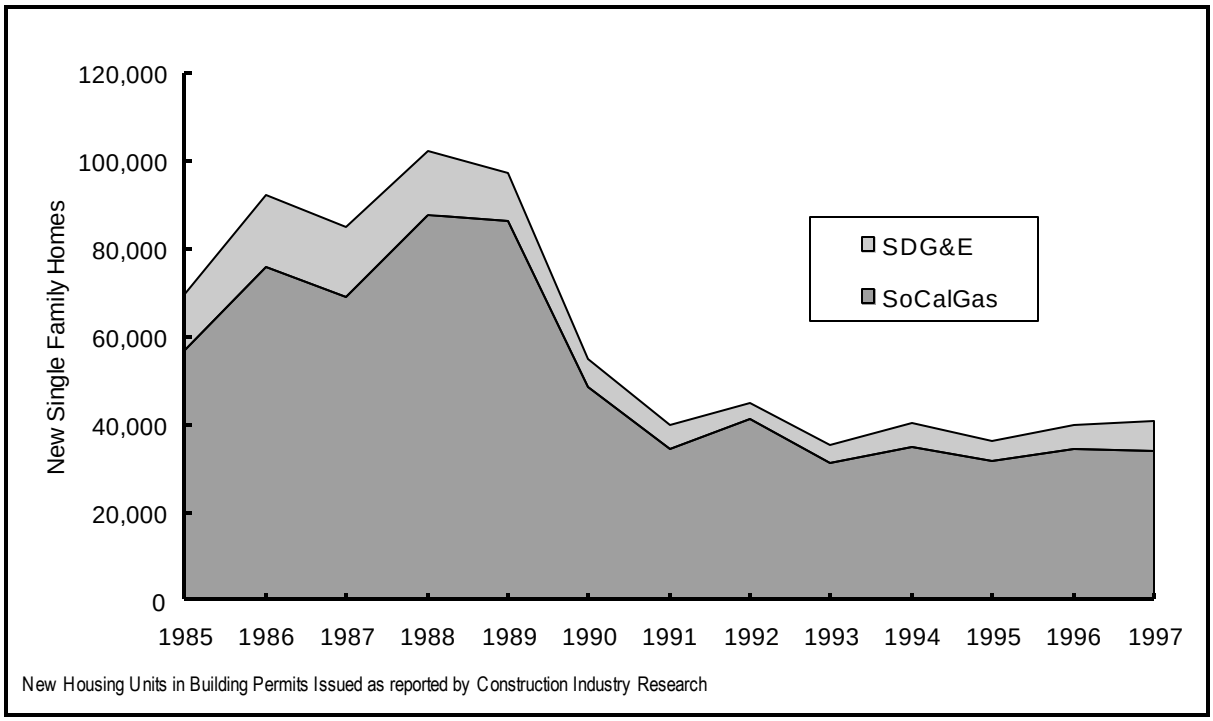
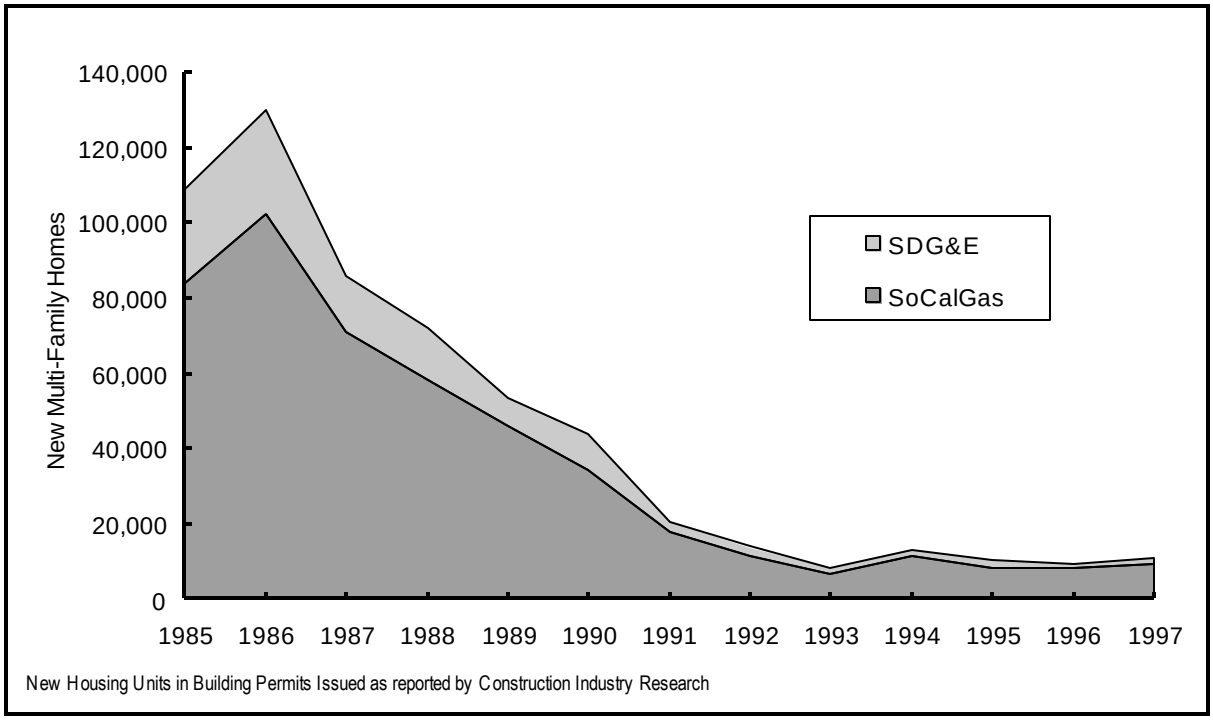


Figure 2-6: Southern California Total Single Family New Housing Units



Multi-family housing permits in Southern California for the same period have experienced a much steeper decline of 30.8% per year. As shown in Figure 2-7, permits started at 129,780 in 1986 and dipped to 20,620 by 1991. Construction of new multi-family homes has held steady at around 12,000 permits over the last six years.

Figure 2-7: Southern California Total Multi-Family New Housing Units



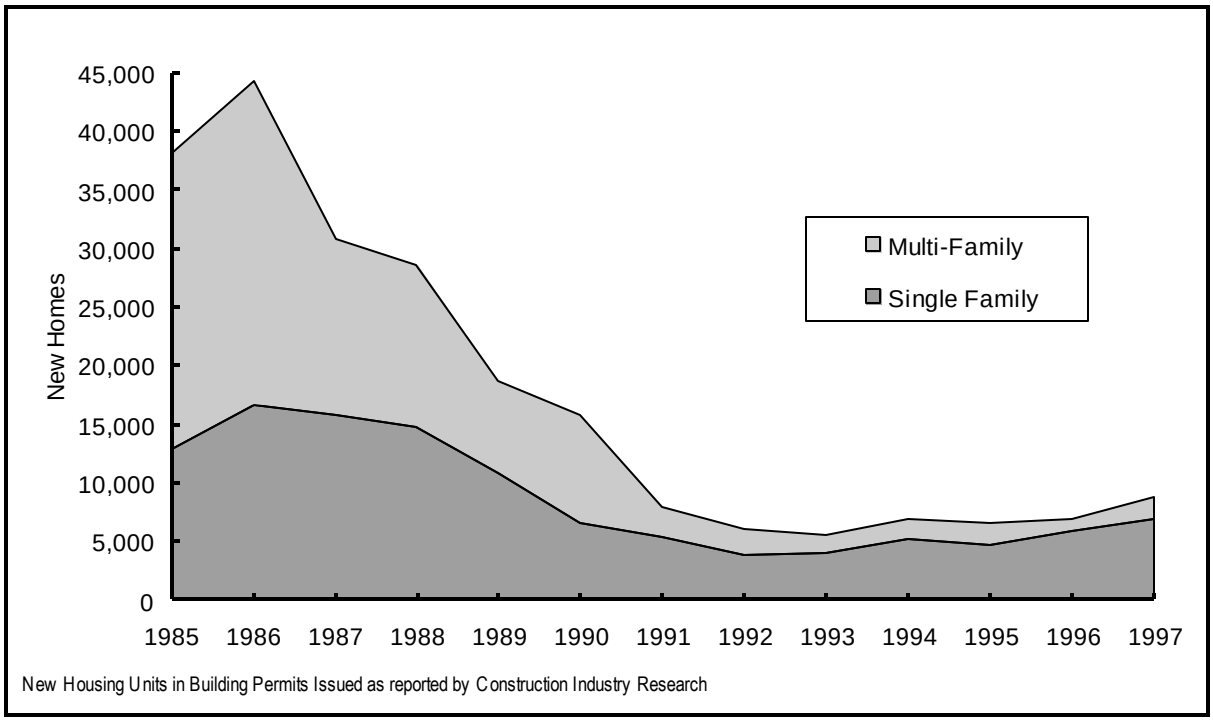
San Diego Gas & Electric

Figure 2-8 presents new housing units for the San Diego metropolitan statistical area (MSA). New construction in San Diego County declined from nearly 44,320 issued permits in 1986 to 7,910 in 1991, representing an average of almost 6,070 fewer permits or 29.2% less annually.[3,4] The rate of decline is higher than the overall rate for Southern California area and for SoCalGas during the same period (22.9% and 21.7%, respectively). This is depicted in Figure 2-5 through Figure 2-7 with a comparison between SDG&E and SoCalGas. Although the levels are significantly lower than SoCalGas (17,540 permits per year), single family housing permits have been declining at an average of 1,510 permits or 20.3% per year, and 37.9% or 4,560 permits for multi-family housing permits.

[3] The Construction Industry Research Board provided counts for new housing units reported by building permits issued.

[4] This is comparable to the statistics obtained from the San Diego Association of Governments (SANDAG).

Figure 2-8: SDG&E Total New Housing Units



Southern California Gas

The SoCalGas service area includes Los Angeles, San Bernardino, Santa Barbara, Kern, Riverside, Orange, Tulare, Kings, San Luis Obispo, Ventura, Fresno, and Imperial counties.[5]

As shown in Figure 2-5 through Figure 2-7 and Figure 2-9, the rate of decrease of new construction in the SoCalGas service area has been slightly lower than in Southern California, as a whole. In particular, the average annual decline for SoCalGas permits for 1986 through 1991 was 21.7%, compared to 22.9% in all of Southern California. These rates of decline represent the decrease of permits from nearly 177,620 permits to 52,390 permits, or an average decrease of 17,540 permits per year. The decrease of new construction permits in SoCalGas is greater when compared to SDG&E (by 6,070 permits per year), even though the annual rate of decline in SDG&E' s territory is higher at 29.2%.

Single family housing permits in SoCalGas' territory have been declining at an average of 4,450 permits (14.6%) per year and 29.3% or 13,090 for multi-family permits.

[5] The Construction Industry Research Board provided counts for new housing units reported by building permits issued for the following metropolitan statistical areas: Bakersfield, Fresno, Los Angeles-Long Beach, Orange County, Riverside, San Bernardino, San Luis Obisbo-Atascadero-Paso Robles, Santa Barbara-Santa Maria-Lompoc, Ventura, and Visalia-Tulare-Porterville. Note that Bakersfield is only partially (estimated 50%) served by SoCalGas and Long Beach is not served by SoCalGas.

Figure 2-9: SoCalGas Total New Housing Units

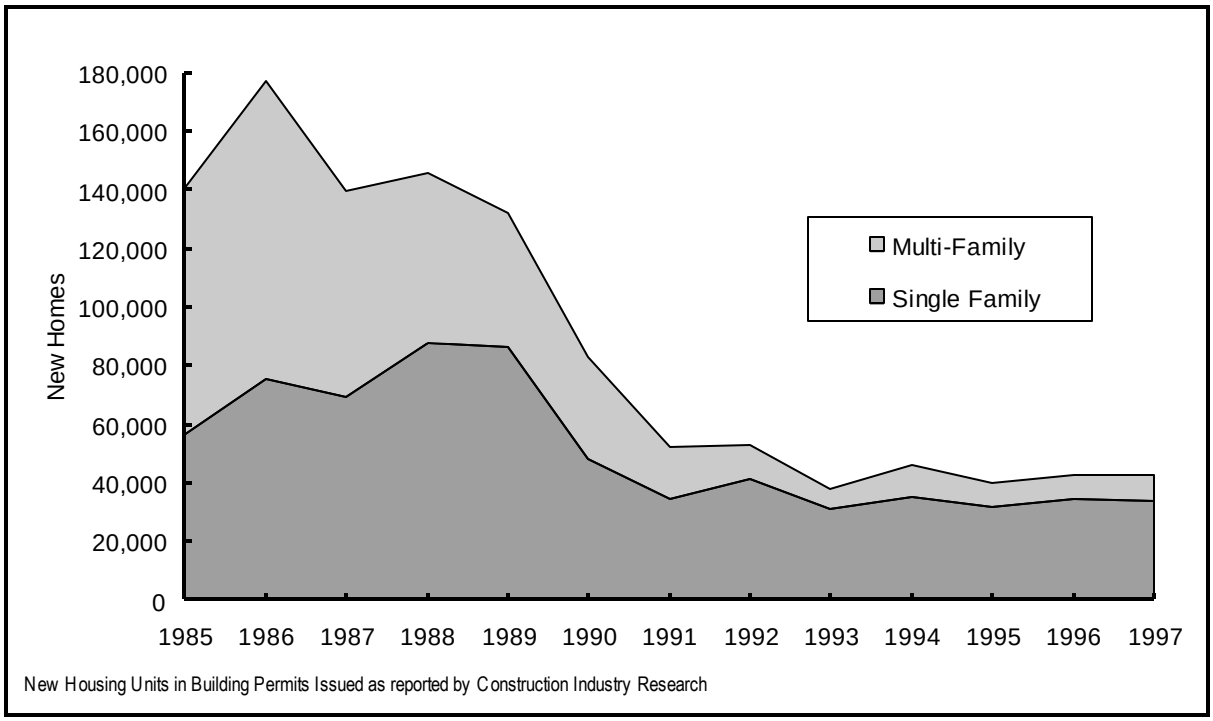


Table 2-1: Total Permits Summary

	California State		Southern California		SDG&E		SoCalGas	
Year	Single Family	Multi-Family	Single Family	Multi-Family	Single Family	Multi-Family	Single Family	Multi-Family
1985	114,202	158,115	69,473	108,860	12,890	25,349	56,583	83,511
1986	146,569	168,000	92,152	129,779	16,585	27,730	75,567	102,049
1987	136,128	117,043	84,801	86,009	15,743	15,177	69,058	70,832
1988	162,167	93,392	102,346	71,830	14,749	13,803	87,597	58,027
1989	162,651	75,096	97,338	53,565	10,856	7,854	86,482	45,711
1990	103,819	60,494	54,961	43,539	6,621	9,175	48,340	34,364
1991	73,809	32,110	39,680	20,615	5,342	2,566	34,338	18,049
1992	76,187	21,220	44,809	13,835	3,762	2,297	41,047	11,538
1993	69,901	14,755	35,279	8,324	4,076	1,526	31,203	6,798
1994	77,115	19,932	40,259	12,969	5,247	1,688	35,012	11,281
1995	68,689	16,604	36,368	10,112	4,736	1,872	31,632	8,240
1996	74,923	19,360	40,027	9,387	5,816	1,052	34,211	8,335
1997*	74,632	20,263	40,693	10,856	6,977	1,768	33,716	9,089

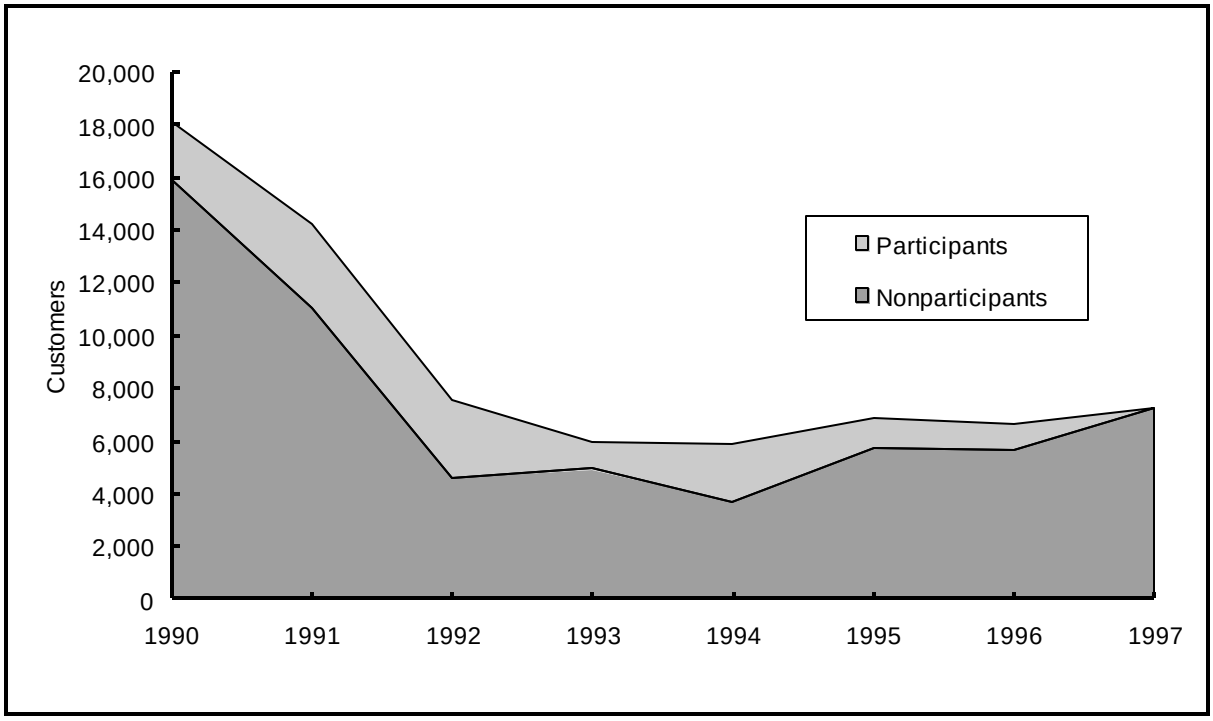
*1997 numbers are estimates based on the first eight months

2.4 Estimates of New Residential Customers

San Diego Gas & Electric

The total number of new residential customers in SDG&E' s service area were derived using new meter hook up counts and program participant counts, both provided by SDG&E. Nonparticipation counts for SDG&E were estimated using the new housing permit data in conjunction with an SDG&E study with nonparticipant numbers for 1991 and 1992. The total new residential customers were estimated using the 1991 and 1992 nonparticipant counts and new housing permit data, assuming that 80% of the permits issued are not completed until the year after. Participant counts are then subtracted from the total new customers to derive the nonparticipant counts, as shown below in Figure 2-10.

Figure 2-10: SDG&E Total New Residential Customers



Southern California Gas

The total number of new residential customers in the SoCalGas service area was derived using new meter hook up counts and the total number of program participants provided by SoCalGas. The total number of nonparticipants was calculated using the same process as those in the SDG&E service area. The new meter hook-ups were, on average, within 0.1% of the counts provided by SoCalGas. Participant numbers are subtracted from the new meter hook-up counts to derive the nonparticipant counts, as illustrated in Figure 2-11.

Figure 2-11: SoCalGas Total New Residential Customers

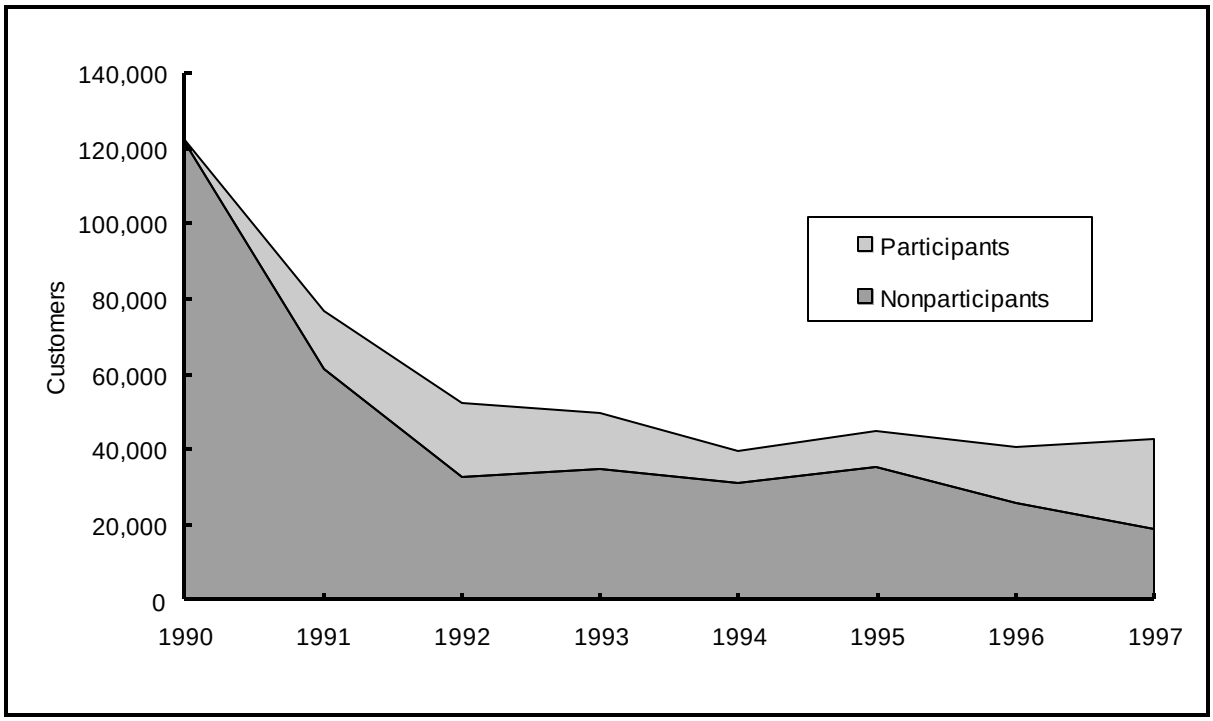
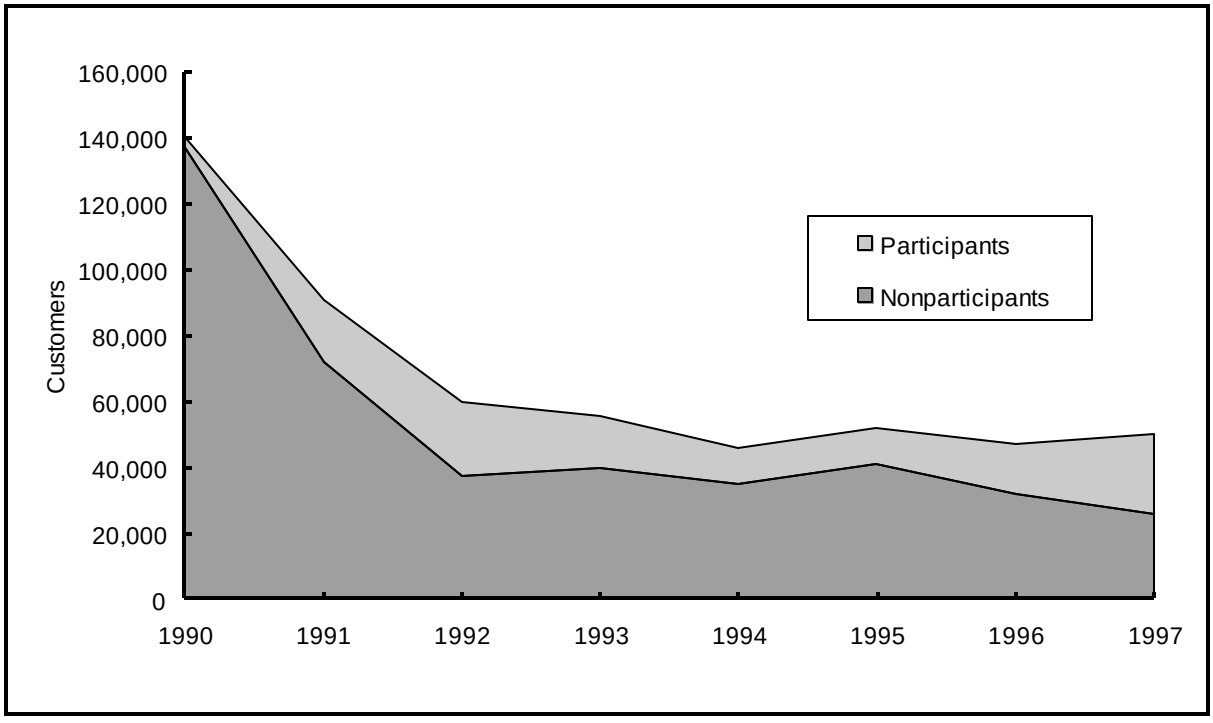


Figure 2-12 combines the two service territories, revealing that there were almost 138,000 total new residential customers in 1990 and nearly 26,000 in 1997.

Figure 2-12: Total New Residential Customers in Southern California



2.5 Appliance and Building Efficiency Standards

This section reviews efficiency standards of both appliances and buildings. Included in the discussion are the differences between national and state standards.

Background

The Energy Policy and Conservation Act of 1975 (EPCA) established an energy conservation program that related to major household appliances and required the U.S. Department of Energy (DOE) to set testing procedures and standards for major appliances. The National Appliance Energy Conservation Act of 1987, an amendment to the EPCA, set national efficiency standards for appliances and established a schedule for regular updates. The Energy Policy Act of 1992 (the Act) expanded the coverage of the EPCA to include HVAC equipment, water heaters, and other devices. The Act also provided for voluntary testing and consumer information programs for certain electrical devices, windows, and some plumbing equipment.

National Appliance Efficiency Standards

In 1987, Congress passed the National Appliance Energy Conservation Act (NAECA). The act sets federal efficiency standards for thirteen classes of consumer products including gas water heaters and furnaces. These standards are aimed at manufacturers. NAECA sets forth an administrative rulemaking schedule for each product category. Under the act, at least two administrative reviews are scheduled through 2007. Standards are only revised or tightened if analysis indicates that changes are economically justified and are technically feasible. Table 2-2 illustrates the energy conservation standards timeline from 1988 to 1997 for gas water heaters and furnaces.

Table 2-2: Energy Conservation Standards Timeline

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Gas Water Heaters	☆											✪					
Furnaces			☆														✪

☆ Standard' s effective dates
✪ Scheduled for review

The Code of Federal Regulations (CFR) Title 10, Part 430, documents the Department of Energy' s (DOE) official laboratory test procedures for measures of energy consumption. Gas water heaters are covered under Appendix E and furnaces are under Appendix N.

Gas Water Heaters. The standards on residential water heaters became effective on January 1, 1990. NAECA mandated that for gas water heaters manufactured on or after the effective date, the energy factor (EF) shall satisfy the requirement:

$$EF \geq 0.62 - (0.0019 \times \text{the rated storage volume in gallons})$$

For example, a 40 gallon water heater would have a .54 EF (0.62 - (0.0019 × 40)). An EF is a unitless number and is the ratio of delivered heat from the tank (in Btu) to the heat content of fuel input (in Btu). The standards were also reviewed in 1991 but the review did not lead to efficiency level revisions. Modest improvements in gas standards to .60 EF are scheduled for the year 2001.

Gas Furnaces. The NAECA requires residential gas furnaces manufactured after January 1, 1992 to have an annual fuel utilization efficiency (AFUE) rating of at least 78%.

An AFUE is the energy efficiency rating based on DOE testing procedures that simulate a system's typical use. An AFUE is the ratio of annual heat output to the annual gas input (in Btu). DOE conducted the initial analysis in 1993 for updating furnaces, but due to a shortage of funding this analysis has been put on hold. The improvement would most likely be for an 80% AFUE rating for the year 2006.

National Building Standards

The regulation of building construction in the U.S. is accomplished through building codes. Codes are adopted by a state or local government's legislative body, then enacted to regulate building construction within a particular jurisdiction. A building code is a collection of laws, regulations, ordinances, or other statutory requirements adopted by a government legislative authority involved with the physical structure and healthful conditions for occupants of buildings. A building code regulates new or proposed construction. There are three organizations of code enforcement officials: the Building Officials and Code Administrators (BOCA) International, the Conference of Building Officials (ICBO), and the Southern Building Code Congress International (SBCCI).

The Council of American Building Officials (CABO) was created in 1972 as a forum to coordinate the efforts of the three model code organizations at the national level. CABO is composed of members of the Board of Directors of each model code organization and is supported by their technical and educational staffs.

CABO created the Model Energy Code (MEC) in 1978. The MEC is a document maintained by a Code Development Committee consisting of representatives from BOCA, ICBO, and SBCCI. The committee is responsible for incorporating appropriate emerging thermal performance issues reflecting state-of-the-art information in building energy performance. The latest revision was adopted in 1995. It is often used as the standard in state-level building codes.

The North American Insulation Manufacturers Association (NAIMA) produces the *MEC Thermal Envelope Compliance Guide* for determining MEC compliance. The guide presents applications and trade-off worksheets and R-values of numerous component constructions to enable users to determine MEC compliance of thermal envelope for one- and two-family dwellings. Compliance is defined as either a prescriptive or a performance requirement and categorized in three basic methods.

1. Component Performance Method.
2. Systems Analysis Method.
3. Acceptable Practice Method.

Component Performance Method (Prescriptive). This approach is relatively simple and well defined. This compliance path establishes a limitation on the overall U-value for each building attribute. No trade-offs are allowed but this method allows builders to use a variety of materials and designs.

Systems Analysis Method (Performance). The system analysis compliance method establishes an overall energy consumption level. It considers building envelope and equipment efficiency. Therefore, there can be a trade-off between insulation and HVAC systems.

Acceptable Practice Method (Prescriptive). This is an alternative simplified compliance path to the Component Performance Method. The Acceptable Practice Method uses pre-calculated thermal properties of construction assemblies for buildings less than 5,000 square feet in gross floor area and three stories or less in height.

California Efficiency Standards

California has been one of the leaders in promoting energy efficiency, as the state' s standards are generally more stringent than defined nationally. California has maintained higher standards for some electric appliances but has adopted most of the national appliance standards as its own – the gas water heating and furnace standards, in particular.

California building standards are more stringent than defined in the MEC. All new buildings in California must meet the energy efficiency standards contained in Title 24, Part 6, of the California Code of Regulations. First established in 1977, Title 24 standards are updated every three years to allow new energy efficiency technologies to be considered.

Title 24 compliance is based on the date a building permit application is filed. The responsibility for compliance rests with the architect and the builder. The architect must specify U-values and shading coefficients on the architectural blueprints. The architect usually relies on an engineer or energy consultant to provide compliance calculations and documentation. It is important to note that Title 24 requirements vary by the sixteen defined climate zones in California.

In general, as with MEC, compliance is defined as either a prescriptive or a performance requirement and categorized in three basic methods.

1. Prescriptive Packages Method.
2. Points Method.
3. Computer Performance Method.

Prescriptive Packages Method. This approach is similar to the MEC component performance method by being relatively simple and well defined. This compliance path establishes a limitation on the overall U-value for each building attribute with no trade-offs allowed.

Points Method (Performance). Similar to the MEC systems analysis method, this method allows trade-offs by awarding points for energy conserving measures and subtracting points for values below the prescriptive levels.

Computer Performance Method. Also similar to the MEC systems analysis method and the most flexible compliance method, this method entails calculation of an annual estimate of the building' s energy performance. This method most accurately reflects the benefits of different conservation measures. The CEC maintains a list of energy analysis computer programs that are in accordance with California Code of Regulations. These programs include the following:

- Calres2,
- Comply 24,
- Energy Pro,
- Micropas 4,
- NRG-24, and
- REA.

3

Conceptual Framework

3.1 Introduction

This section discusses the concept of market transformation and the issues relating to its analysis. Subsection 3.2 offers a general conceptual framework of hypotheses and information about transformation. Subsection 3.3 poses five questions to be answered by the study. Subsection 3.4 discusses the dynamics of market transformation. Finally, subsection 3.5 offers implications for the analysis of residential new construction program market effects.

3.2 General Conceptual Framework

The field of welfare economics is built on the concept that private markets, acting on their own, might not behave optimally from a societal perspective. In general, the performance of markets can be assessed in terms of efficiency and equity.[1] In this context, private markets are efficient if they yield welfare-maximizing amounts of goods and services (exchange efficiency) as well as the least-cost means of producing these goods and services (technical efficiency). Equity is a somewhat more elusive concept, but market results are considered equitable if the distribution of goods and services across individuals is such that it yields maximum aggregate social welfare. In what follows, we focus on the efficiency of the market for demand-side management (DSM) technologies.

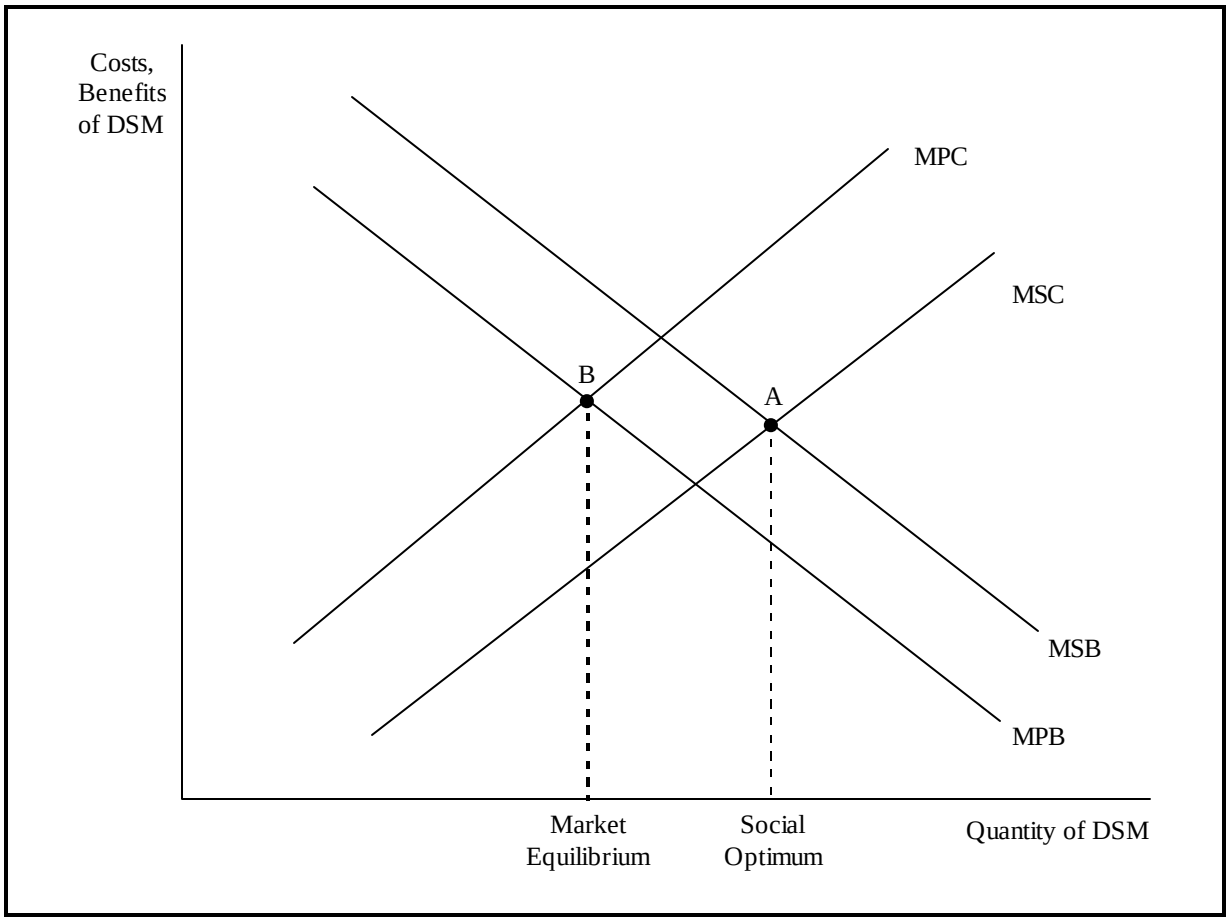
Figure 3-1 depicts a potential market failure in the market for DSM goods and services. Four schedules are presented:

- A marginal social benefit (MSB) schedule, reflecting the incremental benefit received by society as a whole from an additional "unit" of DSM. These benefits would encompass avoided energy costs, inclusive of externalities.
- A marginal social cost (MSC) schedule, indicating the incremental cost of producing another unit of DSM, including incremental measure costs as well as any administrative program costs.

[1] For a discussion on market efficiency, see Debreu, Gerard. *The Theory of Value*. Wiley, New York, 1959.

- A marginal private benefits (MPB) schedule, reflecting consumers' perceptions of their own benefits from an additional unit of DSM. This MPB relationship can be considered a market demand schedule.
- A marginal private cost (MPC) schedule, reflecting the incremental private costs of delivering an additional unit of DSM. Under certain assumptions about competitiveness in the market, this MPC schedule will play the role of a supply curve.

Figure 3-1: Overview of Market Failure



From the perspective of efficiency, the optimum level of DSM is determined at the point where the marginal social benefit and marginal social cost of DSM are equal (point A). Private markets, however, are driven by the private costs and benefits accruing to sellers and buyers. As a result, they will tend to operate at a private equilibrium where marginal private costs and benefits are equalized, or where the supply and demand schedules intersect (point B). If there are market barriers, or differences between social and private costs and benefits, then the market will tend to deviate from its socially optimum level of production. This situation is often referred to as a *market*

failure.[2] The existence of market failures is generally used as a rationale or justification for market intervention.

Utility DSM programs can be considered an example of such intervention in the marketplace. The purpose of these programs is to push the market toward its social optimum by shifting either the demand or supply schedule in a way that moves the market equilibrium toward the social optimum level of DSM. Customer rebates shift the demand schedule, for instance, while manufacturer incentives affect the supply schedule.

A variety of program features could influence the supply of DSM or the demand for DSM in the short and long runs. This project focuses on the means of transforming the market for DSM in a permanent way. Thus, one needs to examine the extent to which programs can cause permanent shifts in demand and supply for efficiency by reducing market barriers in a lasting way. The following section discusses specific market barriers, program features designed to mitigate these barriers, and the potential market effects of these program elements.

3.3 Key Questions

This study focused on five key questions:

- ***What changes in the market shares of the covered technologies have taken place over recent years?*** Answering this question required the development of market data on technology shares currently and in the past.
- ***To what extent have utility programs influenced these changes in market shares?*** This inquiry addresses the issue of attribution and required the utilization of past evaluation studies, as well as surveys and interviews with market actors.
- ***What market barriers were diminished by the programs in question?*** As discussed below, these barriers are highly interactive and sometimes overlapping. Unraveling the impacts of programs into effects on specific barriers is not always straightforward. In general, this process entailed the characterization of changes in these barriers over time and the use of survey approaches to attribute these changes to the particular programs.
- ***Which program features contributed to the mitigation of market barriers?*** This is a critical question with serious implications for the design of programs in a deregulated environment.
- ***To what extent are these impacts of program stimuli long lasting?*** Again, this is an extremely important question in the context of the objectives of this study. Arguably, it was the most difficult to answer.

[2] See, for example, Musgrave, R. *The Theory of Public Finance*. McGraw Hill, New York, 1959.

The extent to which program stimuli are long lasting is particularly important. Subsection 3.4 elaborates on this issue.

3.4 The Dynamics of Market Transformation

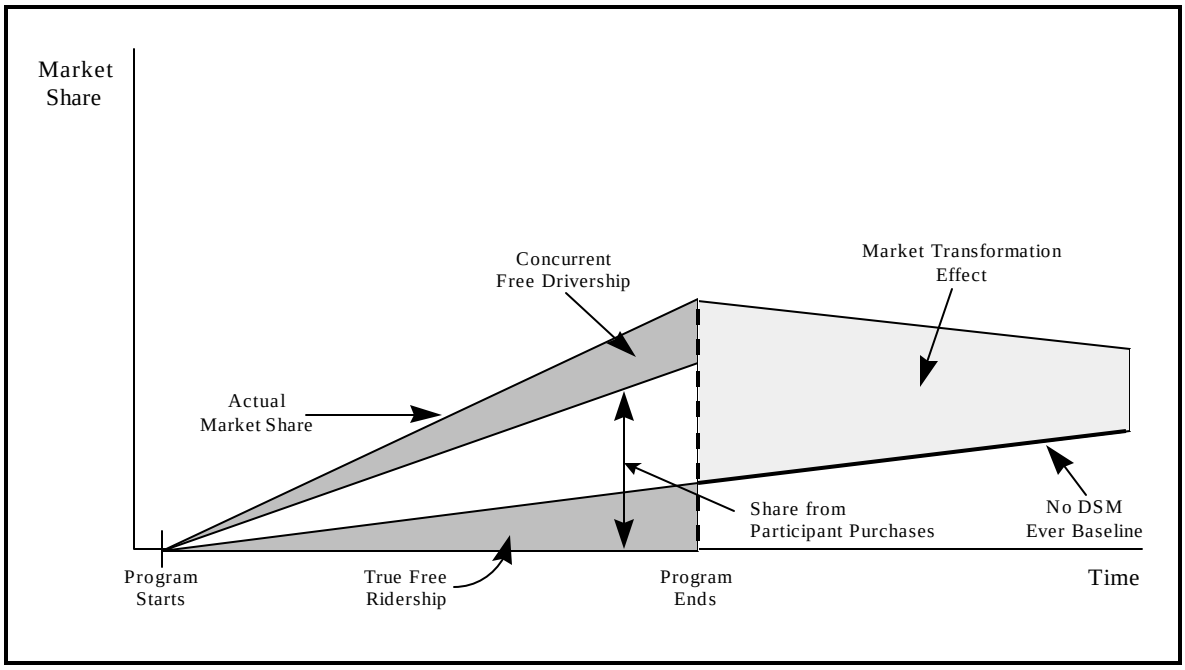
It must be emphasized that the assessment of market transformation required full recognition of market dynamics. Figure 3-2 presents an overview of the evolution of a market for a new DSM technology (McMenamin, et al, 1994). The high efficiency technology' s share of the market is shown vertically, while time is indicated on the horizontal axis. It is assumed that the market share of the technology (in terms of new purchases, not stocks) is zero before the beginning of the program, but that its natural share (the "no DSM ever" baseline) rises over time.

The presence of DSM programs causes an increase in the overall market share through the expiration of these programs. This share consists of participant purchases (some of which reflect true free ridership, defined as the market share that would have prevailed in the absence of all programs up to this point) and induced purchases by nonparticipants (free drivers).

If no market transformation has occurred over the program period, the termination of these programs will cause the market share of new purchases to return to the dynamic no-DSM-ever baseline. The difference between actual market share and this dynamic baseline can be considered market transformation. To fully assess market transformation, then, one needs to be able to estimate the behavior of the market when programs are discontinued or changed substantially. One means of making this assessment under the current project will be to examine the change in behavior that took place when SDG&E terminated its RNC program in December 1994. However, this study will also attempt to assess the permanence of market impacts on the basis of other studies and interview responses.

The practical importance of the market transformation portion of this study is that it could aid in the understanding of the dynamic transformation process for several major DSM technologies, including gas water heaters, gas furnaces, ceiling and wall insulation, window treatments, and duct sealing. The analysis will require an understanding of these markets and the specific impacts conveyed by DSM programs. Specific market actors, market barriers, program stimuli, and market effects are discussed in subsequent sections of this report.

Figure 3-2: The Dynamics of Market Transformation



3.5 Implications for the Study

Answering the questions posed in subsection 3.3 was not an easy process. Indeed, assessing the market effects of residential new construction programs proved to be considerably more difficult than the traditional process and impact evaluations that have dominated the analytical scene for the past several years (Alexander and Marge, 1996; Suozzo and Nadel, 1992). The assessment of market transformation effects required an intimate understanding of the channels through which decisions are made and the specific roles of key market actors. Section 5 includes a detailed discussion of key market actors and their functions in the residential new construction market. It was also necessary to rely extensively on surveys and interviews with actors to address issues that cannot be addressed particularly well with statistical analysis of quantitative market phenomena. Section 4 includes a summary of the survey and interview development processes.

At the same time, it was paramount to assemble as much hard evidence as possible to support the survey-based analysis. It is critical, for instance, that a method is found for tracking market trends in efficiency and at least generally developing baselines against which these trends can be cast. Section 6 presents the development of historical equipment and measure efficiencies.

4

Designation of Comparison Area and Survey Design and Implementation

4.1 Introduction

The majority of information required for the assessment of market effects was obtained through in-depth interviews with market actors in the three areas covered by this study: the San Diego Gas & Electric Company service area, the SoCalGas service area, and a comparison area. The collection effort entailed two methods of data collection: in-depth telephone interviews and structured telephone and mail surveys.

Subsection 4.2 summarizes the designation of a comparison area to assess differences in changes in residential new construction between areas with and without gas efficiency DSM programs. The remaining subsections summarize the sample design, describe the development of the questionnaires, and present the target and completed sample sizes for interviews with each market actor targeted in this study. Appendices C through S include sampling and interview details and the questionnaires used during interviews with each market actor.

4.2 Designation of Comparison Area

One element of this study necessitated the use of a comparison area. Ideally, the comparison area should not have any DSM programs that specifically target gas equipment. The goal was to collect information from market actors in the control area that is comparable to Southern California in respects other than the existence of DSM programs. Information from respondents in a control area helped to assess differences in *changes* in the residential new construction market between areas with gas efficiency programs and those without such programs. In particular, the goal was to examine changes in saturations, awareness, and the availability of high efficiency measures, as well as the market actors' attitudes toward energy efficiency levels in new homes.

Several regions in the Southwestern United States were considered during the process of designating a comparison area for this study. RER reviewed the following characteristics of each area for compatibility with the SDG&E and SoCalGas service areas:

- New home starts,
- Weather conditions,
- DSM programs and
- Residential building energy standards.

During this review process, Arizona and the Austin/San Antonio corridor in Texas were identified as the most likely candidates for the control area. Southern Union and City Public Service, the municipal gas and electric companies in San Antonio, serve gas customers in the Austin/San Antonio region. Arizona is served predominantly by the Southwest Gas Company. A comparison of Arizona and the Austin/San Antonio region in Texas according to the above characteristics revealed the following:

- New home starts in the Austin/San Antonio region are closer to those in Southern California, and both regions have experienced rapid growth in the past two years. The new home starts in Arizona have been stable since 1994.
- Both regions are similar to Southern California in terms of heating degree days. Neither Arizona nor Texas has adopted residential building energy codes, although the Cities of Austin and Tucson have adopted the Model Energy Code. The Home Energy Rating System (HERS) for residential structures is widespread throughout the state of Arizona. There is no planned initiative for state adoption of residential or commercial codes in either region.
- Neither utility company in the Austin/San Antonio region has offered any DSM programs that specifically target gas appliances and equipment. Southwest Gas Corporation in Arizona offers an Energy Advantage Home Program. This informational program presently targets the Phoenix area and allows builders to advertise their new homes as energy-efficient homes. Southwest also offers an Advantage Mortgage for qualifying energy-efficient homes. Arizona Public Service, the largest electric utility in Arizona, offers the Good Cents Program throughout its service territory.

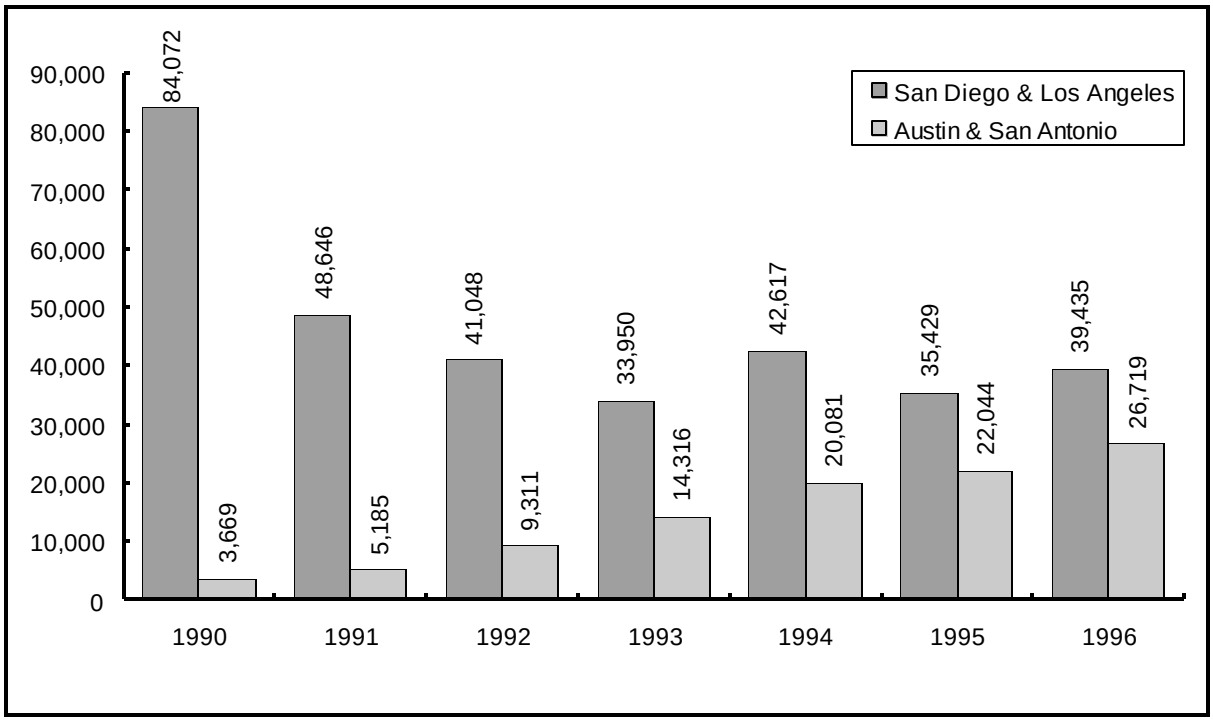
Given its housing starts, weather conditions, DSM program activity, and residential building energy codes, the Austin/San Antonio area was chosen as the comparison area for this study. This decision was primarily based upon the fact that there is very little DSM activity pertaining to gas equipment in new homes in this area.

A more detailed comparison of the new home starts, weather conditions, residential energy codes, and DSM activity between Southern California and in the Austin/San Antonio region in Texas is presented below.

New Home Starts

Figure 4-1 compares the historical trends of new housing starts in the study area with those of the control area. Historically, the Austin/San Antonio area has been somewhat smaller than that in Southern California. However, new housing starting in both regions have been converging, as new housing starts in San Diego and Los Angeles have been declining since 1990, while those in Austin and San Antonio have been rapidly increasing.

Figure 4-1: New Housing Units Authorized[1]



Weather

Table 4-1 presents a summary of heating and cooling degree days for the study area and the control area. The reported heating degree days are similar between the two areas; however, the cooling degree days differ substantially. The CDD incompatibility was not viewed as a problem, as the focus of this study was gas space heating and included no space cooling measures. As we will discuss in Section 7, however, the difference in cooling requirements may have affected the comparability of the comparison area with Southern California.

[1] U.S. Census New Housing Starts. See http://www.census.gov/const/C40/Table2/tb2u9699.txt.

Table 4-1: Summary of Heating and Cooling Degree Days[2]

State/City	HDD	CDD
California		
San Diego	1,284	842
Los Angeles	1,595	728
Texas		
Austin	1,760	2,914
San Antonio	1,606	2,983

DSM Activity

As mentioned above, the comparison region should *not* have any DSM programs that pertain to residential new construction. DSM program activity in Southern California is well documented in Section 2. Neither San Antonio Gas and Electric nor Southern Union Gas has offered any DSM programs pertaining to gas equipment. The Planning Environment & Conservation Services Department of the City of Austin, however, offers a variety of energy conservation programs. Regardless, these programs primarily target electric end uses (air conditioning and electric heating) and/or offer weatherization of elderly and low-income customers' homes. Some low-interest loan programs assist equipment replacement financing, but again, these programs target electric and not gas equipment. The only gas conservation programs in the Austin/San Antonio region are retrofit programs targeting elderly and low-income customers.

Residential Building Energy Codes

While the national appliance and building energy efficiency standards were reviewed in Section 2, this subsection provides a more detailed description and a comparison of the codes in Southern California and the comparison region.

California Energy Efficiency Standards

As explained in Section 2, California adopted its own state energy efficiency standards in Title 24, part 6 of the California Code of Regulations in 1977.[3] Title 24 standards, which vary by the sixteen defined climate zones in California, are updated every three years to allow for consideration of new

[2] HDD and CDD data are long-term normal weather from the National Oceanic Atmospheric Association (NOAA). *Annual Degree Days to Selected Bases*. Asheville, NC.

[3] California Energy Commission, *Energy Efficiency Standards for Residential and Nonresidential Buildings*, P400-95001, July 1995.

energy efficiency technologies. All new buildings in California must comply with the Title 24 energy efficiency standards.

Title 24 standards for some electric appliances are higher than the MEC, but has adopted most of the national appliance standards as its own – the gas water heating and furnace standards, in particular.

Title 24 compliance is based on the date a building permit application is filed. The responsibility for compliance rests with the architect and the builder. The architect must specify U-values and shading coefficients on the architectural blueprints. The architect usually relies on an engineer or energy consultant to provide compliance calculations and documentation.

Control Region Energy Efficiency Standards

State Energy Codes. The State of Texas has not adopted a mandatory statewide energy code for residential buildings, although the state is investigating a program to increase voluntary adoption of the Model Energy Code (MEC) by local jurisdictions. Local jurisdictions can establish energy codes as part of their locally adopted building codes. State-owned or –funded residential buildings must comply with the 1993 MEC.

The Texas Energy Conservation Office is currently working with the University of Texas to develop a Texas Residential Energy Conservation Design Standard. A primary objective of the Energy Conservation Office is to develop a building energy code that is more applicable to a cooling-dominated climate and that specifically addresses the effects of solar gain.

City Energy Codes. The residential building energy codes for thermal shell measures in the cities of San Antonio and Austin are summarized below.

The City of San Antonio has not formerly adopted any residential building energy codes. Thus, all residential buildings must only comply with the national building codes, such as the Universal Building Code (UBC). Low-rise state-owned or funded buildings must comply with the 1993 Model Energy Code. Residential building code training is presently offered to designers and code officials.

The City of Austin has adopted and amended the 1993 Model Energy Code as its building energy code, which is applicable to all residential buildings within the Austin City limits. At the time of this writing, no other cities in Texas have done so. Because Austin officials view the MEC thermal shell requirements as being more applicable to a heating-dominated climate, the City of Austin has amended its locally mandated MEC to further increase thermal shell efficiency standards and to tailor the code to be more applicable to a cooling-dominated climate. A city official interviewed for this study explained that Austin' s amendments to the MEC have resulted in at least a 50% reduction in energy use/energy losses above and beyond what would be achievable under MEC standards.

Comparison of Energy Efficiency Standards

A comparison of California' s Title 24 thermal shell standards with Austin' s energy code is summarized here. Two characteristics of the national and state energy codes are worth noting. First, the efficiency levels of space conditioning equipment are federally mandated and any state adopted energy codes cannot exceed these mandates. Thus, efficiency requirements pertaining to HVAC equipment are the same nationwide and the primary differences between codes in the two study areas pertain to thermal shell requirements. Second, both the MEC and Title 24 energy efficiency standards offer both prescriptive and performance methods of compliance. This, and the fact that Title 24 requirements vary by 16 climate zones, makes it difficult to provide a point-by-point comparison.

The shading coefficient, duct sealing, and insulation requirements specified in California' s Title 24 standards and the Model Energy Code are summarized below.

- ***Shading Coefficient.*** The City of Austin requires a 0.5 shading coefficient on all East, West, and South facing glazing areas. The individual who is responsible for the City' s building energy code explained that this amendment has resulted in substantial energy savings.[4]

  This requirement is similar to the shading coefficient specified in California' s Title 24, which specifies a minimum shading coefficient of 0.15, 0.40, or 0.66 on all South and non-South facing glazing areas, depending upon the climate zone and the package used to compute whole-house performance.

- ***Duct Sealing.*** Austin' s building energy code requires that all ducts be double sealed – an air leak seal and a mechanical seal – with UL181 rated products. This is the first standard requiring a high quality adhesion sealing material to prevent the use of materials that disintegrate, tear, or loosen after one or two years.

  California' s Title 24 does not include any duct sealing requirements at this time.

- ***Insulation.*** The City of Austin mandates a minimum of R11 insulation for walls and R19 insulation for ceilings.

  California' s Title 24 requires a minimum of R13, R19, R21, R25, or R29 wall insulation and R30, R38, or R39 ceiling insulation in most climate zones depending upon the climate zone and the package used to compute whole-house performance.

Given the above, it is evident that the residential building energy codes in California and the City of Austin' s codes are comparable, though there are some differences. California' s Title 24 is more

[4] For example, the individual explained that this requirement reduces the cooling load of a 2,200 square foot home by 1 or 2 tons.

stringent with respect to insulation (depending upon climate zone), while Austin' s building energy code is generally more stringent with respect to the shading coefficient requirement (at least, relative to most areas in Southern California). The most significant difference between the two is Austin' s adoption of duct sealing requirements, to which a significant amount of energy saving is attributed.

The in-depth interviews with builders in the Austin area revealed that many builders exceed the energy codes pertaining to insulation, windows, and air conditioning units. Results of the in-depth interviews with builders in the Austin area that pertain to exceeding the code include:

- Nearly all builders in the Austin area install R30 insulation instead of R19 insulation in the ceiling (some even install R36 or R38),
- Nearly all builders install R13, R15, or R16 insulation in the walls instead of the required R11,
- Many builders specify 12 SEER air conditioning units.

The in-depth interviews revealed characteristics of the comparison region and the City of Austin, in particular (aside from the building energy codes discussed above), that are worth noting here. In general, the City of Austin is more progressive than the rest of the state with respect to energy efficiency requirements and energy conservation, in general. For instance, the City of Austin is very aggressive and proactive in training builders, HVAC contractors, inspectors, architects, and industry participants and informing them about building and energy codes - mostly through the Texas Area Capital Builders Association. The City has monthly meetings or training sessions attended by 60 to 100 industry participants each month. Each session includes training on code compliance issues and provides information about new technologies, installation and sealing methods, and other trade information relevant to the construction industry. Essentially, these sessions provide a forum for open communication and problem solving for builders, inspectors, and involved parties.

A benefit of these monthly sessions has been that all attendees - including builders, code officials, inspectors and plans examiners, and contractors –hear the *same information*. The information does not need to pass through different channels to get to different individuals. This has been an important factor, and has helped builders accept and, more importantly, comply with codes. These monthly sessions also emphasize to the builders that the codes are evenly enforced and that different builders are not treated differently by building department officials. The codes have created a level playing field for the builders, *"as long as they know that everyone must comply, they don't have a problem with it."*

The characteristics of the control region with respect to building energy codes, and the fact that many builders exceed insulation standards in the City of Austin, are quite relevant in Section 7 of this report which compares the interview results among market actors in California and the control region.

4.3 Sample Design

Interview and Survey Approach

RER employed two methods of data collection for this study: open-ended, in-depth telephone interviews and more structured mail and telephone surveys. Market data from manufacturers, developers, HVAC contractors, distributors, lenders, building inspectors, government staff, and Title 24 consultants were collected through the open-ended interview medium. Open-ended interviews provide an excellent means for collecting data from market actors and provide invaluable insights into the mechanics of product manufacturing, distribution, marketing, pricing, and specification that would be difficult to derive from a structured telephone or mail survey. Because the level of influence of sales and real estate agents on the specification of equipment and measure efficiency levels was considered to be secondary in comparison to that of the other market actors, and that the information desired from these individuals could be solicited predominantly with close-ended questions, sales and real estate agents were interviewed with a more structured, quantitative phone survey format. Finally, data from residential gas customers (program participants and nonparticipants) from both areas were collected with a combined mail and telephone survey. RER developed a total of 28 unique interview guides and surveys for the in-depth interviews, surveys, and the consumer mail surveys.

Table 4-2 presents the target number of completed interviews with each market actor in each study area, in addition to the format and survey type for each market actor. As shown, the survey and interview data collection effort specified a total of 288 market actor telephone interviews and surveys. Note that the goal was to complete two-thirds of the phone interviews with respondents in SoCalGas and SDG&E service areas and the remaining third with respondents in the control area.

With respect to the consumer survey, the goal was to receive 1,500 completed surveys. This total includes 600 program participants (300 from each utility service area) and 900 nonparticipants (300 from each utility area and 300 from the control region).

The sources of the sample frames for each market actor are discussed in the following section, and the completed samples are presented in subsection 4.5.

Table 4-2: Survey and Interview Target Sample Sizes

Market Actor	Format Type	Survey Type	SoCalGas	SDG&E	Control Area	Total
Gas Heating Manufacturers	Interview	Phone	na	na	na	6
Gas Water Heater Manufacturers	Interview	Phone	na	na	na	6
Window Manufacturers	Interview	Phone	na	na	na	6
Gas Heating Distributors	Interview	Phone	4	4	2	6
Gas Water Heating Distributors	Interview	Phone	4	4	2	6
Window Distributors	Interview	Phone	4	4	2	6
Builders and Developers	Interview	Phone	25	25	25	75
Architects	Interview	Phone	5	5	5	15
Title 24 Consultants	Interview	Phone	5	5	5	15
HVAC Contractors	Interview	Phone	10	10	10	30
Plumbing Contractors[1]	Interview	Phone	-	-	-	-
Building Inspectors	Interview	Phone	5	5	5	15
Sales Agents	Survey	Phone	15	15	15	45
Realtors	Survey	Phone	15	15	15	45
Lenders	Interview	Phone	5	5	5	15
Consumers- Participants	Survey	Mail	300	300	na	600
Consumers- Nonparticipants	Survey	Mail	300	300	300	900
Government Staff	Interview	Phone	na	na	na	15

1 The plumbing contractors were added during the interview process. Thus, there were no original targets for completions in this category. After plumbing contractors were included, the targets were revised – 15 complete interviews each with HVAC and plumbing contractors.

4.4 Sample Frames

The sources of the sample frames for the market actor interviews are diverse. Descriptions of the sample design characteristics for each of the market actors are presented below and detailed in Table 4-3.

- ***Equipment Manufacturers and Distributors.*** The sample frame for the manufacturer interviews was obtained from various industry trade associations. The project team identified the major equipment manufacturers on the basis of market shares of total shipments. The interview sample was stratified into large and small manufacturers based upon size, as indicated by market share. The frame of equipment distributors was derived from references from the equipment manufacturers and other market actors. The original sample design specified a completion target of 18 interviews with manufacturers and 18 interviews with distributors.
- ***Builders.*** The sample frame for the builder interviews was primarily derived from the lists of builders that bid and/or participated in each utility' s residential new construction program. These lists were augmented with data from trade associations and commercially available lists to identify the largest builders in each of the areas covered by this study. The sample of builders was stratified into "large" and "small" companies according to either the number of developments in progress, the number of employees, or number of electrical connections and/or sales in 1996. Further, an effort was made to interview both RNC program participating and nonparticipating builders. Because of the importance of the builder interviews to this study, the sample design specified 75 interviews with builders, 25 each in the SDG&E, SoCalGas, and control areas.
- ***Architects, Title 24 Consultants, and HVAC and Plumbing Contractors.*** The sample frames for the interviews with these market actors (all of which are usually subcontractors) were derived from referrals from builders, trade association membership directories and websites, and telephone directories. The original sample design specified 30 complete interviews with HVAC contractors and 15 completed interviews each with architects and Title 24/energy consultants. During the interview process, however, plumbing contractors were added to the market actor list. Thus, 15 interviews were subtracted from the HVAC contractor targets and transferred to the plumbing contractor interview target. The final sample design, therefore, specified a total of 15 interviews each for HVAC and plumbing contractors, architects, and Title 24/energy consultants.
- ***Building Inspectors.*** A sample of city and county building inspectors and building plans reviewers was obtained from building departments in each area covered by the study.[5] The sample design specified 15 completed interviews with building inspectors, five in each of the three areas.

[5] The study areas include the Cities of Los Angeles, Orange, San Bernardino, Irvine, Riverside, San Diego, Austin, and San Antonio.

- ***Sales and Real Estate Agents.*** The sample frame for real estate agents was derived from membership lists from the regional Boards of Realtors and lists from the State licensing boards. The sample frame for builder sales agents was obtained primarily from the trade associations and publications, and web sites listing the communities developed by each builder. The sample of real estate agents was stratified into "large" and "small" agencies according to the number of offices and number of employees. The sample of builder sales agents was stratified into "large" and "small" agencies in a manner identical to that used for stratifying the builder sample. The final sample design specified 15 complete interviews with real estate agents and 15 with builder sales agents in each service area and in the control area, resulting in a total of 90 completed interviews.
- ***Lenders.*** The sample frame for lending institutions was derived primarily from trade association member lists. The sample design specified 15 complete interviews with lenders, five with respondents in each utility service territory and five with lenders in the control area.
- ***Consumer Surveys.*** SDG&E and SoCalGas provided the sample frames for customers in the two Southern California service areas. The frames were derived from the respective customer information systems (CIS) and program tracking systems. Samples were stratified by participant status and program years between 1990 through 1997. The sample design anticipated a 30% response rate resulting in completed surveys from 300 participants and 300 nonparticipants in each of the targeted service areas, plus a similar sample for the control area (excluding participants from the control area). The sample frame in the control area was obtained from commercially available lists of home built in 1990 or later with an even distribution of addresses between San Antonio and Austin.
- ***Government Agencies and Nongovernment Organizations.*** Respondents with government agencies were recruited from federal agencies such as the Department of Energy, the Environmental Protection Agency, national research laboratories, contractors conducting policy research, and California state agencies. In addition, several nongovernment organizations involved in promoting the energy efficiency levels of new homes were included in the sample frame.

Table 4-3: Sample Frame Sources for Market Actor Interviews

Market Actor	• Source of List	Description
Gas Furnace Manufacturers	• Gas Appliance Manufacturers Assoc. (GAMA) • Appliance Magazine, September 1997	List of companies, nine of which were identified as "large."
Gas Water Heater Manufacturers	• Gas Appliance Manufacturers Association (GAMA • Appliance Magazine, September 1997	List of companies, four of which were identified as "large."
Window Manufacturers	• National Sash & Door Jobbers Assoc. (NSDJA) • Window World Magazine	List of 45 companies. Manufacturer representatives (5).
Equipment Distributors/ Wholesalers	• Referrals from equipment manufacturers • Referrals from equipment distributors • GAMA • NSDJA • Plumbing, Heating & Cooling Contractors Association	 List of 48 companies. List of 45 companies. Member list.
Builders and Developers	• Homes for Sale Magazine • SDG&E bidding and participating builders • SoCalGas bidding and participating builders • San Diego Business Journal • The San Diego Sourcebook • Texas Capital Area Builders Association • The Austin Business Journal • The Greater San Antonio Business Association • Texas Capital Area Builders Association	List of builders in California. List of residential builders in San Diego. List of the top 11 builders in San Diego. List of members. List of the top 25 builders in Austin, ranked by 1996 sales. List of the top 25 residential builders in San Antonio, ranked by number of electrical connections. List of members.
Architects	• Referrals from builders • Referrals from architects • Referrals from Title 24 consultants • Office rosters and references from several Building Industry Associations (BIA) • Texas Capital Area Builders Association • Yellow Pages	 List of members.

Table 4-3 (Cont'd): Sample Frame Sources for Market Actor Interviews

Market Actor	• Source of List	Description
Title-24 & Energy Consultants	• Referrals from architects	
	• Referrals from builders	
	• California Association of Building Energy Consultants (CABEC)	List of CABEC members, 19 of which are in Southern CA.
	• California Building Officials (CALBO)	CTI roster of Certified Energy Plans Examiners, 51 of which are in Southern California.
	• Yellow Pages	
HVAC Contractors	• Referrals from builders.	
	• Sheet Metal and Air Conditioning Contractors National Association (SMACNA)	List of members, 48 of which are in Southern California.
	• Texas Capital Area Builders Association	List of members.
Plumbing Contractors	• Referrals from builders	
	• Plumbing, Heating, and Cooling Information Bureau (PHCIB)	List of contractors by region.
	• Yellow Pages	
Building Inspectors	• Building Departments for the Cities of Los Angeles, Orange, Irvine, Riverside, San Bernardino, and San Diego.	Names of building field inspectors and building plan reviewers for each municipality.
	• Building Departments for the Cities of Austin and San Antonio	
Sales Agents	• The Austin Business Journal	List of the top 25 builders in Austin, ranked by 1996 sales.
	• The Greater San Antonio Business Association	List of the top 25 residential builders in San Antonio, ranked by number of electrical connections.
	• Texas Capital Area Builders Association	List of members.
	• The Housing Guides of America On Line, and other builder websites	Lists of communities developed or being developing by builders, by region.
Real Estate Agents	• San Diego Association of Realtors	Office roster.
	• The Austin Board of Realtors	Office roster.
	• Beverly Hills, Greater Los Angeles, Ventura County Coastal Associations of Realtors	Office rosters.

Table 4-3 (Cont'd): Sample Frame Sources for Market Actor Interviews

Market Actor	• Source of List	Description
Lenders	• Residential Energy Services Network	List of lenders that are offering or that have offered energy-efficient mortgages.
	• Mortgage Association of California	List of members, 150 of which are in California.
	• Texas Capital Area Builders Association	List of members.
Consumers-Participants	• SDG&E service area	SDG&E billing frame.
	• SoCalGas service area	SoCalGas billing frame.
Consumers-Nonparticipants	• SDG&E service area	SDG&E billing frame.
	• SoCalGas service area	SoCalGas billing frame.
	• Control area	Commercially available list of residents in control area.
Government Staff	• Personal references from CADMAC members, utility staff, and RER contacts	

4.5 Development of Interview Guides and Survey Instruments

The interview and survey questionnaires were developed to accommodate the specific information requirements identified in the preliminary research stages of this study. In some cases, an effort was made to maintain continuity with prior research interview or question formats.[6] Further, informal discussions with a small sample from each market actor group helped to develop the questionnaires. This approach was particularly useful for getting a general feel for the market roles of the actors and ensured that the wording of the interview and survey questions was consistent with the language used by the interview respondents. The final interview guides and survey instruments for each market actor are included in Appendices C through S. The objectives of the market actor interviews and surveys are summarized below.

Manufacturer Interviews. The equipment manufacturer interview guide was designed to solicit information on manufacturing practices, processes, volumes, product and production innovations, costs, and factors influencing changes in the industry. Interview participants were asked to describe historical trends, current conditions, and future plans or expectations. These issues included the following topics:

[6] Pacific Gas & Electric Co., 1993b; Wisconsin Center for Demand-Side Research, 1995; Energy Center of Wisconsin, 1996a, 1996b; Opinion Dynamics Corp. and Regional Economic Research, 1996; Barakat & Chamberlin, 1997, among others.

- Sales and production levels,
- Current product offerings and pricing,
- Active research and development efforts,
- Production investments and innovations,
- Marketing and promotion efforts,
- Decision makers and decision processes,
- Distribution and sales practices,
- Market barriers, and
- Perceptions, roles and influences of utility DSM programs on the manufacturing industry.

Other Market Actor Interview Guides. The primary interview topics for the remaining market actors depended on the specific role of the market actor group. In general, however, the research issues include the following topics:

- Technology awareness,
- Sales volumes or use of high efficiency equipment and/or measures,
- Primary information sources,
- Current product stocking and pricing practices,
- Marketing and promotion efforts,
- Decision makers and processes,
- Consumer perceptions and behavior,
- Market barriers, and
- Perceptions, roles, and influences of utility DSM programs on the new construction industry.

Real Estate and Sales Agent Surveys. Real estate and sales agent surveys were conducted via telephone and focused on the following issues:

- Current practices in promoting energy efficiency of new homes,
- Perceptions of homebuyer valuation of energy efficiency, and
- Primary reasons for homebuyer valuation of energy efficiency.

Consumer Surveys. The consumer mail survey was designed to be comparable to prior evaluation survey formats. The object of the consumer survey was to collect the following information:

- Technology awareness and knowledge,
- Technology perceptions and satisfaction,
- Current ownership status,
- Primary information sources,
- Purchase and decision processes,

- Perceptions, roles, and influences of utility DSM programs on homebuyer behavior,
- Future purchase intents, and
- Equipment information.

Telephone Interview and Survey Protocols

A very basic protocol was followed to complete the market actor interviews and surveys. Although the protocols varied slightly for each market actor in general (depending on the sample, sample size, etc.), the interview procedure included the following:

- As mentioned above, the samples of equipment manufacturers, builders, and sales and real estate agents were stratified into "large" and "small" companies. This enabled RER to oversample the larger companies, thus ensuring adequate market coverage of these market actors.
- All referrals were considered to be "priority" sample points and a strong attempt was made to recruit these companies for participation. In most cases, a referred company was removed from the sample after five unsuccessful contact/recruit attempts. Using referrals not only helped minimize recruiting time (screening was not necessary, and in some cases the source of the referral provided a contact name), but also helped to ensure adequate market coverage. RER researchers became confident that they contacted and recruited the "major players" in the industry.
- A "non-referred" company was removed from the sample after a maximum of three or four unsuccessful contact/recruit attempts. If the contact was identified as "large," the company was not removed from the sample until after five failed attempts.
- During the first contact, each "non-referred" company was screened to ensure that the majority of their business was for residential new construction in either Southern California or the Austin/San Antonio region of Texas.
- A census was attempted with the market actors that had very few companies, primarily equipment manufacturers.

For the consumer mail survey, a single mailing was initially employed. RER designed an attractive, organized, 5½" × 8½" survey booklet with easy to follow skip patterns. To increase the response rate, logos from SDG&E and SoCalGas were included on the design of the survey booklet and mailing envelopes were provided by the utilities. A random sample of 1,000 participants and 1,000 nonparticipants equally distributed by program participation year was requested from each utility. In addition, a mailing list of 1,000 names and address were purchased from Polk Direct for the control area. A total of 5,000 surveys were mailed to consumers.

Appendix C through Appendix S detail the sampling procedures and interview protocols, and provide a list of the companies that participated in this research for each market actor.

Interview Target Revisions

Numerous obstacles during the interview process prohibited RER from completing the target number of interviews presented in Table 4-2. The following problems and issues were encountered:

- At the time of this study, the new construction market in Southern California was very strong. Even though industry participants were responsive and willing to participate, the "turn-around-time" between the original contact and completing the interview was significantly longer than originally anticipated.
- Several of the market actors spend the majority of their time on-site or "on the road." This led to difficulties in making contacts and recruiting interview respondents for builders, HVAC and plumbing subcontractors, equipment manufacturers and distributors, and building field inspectors.
- During the interview process, and through referrals from builders in particular, RER learned that a small number of HVAC and plumbing contractors account for the majority of the gas heating and water heating equipment installations in residential new construction. This, in combination with the fact that these market actors spend the majority of their time on-site (out of the office), contributed to the difficulties and the time required to complete these interviews.
- There are a very small number of equipment manufacturers. In most cases, RER attempted a census of these market actors. Strangely enough, a larger percentage of manufacturers and distributors refused to participate than any other market actor group.[7]
- The vast majority of the residential new construction is sold through builders' sales agents and not real estate agents.
- Completing interviews with market actors in the control region was particularly difficult. In addition to the problems described above, many individuals in the Austin/San Antonio region did not have a vested interest in this research and did not feel they could benefit from the study. Thus, they were less likely to participate than their counterparts in Southern California.

In general, the problems described above significantly increased the amount of time required to recruit respondents and complete the interviews. To help mitigate these issues, RER revised the targets of completed interviews, as shown in the second numeric column of Table 4-4. The reductions were proportional across regions for each market actor.

[7] Most refused to participate because either they did not want to release proprietary information or the company had a policy to not participate in surveys. This was a significant issue, particularly because there are very few "major" manufacturers and distributors in the industry.

Table 4-4: Revised Market Actor Interview Targets

Market Actor	Original Target	Revised Target
Gas Furnace Manufacturers	6	6
Gas Water Heater Manufacturers	6	5
Window Manufacturers	6	6
Gas Furnace Distributors	6	6
Gas Water Heater Distributors	6	6
Window Distributors	6	6
HVAC Contractors [1]	30	12
Plumbing Contractors (added later) [2]	-	12
Architects	15	12
Title 24 Consultants	15	12
Builders and Developers	75	45
Building Inspectors (added later)	-	12
Lenders	15	15
Government Staff	15	12
Realtors	45	10
Sales Agents	45	45
Total	291	222

1. The original goal was to complete 30 interviews with HVAC contractors, 10 in each area. These targets were halved when plumbing contractors were included in the study.
2. Plumbing contractors were not included in the original sample design.

In addition to revising the targets for completed interviews with market actors, RER also revised the targets of completed consumer mail surveys per area. The original targets per area, as presented in Table 4-2, were based upon assumptions that the required number of participants and nonparticipants would be provided by SDG&E and SoCalGas. SDG&E was only able to provide limited program participant and nonparticipant information for 1994 and only nonparticipant information for 1997. The overall number of completed survey targets was kept the same. Specifically, SDG&E provided 287 participants and 257 nonparticipants in 1994 with 1,387 nonparticipants in 1997. SoCalGas targets were increased in order to adjust for the lack of information in the SDG&E area, as shown in Table 4-5.

Table 4-5: Revised Consumer Mail Survey Targets

	Original Target	Revised Target
Total Participants	**600**	**544**
SoCalGas Participants	300	458
SDG&E Participants	300	86
Total Nonparticipants	**900**	**656**
SoCalGas Nonparticipants	300	458
SDG&E Nonparticipants	300	198
Control Area Nonparticipants	300	300

Completed Survey and Interview Samples

Table 4-6 presents the number of completed interviews for each market actor and the response rates for completing the interviews. As shown, a total of 213 market actor in-depth interviews and phone surveys and 854 consumer surveys were completed for this research.

Response Rates. Table 4-7 presents the response rates for the market actor interviews. As shown, the overall response rate for completing the market actor interviews was 45%. With the exception of window manufacturers, the efforts to recruit interview respondents that work on-site resulted in the lowest response rates, as anticipated. Several points needs to be made about the market actor interview response rates. First, the first numeric column of Table 4-7 includes the number of companies or individuals contacted to participate in this study. These counts exclude those with whom the correct contact was never reached, those not qualified to participate, and any wrong or disconnected numbers. In other words, these represent the number of qualified respondents that were actually asked to participate. The second numeric column included the total number of completed interviews with each market actor. The final column of the table presents the response rates, or the number of completes divided by the total number of eligible contacts.

The consumer survey initially employed a single mailing approach and assumed a normal rate of response of 30% for utility residential surveys. The actual overall response rate was only 18%. A further breakdown by area reveals the SDG&E service territory response rate to be at 30%. SoCalGas was slightly lower at 17%. The control area had the lowest response rate at 9%. A lower response rate should have been anticipated due to the lack of local utility association.

The consumer mail survey resulted in such a low response rate, it was decided to do a telephone survey follow up to increase the response rate closer to the expected 30%. The final overall response rate was 29%. A breakdown by area reveals the SDG&E service territory and the control area both ended up with a response rate at 30%. The final SoCalGas response rate was 28%.

Table 4-6: Target and Actual Complete Samples

Market Actor	SoCalGas		SDG&E		Control Area		Total	
	Target	Complete	Target	Complete	Target	Complete	Target	Complete
Gas Heating Manufacturers	na	na	na	na	na	na	6	5
Gas Water Heater Manufacturers	na	na	na	na	na	na	6	5
Window Manufacturers	na	na	na	na	na	na	6	4
Gas Heating Distributors	na	na	na	na	na	na	6	5
Gas Water Heating Distributors	na	na	na	na	na	na	6	5
Window Distributors	na	na	na	na	na	na	6	5
HVAC Contractors	4	4	4	4	4	4	12	13
Plumbing Contractor	4	1	4	3	4	2	12	6
Architects	4	6	4	3	4	5	12	14
Title 24 Consultants	4	7	4	2	4	2	12	12
Builders and Developers	15	15	15	15	15	15	45	45
Building Inspectors	4	7	4	2	4	2	12	12
Real Estate Agents	15	1	15	9	15	0	45	10
Sales Agents	15	16	15	14	15	15	45	45
Lenders	5	5	5	5	5	5	15	15
Government Staff	na	na	na	na	na	na	12	12
Consumers - Participants	458	460	86	96	na	Na	544	556
Consumers - Nonparticipants	458	425	198	183	300	301	956	909

Table 4-7: Market Actor Interview Response Rates

Market Actor	Total Contacts	Complete	Response Rate
Gas Furnace Manufacturers	6	5	83%
Gas Water Heater Manufacturers	5	5	100%
Window Manufacturers	14	4	29%
Gas Furnace Distributors	8	5	63%
Gas Water Heater Distributors	9	5	56%
Window Distributors	5	5	100%
HVAC Contractors	35	13	37%
Plumbing Contractors	26	6	23%
Architects	35	14	40%
Title 24 Consultants	16	12	75%
Builders and Developers	155	45	29%
Building Inspectors	16	12	75%
Real Estate Agents	22	10	46%
Sales Agents	87	45	52%
Lenders	19	15	79%
Government Agencies/NGOs	13	12	92%
Overall	**471**	**213**	**45%**

5

Market Actors and Decision Channels

This section details the roles of key market actors and the channels through which decisions are made regarding energy efficiency levels of equipment and shell measures. The findings presented in this section are the result of in-depth interviews with over 200 market actors in the residential new construction market, including equipment manufacturers and distributors, builders, architects, energy consultants, contractors, real estate and sales agents, lending institutions, and government agencies.[1] The remainder of this section is organized as follows:

- Subsection 5.1 provides an overview of the residential new construction market in Southern California,
- Subsection 5.2 presents a preview of the market structure and interactions among market participants,
- Subsection 5.3 describes the variation of function and influences of various market actors among key market segments,
- Subsections 5.4 through 5.10 discuss the market actors involved in the supply side of the market,
- Subsections 5.11 through 5.18 present those involved in the demand side of the market, and
- Subsections 5.19 and 5.20 describe the roles and influences of consumers and government agencies and nongovernment organizations, respectively.

5.1 Overview

The market for shell measures and high efficiency gas equipment consists of exchange transactions between a variety of actors, some acting as suppliers to the market and others acting to create demand for these products. This section discusses in detail the functions and areas of responsibility of these actors, their typical methods of interaction, and their relative influence and presence in the market. The following industry participants are considered to be key market actors:

[1] The subsections pertaining to equipment manufacturers and distributors were augmented with market size data and information from a variety of sources.

- Equipment manufacturers,
- Equipment distributors and wholesalers,
- Builders,
- Architects,
- Title 24/energy consultants,
- HVAC contractors,
- Plumbing contractors,
- Building inspectors,
- Sales and real estate agents,
- Lenders,
- Consumers, and
- Government and nongovernment agencies.

Each industry participant exerts some influence on decisions relating to market transactions, including decisions ranging from production, stocking, distribution, and pricing of the products to decisions pertaining to home design, equipment and measure specification, cost effectiveness, regulatory requirements, and consumer preferences.

Figure 5-1 depicts the general structure of the residential new construction market and the links and interactions among key market actors. The *supply side* of the market consists of equipment manufacturers and distributors and wholesalers. The government has a substantial influence on equipment manufacturing through the implementation of federal equipment manufacturing standards. Manufacturers sell product to distributors and sometimes directly to the contractors who install the equipment. Manufacturers' primary links to contractors and builders (those that demand the product), however, are through equipment advertising and marketing. Manufacturers influence these market actors through many channels of communication, including in-person contact, trade literature, and trade shows and conferences.

As shown in Figure 5-1, the *demand side* is comprised of the remaining market participants, including builders, HVAC and plumbing contractors, architects, Title 24 energy consultants, building inspectors, real estate and sales agents, lending institutions, and, of course, residential consumers. It is quite obvious from the diagram that builders are linked to nearly every key market actor, and, as will be discussed in subsequent sections, are the primary decision makers in most aspects of residential new construction. With respect to the specific focus of this study, builders have the most influence and make nearly all final decisions pertaining to the energy efficiency levels of equipment and shell measures of new homes.

The builder works with the architect(s) during the project planning and design phase of construction. After the basic plans of the house are finalized, the plans are "elevated" to

include all other specifications, including HVAC and plumbing system design and specification, and the specification of all shell measures. At this point, there is a great deal of interaction that occurs between the HVAC contractor, the builder, and the Title 24 consultant until the builder approves of all specifications and until the plans meet all building code and Title 24 requirements. A building plans examiner reviews the plans and Title 24 documents and issues the necessary building permits upon approval. [2]

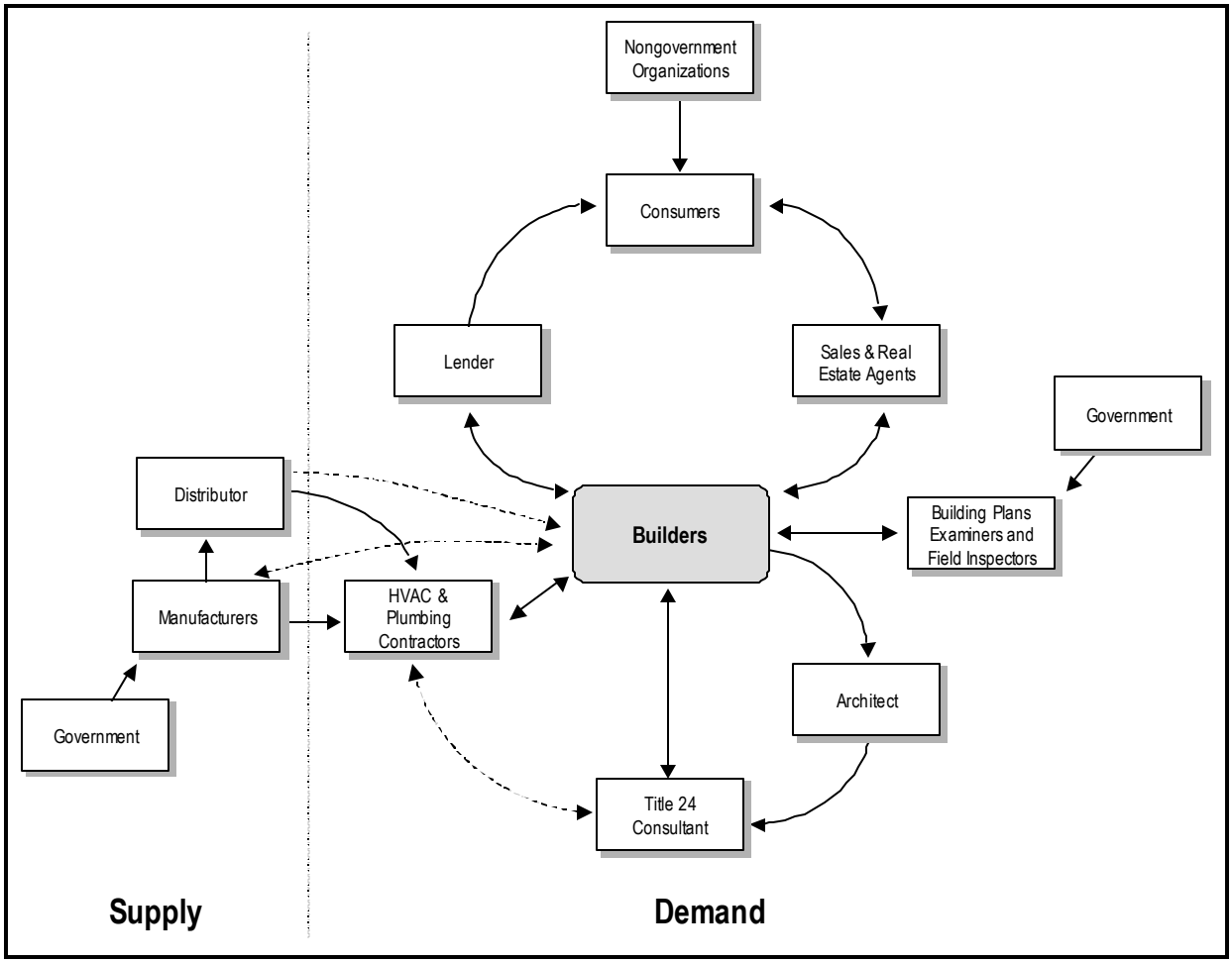
The builder solicits bids for various aspects of construction, including HVAC and plumbing equipment installations, based upon the final specifications. The contractor awarded with the bid is responsible for purchasing and installing all equipment and materials as per the building plans. Building inspection occurs at various stages of construction to ensure that all material and equipment coincide with the building plans and that all equipment has been installed according to the manufacturers' guidelines.

Sales and real estate agents are responsible for selling the property to consumers. They not only work with consumers in finding homes that are compatible with their lifestyles and needs, but also relay homebuyer preferences to the builder during project planning and market research. Note that the sales agents are the most direct link between the builder and consumers.

Finally, Figure 5-1 reveals that government agencies and nongovernment organizations interact with several market actors. As explained in the following sections, the roles of government and nongovernment agencies involve implementing standards and regulations in the market, as well as supplying information to key market actors.

[2] It is interesting to note that all of the intermediaries are state licensed except for the Title 24/energy consultant, for whom no license is required.

Figure 5-1: General Structure and Market Interactions



5.2 Preview of the RNC Market

For the most part, the residential new construction market can be characterized as one in which each industry participant receives market signals from downstream market actors and reacts accordingly. Market behavior is based upon the most elementary economic principal: maximize benefits subject to costs or a budget constraint. For example, in the residential new construction market, builders seek to maximize profits and minimize construction costs, while consumers seek to maximize their satisfaction and minimize their fixed costs. Essentially, all market actors are willing and able to supply more energy-efficient products if there is a market actor(s) downstream that is willing to pay for them.

The most prevalent characteristics of the market actors and decision channels in the residential new construction market are summarized below.

Supply-Side Market Actors

- Gas space and water heating equipment manufacturers are sensitive to demand from market actors downstream, mainly distributors and builders. The efficiency levels of the equipment they produce are most strongly influenced by equipment efficiency level regulations mandated by government agencies and by competition among manufacturers.
- Equipment distributors have little influence in the market and are not a primary source of information for other market actors.
- The strongest link between the supply- and demand-side market actors is the information flow from manufacturers to builders, contractors, and other industry participants.

Demand-Side Market Actors

- Builders are the primary and central decision makers in all aspects of product development, including specification of energy efficiency levels of gas space heating equipment and shell measures. Because tract developers' objectives are to minimize construction costs subject to building code compliance, tract homes rarely exceed the minimum Title 24 requirements.
- Builders rely on the expertise of other market actors in the decision-making process. During the specification stage of product development, architects, Title 24 energy consultants, and HVAC contractors participate in and influence the builder' s decisions regarding equipment and shell measure specification. In some cases, these market actors might make the final decision regarding energy efficiency levels. However, decisions made by other market actors must be made within the builder' s parameters, such as the project' s budget.
- Builders' sales agents are the only link between builders (the central decision maker) and consumers. Sales agents provide input to builders regarding consumer preferences during the preliminary stages of development.
- The extent to which sales agents provide information to consumers on energy efficiency levels of new homes is limited by the builders' willingness to train the agents and supply such information.
- In general, consumers have a "generic" understanding of energy efficiency and have a limited knowledge of energy efficiency levels of specific equipment and shell measures. Thus, they are unlikely to ask sales agents about specific energy-related features. Moreover, energy efficiency is not a priority for consumers when purchasing a new home.
- Consumers expect homes to be energy efficient, and tend to think that if a home meets building code requirements then the home is as energy efficient as possible. Consumers rarely opt to upgrade the energy efficiency levels of a new home. (It is also important to note that builders rarely offer upgrades of energy-related equipment and features.)

- Although building energy code revisions are designed to be democratic, builders have the strongest presence and lobby force. Thus, the final outcome does not represent consumer preferences and interests.
- Nongovernment organizations provide informational services to consumers and other market actors about the energy efficiency of residential buildings. These organizations are reactive rather than proactive. In particular, their strategy is to "fit into" the market mechanism (i.e., the home purchasing process), rather than target a specific market actor. As such, they respond to questions and requests for information rather than disseminate information to industry participants.
- Much of the complacency surrounding energy efficiency (on the part of both builders and consumers) is related to the temperate climate in Southern California. Moreover, the average consumer lives in a home for seven years, which is considerably less than the payback period for more energy-efficient equipment.

While the discussion points presented above are generalizations about the residential new construction market, and the residential tract development market in particular, it is important to highlight some exceptions, as well. The following subsection explains how the market actors' functions and influences in residential new construction vary according to market segments identified during the interview process.

5.3 Market Segmentation

Interviews with key market actors revealed that the functions and relative influences of some industry participants can vary according to other market characteristics, such as project type. Functions and influences vary by project type, value, residence type, and consumer type. For example, in the custom home market, the consumer' s role and level of influence are expanded; in the tract home market, the consumer has very little influence, if any at all, and the influence of other market actors is more dominant. To examine the key roles of market actors and their relative influences on the energy efficiency levels of new homes, it is useful to segment the residential new construction market according to the following four characteristics identified during the market actor interviews:

- Project type,
- Home value,
- Residence type, and
- Consumer type.

Each of these characteristics is discussed briefly below.

Project Type. The project type refers to whether a home is a custom home or part of a tract development. With respect to custom homes, the consumer is the primary decision maker on

all aspects of design and construction, including the specification of energy efficiency levels and equipment and shell measures. While the architect and HVAC and plumbing contractors consult directly with the builder (as with all projects, whether custom or tract), there is a considerable amount of communication between these market actors and the homebuyer. Thus, the architect and HVAC and plumbing contractors have more influence on homebuyer preferences in a custom project than in a tract development.

In a tract home development, the builder/developer is the primary decision maker. Although the builder typically relies very heavily on the expertise of the architect and the HVAC and plumbing contractors, they make all final decisions pertaining to equipment and shell measure specification. Depending on the size of the company, several of the market actors, such as the architect and engineer, are either "in-house" or hired as a subcontractor to the project. Larger builders/developers are likely to have in-house personnel, while smaller tract builders are more likely to subcontract these functions to external firms.

Several builders classified some of their projects as "semi-custom," a combination of the custom and tract project types. In semi-custom projects, the builder utilizes one building plan for multiple houses, just as for a tract or mass development. However, the consumer has more freedom and influence with respect to the home's design, features, and characteristics than with a tract home.

Home Value. The energy efficiency levels of equipment and measures vary somewhat according to the value of the home. In particular, higher value homes tend to have more expensive and, therefore, more energy-efficient equipment. These home also tend to have higher R-value insulation, higher quality windows, and other energy use related features. Basically, the buyers of higher value homes are more able and willing to afford more expensive and energy-efficient equipment. Thus, compliance with Title 24 is not a primary concern, as the builder is well aware that the requirements are fulfilled (and often surpassed).

Residence Type. Whether or not a project is single or multi-family influences builders' decisions regarding equipment features. In general, operating costs are more influential in equipment decisions for multi-family projects than for single family projects. There are several reasons for this. First, the market actor that experiences the maintenance costs of energy-related equipment is typically not the resident of a multi-family building, particularly so if the units are not separately metered.[3,4] Second, after the sale of a single family home, the builder has no involvement or responsibility with the maintenance or operating costs of the equipment and property, in general. With respect to multi-family projects, the builder

[3] While higher quality equipment does not necessarily imply high efficiency equipment, interview respondents explained that this was generally the case.

[4] Roughly 30% of the multi-family housing in Southern California is master metered.

might also be the property manager and, therefore, must "live with" the equipment and features – and operating costs – after the completion of construction. Thus, they are more likely to specify higher quality, more energy-efficient equipment for multi-family housing.

Consumer Type. Many builders emphasized that first-time homebuyers have different preferences and priorities in their purchase decisions than do repeat buyers. In particular, first-time homebuyers are less likely to request equipment and measure upgrades, "they are just happy to get into a home." They are more concerned about the *fixed costs* (the purchase price of the home) and are less familiar with a home's *variable* costs, or the monthly utility expenses and equipment operating and maintenance costs. Repeat homebuyers, on the other hand, have more experience with such variable costs and are less likely to "settle" for minimum specifications. First-time homebuyers also have more restricted budgets and are more likely to purchase a tract home.

Throughout this subsection, the differences and similarities of the market actor roles and functions between and within these segments will be highlighted when necessary and appropriate.

Organizational Procedures and Decision-Making Processes

Since some of the hypotheses to be tested in this market study include effects on standard business practices and costs of doing business, it is necessary to examine the typical organizational procedures and decision-making processes in the market. The following subsections discuss the functions, typical decision-making responsibilities, and influences of each market actor regarding energy efficiency levels of residential new construction.

5.4 General Characteristics of Equipment Manufacturers

Within the organizational structure of equipment manufacturers, there are a number of distinct strategies, each involving different decision-making activities. This section describes the key corporate, marketing, sales, engineering, and operations strategies of equipment manufacturers.

Corporate Strategy

The corporate strategy generally rests with only a few executives from the firm's senior-level management. This group conducts high-level decision making that affects the long-term success of the firm. Such decisions include the following:

- The markets to serve (i.e., residential, commercial, and/or industrial),
- The products to offer,

- The product types to offer (i.e., only gas furnaces, gas furnaces and boilers, or gas- and oil-fired furnaces and boilers), and
- The range of the product line(s) (i.e., the number of models).

The corporate strategy also involves high-level decisions that determine the relative position of the firm's products in the marketplace (i.e., low-price leader, quality leader, service leader). Corporate strategic decisions also pertain to the sales channels to be pursued by the company (i.e., distributors only, distributors and large retail chains, or distributors, large retail chains, and large tract homebuilders). Another issue considered is whether to pursue a strategy of independent distribution channels, company-owned distribution, or a mix of both.

Marketing Strategy

The primary objectives of a marketing strategy, typically developed and implemented by a "marketing department" or "marketing team," include the following:

- To gain an understanding of the market,
- To identify the different needs of the different segments of the market, and
- To identify the need and potential for the firm's product(s) in the market and/or market segments.

These objectives are generally accomplished through market research and the identification of the various customer segments in the market. A furnace manufacturer might, for example, identify cost, quality, durability, and energy efficiency as the chief benefits that customers seek in the purchase of a gas furnace. The marketing department then develops and implements the most appropriate and cost-effective strategies to promote the firm's products in terms of these desired characteristics.

The branding of the firm's products, such as identifying and reinforcing a particular "brand identity" among target customers, is another aspect of a marketing strategy. In conjunction with the sales department, marketing might decide whether a "push" or "pull" strategy will be utilized to sell product. The "push" strategy focuses on heavy selling to wholesale intermediaries, while a "pull" strategy relies heavily on marketing to retail customers in hopes that they will demand the firm's products over those of competitors. The marketing department also tends to be involved in the hiring of an advertising agency and/or public relations firm to deliver a particular message to the targeted market segment(s).

Most large manufacturers have an in-house marketing department responsible for both marketing and sales functions (discussed below). Smaller manufacturers might, however, choose to outsource much of the marketing function to specialty firms.

Sales Strategy

The primary objectives of the sales strategy include the following:

- To divide the sales territory into regions,
- To understand the differences between each region, and
- To actually call upon and sell to the customers within each territory.

High-level decisions made with respect to product sales include whether to maintain a corporate sales representative for each region, or whether to employ an outside manufacturer' s representative sales firm. While overall sales targets might be specified in the corporate strategy, the sales function will also have input into the determination of these targets. Generally, the sales strategy will specify an overall target figure for the firm and translate it into unit and dollar terms for each product line and/or brand. The sales strategy will outline specific targets for each region and product line, and will generally make a determination of which products should be heavily emphasized during the year. The sales strategy will also specify the purchase levels at which volume price discounts become effective, and might also set into place a bonus system for customers who reach certain sales volume targets.

Engineering

The engineering function entails the determination of product specifications and product design, and involves research and product development activities. When developing new products (or modifying existing ones), product engineers are required to translate the product attributes identified by the marketing department into a product design that is feasible from a cost, production, and marketing perspective. Engineers determine the materials, components, and range of performance for the desired product. Factors that the engineering function must consider include the following:

- The desired size and operating capacity of the product,
- The production capacity of the firm,
- New capital equipment that might be necessary for production, and
- Whether or not the firm will need to outsource any of the components required for production.

Research and Development

Nearly all equipment manufacturers have a research and development (R&D) strategy. R&D not only helps a company remain competitive in the industry, but advances manufacturing processes as well. R&D has numerous functions and purposes, some of which include the following:

- Product and materials development,
- Product redesign, and
- Manufacturing innovation to improve efficiency of production.

A company' s R&D strategy relates to and overlaps with the company' s corporate, marketing, and sales strategies, and is typically incorporated into the engineering strategy.

Operations and Logistics

The operations and logistics functions include a variety of production and distribution-related activities in the short-, medium-, and long-term horizons. In the short term, manufacturing operations involve daily production-related decisions such as the products that will be assembled on a particular line, the raw materials and parts that are needed to meet the next day' s production schedule, and whether extra shifts might be needed to achieve the production schedule. In the medium term, operations involve planning for seasonal variations in product demand and the determination of the amount of inventory that must be maintained to accommodate seasonal demand surges. Firms supplying component parts must also be selected and coordinated with to ensure that no production delays occur because of supplier production constraints.

The logistics function overlaps with operations in some respects and tends to play an active role in the coordination of raw material and component part supplies. The logistics function also involves the scheduling of the transportation of finished goods (usually within a traffic department) to regional supply warehouses or directly to customers. In cases where the manufacturer owns distribution or warehouse facilities, it is generally the logistics function that schedules shipments and monitors inventory levels.

Distribution Practices

Distribution practices are typically classified as either two-step, one-step, or direct distribution. The distinction is the number of intermediaries between the manufacturer and the final consumer – the homeowner. In the new construction market, the final consumer is the contractor or builder, not the homebuyer. Each distribution type is defined below.

- ***Two-Step Distribution.*** With two-step distribution, products are sold to a distributor, and then to a retailer who then sells directly to the end user. In general, two-step distribution is most common for renovation and remodeling projects.
- ***One-Step Distribution.*** With one-step distribution, the manufacturer sells products to a distributor who then sells them to either a builder or contractor. One-step distribution is most common in the residential new construction market.

- ***Direct Distribution.*** Direct distribution entails the sale of products from the manufacturer directly to the builder.

Because some manufacturers sell products to both wholesale and retail channels, it is not uncommon for a manufacturer to employ more than one distribution method.

The functions, influences of manufacturers and distributors of gas furnaces, water heaters, and high efficiency windows in the residential new construction market are presented in the subsections 5.5 through 5.10. The roles and influences of the remaining (demand-side) market actors are discussed in subsections 5.11 through 5.20.

5.5 Gas Furnace Manufacturers

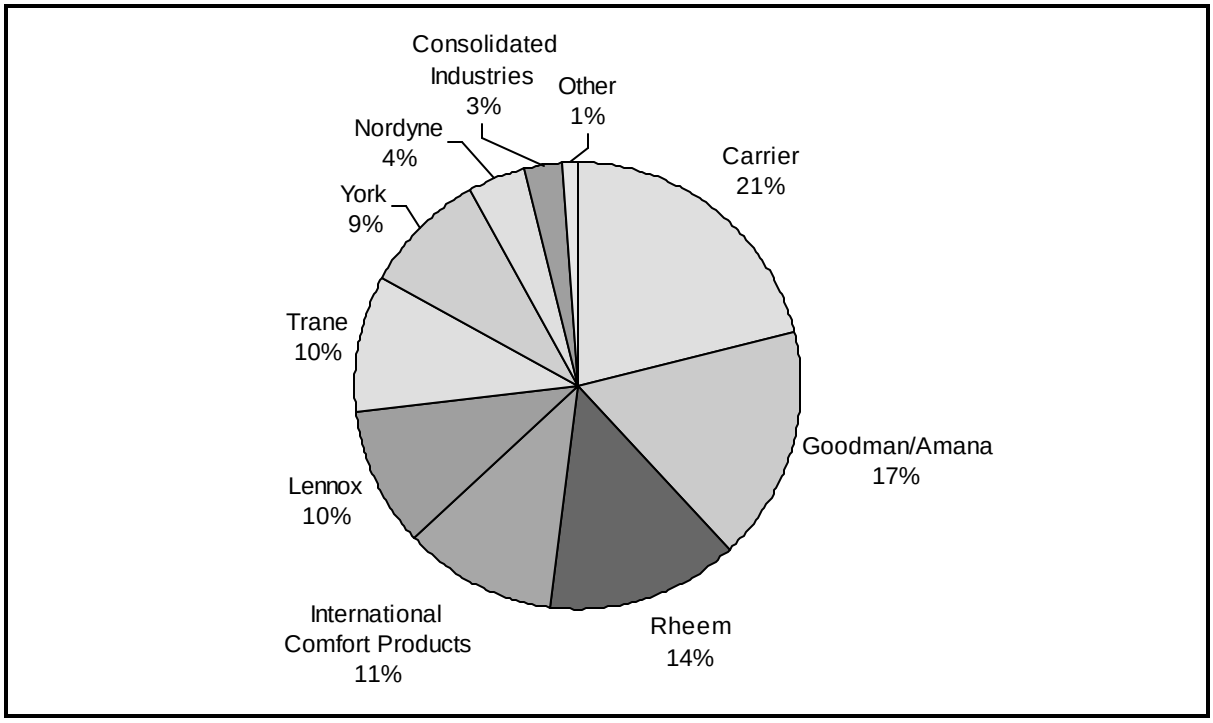
Nationwide, roughly 2.9 million gas-fired forced-air furnaces are produced each year, in addition to approximately 200,000 gas-fired boilers (for hydronic central heat systems). In total, natural gas-fired furnaces and boilers account for approximately 85% of the national market for central heating equipment. The furnace market, as a whole, increased by roughly 5% between 1995 and 1996. [5]

As shown in Figure 5-2, only nine manufacturers account for nearly the entire gas furnace market in the United States. The top three manufacturers (Carrier, Goodman, and Rheem) account for 52% of all gas furnace sales. The next six manufacturers make up 47% of all furnace sales, while the remaining firms account for only 1% of the market. These figures have been adjusted to include the recent purchase of the Amana product line by Goodman Manufacturing. This acquisition increased Goodman' s share of this market from 14% to 17%.[6]

[5] These statistics refer to both the residential and nonresidential gas furnaces.

[6] These statistics refer to both the residential and nonresidential gas furnaces.

Figure 5-2: Gas Furnace Market Share by Manufacturer



Source: Appliance Magazine

The next several sections summarize the following:

- Primary functions and market interactions of manufacturers in the residential new construction industry,
- Equipment brands and product lines of the manufacturers,
- Company size and sales volumes,
- Stocking and inventory practices, and
- Research and development efforts.

Primary Functions and Interactions in the Residential New Construction Market

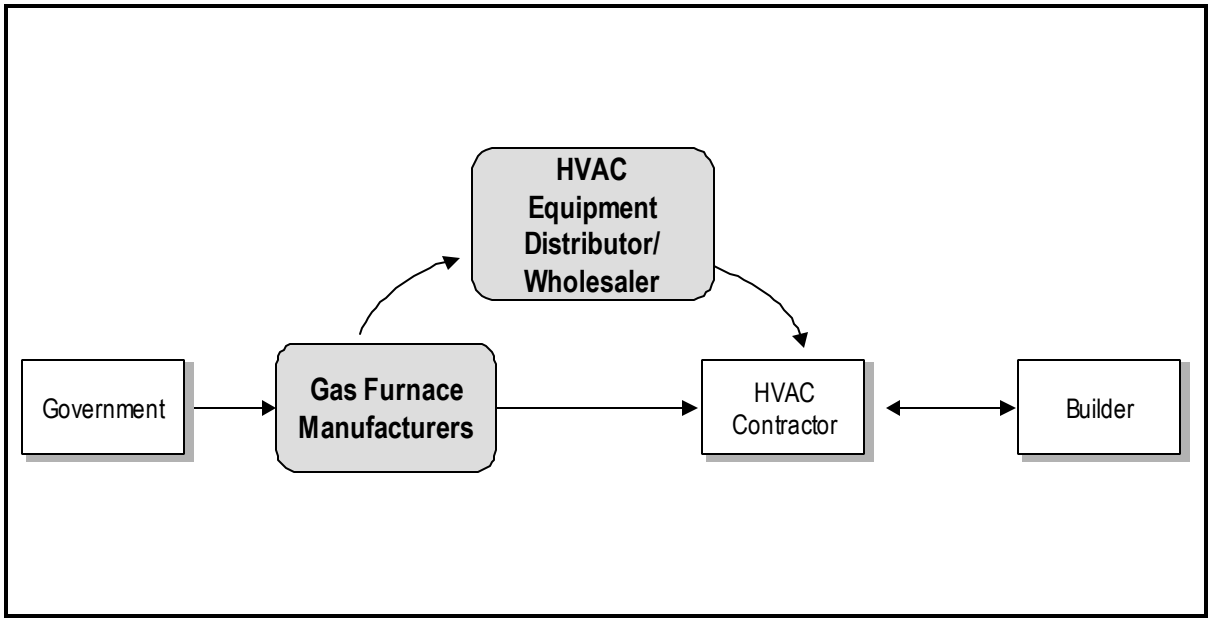
Gas furnace equipment manufacturers have two primary roles in the residential new construction market:

1. The design, development, and production of equipment, and
2. The dissemination of information to other key market actors.

These firms typically produce a variety of heating and cooling equipment for the residential and small commercial market, such as central air conditioners, heat pumps, gas furnaces,

electric furnaces, and air handling equipment. Figure 5-3 depicts the role of manufacturers in the residential new construction market and the market actors with which they directly interact.

Figure 5-3: Gas Furnace Manufacturers and Distributors in the RNC Market



As shown above, gas furnace manufacturers interact primarily with HVAC equipment distributors and HVAC contractors. Manufacturers also communicate with builders by providing them with literature and information about their products. Equipment manufacturing is a demand-driven industry, and the contractors and distributors (those that demand the product) have a great deal of influence on manufacturers and the characteristics of the gas furnaces they produce. The government also has a significant influence on the manufacturing industry through the regulation of efficiency levels of new gas furnaces. These market interactions are discussed briefly below.

- ***HVAC Equipment Distributors.*** Manufacturers interact with distributors mainly through product transfer – the distributors sell the units that the manufacturer produces. All manufacturers employ a two-step distribution system and sell their products to an equipment distributor, who then sells the units to the consumer (the HVAC contractor). While some manufacturers own their own distribution companies, others exclusively sell their product to private and independent distributors. One manufacturer stated that they use a combination of independent and factory-owned distribution companies.
- ***HVAC Contractors.*** While the production of HVAC equipment is their most critical role, manufacturers provide a significant amount of equipment information to demand-side market actors, primarily to HVAC contractors. With the primary

objective of increasing sales and brand/company loyalty, manufacturers provide a great deal of equipment information relating to new technology, equipment features, and installation methods to those purchasing gas furnaces. There are several means by which information is disseminated to the marketplace, including in-person contact between a manufacturer (sales) representative and the HVAC contractors, trade literature, and trade association meetings and conventions.

- ***Government Regulation.*** The greatest influences on the energy efficiency levels of gas furnaces, from the manufacturing perspective are government mandates. In particular, the National Appliance Energy Conservation Act (NAECA), effective January 1991, mandated efficiency level benchmarks for appliances.

Equipment Brands and Product Lines

As indicated in Table 5-1, manufacturers sell gas furnaces under a variety of brand names. The top three manufacturers market their products under nine distinct brand names. Including International Comfort Products (the fourth largest manufacturer in terms of market share), a total of 13 distinct brands account for 63% of all gas furnace sales. In contrast, most of the manufacturers with lesser market shares sell their products under one or only a few brand names.

Table 5-1: Furnace Manufacturers and Brand Names

Gas Furnace Manufacturer	Equipment Brands
Carrier	Carrier, Bryant, Day & Night, Payne
Consolidated Industries	Consolidated, Quatro, Tech-4
Goodman/Amana	Goodman, Amana
International Comfort Products	Heil, Comfortmaker, Tempstar, Arcoaire
Lennox	Lennox
Nordyne	Intertherm, Miller
Rheem	Rheem, Ruud, Weatherking
Trane	Trane
York	York

Through the creation of multiple brands, a single manufacturer can capture a larger share of the distribution channels and retail sales by offering a more diverse product line than their competitors. Another means of securing market share is to offer an exclusive distributorship. Carrier, for example, offers exclusive geographic distributorships for their products. With a product line that spans four brand names (Carrier, Bryant, Day & Night, and Payne), a distributor might be more inclined to become an exclusive distributor of Carrier products rather than represent the brands of multiple manufacturers.

Company Size and Sales Volume

Most gas furnace manufacturers employ their own company sales force, rather than relying on independent manufacturer's representatives. While manufacturers were hesitant to provide company-specific data, the following generalizations can be made with respect to company size and sales growth:

- Manufacturers vary with respect to their overall size. For example, one manufacturer's reported sales in 1997 were about seven times greater than that of a smaller firm.
- Growth in sales ranged from 8% to 30% since 1994.
- There are some seasonal changes in demand, and some manufacturers account for this through the "level-loading" of production.
- The manufacturers interviewed for this study have 750 to 2,500 employees. The proportion of employees involved in the manufacturing of residential gas furnaces ranges between 10% to 100%.[7]

All manufacturers indicated that roughly 20% to 40% of their residential furnace sales are for new construction projects. One, in particular, described its organization as being divided into separate business units, each focusing on a different market (residential, commercial, and international markets). All firms interviewed indicated that the single family housing market accounts for between 85% to 100% of their residential sales. While multi-family dwellings accounted for the remainder of sales to the residential market, some manufacturers stated that many multi-family dwellings use furnaces that are chiefly sold to the commercial market.

Stocking and Inventory Practices

Major manufacturers differ with respect to their production, inventory, and sales strategies, however most indicated that they do not maintain significant levels of product inventory. Prior to the 1990s, many manufacturers practiced traditional batch manufacturing methods, by which a product was manufactured and stocked to cover orders for a specified time period in the future. In the early 1990s, many switched to "just-in-time" or "build-to-order" systems, implying that, in general, inventory levels are kept as low as possible.[8] At least one of the major manufacturers is known to operate on a "build to order" basis, taking into account the seasonal differences in demand. Some companies exert pressure on distributors to inventory and warehouse the furnaces themselves, while other manufacturers maintain some regional inventory stocks that can be shipped to distributors.

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[7] About half of the firms interviewed were hesitant to provide specific statistics pertaining to the company's sales, citing that the data is considered proprietary.

[8] One firm mentioned that this typically means that no inventory is kept on hand, while another indicated that a "safety stock" of roughly 10% of sales is maintained.

A manufacturer of gas furnaces may gain advantage in "locking up" distribution channels by selling a more complete line of HVAC equipment than rival firms. This could explain why many of the more familiar brand names in the gas furnace market are also familiar names in the market for residential air conditioners. An industry source remarked that the broad product lines offered by some manufacturers allow a distributor to build an entire business around the products of one manufacturer. One may presume that there are also some cost advantages accruing to those manufacturers capable of spreading their administrative, selling, and advertising costs over a multi-product line of "home comfort" products. Other manufacturers solely in the business of producing furnaces or air conditioners would presumably not enjoy such benefits.

Research and Development of New Technologies and Manufacturing Innovation

All of the manufacturers interviewed indicated that their firms engage in research and development, but half of the companies would not divulge specific data regarding research and development efforts. According to those who did respond, research and development efforts can account for between 2% to nearly 20% of the manufacturer' s operating budget.

All respondents mentioned that their company has implemented manufacturing innovations since 1990. In general, the primary reasons for changes in manufacturing include the following:

- To decrease overall manufacturing costs to maintain or increase competitive position in the market,
- To increase efficiency of the manufacturing process, (i.e., reduce the noise level of the manufacturing process), and
- To improve/alter manufacturing techniques for product development (i.e., developed a single furnace with a wider operational range that replaced three existing products).

While companies stated that they each perform their own research and development, respondents cited trade publications, equipment vendors, and competitors as sources of information on new technologies and manufacturing techniques.

5.6 Gas Furnace Distributors

Gas furnace distributors function as intermediaries between manufacturers and HVAC contractors. As shown in Figure 5-3, the distribution of residential gas furnaces is a "one-step" process in which the manufacturer sells product to distributors, who then re-sell the product to HVAC contractors. In fact, most firms will sell only to licensed HVAC contractors. Distributor either ship the units to the HVAC contractor or directly to the job site, depending on the size of the order.

In general, the distributor's function in the new construction market is limited to the sale of product to contractors. They typically have little influence on equipment purchase decisions because they do not interact directly with the builder or development team. Further, distributors are not viewed as market actors that provide the builders and contractors with a significant amount of information. Although some might have their own sales representatives, distributors do not typically market the products they carry and rely heavily on the manufacturers' marketing and advertising efforts.

The distribution market in Southern California, as in many other areas of the country, has consolidated over the past 20 years with many of the smaller distribution firms being bought out by larger rivals. There are now only 10 to 15 distributors of HVAC equipment for the residential and small commercial markets in Southern California. Of these firms, five or six account for about 70% of the market with each distributor operating more than one business location. Some of the larger distributors have as many as 10 to 15 individual locations. Southern California's key HVAC equipment distributors include Heating Supply, SACAD (the Carrier distributor for Southern California), Familian HVAC, Air Cold Supply (a division of Westburn Supply), and Howard. Some of the firms involved in furnace distribution are said to be part of larger publicly traded companies. Most HVAC distribution firms reported that, while some changes have occurred in the industry, no major changes have occurred to their distribution practices during the 1990s.[9]

All of the firms interviewed for this study are independent distributors that specialize in the products of just two or three manufacturers. The brands carried by these distributors include the Carrier brands (Bryant, Payne, Day & Night), York, Goodman, Modene, Mitsubishi,

[9] One distributor mentioned that a recent change in the furnace market is the introduction of gas furnaces into large home center stores, such as Home Depot. This distributor indicated that his firm serves an HVAC contractor who effectively sells furnaces for Home Depot. When a customer walks into a Home Depot store and looks at furnaces, a tag on the product instructs them to call a toll free number which puts them into direct contact with the HVAC contractor. This contractor actually performs the furnace sale on behalf of the Home Depot store. One of the distributors interviewed is the source of furnaces that this HVAC contractor uses to stock furnace product in the Home Depot store. This change in the industry does not affect the new construction market, as contractors for new construction projects are still more likely to purchase equipment from the "traditional" distributor.

Resher, Teledyne-Laars, and Bard. While the manufacturers set price guidelines for furnaces, distributors retain the right to set the prices for the products they sell.

Types of distribution, equipment brands and product lines, company size characteristics, and stocking and inventory practices of gas furnace distributors are discussed below.

Distribution Practices

All manufacturers sell their product to an intermediary firm for distribution to the retail sector or to the end user. While some manufacturers own these distribution companies (i.e., "factory branches"), others exclusively use privately owned independent firms. Some also use a combination of both factory-owned and independent distribution. It is estimated that about 85% to 90% of all furnace sales move through traditional independent distribution channels. Each of these distribution types is described below.

- ***Factory-Owned Distribution.*** The factory-owned distribution firm is essentially nothing more than a regional warehousing operation for the manufacturer, complete with a sales force and transportation fleet. Their strategic decisions center around understanding the needs and motivations of the firm's existing customer base, as well as how to increase sales by targeting new customers.

  Manufacturers that own their distribution companies are the exception rather than the rule. At least one independent distributor in Southern California was owned by a manufacturer until the management bought the company less than a decade ago. As one manufacturer's representative explained, "It takes a lot of money to buy warehouse space across the country and to employ a nationwide sales force."

- ***Independently Owned Distribution.*** Independent distributors have a unique position in the distribution industry. Since these distributors are **not** owned by equipment manufacturers, they can competitively choose its equipment stock from a wide selection of products offered by a number of manufacturers. It is not uncommon to find distributors that are privately held firms that have been controlled by a particular family for as many as three generations.

  Some in the industry question how much power and control the manufacturers exert over independent distributors. The issue has been characterized as manufacturers putting pressure on distributors to "take" a large amount of their product, in some cases, possibly more than the distributor can handle. For distributors who are not in good financial health to begin with, such practices could result in the distributor going out of business. In other cases, the manufacturer might seek to keep the distributor operating by offering to purchase an ownership stake in the business. Some of these privately held distributors may be partially owned by manufacturers.

- ***Combination Distribution.*** Other manufacturers employ both factory owned and independently owned distribution approaches. For example, Carrier's

distribution philosophy has been characterized as using "either independent wholesalers or factory branches" and offering exclusive distributorships. Carrier claims to have 200 independent distributorships nationwide, each operating in its own geographic territory. These companies, in turn, sell product to independent HVAC dealers. The Carrier distributor in Southern California (SACAD) was at one time a factory branch, until SACAD management offered a plan to buy the distributorship from the manufacturer. Other companies, such as International Comfort Products (with brands such as Heil and Tempstar) do not offer exclusive distributorships.

Equipment Brands and Products

Most residential and commercial HVAC distributors carry a wide range of HVAC products and operate within large regional areas. Due to the benefits achieved by purchasing in volume, most HVAC distributors tend to carry the products of only one or two manufacturers at most. In addition to gas furnaces, distributors sell air conditioners, filtration equipment, ventilation fans, blowers, registers and grills, refrigeration equipment, and related supplies, such as sheet metal, ductwork, tools, replacement parts, and adhesives.

Some manufacturers will compensate their distributors for reaching a particular "sales plateau," or achieving a market share target for a particular region. For this reason, competition between brands tends to become more intense at the distributor level, with various distributors trying to get their products to retail dealers. Adding to competition at the distributor level is the fact that buying power among retail contractors is relatively strong in terms of extracting a favorable price from distributors.

Company Size and Sale Volume

The gas furnace distributors that participated in this research each sold between 10,000 and 15,000 residential gas furnace units in 1997; sales have grown just less than 10% annually since 1994. One distributor, however, explained that their company is phasing out the residential gas furnaces that they carry and concentrating on the commercial market.[10] Most distributors reported that sales for new construction projects account for 25% to 40% of total sales.[11] These distributors tend to be large companies that can accommodate the large orders of residential tract builders. Firms uniformly responded that virtually all (92% to 100%) of their residential furnace sales are for single family projects.

[10] This distributor stated that his firm sold less than 100 residential gas furnaces during 1997.

[11] One distributor interviewed (the smallest of those interviewed) reported that 0% of 1997 sales went to this market.

Stocking and Inventory Practices

The stocking and inventory practices of HVAC equipment can be described as a balance between the ability to meet current demand for a variety of products and the prevention of stock-outs on popular items. It is crucial that the distributors ensure that they stock all advertised and promoted items. Distributors often forecast sales and inventory needs based on past demand, future orders, and marketing plans. Once these factors have been taken into account, inventory levels are then set to meet the expected demand.

Some distributors can be considered " full-line supply houses" that stock all products that the HVAC contractor requires to install and service a residential or small commercial products. While one distributor indicated that his firm is stocking less residential and more commercial product, others noted that inventory levels have increased during the 1990s to meet the need for large or immediate orders and to accommodate the expanding new construction market in Southern California.

5.7 Water Heater Manufacturers

Roughly 8.9 million water heaters were sold in the United States during 1996. Preferences for gas-fired over electric-fired water heaters vary according to the fuel cost differential in a particular area of the country. Gas-fired water heaters accounted for 53% of all water heater sales last year, 92% of which used natural gas. Liquid propane (LP) gas-fired water heaters account for the remaining 8% of gas water heaters. As a whole, the market for water heaters has increased roughly 6% from 1995 to 1996.

There are currently five manufacturers of standard (direct-fired) residential gas water heaters in the United States – A.O. Smith, Bradford White, Rheem, Southcorp, and State Industries.[12] In the 1960s, there had been as many as 60 to 100 companies, but the industry has since consolidated because of the economies of scale required for production and the complex technology required to produce gas-fired units.[13] In addition to the primary manufacturers, two Canadian firms sell a small amount of product into the United States.

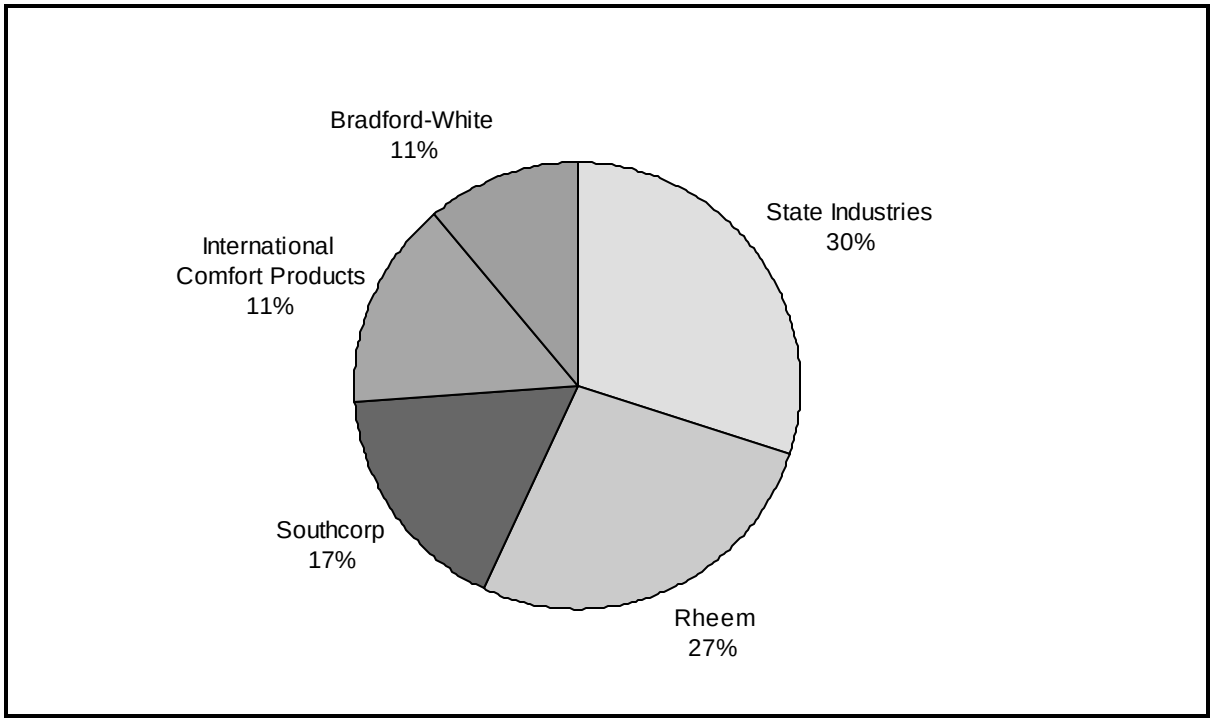
As shown in Figure 5-4, State Industries and Rheem Manufacturing accounted for 57% of the market in 1996. Southcorp is the third largest player in the U.S. water heater industry with a market share of 17%. Southcorp is an Australian-based firm owning a number of water heater manufacturers around the world and markets some of its products under the "Rheem"

[12] This does not including those that manufacture indirect-fired units where water is heated indirectly, typically from a central furnace.

[13] The combustion technology required in gas water heaters was also mentioned as a potential barrier to entry in the industry.

brand name throughout Australia and New Zealand. A.O. Smith and Bradford-White are the smallest two of the five primary firms, with market shares of 15% and 11% respectively.

Figure 5-4: Water Heater Market Share by Manufacturer



Source: Appliance Magazine

In addition to these five primary firms, other small water heater manufacturers exist that serve specialty niche or regional markets.[14] For example, Vaughn Manufacturing, a manufacturer of electric water heaters in New England, serves specialty markets too small to be of any interest to the larger manufacturers. A particular product niche served by Vaughn includes the market for indirect water heaters that are heated through a connection to the home' s central furnace.

The water heater manufacturers interviewed for this study included American Water Heater (a subdivision of Southcorp), A.O. Smith, Bradford White, and Rheem. All are large firms in which water heater manufacturing is either the primary business or among the core businesses of the firm. Large manufacturers can have multiple manufacturing facilities and sales regions, each with its own corporate office.

The remainder of this section summarizes the water heater manufacturing industry, including the following;

[14] The shares of these small manufacturers are not included in the shares presented in Figure 5-4.

- The primary functions and interactions of water heater manufacturers in the residential new construction industry,
- Primary equipment brands and product lines,
- Company size and sale volumes,
- Stocking and inventory practices, and
- Research and development initiatives.

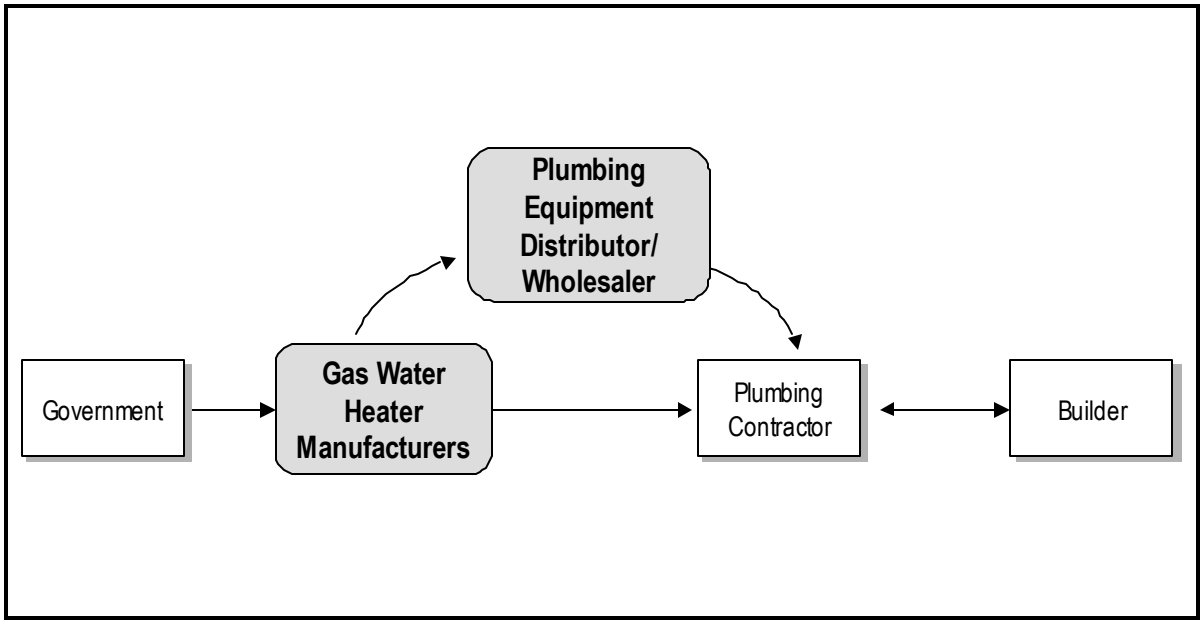
Primary Functions and Interactions in the RNC Market

Gas water heater manufacturers have two primary roles in the residential new construction market:

1. The design, development, and production of equipment, and
2. The dissemination of information to other key market actors.

The role of gas water heater manufacturers is very similar to that of gas furnace manufacturers. Figure 5-5 depicts the role of gas water heater manufacturers in the residential new construction market and the market actors with which manufacturers directly interact. As shown, manufacturers interact with equipment distributors and plumbing contractors, and provide builders with product and technology information. Though the dissemination of information is critical to builders and the development teams that specify equipment, their primary function in the new construction market is to produce and sell water heaters to plumbing supply distributors and wholesalers, who then distribute the water heating equipment to the rest of the market. In the residential new construction market, plumbing equipment distributors and supply companies sell product primarily to plumbing contractors.

Figure 5-5: Gas Water Heater Manufacturers and Distributors in the RNC Market



As with the gas furnace marketing industry, gas water heater manufacturing is demand driven. The market actors demanding the product – mainly distributors and plumbing contractors – have a strong influence on manufacturers. The government also has a substantial influence through the regulation of efficiency levels of the units produced. These market interactions and influences are discussed below.

- ***Equipment Distributors.*** As with other industries, water heater manufacturers interact with distributors mainly through product transfer. Through these interactions, distributors are providing the manufacturers with market signals with respect to the products that market actors downstream are demanding. Distributors, otherwise known as plumbing supply houses, act as intermediaries between the manufacturer and either the plumber or the end user. There are two primary channels of distribution – the retail channel and the wholesale channel. The retail channel consists of national retail chains (such as "do-it-yourself" stores) that generally procure product centrally through a corporate buyer. Retail chains do not deal in the new construction industry and account for roughly 51% of the entire residential market.

  The wholesale channel, which primarily serves the residential new construction market, consists of product distributors (generally plumbing supply distributors) who then sell product to plumbing contractors. While most manufacturers sell through both the retail and wholesale channels, none sell directly to builders, primarily because the manufacturer cannot provide the same quality of service as an equipment wholesaler or retailer. In projects for large builders, a wholesaler representative is typically on the job site daily.

- ***Plumbing Contractors.*** While the production of water heating equipment is their primary function, manufacturers provide a significant amount of information to other market actors, primarily plumbing contractors, builders, and equipment distributors. Such information generally pertains to new equipment and products and is disseminated by literature, sales representatives, and through trade associations. One of the largest manufacturers, in particular, is very proactive in its efforts to provide plumbing contractors with information, training, and technical assistance.
- ***Government Regulation.*** Similar to gas furnace manufacturers, government mandates are one of the greatest influences on energy efficiency levels of gas water heaters, from the manufacturing perspective. In particular, NAECA, effective January 1991 and subsequently revised, mandates minimum efficiency levels for water heaters.

Equipment Brands and Product Lines

In addition to water heaters, some manufacturers produce other water or electricity-related equipment. For example, one manufacturer operates four separate product divisions, including a water products group, an electric motor division, a plastic piping division, and a coatings division. The water products group manufactures residential tank water heaters, copper boilers, storage tanks, hydronic heating systems, and commercial water heaters. Another firm has two divisions: a heating and air division and a water heater division. The water heater division is segmented into retail and wholesale market segments.

Table 5-2 presents the brands of gas water heaters produced by each of the five primary manufacturers. Unlike the gas furnace market, most of the largest manufacturers (in terms of market share) have only one brand name under which they sell. One possible explanation for this difference is that a distributor of plumbing equipment cannot typically build its business solely around the products of a water heater manufacturer. This is in contrast to the HVAC distributor, who could exclusively stock the wide product line of a single HVAC manufacturer. Excluding Rheem, all major water heater manufacturers produce water heaters only. Rheem has two distinct business entities producing each product, indicating that there might not be much synergy achieved in combining the manufacture of both products.

Table 5-2: Water Heater Manufacturer and Brands

Water Heater Manufacturer	Brands
A.O. Smith	A.O. Smith
Bradford-White	Bradford-White
Rheem	Rheem, Ruud
Southcorp	American Water Heater, Mor-Flo, Proline, U.S. Craftmaster
State Industries	State

Company Size and Sales Volume

Most water heater manufacturers rely on outside sales firms, such as manufacturer's representatives, to promote their products to plumbing supply distributors and wholesalers. One of the firms interviewed claims to have the only "factory employed" sales force in the industry. Gas water heater manufacturer sales and size characteristics include the following:

- Company sales ranged from 1 million to 1.5 million water heaters in 1997.
- Rates of growth in sales ranged from as low as 3% to 4% up to 10% to 13% since 1994. Sales growth was lower prior to 1994, with estimates of about 1.5% annually between 1990 and 1994.[15]
- About 20% of annual water heater sales are for residential new construction projects, though most responses ranged between 15% and 30%. One manufacturer indicated that between 90% and 95% of the units are sold to the residential market, roughly 50% of which are gas fired.
- Sales to the single family new construction market far outweigh those for the multi-family market. Single family projects account for roughly 70% to 80% of the total sales to the new construction industry.[16]
- Manufacturers employ between 970 to 5,000 employees, 30% to 85% of which are involved in the production of gas water heaters.

The in-depth interviews revealed that there are seasonal fluctuations in the demand for water heaters, with a moderate increase occurring in the fall or winter. Increases are primarily due to the failure of units in cold weather, increases in the new construction market in the Northern United States, and wholesalers' efforts to increase their buying in November and December in anticipation of January manufacturer price increases.

[15] Variance in the level of housing starts could also help to explain the wide variation in the sales growth rates experienced during the early and mid 1990s.

[16] One respondent mentioned that multi-family structures often use commercial water heaters, and that single family homes are the vast majority of the new construction market.

Stocking and Inventory Practices

Water heater manufacturers generally employ either a "build-to-inventory" or a "build-to-order" strategy. "Build-to-inventory" firms tend to emphasize quick delivery, with the goal of supplying customers with product usually within 10 days of receiving the order. The "build-to-order" firms usually manufacturer product only after an order has been received and might stock only three to four days worth of inventory at one time. The manufacturers indicated that they maintain warehouses across the country and that their distributors also maintain their own warehouse space.

Overall, stocking and inventory practices have decreased since 1990, mostly because of company downsizing and operational and restructuring changes. Several manufacturers have either consolidated warehouses and/or sales regions, or have eliminated them altogether.

Research and Development of New Technologies and Manufacturing Innovations

All manufacturers have R&D departments. Although most were not sure or could not comment on the level of spending, one firm estimated R&D spending levels at 2% of annual operating costs.[17] Manufacturers that operate American Gas Association (AGA) approved labs, however, claim to have larger R&D efforts other water heater manufacturers. Most R&D spending levels have increased since 1990. One firm specifically stated that an increase aimed at assisting product development began in 1995. Other sources of information on new technologies among these manufacturers are R&D sponsored by GAMA and the exchange of manufacturing techniques and innovations at trade shows.

The majority of manufacturers have instituted some form of change to their manufacturing techniques since 1990, most of which have been ongoing over the past several years. As in other industries, the primary reasons for such changes include the following:

- To develop new product and/or improve the quality of existing products,
- To maintain the firm' s competitive position in the marketplace,
- To increase the efficiency of manufacturing processes and lower overall manufacturing costs, and
- To develop innovative manufacturing techniques that lower manufacturing costs without sacrificing product quality.

[17] One respondent was unsure as to the level of R&D spending at his firm because these efforts are paid for out of the budget of a separate but affiliated company.

5.8 Water Heater Distributors

As explained in the previous subsection, water heater distributors to the residential new construction industry function as intermediaries between manufacturers and plumbing contractors. The distribution of water heaters is a relatively concentrated industry, much the same as the distribution of gas furnaces. The primary water heater distributors in Southern California are Todd Pipe & Supply, Familian, Golden West, Hersch, Westburn, Don Miller, Niagara Plumbing, and P&M Service & Repair.

The water heater distributors interviewed for this study include Niagara Plumbing, Todd Pipe & Supply, Vista Pipe & Supply (Morally Wholesale), Moore Supply, and San Antonio Plumbing, all of which are independent firms that distribute the products of more than one manufacturer. Among the brands of water heaters distributed were American, Bradford-White, A.O. Smith, and Rheem/Ruud. In addition to water heaters, these distributors sell all plumbing-related products and accessories, such as fittings, parts, and pipes. All of the firms interviewed have a regional scope of operation that typically includes at least two major cities or spans multiple counties.

As previously shown in Figure 5-4, distributors primarily interact with plumbing contractors and manufacturers. As with gas furnace manufacturers, the plumbing equipment distributor' s function in the new construction market is limited to the sale of product to plumbing contractors. They have little influence on equipment purchase decisions because they do not interact directly with the builder or development team. Further, distributors do not provide the builders and contractors with a significant amount of information. Although some might have their own sales representatives, distributors rely heavily on the manufacturers' marketing efforts and do not typically need to aggressively advertise the products they stock.

Distribution Practices

As in the gas furnace industry, all manufacturers sell product to distributors, who act as an intermediary between the manufacturer and the final end user. Distributors sell to a variety of customers, including plumbing contractors, builders and building contractors, retail and plumbing supply stores, hardware stores, and occasionally, other distributors.

- ***Wholesale Distribution Channel.*** The wholesale distribution channel primarily serves the residential new construction market. In the wholesale distribution channel, manufacturers sell water heaters to distributors (also known as plumbing supply houses), who then sell water heaters to plumbing contractors, and sometimes to builders for installation in both the residential new construction and replacement/renovation markets.[18]

[18] One distributor indicated that, in California, it sells exclusively to C-36 licensed plumbing contractors.

- ***Retail Distribution Channel.*** The other primary channel of distribution is through national retail outlets, such as building supply chains and "do-it-yourself" stores. Because of their ability to buy in large quantities, these large retail chains typically purchase direct from the manufacturer and sell directly to the public and plumbing contractors.

  The retail channel of distribution is said to have cut significantly into the water heater business of many traditional plumbing supply distributors in recent years. One market actor (in water heater manufacturing) characterized the distribution of water heaters as being nearly evenly divided between the two channels of distribution. One of the major manufacturers of water heaters has exploited this change in the market by heavily marketing to plumbing professionals. Plumbing supply stores and "do-it-yourself" retail stores are described in more detail below.

  - ***Plumbing Supply Stores.*** The plumbing supply firm distributes a wide assortment of plumbing-related products and equipment to the plumbing trade. The purchasing decisions made by the supply firm relate to a variety of manufacturers and products, only one of which pertains to water heaters. For this reason, the relationship between the supply firm and the water heater manufacturer is less critical to the success of the supply firm than is the similar relationship between independent firms and manufacturers. The issue of volume purchasing, however, is still an important one and probably explains the fact that most supply firms will carry the water heaters of only one or two manufacturers at most.

    Among supply firms, some of the most important decisions relate to product pricing and stocking. With the recent advent of "do-it-yourself" firms entering the market for water heaters and other plumbing supply equipment, the supply stores have come under increased pressure to provide competitive pricing and still maintain a wide product selection. In order to be competitive with "do-it-yourself" firms, supply firms must negotiate the lowest possible prices with manufacturers and still maintain a wide selection of equipment required by the trade. With their historical price margins coming under pressure, and a large portion of their business being taken by the "do-it-yourself" firms, the supply firm must find ways to either increase volume or find specialty market niches as a way to maintain historical profitability levels.

  - ***"Do-It-Yourself" Distributors.*** The "do-it-yourself" firms are the most recent entrant into the water heater distribution industry. These stores primarily serve the replacement market for water heaters, but their role in the market appears to be a combination of both distributing and retailing. While some "do-it-yourself" firms have also entered the retail market for central furnaces, they do not appear to have made significant inroads at this time. Within the water heater market, these firms serve as both a retailer to the general public and a supply source for the plumbing trade. Because of their large volume purchasing capacity, the "do-it-yourself" firms exert significant

power over manufacturers and are often able to extract a more favorable price than the plumbing supply companies. The purchasing decision of "do-it-yourself" firms is therefore a significantly important one.

Some of the factors in making this decision relate to the manufacturer's volume-purchase price policy, the ability of a manufacturer's product line to serve the needs of the wide geographic market, and the willingness of manufacturers to provide extra service to the "do-it-yourself" firm. Other important decisions include the amount of floor space to allocate among the assortment of products, the retail price (and contractor price) for the products, and the share of total product space occupied by the products of one manufacturer versus those of another.

The entry of these stores into the market is said to have put some of the plumbing supply wholesaler and distributors out of business. Because of their ability to buy in large volumes, "do-it-yourself" stores avoid the traditional distributor and purchase directly from the manufacturer and are often able to provide plumbing contractors with a better price than they could obtain through a plumbing supply store. This has caused increased competition for the plumber's business between the traditional plumbing supply stores and the "do-it-yourself" stores.

An important aspect of "do-it-yourself" stores is that they will typically sell equipment directly to the retail public. A water heater can be purchased either by itself without installation, or with installation by a plumber with whom the store has contracted.

Some manufacturers have viewed the increased competition among plumbing supply stores and "do-it-yourself" stores as a market development that can be exploited. Bradford-White, in particular, has positioned itself as selling "Water Heaters Built for the Plumbing Trade." In literature aimed at the plumbing trade, the company states that "almost every company making water heaters has made the decision to sell direct to your competition, the big retailers and home centers." The company states that it does not split its loyalties and believes that water heaters should "only be installed by professionals." Other manufacturers have come out with their own "professional" product line that is only available through plumbing supply houses.

Similar to the furnace market, there is a varying amount of manufacturer involvement in the ownership of distribution channels. Goodman Manufacturing owns a distribution firm called Janitrol, which is a major player in the Wisconsin markets. The focus of this firm is on low margin, high volume sales with very few frills. Their primary mission is to get equipment to the market inexpensively and reports are that they have been successful in their efforts to compete with the traditional distribution supply houses.

Products and Brands

Plumbing supply stores and distributors target the needs of residential and small commercial customers. Even though there is not a great deal of overlap between the distributors of residential furnaces and residential water heaters, a few major distributors stock both gas furnaces and water heaters. While exclusive distributorships in the water heater business are not common, it is rare to see distributors carrying more than just one or two brands. As in the furnace distribution market, manufacturers often set market share targets that allow distributors to earn an extra bonus if met. Margins on water heaters are lower than those on HVAC equipment and, as a result, some distributors believe that there "isn't as much at stake" in determining which manufacturer's products to carry. One contractor remarked that supply houses seem to switch the brand of product they carry every one and a half to three years.

Company Size and Sales Volume

The distributors that sell the majority of water heating units for residential new construction typically have higher sales volumes than the companies that target the replacement and renovation market. One firm in particular explained that their water heater sales in 1997 were roughly 10,000 units, 70% of which were sold for single family new construction market projects. Because of the growth in the new construction market in Southern California, sales for residential new construction have increased over the past several years. Single family new construction accounts for roughly 70% to 90% of water heater sales by distributors, the remainder being sold for renovations and remodeling projects.

Stocking and Inventory Practices

Most water heater distributors stock substantial levels of product to ensure the water heaters can be delivered to the job site on time. However, some companies have been decreasing their stock and relying more heavily on forecasting future business based upon past sales. Inventory is therefore reduced and the company reorders from the manufacturer more often. There have been no significant changes in the stocking and inventory practices of water heater distributors over the past several years.

5.9 Window Manufacturers

There are several thousand firms manufacturing windows nationwide. The firms in the industry vary in structure and produce a wide variety of window and non-window products. Many of these manufacturers tend to be small firms that sell their product only in one local area or region, while a few of the largest window manufacturers have well over a thousand employees and distribute their products internationally. The characteristics of large, medium, and small window manufacturers are summarized below.

Large Manufacturers. The four largest national window manufacturers are Andersen, Marvin, Pella, and Weather Shield Manufacturing. The combined market share among the largest window manufacturers has been estimated in the range of 20% to 30% of the overall market (Eto, Arasteh, Selkowitz, 1996). The total number of large window manufacturers (producing more than 1,000 windows per day) is estimated to be between 12 and 20 firms within the U.S. and Canada. A source at one of these large firms has estimated the combined market share of the four largest firms as closer to 20%. These four firms are located in a relatively concentrated geographical area in the Midwest, with both Andersen and Marvin in Minnesota, Weather Shield in Wisconsin, and Pella in Iowa.

The largest firms occasionally purchase small- or medium-sized manufacturing firms, sometimes maintaining the old brand name, but usually replacing it with the larger firm' s brand name eventually. Andersen Windows owns two window manufacturers in Atlantic Canada and has maintained the brand names of the original manufacturers. Andersen is said to have purchased nearly a dozen small manufacturers during the past year.

One recent industry trend has been the acquisition of several small, regional manufacturers by the larger national firms. While some of the acquiring firms will integrate the new firm into their current corporate structure, others will continue to operate the acquired firm under its traditional corporate name. A number of holding companies also exist that own several small or medium manufacturers and operate these firms as independent businesses. If considered as one firm, some of these holding companies might be viewed as large organizations with substantial market share.

Medium Manufacturers. The number of medium-sized window manufacturers has been characterized as "moderate," with their combined market share estimated at between 30% and 50% (Eto, Arasteh, Selkowitz, 1996). In particular, the number of medium-sized manufacturers within the U.S. and Canada has been estimated at about 200 firms. These medium-sized firms tend to focus on serving the needs of their region, rather than only a local area or a huge national territory. Much as with the industry as a whole, it is difficult to generalize about what these firms "look" like. Some millworking firms produce a variety of wood products for the building industry and also produce wood doors and windows. Other firms engaged in the manufacture of either metal or plastic building materials may also produce aluminum or vinyl windows. Still other firms will buy either linear aluminum or vinyl from extrusion firms, glass from a manufacturer, and assemble the finished window themselves. Firms that mold the purchased framing materials, cut the glass to required sizes, and assemble the window are known as "fabricators." These fabricators are also categorized as window manufacturers.

Small Manufacturers. The majority of window manufacturers are small firms operating within a localized geographic area. Among these small firms, there is said to be substantial entry and exit into the window manufacturing industry, as well as "intense" price competition among the firms (Eto, Arasteh, Selkowitz, 1996). These small manufacturers (estimated to number over 2,000 nationwide) are believed to have a combined market share of 20% or less (Eto, Arasteh, Selkowitz, 1996). Many serve only their immediately local markets and have sales forces based out of the same facility where manufacturing occurs. Due to the expertise and capital required, many of these smaller firms do not have a strong offering of energy-efficient products (Eto, Arasteh, Selkowitz, 1996).

The following sections summarize the following:

- Primary functions and market interactions of manufacturers in the residential new construction industry,
- Equipment brands and product lines of the manufacturers,
- Company size and sales volumes,
- Stocking and inventory practices, and
- Research and development efforts.

Primary Functions and Interactions in the Residential New Construction Market

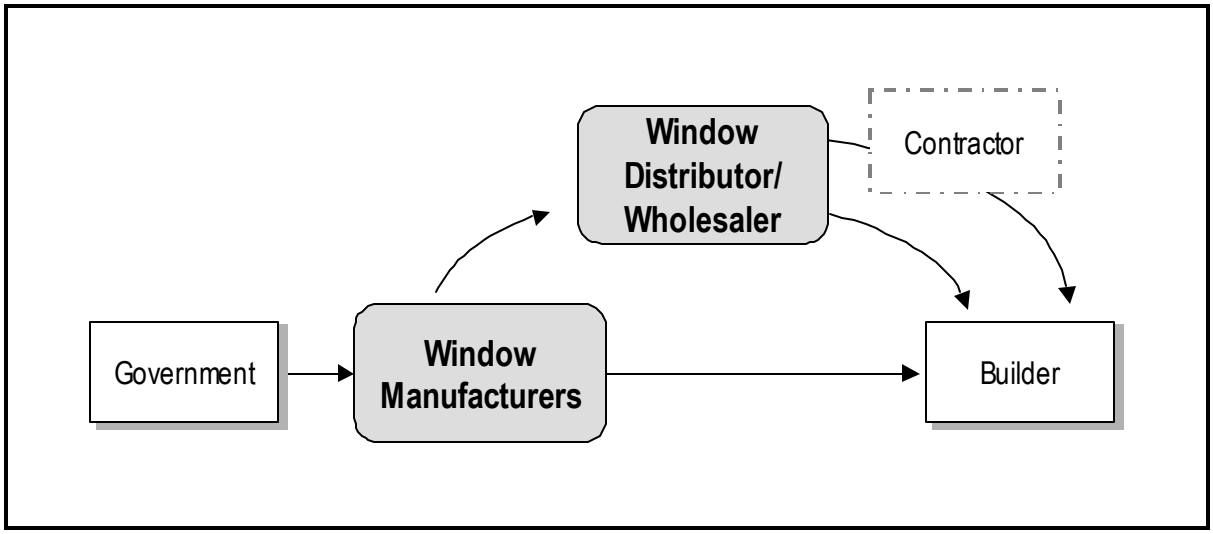
Similar to gas space and water heating equipment manufacturers, window manufacturers have three primary roles in the residential new construction market:

1. The design, development, and production of equipment,
2. Direct sales to builders or distributors, and
3. The dissemination of information to other key market actors.[19]

Figure 5-6 depicts the role of window manufacturers in the residential new construction market and the market actors with which they directly interact. As shown, window manufacturers interact primarily with window distributors and builders. Because manufacturing is demand driven, the builders and distributors (those that demand the product) have a great deal of influence on manufacturing decisions and the characteristics of the windows produced. The government also has a significant influence on the industry through the regulation of efficiency levels and other characteristics of the windows that are manufactured. These market interactions are discussed briefly below.

[19] Note that neither window manufacturers nor builders interviewed for this study indicated that manufacturers performed installations. Information obtained from the in-depth interviews indicates that builders and/or subcontractors install windows.

Figure 5-6: Window Manufacturers and Distributors in the RNC Market



- ***Window Distributors.*** Manufacturers interact with distributors mainly through product transfer – the distributors sell the units that the manufacturer produces. Through these interactions, distributors are providing the manufacturers with market signals with respect to the products market actors downstream are demanding. Window manufacturers either exclusively own their own distribution companies or sell to an independently owned distributor. Window manufacturers mostly employ either a "two-step" or a "one-step" distribution process, selling their product to distributors, who then sell to either contractors (for installation in new homes) or to retail stores (for purchase by contractors and homeowners). One manufacturer in particular has about 100 exclusive distributors nationwide to handle its product line. Another manufacturer estimated that more than 90% of its units are distributed through a one-step system by using independent distributors.
- ***Builders.*** Interviews with both builders and window manufacturers reveal that roughly 35% of the builders purchase windows directly from the manufacturer.[20] With the primary objective of increasing sales and brand/company loyalty, manufacturers provide a great deal of equipment information relating to new technologies and materials. There are several means by which manufacturers disseminate information to the marketplace, including in-person contact between a manufacturer (sales) representative and the builders, trade literature, and trade association meetings and conventions.
- ***Competition.*** While all market actors interviewed for this study cited competition as a strong influence on the equipment they either produce for or install in residential new construction, window manufacturers explicitly stated that competition from other manufacturers influenced the variety and quality of products they manufacturer.

[20] The remaining 65% are equally split between purchasing from a window distributor and from subcontractors.

- ***Government Regulation.*** Even though all equipment manufacturers are subject to government regulations, the window manufacturers interviewed for this research placed less emphasis on government mandates than did the other manufacturers. However, window manufacturers cannot ignore pressures from both state and federal building codes. In particular, manufacturers cited the Model Energy Code and California' s Title 24 as influential on their manufacturing processes.

Equipment Brands and Product Lines

The product mix of window manufacturers varies from firm to firm, but most window manufacturers produce a wide variety of window and door-related building products, each specializing in a certain material and quality and/or style (i.e., clad with either wood, vinyl,or aluminum, or specializing in patio doors).[21]

Company Size and Sales Volume

Among those interviewed, production ranged from 45,000 units to over 4 million units in 1997. The largest manufacturer in the sample with international distribution produced over 60 million residential windows last year. Overall, the manufacturers indicated that sales have been increasing since 1990, but are sensitive to the economy and the strength of the housing market.

The largest manufacturer interviewed for this study explained that their traditional retail market used to be among custom builders and/or remodelers. However, many window manufacturers are recognizing the large national builders of tract home developments as a new target market. Window sales for new construction projects can be generalized as follows:

- The residential new construction market accounts for over 50% of the total units sold in 1997. Manufacturers estimated that 55% to 90% of the total number of units sold are for residential new construction projects.
- Sales for single family projects range from 20% up to 80% to 90% of the total sales to the new construction market.

Stocking and Inventory Practices

Most manufacturers described their current stocking and inventory practices as "build-to-order." In general, they stock a significant number of parts, but windows are only assembled once an order has been received. Manufacturing innovations in glass cutting, for instance, have drastically reduced production time, thereby enabling the manufacturers to fill orders

[21] With the decline of aluminum window products, many forma aluminum window manufacturers have switched production to vinyl windows (Eto, Arasteh, and Slekowitz, 1996).

more quickly and reduce storage costs. While some manufacturers might stock up to two or three weeks of product at a time, most operate on a "build-to-order" basis.

Research and Development of New Technologies and Manufacturing Innovations

All window manufacturers have a research and development department, with R&D spending accounting for roughly 1% of the annual operating costs. All manufacturers indicated that R&D spending has increased since 1990 and that the increasing efforts have been a continuous process over time. Some manufacturers might also have access to the R&D efforts of its parent company. One manufacturer in particular explained that their R&D department was very active working with utilities and helping to develop National Fenestration Rating Council standards. In general, R&D efforts and manufacturing innovations accomplish the following:

- To continue to improve product quality and durability,
- To continue to improve manufacturing processes,
- To develop low maintenance products, and
- To develop new energy saving technologies.

5.10 Window Distributors

As explained in the previous subsection, window distributors in the residential new construction industry function as intermediaries between manufacturers and plumbing contractors or builders.

The majority of window distributors are independent companies that stock a variety of windows, doors, and related building materials. They have regional sales territories and sell primarily to retailers such as Home Depot and lumberyards, in addition to builders and some contractors. The following sections discuss the distribution practices, size and sales volume, products and brands carried, and the stocking and inventory practices of window distributors.

Distribution Practices

Distribution within the window industry occurs through "two-step," "one-step," or "direct" methods. Window distributors sell to a variety of market actors, including builders, retail lumberyards, and "do-it-yourself" stores or retail chains such as Home Depot. Products for residential new construction projects are sold to both builders and contractors and retail stores. In the case of large builders purchasing a national brand, the issue of going through the distributor occurs on paper only and the manufacturer ships the product directly to the builder. Other manufacturers sell directly to retail outlets, such as window and door stores or lumberyards, and require the builder to purchase from these retailers. In the case of smaller

builders, such as custom homebuilders, national brand windows can typically only be obtained through a window retailer.

Company Size and Sales Volume

The majority of window distributors operate in regional areas consisting of multiple cities or counties. The size and sales volume characteristics of the distributors interviewed for this study include the following:

- Sales volumes of residential windows ranged from 10,000 to 26,000 units in 1997.
- Most firms would not provide historical sales data, but indicated a 50% growth in sales from 1990 to 1994 and a 26% increase in from 1994 to 1997.
- Roughly 20% to 25% of total employees are involved in the distribution of residential style windows.
- New construction projects account for 40% to nearly 90% of residential window sales.
- Roughly 90% to 100% of sales to the residential new construction market is for single family housing projects.

Products and Brands

While some distributors carry only the window products of one manufacturer, others carry the products of multiple manufacturers. The desire of some manufacturers to have exclusive distributors can be attributed to some extent to the manufacturer' s desired product positioning as a premium or exclusive brand. Despite the fact that some of these distributors are exclusive, the retail stores or lumberyards that they sell to are not. Exclusive distributors either carry their own brands or the brands of other manufacturers in non-competing product lines such as lumber. Most distributors are engaged in a broad product line of building materials, but there are distributors specializing in windows and doors. Some firms only distribute products, while others will "add value" to a bare window or door by adding window moldings or an entrance unit that surrounds the product itself.

Stocking and Inventory Practices

Stocking and inventory practices vary across distributing companies, but there is a common trend toward decreasing inventory levels, placing more orders from the manufacturer, and selling more product that is shipped directly from the manufacturer to the customer. As in other equipment industries, window distributors are relying more on forecasting future sales and will only maintain higher inventory levels of product with quick turnover times. About half of the distributors indicated that they maintain inventory levels on hand of between $1 million to $1.25 million, while others will typically inventory about seven to 10 days worth of product.

5.11 Builders

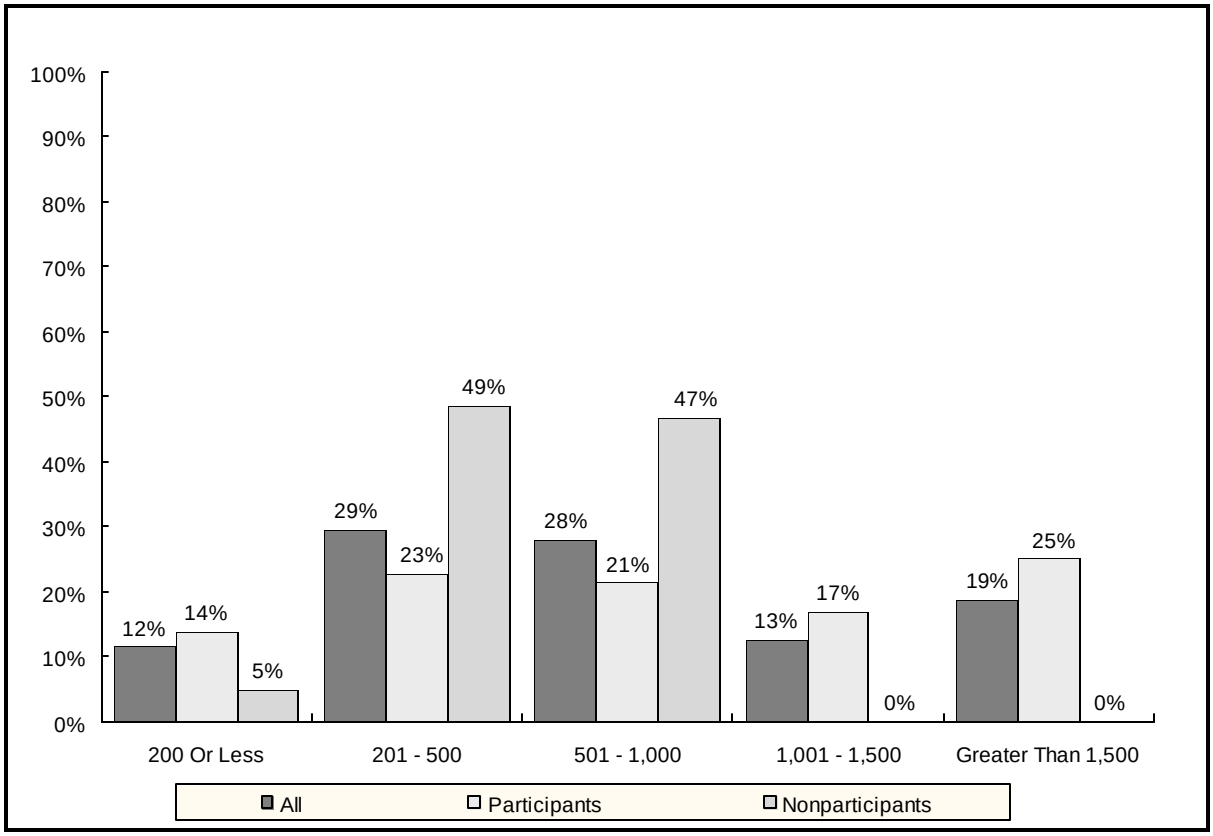
In the context of this study, the term "builder" refers to a composite of roles, which might or might not be handled by the same entity, including those of developer, builder, and general contractor. In a general sense, the builders' primary functions include project planning, design, specification, and supervision.

The interview sample of builders included the following major builders in Southern California: Barratt, Beazer, Brookfield, Centex, Del Webb, Fieldstone, Greystone, John Laing Homes, Kaufman and Broad, Lewis Homes of California, Pacific Bay, Pardee Homes, and Standard Pacific.

The sample of builders interviewed for this study is fairly representative of the new construction market in Southern California. The majority of builders are developers of single family tract housing, though several respondents also built custom homes in 1997, and a few developed multi-family buildings. Approximately 90% of the homes built by the builders in the interview sample were single family homes, 96% of which were tract housing developments.

Figure 5-7 shows the distribution of the California builders in the sample according to the number of homes built in 1997. As shown, about 12% of the builders in the sample from Southern California built 200 homes or less in 1997, several of which were involved in custom projects. Nearly 60% reported completing between 200 and 1,000 homes and about 32% reported completing more than 1,000 homes in 1997. This figure reveals that none of the nonparticipant builders reported building more than 1,000 homes. A greater percentage of the nonparticipants completed between 200 and 1,000 homes compared to the participants.

Figure 5-7: Number of Homes Built in 1997 (Self Reported)



The remainder of this section describes the following in detail:

- The builder' s primary functions and interactions in the residential new construction market,
- The decision process through which builders specify energy-related equipment and shell measures,
- The influences that other key market actors have on builder decisions regarding equipment and shell measures,
- The equipment characteristics and features that builders feel are most important in their decisions regarding energy-related equipment and shell measures, and
- Builders' primary information sources for trade-specific information and information pertaining to the latest technologies and methods to increase energy efficiency.

The differences between single family custom and tract housing and the multi-family markets are also explained in each section, where applicable.

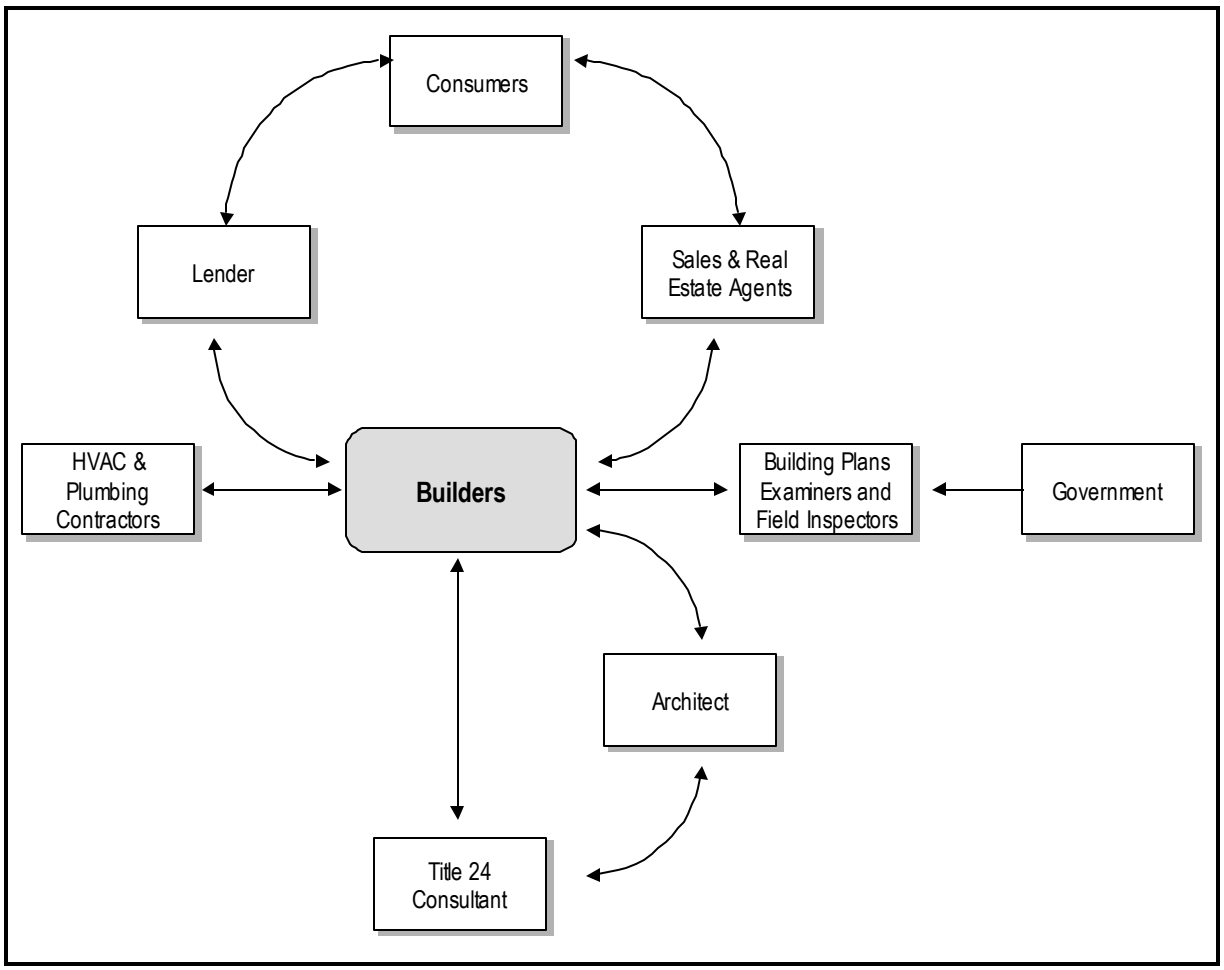
Primary Functions and Interactions in the Residential New Construction Market

Being the central figure in the residential new construction industry, the tract development builder performs numerous functions in the market, including the following:

1. Implementing market research,
2. Overseeing the design and planning of the home(s),
3. Specifying equipment and shell measures,
4. Soliciting and awarding bids for contractors,
5. Overseeing construction, and
6. Initiating the sale of the home.

As depicted in Figure 5-8, builders interact with numerous key market actors, including equipment manufacturers and distributors, architects, Title 24 consultants, HVAC and plumbing contractors, lending institutions, and sales and real estate agents. Builders also interact with building plans examiners and building inspectors, who ensure that the plans meet the minimum energy efficiency requirements as mandated by Title 24.

Figure 5-8: Builders in the RNC Market



The extent to which builders interact with other market actors, the influence that builders have on energy efficiency levels of the home(s), and the functions they perform in the market, in general, can vary depending on the size of the builder and the project type (i.e., tract or custom). For example, the in-depth interviews with builders revealed notable differences between the roles of some market actors and decision-making influences of custom and tract developers. Builders concentrating on custom home construction are typically smaller companies that have a substantial amount of interaction with their clients. Essentially, the consumer is the ultimate decision maker in a custom home project. In contrast, builders concentrating on tract developments are typically larger corporations with various departments and managers sharing the decision-making process.

Tract Developers. Builders of tract developments are typically larger corporations with various departments and managers within the corporate structure sharing the primary decision-making responsibilities. Large builders and developers perform two primary functions: they plan master communities, and plan and design the homes within the

communities. A key characteristic of a tract development is that a small number of building plans (or multiple variants of a single plan) are used to design all homes in a single development.[22]

Within a large building firm, a team of individuals consisting of some or all of the following provides their input and expertise throughout the planning, design, specification, and construction phases of tract development:

- Vice President,
- Regional or Division Manager/President,
- Vice President of Development,
- Director of Construction,
- Director of Purchasing,
- Director of Marketing,
- Engineering Department,
- Architecture Department,
- Design Department, and
- Sales/Customer Operations.

The Vice President and Division or Regional Manager have broad areas of responsibility and oversee all company operations, including forward planning and development. The Vice President or Director of Development typically oversees all company subdivisions and company operations, including land development, marketing, product development/design, construction, architecture, engineering, and sales. Purchasing Directors often oversee all project bidding, product specifications, budgets, and design development. The Director of Construction supervises the development of all projects, while the Project Managers oversee the operations of one or more particular projects. They are typically involved in the product development, mapping, design, subcontracting, and construction of specific projects.

All large developers have a Sales Department to initiate the sales of the homes, usually during and early stage of construction, and to provide input in the preliminary design phase of a project as well. At the "point-of-sale," consumers might have the opportunity to choose color schemes, flooring, appliances, and possibly upgrade energy-related equipment and features to be installed in the home. Some builders combine the Sales and Marketing Departments or have a Sales/Customer Operations Division that is responsible for all sales and marketing tasks.

[22] Some builders mentioned modifying the plans of one development to create the plans of another to lower building costs.

The areas of responsibilities of the individuals within the company often overlap, even though each has its own area of expertise. All of these individuals are involved in the product development process (i.e., the planning, design and specification of equipment and shell measures in the home), which will be discussed further in subsequent sections. Depending on the size of the company, one individual might be responsible for several of the tasks described above. The marketing, purchasing, design, and construction departments are combined in small building companies, in which the owner or partner typically handles these responsibilities.

The Basic Decision Process

The basic decision process through which builders determine the efficiency levels of equipment and shell measures (often referred to as "product development") is an iterative process involving several individuals within the company – typically a team of division directors, the architect(s), and a Title 24 consultant. Of course, every company is different, but the market actor interviews revealed that tract developers follow the same general operational procedures in the planning, design, and specification phases of construction.

Three primary phases were identified in which decisions regarding energy-related equipment and shell measures are made: a preliminary design phase, the specification phase, and a final specification and purchasing phase. While the following sections describe each of these three phases, a more detailed description of the roles and influences of the other market actors follows in the next section.

Preliminary Design

After the builder purchases a tract of land, the marketing department implements a marketing study to identify the target market' s buyer profile and desired home characteristics, such as square footage, floor plan(s), and number of rooms. These parameters are then passed to the architect(s), who could either be in-house or a subcontracted architecture firm. During the preliminary design phase, the architect prepares the preliminary building plans, incorporating input from the marketing study and other general parameters designated by the company. The preliminary building plan is most often designed to the "worst-case" situation in terms of meeting Title 24 requirements (i.e., the plan just meets the minimum requirements). Energy usage is generally not considered at all at this point.

Specification

The second specification phase begins after the marketing department approves the preliminary design plans and the design is forwarded to a development team and the Title 24 consultant. This is sometimes referred to as an "elevation" stage, during which the preliminary designs are "elevated" to include detailed specifications, such as style, colors,

equipment types, window types, and other shell measures. This phase is an iterative process during which several design meetings are conducted to discuss and finalize equipment and shell measure specifications. Participants in this phase will generally include the Project Manager(s), the Director of Construction, Director of Purchasing, the Director of Marketing, and the Vice President of Product Development/Operations. This development team, along with the architect and the Title 24 consultant, revise the preliminary plans until they are satisfied. The engineers and the HVAC and plumbing contractors are sometimes included in these meetings to provide trade-specific information regarding the air distribution and plumbing system designs and equipment options. Information from equipment manufacturers also helps the team to finalize equipment choices.

As a result of this phase, the builder and the development team decide on the equipment size/tonnage, number of units, and efficiency levels that are appropriate for the design of the home and that are necessary to meet the Title 24 energy efficiency requirements.

Final Specification and Purchasing

During the final specification and purchasing phase, the builder makes the final equipment decisions and solicits bids from subcontractors, who purchase and install the equipment based upon the final specifications. In general, the builder will not specify the manufacturer, brand, or model of the equipment, unless they have a strong preference (or dislike) of a particular product. The majority of the tract housing builders leave the specific equipment choice decisions up to the HVAC and plumbing contractors. By giving the contractors the freedom to choose the manufacturer, brand, and model, the builder is assured that the contractor will choose equipment that they are familiar with in terms of installation and maintenance procedures. In essence, the builder relies on the expertise of their contractors and has confidence that they know the equipment better than anyone in the industry.

If the builder has a national contract with an equipment manufacturer, or specifies the equipment in more detail, however, the subcontractors will incorporate the builder's preferences in their bid for the project. Builders soliciting bids that specify the equipment brand and model commented that it is easier for the contractors to bid these types of jobs and that they "put all subcontractors on a level playing field."

Large national tract developers without a national account purchase equipment directly from the manufacturer, usually for all projects within an entire geographic region (instead of for a particular project). In such cases, the purchasing department solicits competitive bids for equipment and makes the final decisions based upon the best equipment package for the cost. Equipment is reviewed based upon price and quality – the best equipment for the money is selected. The project managers give their input, but usually either the Director of Construction, the Director of Purchasing, or the Regional Manager makes all final decisions.

All single family tract builders followed a variant of the product development phases described above. The degree of involvement and influence on decisions, however, varies even between companies of different structures. For example, one large national corporation has an office that specifies the "eligible" equipment for each regional division. Through its national accounts and purchasing department, the corporate office decides which HVAC and water heating equipment tonnage and/or models can be installed in a particular size home at a particular price point. This was also the case for windows up until this year. Wall, ceiling, and floor insulation, however, is chosen at the division level.

Decisions for Custom Projects. The basic decision process for a custom project is very similar, but has some notable difference. First, during the "preliminary design phase," the consumer will discuss the general layout and parameters with the builder and/or architect. For a semi-custom project, the consumer will review some pre-existing drawings and provide input for revisions.

During the "specification" stage, the consumer is the primary decision maker on all aspects of design and equipment and shell measure specification. In most cases, the builder and the architect will "elevate" the plans, then confer with the client and revise the plans to incorporate their input. The consumer might also communicate extensively with the HVAC and plumbing contractors, in which case these individuals would have considerable influence over equipment specification. Whether or not a builder utilizes a Title 24 consultant for a custom project varies, but it is quite uncommon. First, the marginal cost to hire a Title 24 consultant is high for a custom project. Second, custom homebuyers are often able and willing to pay for more expensive and more energy-efficient equipment and shell measures, so compliance with the Title 24 requirement is not a primary concern for the builder. A custom-homebuilder is likely to use the prescriptive method of compliance.

Influences of Other Market Actors

Although the builder has the ultimate power in decisions pertaining to the efficiency levels of energy-related equipment and shell measure specifications, only 21% of the builders in Southern California indicated that they made the final decision for <u>all</u> homes built by their company in 1997. Just over 60% of the builders, on the other hand, revealed that they made the final decision in less than half of the homes built by their company. Interview discussion also revealed that builders often rely on the expertise of other market actors when it comes to energy-related equipment and shell measures.

Title 24 consultants, architects, and HVAC contractors have a significant influence in the decision-making process. In fact, about 39% of the builders indicated that architect made final decisions on some projects, and nearly 60% of the builders indicated that Title 24

consultants made final decisions on some or all projects. The key here is to recognize that these individuals make final decisions *within parameters that are specified by the builder*, such as the budget. The following sections discuss the roles and influences of other market actors in the builder' s decision process.

- ***Title 24 Consultant.*** The Title 24 consultant performs the calculations for building permits and makes recommendations to the development team on the equipment and measure installation specifications that are necessary to comply with the Title 24 standards. Because most builders work with the same Title 24 consultant on most projects, the Title 24 consultant becomes very familiar with builder preferences for Title 24 compliance. About 62% of the single family tract developers in Southern California interviewed considered recommendations by Title 24 consultant as *very influential* in their decisions relating to the energy efficiency levels, and 4% did not consider them influential at all. The remainder of the sample (34%) considered them to be *influential* or *somewhat influential.*

- ***Architect.*** The architect prepares the preliminary floor plans, then works with the marketing department, the development team, and the Title 24 consultant to finalize the designs and elevate the building plans. Many builders contract with an architectural firm for each project, but large national corporations typically have an in-house architecture department. Within these national corporate structures, the architects might work with national accounts purchasing and, therefore, have a very large role in equipment and shell measure installation decisions.

  Because they work closely with the Title 24 consultant in the early design phases of the project, builders noted that the architect(s) has (have) a significant influence in their energy efficiency related decisions. About 28% of the single family tract developers in Southern California considered recommendations by architects as *very influential* in decisions relating to the energy efficiency levels. About 39% considered them to be *influential* or *somewhat influential*. The remaining 33% did not consider architect recommendations influential at all.

- ***HVAC Contractor.*** The HVAC contractor provides input in the preliminary specification phase. Many builders stressed during the interviews that they relied heavily on the expertise of their HVAC contractors with respect to designing the HVAC system, making equipment recommendations, and making suggestions where they feel improvements are appropriate and/or necessary. The HVAC contractor' s influence during the design phase depends upon the builder' s preferences and corporate structure. For example, the role of the contractor is limited to *only* installation if the builder has an in-house mechanical engineer or contracts the duct system design to an engineering firm. One builder noted that HVAC contractors have little influence on decisions regarding energy efficiency levels, but their recommendations might be incorporated into an upgrade option. Regardless, in all projects, the HVAC contractor purchases and installs all equipment and materials as specified in the building plan specifications.

All single family tract developers in Southern California regarded recommendations by HVAC contractors as influential. Nearly 32% considered their recommendations as *very influential*, and the remaining 68% considered them to be *influential* or *somewhat influential*.

- ***Plumbing Contractor.*** The role of plumbing contractors is not as prominent in the decision process as that of HVAC contractors. Some plumbing contractors examine the house plans and provide trade-specific information on the design of the plumbing system. Several large builders noted that they rely on the plumbing contractors as being the experts and that they have a prominent role in terms of the water heating equipment specifications. For many builders, however, the plumbing contractor' s role is limited to equipment purchasing and installation according to the building specifications.

- ***Equipment Manufacturers.*** The extent to which recommendations by equipment manufacturers influence builder decisions regarding energy efficiency levels depends greatly on how equipment is purchased. Interviews revealed three primary purchasing arrangements: (1) purchasing equipment directly from the manufacturer, (2) purchasing from the distributor, or (3) purchasing the equipment through the contractor performing the installation. Less than 5% of the builders interviewed indicated they purchased gas water heaters from the manufacturer, and about 10% purchase gas furnaces from the manufacturer.[23]

  In general, the space and water heating equipment that the builder purchases directly from the manufacturer is purchased under a national contract with a particular manufacturer. Through a national contract, the builder agrees to purchase the manufacturer' s product exclusively for all or a portion of the projects.[24] In such cases, the recommendations by the manufacturer are influential with respect to the efficiency level of a new home.

  Over 30% of the builders indicated they purchase windows from the manufacturer. As most homes contain a large number of windows, builders find it more convenient and economical to purchase directly from the manufacturer.

  Irrespective of a national purchasing contract, equipment manufacturers can influence builder decisions. Through sales literature and in-person visits by sales representatives, the manufacturers make appliance or equipment recommendations that the company will take into account when choosing the equipment to be installed in new homes. About 8% of the builders in the sample indicated that manufacturer recommendations were *influential* and approximately 69% of the sample indicated they were *somewhat influential* in their decisions relating to energy efficiency. Just over 22% indicated that manufacturers were *not at all influential*.

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[23] The remaining percentages of builders indicated that the subcontractors deal with either the manufacturers or distributors in equipment purchasing.

[24] Some large corporations have a national account purchasing department for equipment purchases. This department is generally responsible for setting up and maintaining agreements with manufacturers of equipment that is installed in new homes nationwide.

- ***Equipment Distributors.*** None of the builders in the sample indicated that they purchased gas space and water heating equipment from distributors, however, over 35% purchased windows from a distributor. Across all builders, subcontractors handled gas space and water heating equipment purchases from distributors. Because there generally is no interaction between the builder and the distributor, builders noted that distributors have little influence on decisions regarding energy-related equipment. Approximately 49% *somewhat influential*, and the remaining 51% *not at all influential*.
- ***Other In-House Personnel.*** Other in-house personnel include all "non-construction" related departments, such as the purchasing and marketing departments. Representatives from these departments often participate in the development and design phases discussed above, and are therefore considered to be fairly influential in the decision process. About 45% of the builders considered their recommendations as either *very influential* or *influential*, 52% as *somewhat influential* and the remaining 3% considered them *not at all influential*.
- ***Sales and Real Estate Agents.*** Builders were about equally divided with respect to the influence of recommendations by realtors and sales agents in the equipment or energy efficiency level of new homes. About 36% of the sample indicated that recommendations by sales agents were *very influential* or *influential* in their energy efficiency related decisions, 30% indicated that they were *somewhat influential*, and just over 34% indicated that sales and real estate agents were *not at all influential*. The in-depth interviews revealed that sales agents rarely discuss details pertaining to energy efficiency levels of specific equipment in the home with potential buyers when they relay consumer preferences to the builder during the preliminary design phase of development.
- ***Consumers.*** In the single family tract housing market, the homebuyer typically does not have much influence on the energy efficiency levels of the equipment or measures installed in the home. The consumer can influence the energy efficiency levels of their home, however, if they choose to upgrade the space or water heating equipment, or specify more energy-efficient shell measures. The extent to which homebuyers can upgrade varies from builder to builder. Although most builders claimed that they would install anything the homebuyer is willing to pay for, the upgrade packages and options that are typically available to the homebuyer rarely pertain to energy-related equipment or measures. The most common energy-related upgrade packages in tract housing enable the buyer to upgrade the air conditioning unit or give them the option to have re-circulating plumbing (instant hot water).[25]
- ***Competition From Other Builders.*** Competition from other builders strongly influences the efficiency levels of new construction projects. Competition is generally more influential with respect to visible home features, such as windows,

[25] Most options available to the consumer in the tract housing market are related to cosmetic or aesthetic features, such as color, carpeting, and flooring. Some builders offer kitchen appliance upgrades and some offer upgrades for insulation.

kitchen appliances, and other aesthetic attributes. Competition indirectly influences the specification of HVAC equipment to the extent to which higher efficient units increase the final selling price of the home.

- ***Property Management Company.*** In multi-family building development, builders will often confer with and rely upon input from the property management company. In addition to a marketing study, the property management company provides the builder with tenant preferences and market characteristics. Most importantly, the property management company will relate not only tenant preferences, but "maintenance and shell measure preferences" to the builder, as well. Such information would include the maintenance staff's equipment preferences and past experiences with particular equipment brands and models, preferences for windows and window treatments, and insulation (primarily for acoustic mitigation, not energy efficiency). One builder in particular noted that the property developer, not the builder, provided the specifications for all equipment.

The interactions with and influences of the market actors described above applies to the majority of residential new construction projects in Southern California. However, the market actor influences vary according to project type. In particular, the builder, architect, contractor, and consumer have different roles in custom home projects. With a custom home project, the consumer is the primary decision maker on all aspects of design and construction, including the specification of energy efficiency levels for equipment and shell measures. While the architect and HVAC and plumbing contractors still consult and work directly with the builder, there is substantially more communication between these market actors and the homebuyer. Thus, the architect and HVAC and plumbing contractors have more influence on homebuyer preferences and equipment specification in a custom project than in a tract development. In fact, one contractor specifically mentioned that if he can communicate with the consumer and explain the equipment and differences in energy efficiency levels and their respective impacts on the consumer's operating costs, then he can convince them to switch to a more efficient unit.

Equipment Characteristics and Features

For the most part, equipment and shell measure decisions are heavily influenced by California's Title 24 requirements. In tract developments, the homebuyer has little influence (and/or no interest) in upgrading the energy efficiency levels of their new home. From the builder's perspective, the primary objectives are to comply with Title 24 standards and offer the consumer a quality product for the lowest cost possible. Equipment decisions, therefore, become somewhat of a balancing act between cost, quality, and meeting the requirements.

Most (if not all) tract developers use the performance method of compliance; thus, meeting the Title 24 standard involves trade-offs. In particular, the builder, Title 24 consultant, and/or the entire development team weigh the cost of each energy conservation measure and

the number of points earned to meet Title 24. For example, builders can earn "more points for the dollar" by specifying a more efficient water heater or a water heater blanket instead of upgrading the HVAC unit.

- ***HVAC Equipment.*** Builders explained that upgrading the efficiency levels of HVAC equipment is the most expensive option in terms of the points earned to comply with Title 24. Thus, the minimum efficiency standards and equipment costs are the primary influential characteristics considered by builders during HVAC equipment specification. Builders stated that the following characteristics of HVAC equipment are important factors when specifying the equipment (in descending order of the number of builders that mentioned each characteristic):
  - Efficiency/Title 24 requirement,
  - Cost/value,
  - Name brand, reputation of manufacturer,
  - Quality, reliability, and product longevity,
  - Serviceability and ease of maintenance,
  - Product availability,
  - Corporate specifications or terms national contract,
  - Warranty extensiveness and coverage, and
  - Noise level.

  Builders of multi-family projects cited the size of the unit, noise level, maintenance level, cost, control, efficiency, and reliability as the most important factors when choosing HVAC equipment.
- ***Water Heaters.*** As mentioned above, upgrading the water heater efficiency level is a cost effective means to meet Title 24 if using the points method. Builders stated that the following characteristics of water heating equipment are important factors in their decisions (in descending order of the number of builders that mentioned each characteristic):
  - Efficiency/Title 24 requirement,
  - Cost/value,
  - Name brand, reputation of manufacturer,
  - Quality, reliability, and product longevity,
  - Serviceability and ease of maintenance, and
  - Warranty extensiveness and coverage.

  Builders also mentioned subcontractor recommendations, size of home, buyer demand, product availability, and corporate national account specifications as important factors.

Builders of multi-family projects cited efficiency, maintenance level, high recovery, capacity, and cost as the most important factors when choosing water-heating equipment.

- ***Windows.*** With respect to windows, quality, reliability, and visual characteristics were mentioned more often by builders as important factors in their decision process than with space and water heating equipment.[26] Cost and efficiency levels, however, were mentioned most frequently during the interviews. Builders cited the following factors as influential when they are specifying windows:
  - Quality, performance (no leaks),
  - Efficiency/Title 24 requirement,
  - Cost/value,
  - Aesthetics,
  - Name brand, reputation of manufacturer, and
  - Warranty extensiveness and coverage.

  Other comments noted that subcontractor recommendations, buyer demand, acoustic mitigation qualities, and national contract specifications were also important factors.

  Builders of multi-family projects cited maintenance level, aesthetics, "cleanability," and cost when specifying windows.
- ***Insulation.*** Efficiency levels and Title 24 requirement are important factors when builders specify shell measure efficiency levels. Tract builders cited the following as the most important factors:
  - Efficiency/Title 24 requirement,
  - Cost,
  - Quality/material,
  - Recommendations by contractors, manufacturers, and/or distributors,
  - Name brand/reputation of manufacturer, and
  - Product availability.

  Builders of multi-family projects cited the effectiveness and cost when specifying insulation.

In custom home projects, builders do not consider Title 24 requirements and costs as much (or at all) when choosing equipment and shell measures. Information obtained during the in-depth interviews revealed that custom-home builders tend to use the prescriptive, rather than the performance method of Title 24 compliance. This, and the fact that consumers are more likely to opt for more expensive and more energy-efficient equipment for their custom-built

[26] This was often the case in discussions pertaining to any visual or aesthetic characteristics of the home – the buyer is much more conscious of what they can see than of what they cannot see.

home enables the builder to rely less on a Title 24 energy consultant to ensure compliance. Reliability, reputation, warranty coverage and extensiveness, performance, customer service, and payback period were important factors mentioned by builders in discussions relating to equipment and shell measure specified for custom homes.

Primary Information Sources

Builders rely on the expertise of numerous individuals with a variety of backgrounds for trade-specific information pertaining to energy-related equipment and shell measures, the latest technologies and methods to increase energy efficiency, and about energy efficiency in general. Most notably, the builders mentioned subcontractors most often in discussions relating to their primary information sources on new technologies. Subcontractors not only attend design meetings and make equipment recommendations, but they also introduce builders to the latest technologies and explain the costs and benefits of new products. The Title 24 consultant, architect(s), manufacturer representatives, and utility representatives were also sited as primary information sources. In addition to these key market actors, every builder interviewed mentioned trade shows, conferences, seminars, and publications as their primary sources of information.[27]

5.12 Architects

Builders employ architects to design the home and prepare the building plans for inspection. While most builders hire an outside architect or architectural firm, large national builders have an in-house architecture department. Architects in California are licensed by the Architectural Examiners Board. Currently, the state has approximately 20,300 active licensed architects, of which about 7,200 are located in Southern California.[28] The largest architectural firms in San Diego in 1996 working on residential projects were Bowlus, Edinger & Starck Architects, Robbinns Jorgensen Christopher, and Case Group Architects.[29]

Nearly 95% of the architects interviewed work for an architectural firm. On average, almost 75% of the residential building plans completed in 1997 were for builders and other parties – mostly homebuyers for custom home projects – contracted the remaining plans. On average, each architect (or architectural firms) worked for 13 different builders last year (responses ranged from five to 60 builders).

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[27] Four such trade publications include Builder Magazine, Professional Builder, Light Construction, and Fine Home Building. Trade conferences include the National Association of Home Builders (NAHB) Show and the Pacific Coast Builders' Conference.

[28] The Architectural Examiners Board.

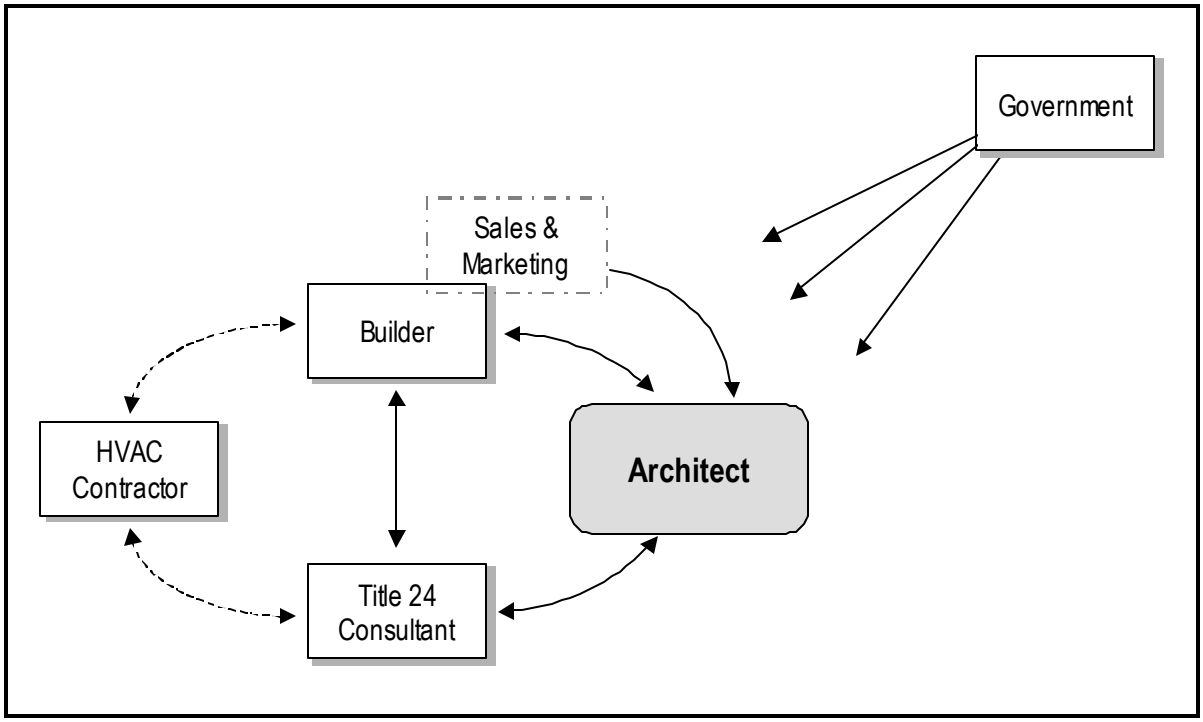
[29] "The Lists 1997," San Diego Business Journal, Volume 17, Issue 53 (based on total number of employees).

The remainder of this section describes architects' primary functions, interactions with other actors, and influences in the residential new construction market in Southern California.

Primary Functions and Interactions in the RNC Market

The architect' s primary function in the residential new construction market is to design a home that is structurally sound, comfortable, and aesthetically pleasing to the homebuyer. As shown in Figure 5-9, architects interact primarily with builders and Title 24 consultants in the residential new construction market. The architect prepares the preliminary building plans, incorporating information from marketing studies and the builder' s general parameters, such as square footage, number of rooms, and basic floor plans. Working from these preliminary plans, the architect(s) works with several market actors, such as the builder, Title 24 energy consultant, engineers, and other members of the design team, until the plans are finalized. For tract development planning, the building plan often represents the "worst case" in terms of meeting Title 24 requirements. With custom home projects, the architect works closely with the homebuyer and the builder during all stages of design and specification.

Figure 5-9: Architects in the RNC Market



Decision Making and Market Influences

Because architects are not directly involved with energy efficiency levels, they do not have a strong influence on the builder with respect to energy-related specifications. Less than 10% of the architects reported that they had/have the opportunity to suggest that the builder exceed Title 24, all of which have actually done so. The majority of architects that have made such suggestions to their clients indicated that their suggestions were followed. It is important to note here that the architects who indicated that builders are receptive to suggestions designed mostly custom homes last year. All of the architects who only design tract homes explained that energy efficiency issues are not in the scope of their responsibilities, and that builders rely on Title 24 consultants to specify energy-related features, such as windows and insulation. Therefore, neither is in the position, nor do they want, to offer suggestions that the builder exceed Title 24.

Because of the nature of their profession, and the fact that architects often interact with Title 24 consultants, they generally have a good working knowledge of Title 24 requirements. Overall, architects in Southern California are fairly aware of the latest available energy efficiency technologies. On average, the architects self reported that they are *very aware* of insulation and efficiency windows, and *somewhat aware* to *aware* of gas furnaces and gas water heaters. However, architects indicated that they are *not very aware* of the latest duct testing and sealing methods. Architects' primary information sources include Title 24 energy consultants, manufacturer sales representatives, trade shows, and various other newsletters and trade publications.

5.13 Title 24 Energy Consultants

In the residential new construction industry, Title 24 consultants work with builders, architects, and sometimes HVAC contractors to ensure that building plans comply with Title 24 requirements. Essentially, Title 24 consultants are energy consultants who help builders complete the forms required by the state in order to prove compliance with Title 24 energy efficiency standards.[30, 31] About 99% of the builders interviewed for this study indicated that they use the services of a Title 24 consultant. However, builders are not required to do so if they complete the analysis and the required paperwork on their own. The latter is more common in custom projects and rare if not nonexistent for tract developments.

There are no requirements and no certifications needed to become a Title 24 energy consultant. Typically, these consultants are already working in the industry as designers, engineers, or building plans examiners. There is optional certification available through the

[30] The CF-1R and C-2R forms are generally used; one or both may be required.

[31] *Energy Efficiency Standards for Residential and Nonresidential Buildings,* California Energy Commission, July 1995

California Association of Building Energy Consultants (CABEC). CABEC requires its members to pass a state building code exam and undergo additional training.[32] All of the Title 24 energy consultants interviewed for this study are certified by CABEC.

For the majority of projects, the consultants utilize computer software to simulate the energy usage of the designed house. The program used by consultants is called Micropass.[33] Other packages include Calres2, Comply 24, Energy Pro, NRG-24, and REA. The analysis does not need to be done with a computer simulation, however most consultants use the software.

Most builders employ the same Title 24 consultant for every project. In doing so, the builder and the Title 24 consultant develop a strong working relationship in which the consultant becomes very familiar with the builder's preferences for meeting Title 24 requirements (i.e., specification priorities, willingness to increase costs, etc.), and their business practices, in general. Just over 40% of the consultants interviewed work independently, the remainder work for energy consulting companies or engineering firms. On average, each consultant worked for 98 different builders and prepared Title 24 reports for about 560 building plans in 1997.[34] While all respondents explained that they provide the builder with hard copies of the final Title 24 reports and calculations, some also submit their own summary report. Roughly 40% of the consultants indicated that they report results differently to different builders. Those that report results differently to different builders explained that some builders are not interested in the actual Title 24 reports, while others require all information and calculations – "*they need to know everything.*"

Primary Functions and Interactions in the RNC Market

As illustrated in Figure 5-10, Title 24 consultants directly interact with builders and architects. In most cases, the Title 24 consultant is provided with the preliminary plans and provides input and recommendations for final specifications in order for the plans to comply with the minimum requirements. As discussed in subsection 5.11, the consultant also attends the design meetings to discuss specification options with the architect and other members of the development team. *Cost effectiveness* is the operative term here and most important concept to the builder during the specification stage. As such, the consultant's most important function is to provide the builder with cost-effective options for compliance.

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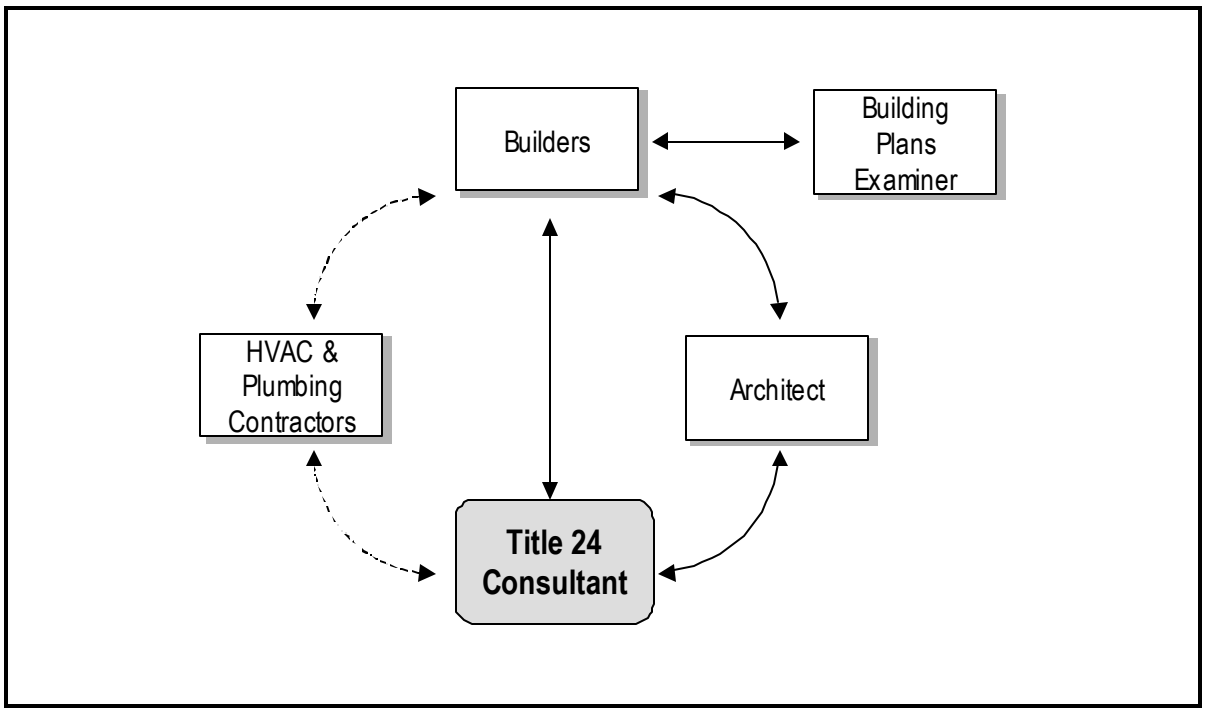
[32] CABEC is a nonprofit organization that provides certification and training to professionals involved in Title 24 compliance work. Its members include energy consultants, architects, engineers, utility companies, and vendors of energy conservation products and services. CABEC offers a Certified Energy Analyst Program that requires work experience, training, and testing. In addition, all CABEC members subscribe to a code of ethics. For 1996, CABEC listed 71 energy consultants in their member roster. Of these, 19 work in Southern California.

[33] Micropass simulates energy usage based on temperature and other factors and produces a figure of kBtu per square foot per year.

[34] The number of builders ranged from six to 30 builders, and the number of plans ranged from 35 to 1,000.

Figure 5-10: Title 24 Consultants in the RNC Market



Decision Making and Market Influences

Consultants, by definition, are in a very influential position to recommend that their client's building plans exceed the minimum energy efficiency standards. The in-depth interviews with both builders and Title 24 consultants revealed whether or not consultants exercise this influence and builders' receptiveness to such recommendations. In general, Title 24 consultants seem to have some influence with builders, even though the options and recommendations they provide are typically within parameters defined by the builder.

Indications of Title 24 consultants' influence on specifications that exceed Title 24 include the following:

- About 60% of the builders interviewed indicated that Title 24 consultants made final decisions on all or some projects.
- Over half of the builders indicated that recommendations by Title 24 consultants were *very influential* in their decision process, while the remainder of the sample considered their recommendations at least *somewhat influential*.
- Over all, Title 24 consultants indicated that they are *very influential* in assisting builders that want to exceed Title 24.
- Nearly 60% of the consultants indicated that they have the opportunity to suggest that the builder exceeds Title 24, and almost half of those have actually done so.

- When such suggestions were made to the builder, the suggestions were almost always followed.[35]

Despite their relatively high influence with the builders, Title 24 consultants generally operate within the builder's guidelines and budget constraints. Their primary function is to ensure the plans meet, not exceed, the standards. Further, consultants will only make suggestions when they are confident the option is cost effective for the builder. For example, suggestions to exceed Title 24 usually pertain to windows and water heaters, because these features cost much less than upgrading the HVAC unit.

Those that do not have the opportunity to suggest that the builder exceed Title 24 explained that doing so would be out of the scope of their position. They also commented that *"homes built to Title 24 standard have little cost-effective room for improvement,"* or that the builder does not want to do anything above minimum requirements.

Title 24 consultants are very aware of the latest technologies of energy-related features and measures. Table 5-6 includes Title 24 consultants' self-reported awareness levels of the latest available technologies of equipment, measures, and duct testing and sealing methods.[36]

Table 5-3: Average Awareness of Latest Energy-Efficient Technologies[1,2,3]

Gas Furnaces	Gas Water Heaters	Windows	Insulation	Duct Testing Methods	Duct Sealing Methods
4.9 *(0.15)* *n=11*	4.6 *(0.26)* *n=11*	4.9 *(0.11)* *n=11*	4.9 *(0.11)* *n=11*	3.9 *(0.38)* *n=11*	3.7 *(0.46)* *n=11*

1. Each respondent rated their own awareness, with a one 1 meaning "not at all aware," a 3 meaning "somewhat aware", and a 5 indicating "very aware."
2. Means were weighted according to the number of plans reviewed in 1997, as reported by each respondent.
3. Standard errors are included in parentheses.

Consultants' primary sources of information include manufacturer's literature and sales representatives, CABEC, industry trade shows, and various trade literature and publications.

[35] Two consultants could not respond to this question. One noted that sometimes the suggestions were followed, but only *"when it didn't cost them anything."* The other could not respond because they do not typically visit the site during construction.

[36] Respondents indicated on a scale of 1 to 5, with a 5 meaning "very aware", a 3 representing "somewhat aware," and a 1 meaning "not at all aware," how aware they were of the latest available energy saving technologies.

5.14 HVAC Contractors

Builders employ HVAC contractors to design the air distribution systems and to purchase and install all HVAC system materials and equipment. HVAC system contracting in the residential new construction market is a fairly concentrated industry.[37] The in-depth interviews with both HVAC contractors and builders revealed that only a handful of contractors account for the majority of installations in residential new construction projects in Southern California. For example, one contractor noted that only five or six contractors account for 90% of the residential new construction projects in Southern California.

Just over 90% of the contractors interviewed work for an HVAC company and the rest are independent contractors hired directly by the builder or as a subcontractor for another HVAC contracting company. Last year, each contractor worked with an average of 38 different builders (range 2 – 50) and installed systems in over 4,300 homes (range 1 – 7000).

The remainder of this subsection details the HVAC contractors' primary functions and interactions in the residential new construction market, and the scope of influence contractors have with respect to the specification of HVAC equipment that exceeds the minimum Title 24 requirements.

Primary Functions and Interactions in the RNC Market

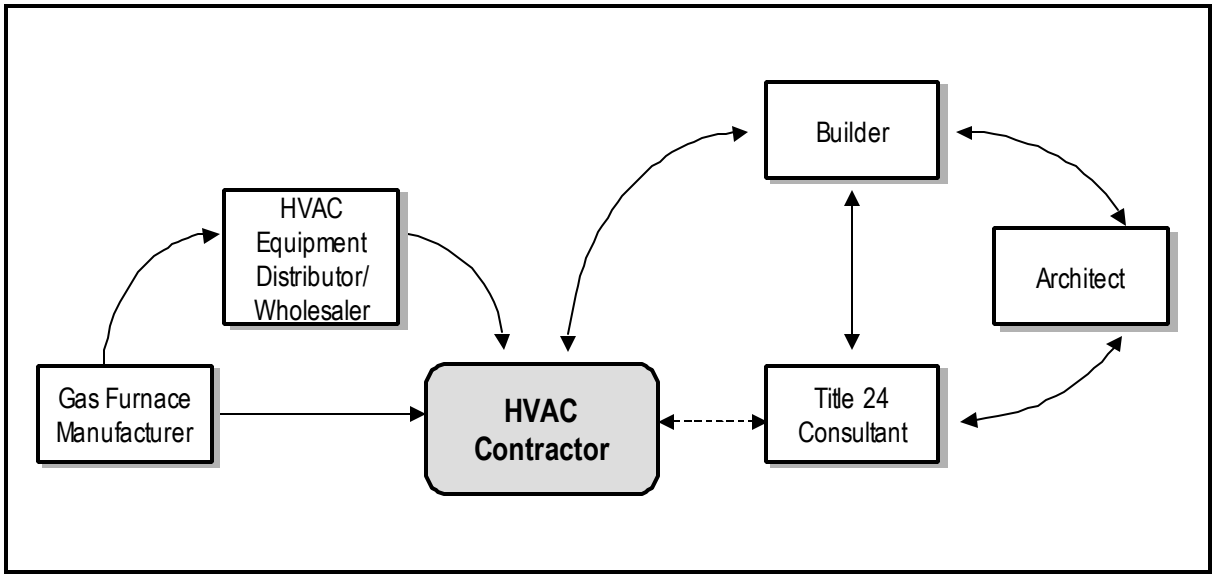
HVAC contractors have two primary functions in the industry:

- Air distribution system design, and
- HVAC equipment purchasing and installation.

As shown in Figure 5-11, HVAC contractors directly interact with builders, architects and Title 24 consultants, and equipment distributors and manufacturers to accomplish these tasks. Each of these functions is discussed below.

[37] A recent development in the residential HVAC market has been the development of large regional HVAC contractors that have developed and grown through the purchase of mom and pop retail dealers. This has occurred particularly in Texas and Florida in recent years.

Figure 5-11: HVAC Contractors in the RNC Market



HVAC System Design and Equipment Specification

HVAC contractors work directly with other market actors when designing the duct system. As shown in Table 5-4, the builder, HVAC contractor, and Title 24 consultant have different responsibilities regarding HVAC equipment and system design and specification. During the specification stage of product development, the builder and the Title 24 consultant typically designate the equipment' s efficiency rating, and the Title 24 consultant will specify the R-value of duct insulation.[38] Usually, the contractor becomes involved during the final specification phase after the Title 24 consultant has completed their evaluation of the building plans. During the final specification stage, the HVAC contractor reviews the building plans and Title 24 reports with the appropriate individuals and designs the air distribution layout. The contractor works with some or all of the following market actors to design the HVAC system: builder (including members of the design team described previously), architect, Title 24 consultant, and/or engineers. As shown in Table 5-4, the HVAC contractor is primarily responsible for designating the equipment tonnage (and number of units) and the duct installation and sealing methods.

[38] The interviewed revealed that duct insulation rarely exceeds Title 24 requirement of R-4. Contractors explained that increasing to an R-6 or an R-8 is prohibitively expensive.

Table 5-4: HVAC Equipment Specification Responsibilities[1,2,3,4]

	Builder	HVAC Contractor	Title 24 Consultant
Efficiency Rating (n=7)	55.3% *(0.20)*	0.0% *(0.00)*	44.6% *(0.20)*
Equipment Size (n=7)	0.0% *(0.00)*	94.1% *(0.10)*	5.9% *(0.10)*
Duct Installation Methods (n=7)	0.0% *(0.00)*	100.0% *(0.00)*	0.0% *(0.00)*
Duct Insulation R-value (n=6)	0.0% *(0.00)*	0.0% *(0.00)*	100.0% *(0.00)*

1. Percentages represent the portion of HVAC contractors who indicated the market actor who determines the efficiency rating, size, and duct installation and sealing methods.
2. Means were weighted according to the number of installations in 1997, as reported by each respondent.
3. Standard errors are included in parentheses.
4. Note that some contractors indicated that more than one market actor was responsible for each task.

Equipment Purchasing and HVAC System Installation

Builders typically solicit bids from HVAC contractors for equipment purchasing and installation. However, they prefer to work with the same contractor(s), so the bidding process is often a formality. The contractor reviews the building plans and Title 24 reports, negotiates the equipment and material purchase prices and delivery with an equipment distributor or manufacturer, then contracts with the builder to complete the equipment and duct system installation. Builders consider many factors when reviewing bids in addition to the final equipment and labor costs, including the quality of workmanship, familiarity with the contractor, and timeliness.

Both builders and contractors value strong, positive working relationships. One contractor explained that when the economy is strong (and the new construction market is booming), the price in the contractor' s bid is not the most important evaluating factor considered by the builder. Manpower is the key factor, particularly since there are so few contractors working on residential new construction projects. Builders are willing to pay more for contractors that take responsibility for correctly installing the ducts and equipment on time. They also value contractors who are familiar with their building plans, preferences, and overall business practices. In turn, contractors can often choose the builders they want to work for and will only bid for projects with builders who have a reputation for paying contractors on time and with whom they have had a good relationship with on previous projects.

While the equipment size, efficiency rating, and number of units per home are already specified in the building plans and Title 24 reports, the HVAC contractor often chooses the

equipment brand and type. The builder rarely specifies these parameters, as they want the contractor to choose equipment that is of good quality, has low maintenance, and that they are familiar with. If the builder has a national account, however, the contractor must purchase that particular brand.

As shown in Table 5-5, about 35% of the contractors purchase equipment directly from the manufacturer, while nearly 85% purchase through an HVAC equipment distributor. One distributor had emphasized that they sell HVAC products only to these state-licensed contractors.[39]

Table 5-5: Equipment Purchasing Practices[1,2,3]

Purchase Equipment from Distributor	Purchase Equipment from Manufacturer
84.7% *(0.14)* *n=8*	35.6% *(0.18)* *n=8*

1. Means were weighted according to the number of installations in 1997, as reported by each respondent.
2. Standard errors are included in parentheses.
3. Some contractors indicated they purchase from both manufacturers and distributors.

Decision Making and Market Influences

During the in-depth interviews, many builders stressed that they rely on the experience and knowledge of the HVAC contractor, particularly since both equipment and air distribution specifications have become very complex and technical in recent years. HVAC contractors participate in engineering meetings with builders, Title 24 consultants, engineers, and architects and give their input and recommendations on system design for the final building plans. As explained above, less than 20% of the contractors indicated they choose the equipment efficiency rating.

As noted in subsection 5.11, about 32% of the builders considered recommendations by HVAC contractors as *very influential*. Further, the HVAC contractors in Southern California revealed that they are influential with builders who want to exceed Title 24 requirements. It is important to remember that, even though several market actors participate in the decision-making processes, their influence is constrained by the builder' s parameters. In other words, builders must *want* to exceed and be receptive to an HVAC contractor' s suggestions in order for the contractor to be influential. When builders want to exceed Title 24, just less than

[39] The California Contractors State License Board reports 9,071 total active licensed HVAC contractors in the state.

20% of the contractors claimed to be *very influential*, about 50% *somewhat influential*, and just over 30% are *not very* or *not at all influential* in helping the builder do so.

About 25% of the contractors in Southern California indicated that they have the opportunity to suggest that the HVAC equipment exceed Title 24, 80% of which have made such suggestions in the past. The majority of contractors explained that their suggestions to exceed Title 24 are followed, but only if the builder can justify the additional cost. Gas heating units are rarely upgraded above the minimum requirement because the cost to do so is prohibitive. Rather, the builder is likely to be receptive to upgrading ductwork by adding more return air inlets or other measures to increase the efficiency of the entire air distribution system.

Table 5-6 presents HVAC contractors' self-reported awareness of the latest available high efficiency gas space and water heating equipment, windows, insulation, and duct testing and sealing methods. On average, the HVAC contractors in Southern California reported that they were not quite *very aware* of the latest high efficiency gas furnaces and indicated they were *somewhat aware* of the latest insulation, high efficiency windows, and duct testing and sealing methods. Not surprisingly, the contractors were least aware of the latest available gas water heating units.

Table 5-6: Average Awareness of Latest Energy-Efficient Technologies[1,2,3]

Gas Furnaces	Gas Water Heaters	Insulation	Windows	Duct Testing Methods	Duct Sealing Methods
3.8 *(0.72)* *n=8*	2.8 *(0.29)* *n=6*	3.1 *(0.54)* *n=6*	3.1 *(0.54)* *n=6*	3.1 *(0.66)* *n=8*	3.5 *(0.72)* *n=8*

1. Each respondent rated their own awareness, with a one 1 meaning "not at all aware," a 3 meaning "somewhat aware", and a 5 indicating "very aware."
2. Means were weighted according to the number of plans reviewed (Title 24 consultant), the number of plans completed (architects), or the number of installations (HVAC contractor) each respondent reported completing in 1997.
3. Standard errors are included in parentheses.

HVAC contractors' primary source of information on new technologies and installation methods are the manufacturer sales representatives, who contact the contractors on a regular basis, explain new equipment and products, and deliver literature. The sales representatives also keep the contractors informed about any equipment rebate programs offered by the

manufacturers.[40] Other sources of information include training classes (pertaining to installation and sealing methods and system design and indoor air quality issues), trade shows, and trade literature. In addition, one of the largest and most proactive contractors in Southern California sets up their mock air distribution systems for system and testing experimentation and training. They noted that HVAC system design is not "text book," and that more efficient design must be learned through trial and error.

5.15 Plumbing Contractors

Builders employ plumbing contractors to purchase and install gas water heating equipment and the plumbing system. The in-depth interviews with both plumbing contractors and builders revealed that only a few contractors account for the majority of installations in residential new construction projects in Southern California. For example, two contractors account for 75% of the residential new construction projects in the SDG&E service area (both of which were interviewed for this study). The major plumbing contractors in Southern California that were referred by builders include Alpine Plumbing, Executive Plumbing, Hood Plumbing, New Plumbing, PVN Plumbing, Saber Plumbing, and Sun Plumbing.

All of the contractors interviewed for this study work for a plumbing contracting company. Last year, each contractor worked with an average of 30 different builders (ranging from 4 to 40 builders) and each installed equipment into an average of almost 1,940 homes (ranging from six to 2,500 homes).

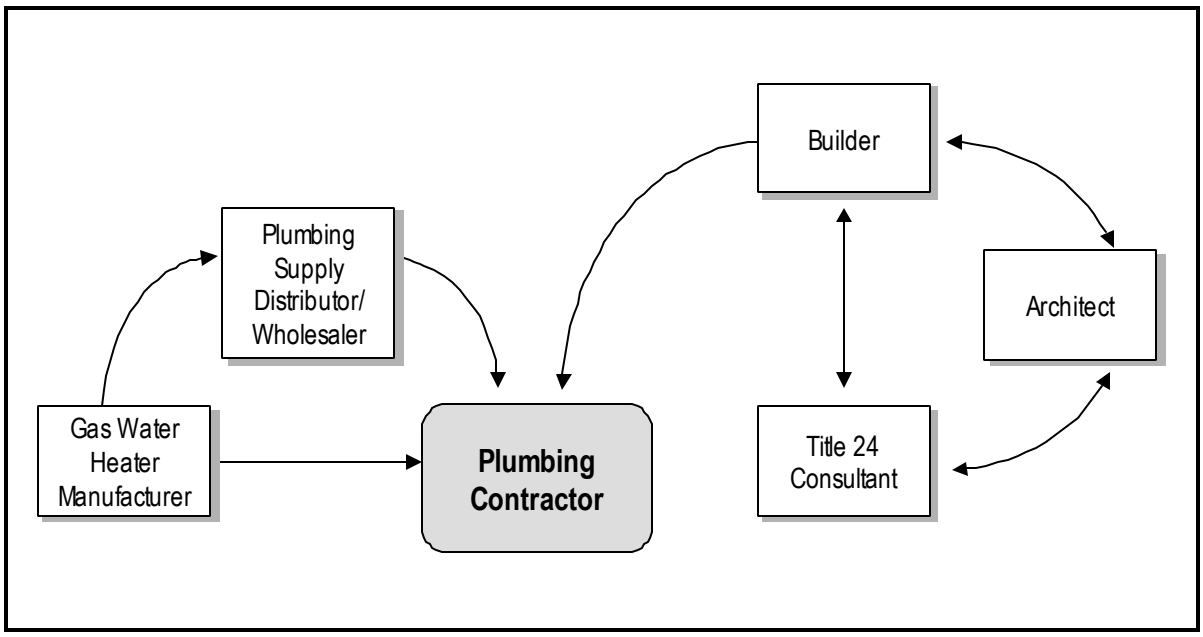
The remainder of this subsection summarizes the plumbing contractors' primary functions, interactions, and influences in the residential new construction market.

Primary Functions and Interactions in the RNC Market

Equipment purchasing and installation is the plumbing contractor' s primary function in the residential new construction market in Southern California. As illustrated in Figure 5-11, plumbing contractors directly interact with builders, equipment distributors, and manufacturers to accomplish these tasks. Unlike HVAC contractors, plumbing contractors are not usually involved in the specification phase of product development, thus they have little (if any) interaction with architects and Title 24 energy consultants.

[40] Contractors explained that manufacturer rebates often have a strong influence on the HVAC equipment specified in the building plans, and will often induce both contractors and builders to purchase a particular unit.

Figure 5-12: Plumbing Contractors in the RNC Market



Builders typically solicit bids from plumbing contractors for equipment purchasing and installation. As with the HVAC contractors, builders explained that they prefer to work with the same contractor(s), particularly since there are so few working in the residential new construction market. The contractor reviews the building plans and negotiates the equipment and material purchase prices and delivery with an equipment distributor or manufacturer, then contracts with the builder to complete the water heater and plumbing system installation.

While the builder and/or the Title 24 consultant often specify the water heater efficiency rating and size, the plumbing contractor usually chooses the equipment brand and type. The builder rarely specifies these parameters, as they want the contractor to choose equipment that they are familiar with and that is of good quality and has low maintenance. All of the plumbers interviewed indicated that they purchase equipment from plumbing supply distributors.

Decision Making and Market Influences

The in-depth interviews revealed that plumbing contractors have little influence on equipment efficiency specification, nor do they participate in the decision-making process. In particular:

- Less than 10% of the plumbing contractors indicated that they have the opportunity to suggest that the builder increase the efficiency of the water heating equipment beyond the Title 24 minimum standards. Of these, none have actually done so.

- Plumbing contractors indicated that they are *not very influential* or *not at all influential* in assisting builders who want to exceed Title 24. This is primarily due to the fact that the contractors are not usually involved in the equipment specification and only become involved in a project when the builder solicits bids for equipment and installation.

Plumbing contractors' primary sources of information on new technologies and installation methods are the manufacturer sales representatives, who contact the contractors on a regular basis, explain new equipment and products, and deliver literature. Other sources of information include trade shows and trade literature.

5.16 Building Inspectors

The primary task of building inspectors in the residential new construction market is to ensure that all new residential buildings comply with both state and federal building codes. It is important to note that even though state and federal government agencies design and administer the building energy codes, enforcement occurs at the local level, typically through a municipal building department. The enforcement of building codes actually occurs at two different stages of development and is conducted by different individuals within the building department. First, a *building plans examiner* reviews both the building plans and Title 24 compliance forms submitted by the builder before issuing a building permit. Second, during on-site visits, *field inspectors* check for code compliance as various stages of construction are completed. During an on-site visit, the field inspector ensures that the equipment and shell measures installed coincide with those specified in the building plans. More importantly, however, inspectors ensure that all equipment and measures were installed properly, as per the manufacturer' s recommendations. Both building plans examiners and field inspectors were interviewed for this study.

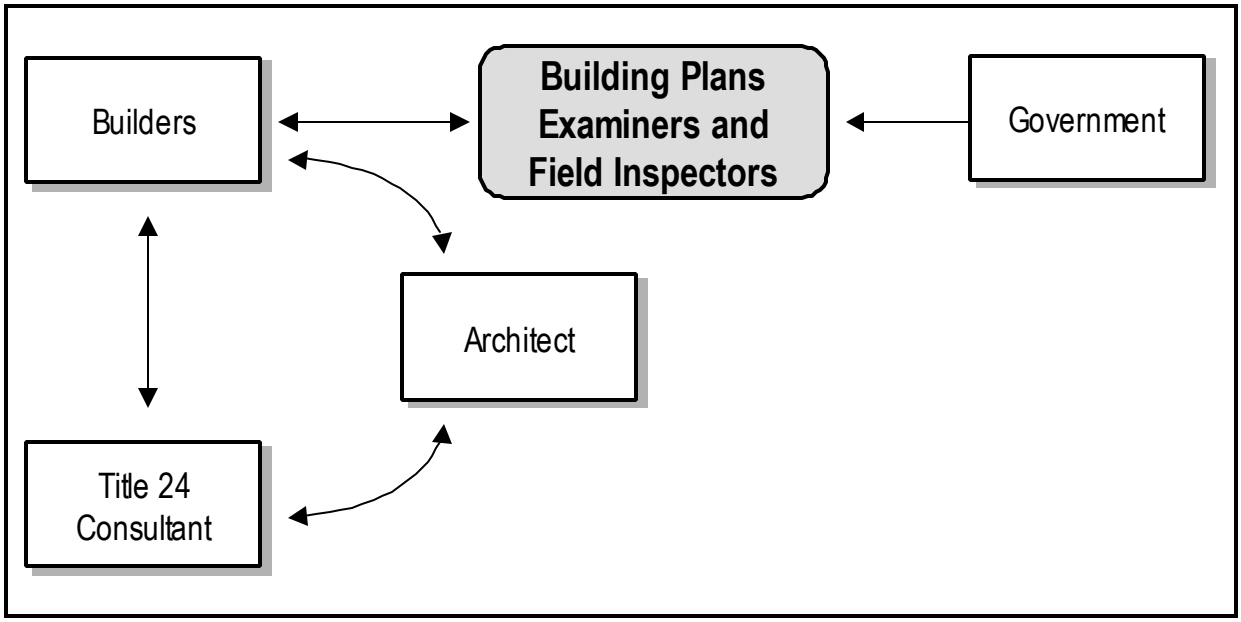
Most building plans examiners and field inspectors have engineering backgrounds and specialize in a specific aspect of construction. For example, most building departments have structural, mechanical, plumbing, electrical, and general building inspectors. (Those relevant to this study are mechanical, plumbing, and general building inspectors.) Most, if not all, building departments have chief inspectors who oversee all field inspectors in the department.

Primary Functions and Interactions in the RNC Market

As illustrated in Figure 5-11, building plans examiners and field inspectors directly interact only with the builder. Note that in-person communication between builders and plans examiners is minimal, unless the plans do not comply with the building code requirements and require revision before issuance of a building permit. In-person communication between

builders and field inspectors is more common, and typically occurs with a project manager or site manager. Again, builders interact more with inspectors if problems are identified.

Figure 5-13: Building Plans Examiners and Inspectors in the RNC Market



Decision Making and Market Influences

The in-depth interviews with building plans examiners and field inspectors revealed that these market actors have no influence on builders' decisions regarding the efficiency levels of gas equipment and shell measures. The primary (only) function of these market actors is to ensure that builders comply with the building codes. Some respondents noted that builders and/or architects might ask the building department questions relating to Title 24 compliance. Further, building departments, in general, might provide informational services for builders with respect to compliance issues, as well as general information on equipment and shell measures, installation requirements, and other construction and/or building code issues. However, the function of building plans examiners and inspectors in the residential new construction market pertains only to code compliance. (*"We make information available, but in the end, anything more than minimum requirements is voluntary."*) As such, (professional) interest in building plans that exceed the minimum requirements is beyond the scope of their profession.[41] Some inspectors even commented that making suggestions that do not pertain to *just* meeting the standards would constitute a conflict of interest. *"The inspector must [maintain] a neutral position due to state law."*

[41] If the building plans do not meet Title 24, the building plans examiner might explain possible trade-offs or give advice so the builder will not have to recompute Title 24 compliance calculations. If everything meets the minimum requirements, they do not make any suggestions or offer any advice.

Because of the nature of their profession, all building plans examiners and field inspectors are very aware of state and federal energy codes, the latest available high efficiency technologies and shell measures, and duct testing and sealing methods. Their primary information sources include professional seminars, training sessions, California Energy Commission (CEC) publications and hand-outs relating to Title 24 compliance (such as "Blue Print"), literature from manufacturers, and other trade literature and organizations.

5.17 Real Estate and Sales Agents

Real estate and sales agents facilitate the sale of the home and are responsible for all transactions between the consumer and the builder or developer. Their primary function is to help consumers locate a home in which they feel comfortable and that fits their lifestyle. Essentially, a buyer who employs an agent relies on their judgment and knowledge of the market to help them in their decision-making process. This subsection discusses the responsibilities of real estate and sales agents in the new construction market, their interactions with other market actors, and their primary influences within the market.

In the context of this study, a real estate agent is defined as a representative of a real estate office, such as Coldwell Banker or Century 21, or a self-employed individual selling residential housing. A real estate agent or broker belonging to an Association of Realtors uses the Realtor title and subscribes to the Association of Realtors code of ethics.[42] Agents employed or contracted by the builder are referred to as sales agents. The Department of Real Estate must license all real estate agents, brokers, and sales agents in California.[43]

Primary Functions and Interactions in the RNC Market

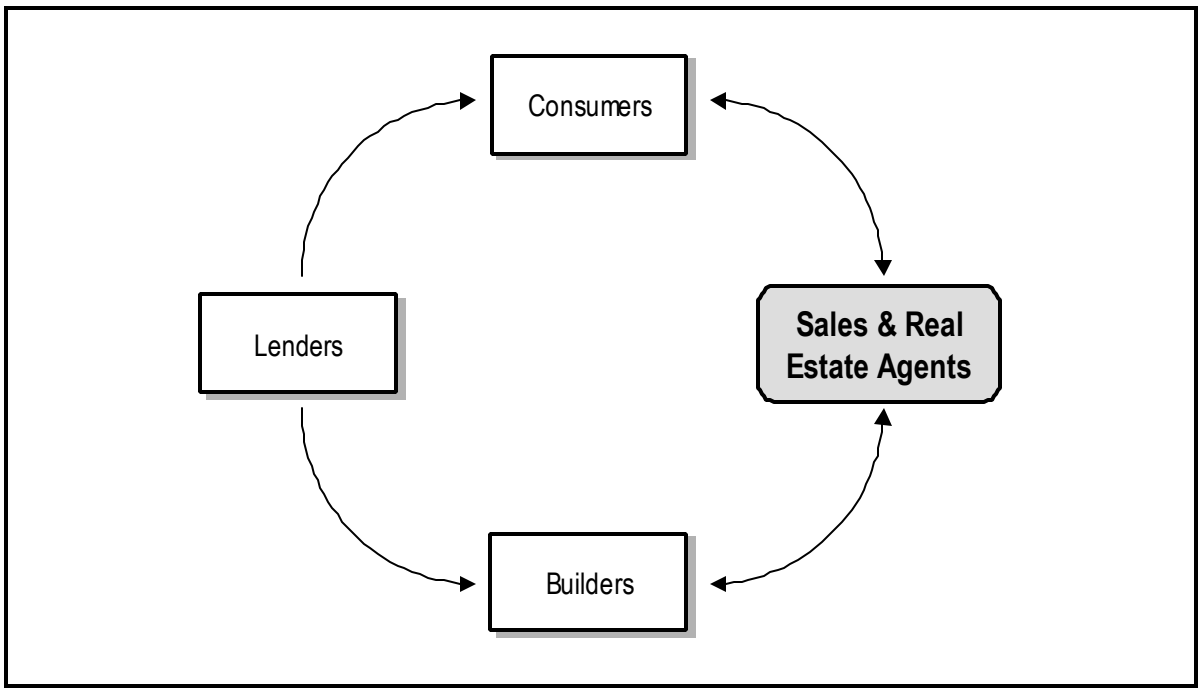
As depicted in Figure 5-14, sales agents interact with builders and consumers. As such, the real estate and sales agents' primary objectives are to sell homes for the builder and satisfy the consumers.

The in-depth interviews revealed that sales agents, who are representatives of *builders*, are the key players with respect to new construction tract home sales. Sales agents typically work out of a sales office within a community or development during construction. They provide the consumer with literature and sales and marketing materials made available by the builder regarding the home's features and about the community in general.

[42] The California Association of Realtors (CAR) has approximately 100,000 members in California. The San Diego Association of Realtors, one of five Realtor associations in San Diego County, has approximately 3,200 members.

[43] There are approximately 213,300 licensed real estate agents in California, about 126,850 of which are located in Southern California (Department of Real Estate).

Figure 5-14: Real Estate and Sales Agents in the RNC Market



In contrast, real estate agents primarily resell homes rather than sell new construction; they rarely have any direct interaction with a builder. Thus, real estate agents have a very limited function in the residential new construction market. In the rare case when a real estate agent becomes involved in the purchase of a new home, the agent becomes an agent of the *buyer*. In order for a real estate agent to become involved in the purchase of a new home, the buyer takes their real estate agent to the new home before engaging in negotiations with the sales agent. In this case, the real estate agent can be very influential in helping the buyer to decide what features of the house are important for comfort or investment.

The market influences of sales agents are discussed below. (Because of the negligible role of real estate agents in the new construction market, the remainder of this subsection pertains only to sales agents.)

Decision Making and Market Influences

Sales agents can influence and be influenced by both builders and consumers. The level of influence largely depends upon the following:

1. Consumer awareness levels regarding energy efficiency (if consumers are not aware of energy efficiency, they do not know to ask the sales agents the "right" questions),
2. The level of consumer interest in energy-related features (regardless of actual knowledge),

3. The knowledge of the sales staff regarding equipment and shell measures, and
4. The extent to which builders train sales staff and provide them with information regarding equipment and shell measures.

Given the above, the degrees to which sales agents influence and are influenced by builders and consumers are discussed below.

Consumers. The first two items above refer to consumer demand and awareness of energy-efficient equipment and features. The extent to which sales agents are involved with and can influence consumer decisions regarding energy efficiency levels could depend largely upon how sales agents perceive consumer interest in energy efficiency of their new home. First, 35% of the sales agents interviewed for this study indicated that 100% of their customers "have asked about homes that were more energy-efficient than [what] the state building code requires," and 53% of the agents indicated that 50% or less of their customers ask about homes that exceed energy code requirements. The remaining 12% of the respondents replied that none of their customers ask about such homes.

Second, as presented in Table 5-7, the sales agents in Southern California indicated that there is "some" consumer demand for energy saving equipment and features, as well as "some" demand for energy saving features that exceed the minimum energy efficiency standards. Further, 50% of the respondents felt that consumer demand for energy saving features has increased over the past several years; the remaining 50% indicated that demand has remained about the same.

Table 5-7: Sales Agents' Perception of Consumer Demand[1,2,3]

	Mean Response
Buyer Demand for Energy Saving Equipment or Features	2.1 *(0.10)* *n=30*
Buyer Demand for Energy Saving Equipment or Features That Exceed Minimum Energy Efficiency Standards	1.9 *(0.13)* *n=29*

1. Agents rated consumer demand for energy saving features and demand for energy saving features that exceed minimum energy efficiency standards on a scale of 1 to 4, with a 1 meaning "a lot," a 2 meaning "some," 3 meaning "very little," and a 4 meaning "none."
2. Means are weighted according to the number of homes sold, as reported by each respondent.
3. Standard errors are included in parentheses.

In most circumstances, sales agents are the only market actors with whom consumers interact during the selection and purchasing process. The results discussed above suggest that sales agents do perceive homebuyer interest in the energy efficiency of new homes. The interview results also suggest that agents feel they are fairly influential in consumer decisions regarding the energy-related features in new homes. In particular, over 38% of the agents indicated they were *very influential*, 23% *somewhat influential*, 38% *not very influential*, and less than 1% considered themselves *not at all influential.*[44]

It is important to note that *having* strong influence and *utilizing* strong influence are not necessarily synonymous. About 36% of the sales agents indicated that they suggested that the consumer purchase a home that exceeds the minimum energy efficiency standards. Whether or not the suggestions are followed is also another consideration, but difficult to ascertain. Interview discussions revealed, however, that whether or not a sales agent's suggestion was followed was somewhat conditional upon the consumers predisposition – how interested they were in energy efficiency to begin with and how receptive they were to suggestions. The following are a few responses from sales agents when asked why or why not consumers followed their suggestion to purchase a home that exceeded Title 24.

"..usually the buyer is not interested (especially younger couples)."
" They usually listen to me."
" They seemed to be more concerned with plans, size, and location."
" [The] public doesn't seem interested..."
"..they already know what they want."

With respect to sales agents' influence, however, it is useful to note here that if consumers do not make specific inquiries about energy efficiency, the sales agent might assume they are not interested. One sales agent commented *" I figure they are not interested in energy features unless they ask."*

In addition to consumer preferences in interest in more energy-efficient homes, the extent of sales agents' influence on the energy efficiency levels of the homes that consumers purchase is largely dependent upon the builder. As explained below, the builders train their sales agents and provide them with marketing materials, such as pamphlets and booklets on the energy-related features of the homes. Whether or not the homes exceed standards to begin with or whether the consumer is given the opportunity to upgrade the equipment and shell measures will obviously influence sales agents' ability to sell homes which exceed standards.

[44] On a scale of 1 to 4 with a 1 meaning " very influential" and a 4 meaning " not at all influential" the average response was a 2.0 with a standard error of 0.17 (n=30). Responses were weighted according to the number of homes sold, as reported by each respondent.

Builders. With respect to builders, the sales department provides input during the initial project development phase and conveys to the builder the characteristics and features of homes that consumers find to be most appealing. While most builders seriously consider input from the sales department, they do not rely on sales agents for feedback regarding energy-related equipment and measures.

Items 3 and 4 above essentially refer to how knowledgeable the sales staff if with respect to energy efficiency and Title 24 requirements and how proactive the builder is in promoting energy efficiency to the sales staff and, therefore, the consumer. On average, sales agents reported being *very aware* of the latest available energy saving gas space and water heating equipment and high efficiency windows, and roughly 93% of the agents indicated being aware of Title 24 requirements.

Sales agents reported that they receive quite a bit of information from builders and that they utilize a wide variety of information sources regarding energy-related equipment and measures. The most common source was information from the builder, such as CD-ROMS, videos, pamphlets, and other literature and marketing materials. In order of the number of comments received for each, information sources include the following:

- Literature and materials provided by the builder,
- Personal utility bills,
- Information from architects, Title 24 consultants, and contractors,
- Literature provided by utility companies,
- Training from the builder,
- Trade shows and literature, and
- Literature and equipment information from manufacturers.

When queried about their influence on builders to exceed Title 24, on average, sales agents reported being not very influential. About 8% reported being *very influential*, 39% *somewhat influential*, 13% *not very influential*, and 40% indicated they were *not at all influential*.[45]

At this point is might also be beneficial to compare builder and sales agent' s perceptions on how different features of the home effect its marketability. Table 5-8 presents both builder and sales agent responses to how important certain characteristics are in the marketability of a new home. As expected, both builders and sales agents believe that selling price and location are very important, in addition to the home' s style, floor plan, and square footage. As shown, builders and sales agents provided nearly identical rankings of these attributes.

[45] On a scale of 1 to 4 with a 1 meaning "very influential" and a 4 meaning "not at all influential" the average response was a 2.9 with a standard error of 0.19 (n=30). Responses were weighted according to the number of homes sold, as reported by each respondent.

The ranking of the importance of energy efficiency in the marketability of a new home is interesting and leads to the following observations:

- First, builders and sales agents view energy efficiency as less important with respect to the marketability of a new home relative to the other attributes. This result is supported by discussions with builders, nearly all of which explained that consumers place a much higher priority on visible features of the home, such as kitchen appliances, flooring, and other aesthetic qualities than non-visible features, such as HVAC equipment and insulation.
- Second, a comparison of builder and sales agent ratings of the importance of energy efficiency reveals that builders rated energy efficiency as slightly less important in the marketability of a new home than did sales agents, in absolute terms. Although the difference is not large, it is important to observe that builder's and sales agents' responses were nearly identical for every other characteristic. This is a key result and could suggest that builders might not be receiving the same market that sales agents do with respect to consumer interest in the energy efficiency of new homes.

Table 5-8: Importance of Characteristics for New Home Marketability[1,2,3]

Characteristic	Builder (n=27)	Sales Agents (n=30)
Selling Price	5.0 *(0.02)*	4.9 *(0.08)*
Location	4.8 *(0.08)*	4.9 *(0.07)*
Energy Efficiency	2.5 *(0.18)*	3.8 *(0.20)*
Style of Home	3.8 *(0.16)*	4.0 *(0.16)*
Floor Plan	4.3 *(0.13)*	4.2 *(0.16)*
Square Footage	4.1 *(0.13)*	4.1 *(0.17)*

1. Each respondent rated the importance of each characteristic in the marketability of a new home, with a one 1 meaning "not important," and a 5 meaning "very important."
2. Means were weighted according to the number of homes built (by builders) and sold (by sales agents) each respondent reported completing in 1997.
3. Standard errors are included in parentheses.

The sales agent is in a rather precarious position in the market and their role seems to be more reactive, rather than proactive, with respect to energy efficiency levels. (This is understandable, given that their priority is to sell the homes for the builder, not promote energy efficiency in the market.) Evidence suggests that sales agents aggressively promote the features of homes that they believe to be important to the consumers. The above discussion regarding the role of sales agents in the residential new construction market and the interaction of agents with builders and consumers indicates that sales agents can be fairly influential with consumers but only a little influential with builders with respect to the energy efficiency levels of the equipment and shell measures of new homes. Their influence is constrained by the predisposition of consumers and the willingness of the builder to construct homes with features that exceed the minimum energy efficiency standards, as well as their willingness to provide the consumer with options to upgrade equipment and shell measures. While sales agents perceive demand for energy-related equipment and features that exceed minimum building standards, builders might not be incorporating this information into project development.

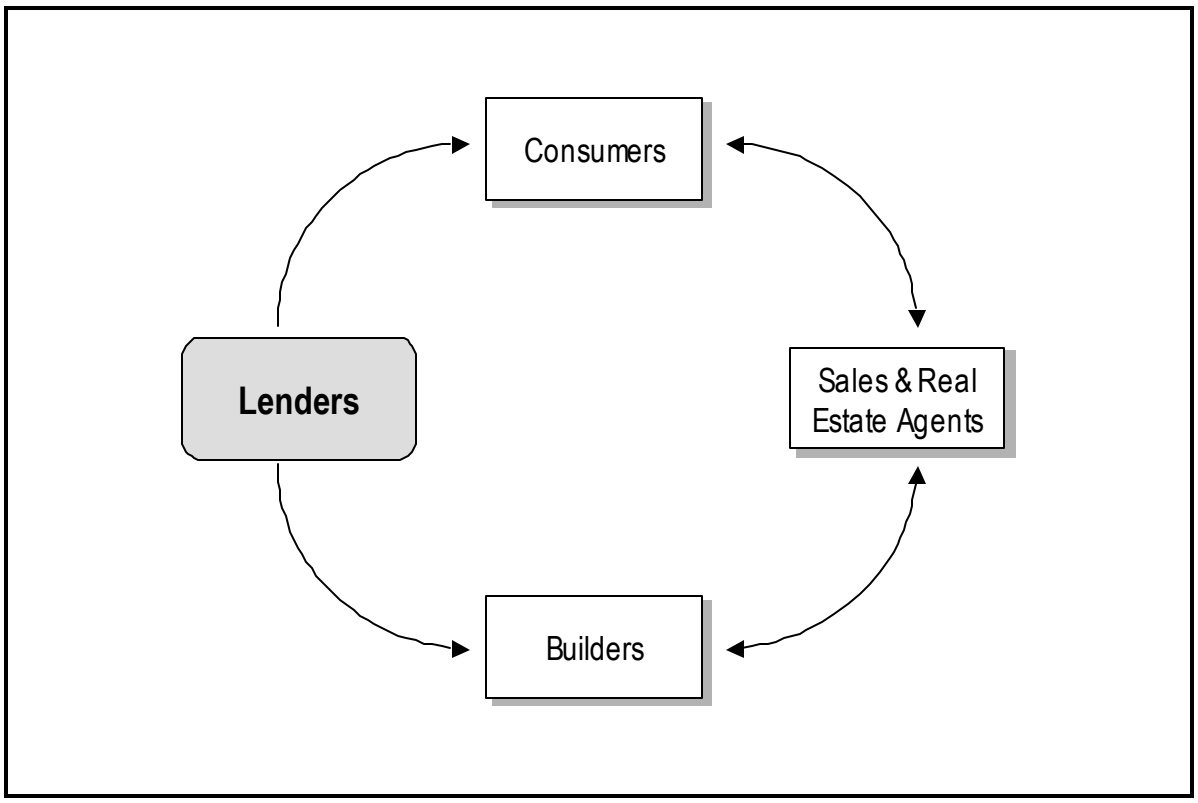
5.18 Lenders

Some lenders specialize in mortgages for new residential construction. These are usually mortgage companies specializing in new housing mortgages, a division of a mortgage company, or a mortgage company owned by a builder.[46]

Figure 5-15 illustrates the interactions between lending institutions and other participants in the residential new construction market. Lenders provide homebuyers with the financing required to purchase a new home and provide builders with the financing necessary for land development. Consumer mortgages and construction loans are discussed below.

[46] Interviews with builders revealed they do not offer loan incentives to homebuyers who are purchasing homes that exceed Title 24 requirements.

Figure 5-15: Lending Institutions in the RNC Market



Consumer Loans and Mortgages

The majority of lenders indicated that the energy efficiency levels of new homes do not influence consumer mortgage terms. In fact, less than 5% of the lenders interviewed for this research require information pertaining to the energy efficiency of equipment or shell measures in the home. Those that do require such information either offer energy-efficient mortgages or work with the California Home Energy-Efficient Rating System.

Since October 1993, newly constructed homes must meet or exceed the energy conservation standards established by the Council of American Building Officials (CABO) in the 1992 Model Energy Code (MEC). California's Title 24 energy standards are higher than this. Accordingly, HUD allows borrowers purchasing these homes to qualify for FHA mortgages at 2% higher than normal qualification ratio.[47] That is, FHA will insure the additional loan amount for the energy-efficient measures without further qualification or down payment.

Lenders offering consumer mortgages indicated that they are *somewhat influential* in assisting homebuyers who prefer to purchase a home that exceeds the minimum energy efficiency requirements. The majority of lenders, however, commented that because the

[47] HUD Mortgagee Letter 93-26.

homebuyer has already selected the home before obtaining financing, lenders are not in a position to provide assistance or strongly influence consumers with respect to the energy efficiency levels of their new home.

Construction Loans

Construction loans are short-term loans to either a developer for a tract community or to an individual for a custom home. For an individual building a custom home, a construction loan is taken out after the lot is purchased. The typical term is one year, after which the homeowner usually has the option of converting the loan into a mortgage or seeking other financing. For tract builders, the typical loan period is one year and the loan is paid off as the homes are sold. There are no lenders for large tract builders in Southern California. However, national or state financial lending institutions, such as CalPERS, Prudential, Chase Manhattan, and Citicorp, usually provide large construction loans.[48] First National Bank, Grossmont Bank, and Scripps Bank may do some locally, but on a small scale.

The lenders interviewed for this study indicated that they were *somewhat influential* in assisting builders seeking financing for homes that exceed Title 24. Most commented that the energy efficiency of the homes is not in the scope of their profession.

5.19 Government and Nongovernment Agencies

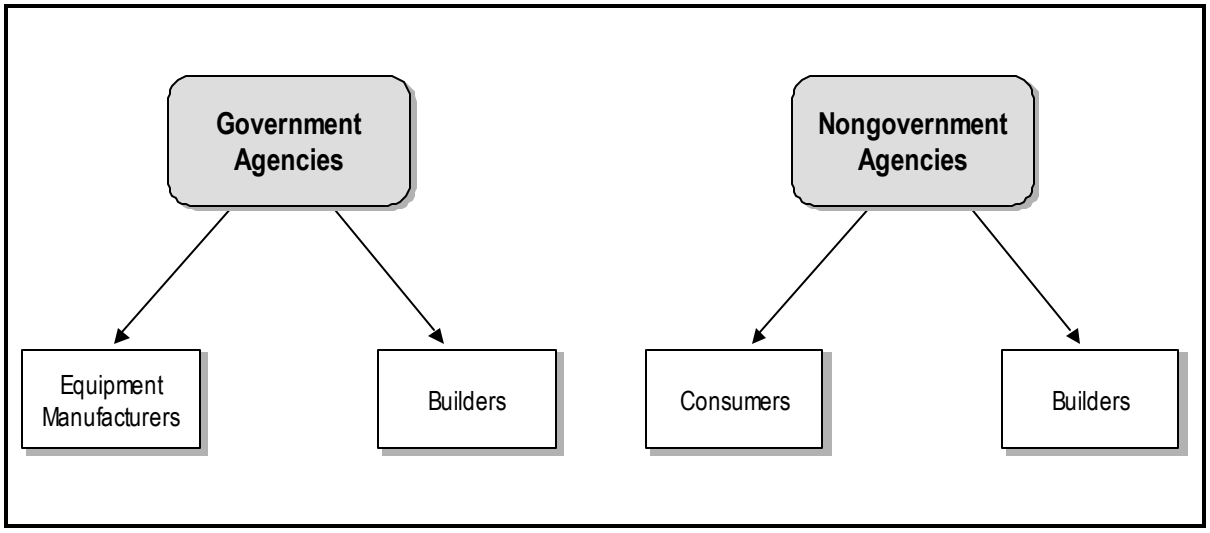
Both government agencies and nongovernment organizations (NGOs) are involved in the residential new construction market. In the context of this research, a government agency is one that receives funding for its operations from a government entity. NGOs are either nonprofit organizations or those that receive funds from private sources. Not only do these agencies implement building energy codes and standards, but they provide informational services regarding energy efficiency, as well. National- and state-level government and NGOs exert influence on other market actors by establishing and promoting building standards, providing educational assistance, and assisting with financing. This subsection discusses the primary functions and their interactions with other market actors.

Figure 5-16 illustrates the position of government agencies and NGOs in the residential new construction market. As shown, government agencies interact with or influence the supply-side actors (manufacturers) and the builders by implementing the energy efficiency requirements of all equipment that is manufactured, as well as administering the residential building energy codes by which all residential buildings must comply. In contrast, NGOs

[48] Note that large tract builders in Southern California typically cannot find adequate financing intermediaries in their local area and are forced to seek financing from national or international corporate institutions.

interact primarily with consumers by providing informational services and programs to promote the demand of more energy-efficient homes.

Figure 5-16: Government and Nongovernment Agencies in the RNC Market



Programs Administering Energy Codes and Standards

Residential energy codes and standards exist as a means of assuring efficient energy use in newly constructed residences. Through building codes and standards, several agencies direct regulatory influence in the residential new construction market. Building energy codes establish a minimum standard of energy-related measures to which all residential buildings must comply. National and state energy codes pertaining to the residential new construction are discussed below.

National Energy Codes

The Office of Codes and Standards of DOE administers the federal appliance standards initiated in the National Appliance Energy Conservation Act (NAECA). Since passage of the law that mandated these standards in 1987, minimum operating efficiencies for various appliances such as furnaces and air conditioners have come into effect.

The revision process for these standards is time consuming – particularly so since the Office has been updating them one at a time due to lack of funds. The process includes a series of notices and public hearings after which a final ruling is made. The analysis process includes reviewing a contracted market study as well as various comments and discussions made during the hearings. The entire process typically takes about three years.

The appliance standards resulting from this process are incorporated into the Model Energy Code (MEC). MEC was designed to be applicable nationwide and, as such, takes all climates

and environments into consideration. FHA and VA financed homes are required to comply with MEC; states may or may not adopt it for their residential new construction.

The Building Officials and Code Administrators (BOCA) administers the process of MEC revision. The process is a democratic one, and anyone may submit proposed revisions. Typically, these proposals come from people in the steel and concrete industries, designers, code officials, and local building officials who issue building permits. BOCA assembles and publishes the proposed revisions and presents them at a series of public meetings, arranged to discuss the revisions. A body of legal code officials from local jurisdictions assembles at a conference to decide on the proposals, and their decisions are published in a supplement to the code. A weakness to the process is that it takes time to modify the code. As such, changes in product developments can not readily be incorporated.

State Codes

In California, the Title 24 energy code is the statewide mandatory minimum code. It exceeds the requirements of MEC. The CEC administers changes to the code. Compliance with Title 24 can be by either a prescriptive approach or a performance approach. A prescriptive approach involves choosing one of several alternative component packages. Compliance with the code is achieved by installing the measures listed in the package, which might include insulation, shading and window treatments, lighting, and HVAC measures. Alternatively, the performance approach provides greater flexibility. Points are accumulated for the use of various conservation measures such as insulation, glazing, HVAC, and water heating. Trade-offs are allowed, provided measures below standards balance out those used that exceed standards. Computer programs are available for modeling the overall energy use of the building. The CEC designed this capacity for trade-offs and flexibility in code compliance to encourage compliance among builders.

Revisions to Title 24 follow a three-year cycle corresponding to the publication of MEC revisions. Proposed changes may be submitted at any time. Proposals are reviewed by CEC staff, discussed in public hearings, and voted on by the CEC. Typically, the following types of people participate in the revision process: building industry interest groups, appliance manufacturers, professional organizations, and consumer protection groups. The revision process happens every three years with the CEC administering the process. A staff team collects revision proposals, arranges meetings, receives feedback from public, and makes recommendations to commissioners.

Federal or state government officials do not enforce residential energy codes. Rather, enforcement occurs through the process of approving building plans. To obtain a building permit, the documentation that builders submit to local building departments must include a *Certificate of Compliance*.

Agencies Administering Energy Codes and Standards

Table 5-9 lists the agencies interviewed for this study that are involved in implementing energy codes and standards. Each of these is defined and discussed briefly below.

Table 5-9: Agencies Administering Energy Codes and Standards

Name of Agency	Administered or Funded by
Office of Codes and Standards	U.S. Department of Energy (DOE)
Building Officials and Code Administrators International (BOCA)	Nonprofit (Part of the Council of American Building Officials.)
Energy Efficiency Standards Office	California Energy Commission (CEC)
California Institute for Energy Efficiency (CIEE)	California Energy Commission (CEC)
Lawrence Berkeley National Laboratory (LBNL)	California Energy Commission (CEC)
Pacific Northwest National Laboratory (PNNL)	U.S. Department of Energy (DOE)

- ***Office of Codes and Standards.*** The Office of Codes and Standards, operated by DOE, promulgates federally mandated energy efficiency standards and amendments to them. In addition, they prescribe test procedures to measure the energy efficiency and use of appliances and, along with the Federal Trade Commission, oversee the labeling of commercial equipment. Their mission is to improve the energy efficiency of buildings through standards, codes, and guidelines for buildings, building equipment, and appliances.
- ***Council of American Building Officials (CABO).*** CABO is an umbrella organization for three model code organizations:
  - Building Officials and Code Administrators International (BOCA), publishers of the National Building Code,
  - International Conference of Building Officials (ICBO), which publishes the Uniform Building Code, and
  - The Southern Building Code Congress International (SBCCI), publishers of the Standard Building Code.

  These organizations strive for uniformity among their codes and, to that end, created the International Code Council to oversee the development of a single set of model codes. Currently, BOCA administers and publishes revisions to the MEC.
- ***Energy Efficiency Standards Office.*** The Energy Efficiency Standards Office, operated by the CEC, develops and implements the standards of the California Energy Code contained in parts 1 and 6 of the State of California' s Title 24. They provide a number of educational services, including a newsletter for building and energy professionals regarding compliance information and a

hotline staffed with trained energy specialists. In addition, they publish a *Home Energy Manual* for homeowners that explains energy-efficient features required in new construction along with guidelines about maintaining an energy-efficient home.

- ***California Institute for Energy Efficiency (CIEE).*** The CIEE at Lawrence Berkeley National Laboratory plans, coordinates, and implements research and development in energy-efficient products and processes for California. Research projects are conducted mostly at colleges and universities and the information is used by the CEC for Title 24 revisions.
- ***Pacific Northwest National Laboratory (PNNL).*** PNNL provides research services used by CABO in revising MEC. In addition to analyzing equipment and systems, they collect feedback from builders and building officials about effective and noneffective parts of the code. They also provide training and educational materials to building inspectors and state building officials on code enforcement. The lab is managed by the Battelle Memorial Institute and funded by DOE.

Programs Providing Informational and Other Services

In addition to the direct influence from the agencies that administer the building energy codes, a number of national- and state-level agencies promote energy efficiency in the market by targeting other market actors, mainly consumers. Many of these programs provide telephone hotlines to answer questions, newsletters, web pages, and publications directed at builders or homeowners with the goal of promoting energy efficiency. These agencies tend to view the market as a whole and target specific market processes rather than groups of market actors. The remainder of this section describes the various informational agency programs operating at both national and state levels.

Table 5-10 lists the agencies interviewed for this study that promote energy efficiency and provide relevant informational services to other market participants. Each of these is defined and discussed briefly below.

Table 5-10: Informational Agencies and Programs

Name of Agency	Administered or Funded by
Energy Efficiency and Renewable Energy Clearinghouse	National Renewable Energy Laboratory, U.S. Department of Energy (DOE)
Energy Star Program	U.S. Environmental Protection Agency
California Home Energy Efficiency Rating System (CHEERS)	Nonprofit association
Buildings Technology Center at Oak Ridge National Laboratory (ORNL)	U.S. Department of Energy (DOE)
Building Technologies Program, Lawrence Berkeley National Laboratory (LBNL)	U.S. Department of Energy (DOE)
Efficient Windows Collaborative (EWC)	Nonprofit association, supported in part by the U.S. Department of Energy (DOE)
Building America Program	U.S. Department of Energy (DOE)

- ***Energy Efficiency and Renewable Energy Clearinghouse.*** The Energy Efficiency and Renewable Energy Clearinghouse is an informational program funded by DOE and operated by the National Renewable Energy Laboratory (NREL). They provide information and consultation on energy efficiency and renewable energy to anyone calling their hotline, and typically speak with homebuyers, architects, and government agencies.
- ***Energy Star Program.*** The Energy Star Program is a federal program administered by the Environmental Protection Agency (EPA). Their primary objective is to encourage the building of homes that are at least 30% more energy efficient than required by MEC. The program has developed an icon and yellow sticker to be displayed on appliances and buildings that meet their efficiency standards, as evidenced by a HERS rating. They provide information and marketing tools to builders and their sales people.
- ***Home Energy Rating Systems (HERS).*** HERS provide ratings of the relative energy efficiency of a house and are used to qualify applicants for Energy-Efficient Financing. The California Home Energy Efficiency Rating System (CHEERS) is a nonprofit corporation developed to provide HERS ratings and to educate consumers about energy efficiency technologies and benefits.
- ***Buildings Technology Center.*** The Buildings Technology Center at the Oak Ridge National Laboratory (ORNL) is funded by DOE and investigates the performance of envelope systems. They promote the use of energy-efficient technologies used in building construction by working with manufacturers and trade associations.

- ***Building Technologies Program.*** The Building Technologies Program at LBNL conducts research on windows and daylighting, lighting systems, and advanced building systems. Research on windows includes materials research, development of new concepts, analysis of window performance, rating of products, and international standards. The program provides educational materials in the form of a web page, publications, and presentations at industry conferences.
- ***Efficient Windows Collaborative.*** The Efficient Windows Collaborative is a nonprofit association formed by DOE and other key players in the window industry with the goal of doubling the market share of efficient windows by the year 2005. It is managed jointly by the Alliance to Save Energy (ASE) and the Center for Building Science at LBNL. Educational efforts are targeted at homebuyers, builders, and window manufacturers, and promote energy-efficient mortgages to homebuyers and sales agents.
- ***Building America Program.*** The Building America Program is an industry partnership program sponsored by DOE. It promotes home-building innovations using systems engineering approaches with the objective of increasing quality and energy efficiency while reducing cost and environmental impacts. A team of building industry professionals work together to recommend trade-offs that will make the building project more cost effective.

Influences and Decision Making

Government agencies and NGOs tend to view the market for residential new construction as a whole, rather than target specific actors. In addition, most of those interviewed described their function as responsive rather than proactive. They tend to provide services to those who approach them rather than actively seek out market actors with the goal of educating or persuading them.

The programs implemented by government and NGOs (and the agencies, themselves) are typically run by boards or overseen by other agencies, causing the decision-making process to be a time consuming and often complex procedure. Because of this, rapid changes in product development and technology are slow to be incorporated into these programs.

The government agencies interviewed for this study identified an overseeing office or agency as the next step up in the decision-making process. Typically, proposals for change would be submitted to the overseeing office and considered during an annual budget review. NGO respondents explained that their agencies were run by boards of directors typically composed of various people in the industry.

5.20 Consumers

Consumers are the final end users of the high efficiency gas equipment and shell measures installed in the house they purchase. Although possibly not aware of the efficiency ratings of these products or of the exact energy savings experienced as a result of their use, consumers are the ultimate beneficiaries of their utilization.

The population of California was nearly 30 million in 1990. This is expected to increase to 43 million (an increase of about 43%) by 2011.[49] Roughly 70% of the survey respondents live in single family homes and 83% of respondents own their own home as opposed to renting. Approximately 91% of the homeowners are the original owner of their current home and about 70% have bought other houses in their lifetime for their own occupancy.

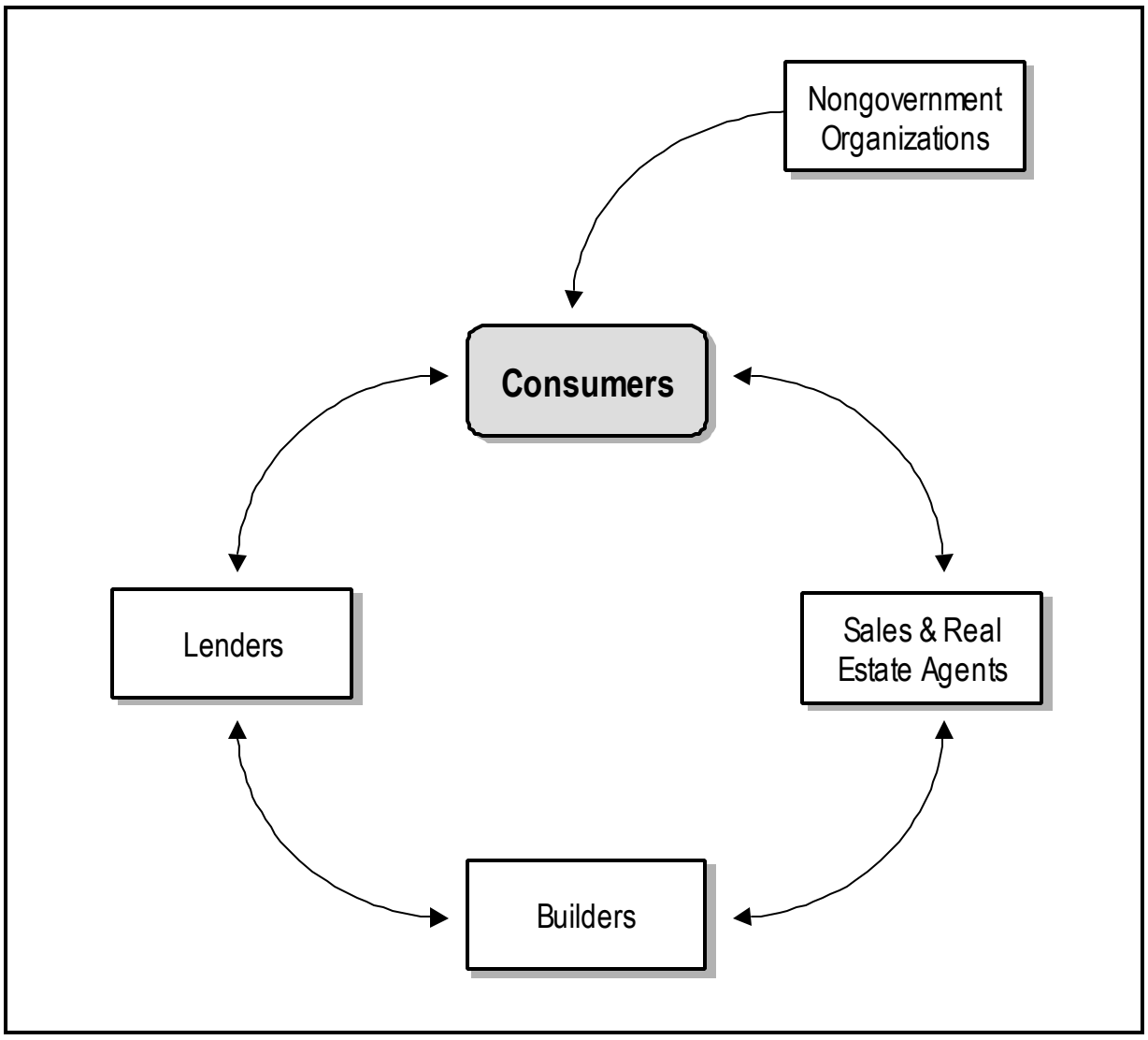
The consumer' s primary functions, interactions, and influences in the residential new construction market, as revealed during the in-depth interviews with industry participants are described below. (Detailed results of the consumer survey are presented in Section 7.)

Primary Functions and Interactions in the RNC Market

Figure 5-17 illustrates the interactions between consumers and other market actors. Typically, consumers interact with sales agents and lending institutions and obtain informational and financing services from government agencies and nongovernment organizations. Market interaction influences differ substantially between tract and custom projects. As explained in subsection 5.1, consumers are the primary decision makers in custom projects, thus interacting directly with the builder, architect, and contractors. In tract development projects, however, the consumer has little influence and no interaction with those responsible for the home' s design and energy-related specifications.

[49] Energy Efficiency Division, California Energy Commission

Figure 5-17: Consumers in the RNC Market



Decision Making and Market Influences

With respect to energy efficiency, consumers do not exert much influence in the residential new construction market. Less than 5% of the builders indicated that homebuyers contribute to the decision-making process and most of these built custom homes as well as tract housing. Some builders indicated that they offer upgrades to the consumers, but the majority of options pertain to aesthetic and visual features, and rarely include energy-related equipment or measures. If opting to upgrade, consumers typically increase the efficiency of the air conditioning unit, the size of the water heater, or choose better quality windows. Homebuyers usually upgrade for better comfort or aesthetic quality (including noise mitigation) rather than to increase energy efficiency.

Observations regarding the influences of the "typical" tract home consumer, as revealed during the in-depth interviews with market participants, include the following:

- In tract development projects, the consumer does not interact with the primary decision maker (the builder).
- Consumers have a "generic" and limited understanding of energy efficiency. Therefore, they do not consider, nor do they understand, energy efficiency with respect to specific equipment and shell measures.
- Consumers tend to think of the energy efficiency of a home in terms of quality and comfort rather than operating costs. One government agent interviewed commented that consumers tend not to think of the code as just a minimum requirement. Consumers tend to think that if a home meets building codes then it is as "energy efficient" as possible.
- Energy efficiency is not a concern for consumers during the purchase process, particularly because of the mild climate of Southern California. The characteristics that are important to homebuyers include price, floor plan, location, square footage, and the number of rooms. Homebuyers are most interested in aesthetic qualities and visual attributes, such as style, flooring, color schemes, kitchen appliances, and whether the home fits their lifestyle, in general.
- Consumers' limitations force them to rely on other market intermediaries, mainly sales agents, to provide information to them in a straightforward nontechnical manner.
- Sales agents relay consumer preferences to builders during marketing studies and preliminary product development. Because consumers are either not interested or not informed enough to make inquiries about energy efficiency, sales agents, and therefore builders, assume that consumers do not care about more efficient equipment and shell measures.
- Homebuyers are typically not aware of the differences in operating costs that result from increasing the efficiency levels of equipment and shell measures.

The lack of influence and overall interest in energy efficiency levels is even more accentuated with first-time homebuyers. Builders, in particular, noted that first-time homebuyers have different preferences and priorities in their purchase decisions than do repeat buyers. They are less likely to inquire about energy-related features and are more concerned about the up-front fixed cost (their monthly payment) than consumers who have previously owned a home. First-time homebuyers are also less likely to be familiar with a home's operating costs.

6

Measure Baselines

6.1 Introduction

This section describes the development efforts to characterize the state of the market for measures covered by residential new construction DSM programs. The following measures are included:

- High efficiency gas furnaces,
- High efficiency gas water heaters,
- High efficiency windows, and
- Wall and ceiling insulation.

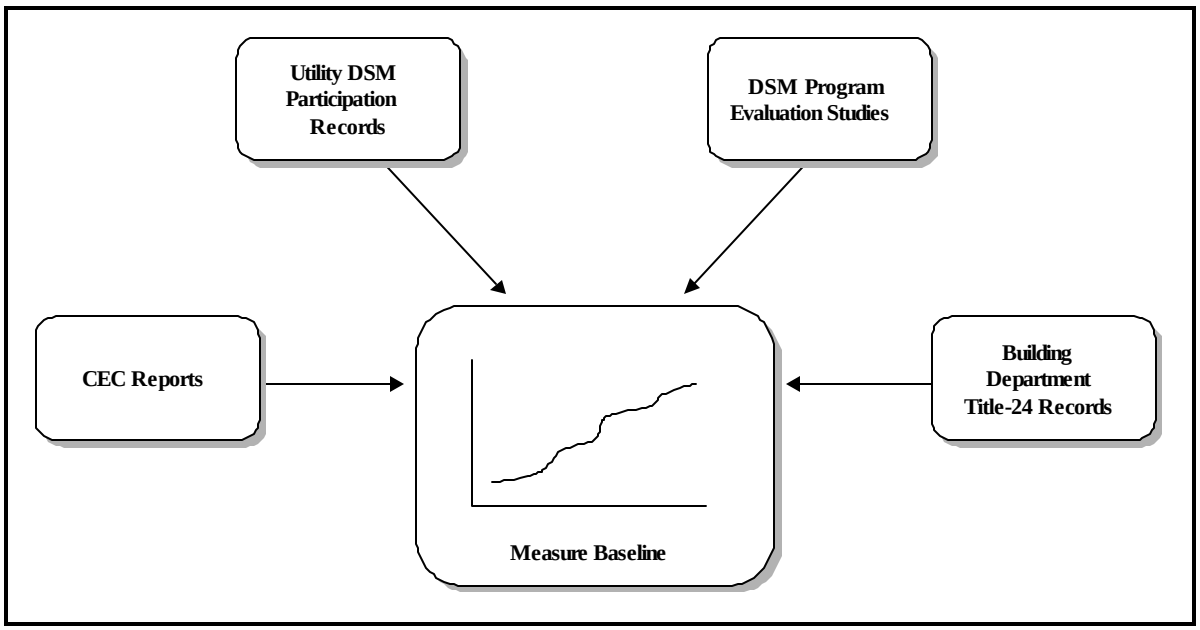
A historical series of efficiency levels of installed equipment and shell measures in new residential construction was used to characterize the market for each of these measures. These historical data are referred to as *measure baselines*. In this context, these baselines refer to historical average values, rather than to values that would have been experienced in the absence of these RNC programs.

RER reviewed and utilized a variety of data sources to develop the measure baselines. However, as will be discussed below, the baselines were developed from four primary sources. These sources, shown in Figure 6-1, include the following:

- The California Energy Commission' s (CEC) Post-Occupancy Residential Survey project,
- SDG&E and SoCalGas residential new construction DSM program records,
- The RER Study Database from the analysis of the 1994 Southern California Gas Company (The Gas Company) Energy Advantage Home Program, and
- Title 24 compliance forms obtained from building departments throughout the SDG&E and SoCalGas service areas.

The following subsections detail the primary data sources and present the measure baselines for each of the covered measures.

Figure 6-1: Overview of Primary Data Sources for Measure Baselines



6.2 Data Sources

Primary Data Sources

A variety of data sources were reviewed to develop the measures baselines.[1] The following are detailed descriptions of the primary data sources used in developing the measure baselines. The primary data sources contain detailed data by household for the following:

- Gas furnace annual fuel utilization efficiency (AFUE),
- Gas water heater energy factor (EF),
- Window efficiency levels (U-values), and
- Wall and ceiling insulation levels (R-values).

CEC Post-Occupancy Residential Survey Data. The CEC Post-Occupancy Residential Survey, conducted by NEOS, collected data on over 400 homes built during the 1990-1994 period throughout all climate zones in California via on-site visits. Of these 400 surveys, 18 homes are located in the SDG&E service area and 142 are located in the SoCalGas service area.

SDG&E and SoCalGas Program Records. Utility program records typically contained the C-2R or CF-1R Title 24 compliance forms from which information was obtained about

[1] A number of other data sources were reviewed but not used in the analysis. These are described in a subsequent subsection.

the proposed types of measures specified in the building plans. The builder, or an agent employed by the builder, must complete these Title 24 compliance forms during the building permit application process. The forms include proposed installations only and some of the installed measures could change, as confirmed with on-site surveys of recently built homes.

The effort to obtain information from utility records resulted in the collection of data for 2,417 homes in the SoCalGas service territory and 3,395 in SDG&E' s service territory. The majority of this data was for participating homes. It is also important to note that individual participants could have received any mix of available measures and there was no indication of what measures were installed at each particular site. Therefore, insofar as the efficiency averages reported for participants might contain a mix of participants and nonparticipants for any single measure, the average efficiencies reported here should be viewed with caution. Regardless, this data proved very useful in describing the lag time between Title 24 compliance filing dates and when the building was actually completed.

RER Study Database. RER evaluated the SoCalGas 1994 Energy Advantage Home Program. The RER database contained on-site survey data for 300 participant and 200 nonparticipant homes in the SoCalGas service area. Further, several original Title 24 compliance forms were obtained from building departments in the SoCalGas service area to compare on-site survey *confirmed* measure installations with *proposed* measure installations. The data collected from this evaluation served as a benchmark in developing the measure baselines.

Building Department Data. Although a considerable amount of historical efficiency data was available from existing studies, secondary data from more recent years were not available. Therefore, a primary data collection effort was undertaken to collect measure efficiency data in the form of Title 24 compliance forms (C-2R, CF-1R, 1C-1, and C-6R forms). These were obtained from numerous building departments throughout SoCalGas' and SDG&E' s service areas. The C-2R and CF-1R Title 24 compliance forms include proposed methods to comply with Title 24 standards. The 1C-1 and C-6R forms are completed by a building inspector during on-site inspections.

A sampling plan, representing the major cities in both service areas, was developed to collect data from building departments in Southern California. The initial plan specified in-person visits to the building departments in the SDG&E and SoCalGas service areas, as shown in Table 6-1.

Table 6-1: Building Departments

SDG&E	SoCalGas
City of San Diego	City of Los Angeles
County of San Diego	County of Los Angeles
City of Carlsbad	Orange County
City of Encinitas	Riverside/San Bernardino
	Ventura
	Mission Viejo
	Irvine

At the onset of this collection effort, however, the following obstacles to completing the initial sampling goals were encountered:

- Some building departments specified that only department staff was permitted to handle Title 24 documents. Thus, RER was unable to gather data from all building departments in the sample due to building department staff resource constraints. That is, the building department staff did not have enough staff time to pull the specific addresses requested or to provide a random sample of forms.
- Some building departments did not require Title 24 compliance calculations to be stored with the blueprints.
- Some of the building departments archive old records on microfilm and not all building departments included the Title 24 information in the archives. This was a common obstacle in collecting data on homes more than three years old.
- Some building departments would not permit photocopying of any information without the consent of the builder and the architect.

Thus, the effort to collect data from building departments required numerous in-person visits to departments throughout Southern California, which proved to be a very time-intensive process. Further, upon obtaining records, there was no guarantee that the records would contain the Title 24 compliance forms required to develop the baseline estimates. In some cases, the information was obtained by ordering specific or random samples of Title 24 forms and having the building department staff copy the necessary information. This method proved to be successful for the Cities of Irvine and Mission Viejo.

Table 6-2 presents the final sample of Title 24 compliance records collected from building departments in Southern California. As shown, this includes data on almost 1,400 homes, of which approximately 950 were in the SDG&E territory and 450 in the SoCalGas service territory.

Table 6-2: Number of Homes Covered by Title 24 Compliance Records

Building Department/Utility	Service Area	Number of Homes
City of Carlsbad	SDG&E	348
City of San Diego	SDG&E	616
City of Corona	SoCalGas	336
City of Irvine	SoCalGas	34
City of Mission Viejo	SoCalGas	57
Total		1,391

Summary of Data Sources

Table 6-3 presents a summary of the data sources for the measure baselines by year. A key for each of the identified data sources follows the table.

Table 6-3: Data Sources of Measure Baselines by Year

Measure	Type	1990	1991	1992	1993	1994	1995	1996	1997
Furnace	***Part***		BC	BC	BC	BCFGH	BCGH	CGH	CGH
	Nonpart					GH	GHK	GH	GH
	All	A	A	A	A	ADE	EIJ	EIJ	EIJ
Water Htr	***Part***		BC	BC	BC	BCFGH	BCGH	CGH	CGH
	Nonpart					GH	GHK	GH	GH
	All	A	A	A	A	ADE	EIJ	EIJ	EIJ
Window	***Part***		BC	BC	BC	BCFG	BCG	CG	CG
	Nonpart					GH	GK	G	G
	All	A	A	A	A	ADE	EIJ	EIJ	EIJ
Insulation*	***Part***		BC	BC	BC	BCFGH	BCGH	CGH	CGH
	Nonpart					GH	GHK	GH	GH
	All	A	A	A	A	ADE	EIJ	EIJ	EIJ

* Wall and ceiling insulation.

Data Source Key

A. California Energy Commission. *Post Occupancy Residential Surveys.* P400-94-015. NEOS Corporation, Sacramento, CA. 1997.

B. SoCalGas Company Energy Advantage Home Program participant files
Certification of Measures installed and payment requests (hard copy)

C. SDG&E Residential New Construction participant files
C-2R Title 24 compliance forms (hard copy)

D. RER Study Database*: First-Year Load Impacts of Southern California Gas Company's 1994 Energy Advantage Home Program*.

E. Building Department Data: City of Corona
C-2R Title 24 compliance forms (hard copy)

F. Building Department Data: Orange County
C-2R Title 24 compliance forms (hard copy)

G. Building Department Data: City of Irvine
C-2R Title 24 compliance forms (hard copy)

H. Building Department Data: City of Mission Viejo
CF-6R Title 24 compliance forms and IC-1 Insulation Certificates (hard copy)

I. Building Department Data: City of Carlsbad
C-2R Title 24 compliance forms (hard copy)

J. Building Department Data: City of San Diego
C-2R Title 24 compliance forms (hard copy)

K. *1994 Residential New Construction Program: First-Year Load Impact Evaluation*. SDG&E, February 1996. Sample of 46 nonparticipants (Haynal & Co.). C-2R Title 24 compliance forms (hard copy)

Omitted Data Sources

Several sources proposed in the revised workplan were not utilized in the development of baseline market shares. Each source is listed below, along with the reason for its omission. As explained, most of these data sources simply did not contain the level of detail relating to measure efficiencies required to develop the baselines. Further, some of the sources listed below did not contain any data for the measures of interest.

- *Residential New Construction: The 1990-1992 Energy Partnership Home Program Load Impact Analysis*. Applied Econometrics, Inc., December 1994.
  - This is a program evaluation study of the 1990-1992 RNC program conducted for SDG&E in 1994
  - RER was unable to obtain any efficiency level data from the study records

- SDG&E Home Energy Survey *Miracle X-XII* (1991, 1993, 1995).
  - The Miracle studies are biannual residential appliance saturation studies conducted by SDG&E.
  - The level of detail in the residential survey does not support energy efficiency baselines.
- California Energy Commission. *Energy Characteristics, Code Compliance and Occupancy of California 1993 Title 24 Houses.* California DSM Measurement Advisory Committee. P400-91-031CN. Berkeley Solar Group, Oakland, CA. 1995.
  - This study involved primary data collection for 1,200 in CEC climate zones 10, 12, 13, and 14. Further onsite data collection of duct leakage and metering was conducted for a subset of 100 of these homes.
  - This sample did not contain any homes in the SDG&E or SoCalGas service territories.
- California Energy Commission. *Occupancy Patterns & Energy Consumption in New California Houses (1984-1988).* P400-90-009. Berkeley Solar Group and Xenergy, Oakland, CA. 1990.
  - This study entailed primary data collection of a nested sample of 2,845 mail surveys, 299 on-site surveys, and 40 on-site monitoring. A second phase was added to include more on-site monitoring to assist in space cooling calculations.
  - The databases received from this study included detailed measure data on ceiling R-values and furnaces. However, only a few sites were located in the SDG&E and SoCalGas service territories.
- California Energy Commission. *1994-1995 Monitoring Final Report*. P400-93-022. Valley Energy Consultants, Sacramento, CA. 1995.
  - A monitoring program conducted by the CEC to determine the compliance and enforcement problems associated with the Title 24 standards.
  - This study covers residential and commercial sites and only a handful of residential homes are in the Southern California region.
- Barakat & Chamberlin, Inc. *Compilation of Energy Efficiency Measure Saturation Data for the California Conservation Inventory Group*. Prepared for Southern California Edison Company, January 1995.
  - Insufficient detailed information on measure efficiency levels for use in developing measure baselines.

6.3 Measure Baselines

The remainder of this subsection presents the measure baselines for high efficiency gas furnaces, gas water heaters, windows, and wall, and ceiling insulation. The efficiency rating, efficiency standard(s), shipments, Southern California efficiency data, and derived measure baseline are discussed for each of these measures.

High Efficiency Gas Furnaces

SDG&E and SoCalGas offered incentives to builders for high efficiency gas furnaces for the periods from 1991 to 1994 and from 1990 to 1994, respectively. The incentives were based on the gas furnace efficiency ratings that exceeded code by some predetermined amount. For instance, the 1994 EAH offered incentives to builders installing gas furnaces with an Annual Fuel Utilization Efficiency (AFUE) greater than 88% and SDG&E offered incentives to builders installing furnaces with AFUEs greater than 15% above the minimum standard of 78% AFUE

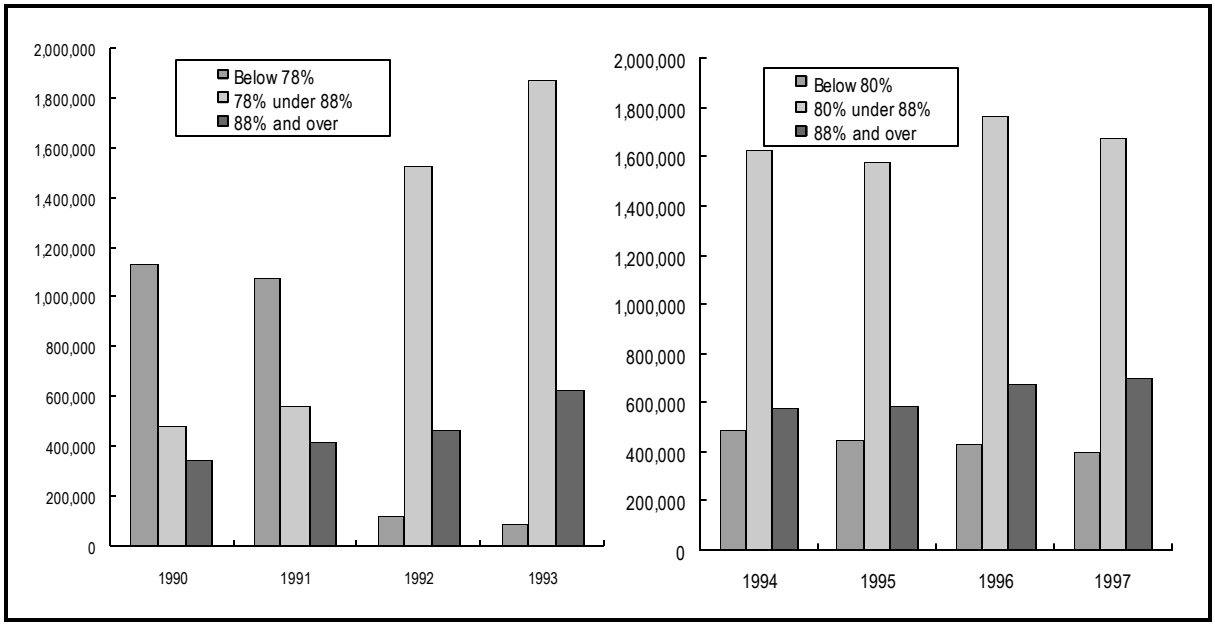
Efficiency Rating. The efficiency of a gas furnace is measured as the AFUE. AFUE is the ratio of annual heat output in British Thermal Units (Btus) to the annual gas input in Btus. This percentage is defined as:

$$AFUE = \frac{HeatingEnergyOutput(Btu)}{GasEnergyInput(Btu)}$$

Efficiency Standards. NAECA requires residential gas furnaces manufactured after January 1, 1992 to have an AFUE rating of at least 78%. DOE conducted the initial analysis in 1993 for updating furnace efficiency requirements but due to a shortage of funding, this analysis has been put on hold. The improvement would most likely be for an 80% AFUE rating for the year 2006.

National Shipments. The Gas Appliance Manufacturer Association (GAMA) records data on national shipments of new gas furnaces by efficiency level. Figure 6-2 presents the average AFUE of shipped new gas furnaces by year. The efficiency levels are split into three categories, and the definition of these categories changed in 1993 as a result of the new national appliance standard for gas furnaces. As shown, there has been a steady increase in the total number of high efficiency units shipped in both absolute terms and as a percentage of total shipments.

Figure 6-2: Average Efficiency of National Shipments of New Gas Furnaces by Year



Southern California Efficiency Data. Data from CEC studies, building departments, and utility participant files were used to develop the gas furnace measure baseline. Table 6-4 presents a summary of the average AFUEs by data source, year, and utility company. The primary difference between these sources is that the CEC data were collected from actual on-site inspections of new residential buildings, and the building department data were gathered from Title 24 compliance records. In order to construct average efficiency data over time, we need to recognize the time lag between when the Title 24 documents were filed and when the house was built and that equipment other than the equipment specified on the Title 24 documents were installed.

A number of studies have identified the problem of discrepancies between the equipment specified on the Title 24 compliance forms and the equipment that is actually installed in a site. To account for this problem, the efficiencies from the Title 24 compliance forms were adjusted upward based upon work completed by the CEC.[2] The CEC reported an average difference of 2.5% between actual and Title 24 compliance AFUE levels (79% AFUE in Title 24 compliance forms versus 81% AFUEs in actual installations). This assumption seemed reasonable given other available data. In particular, a comparison of the average AFUE for all customers from the 1994 EAH evaluation to the Title 24 records gathered for 1994 revealed about a 1% difference (79.9% AFUE Title 24 compliance forms versus 80.6% AFUEs in actual installations). A further comparison was made for the same set of 19

[2] *Energy Characteristics, Code Compliance, and Occupancy of California 1993 Title 24 Houses*. California Energy Commission. P400-91-031CN. May 1995.

participant sites in the 1994 study. In these cases the discrepancies, on average, were understandably higher at 7% (78% AFUE in Title 24 compliance forms to 83.5% in actual installations).

The problem of the lag between the time that the Title 24 compliance forms are filed and when the building is completed was most evident from a review of Title 24 compliance records for the utility program participants. Table 6-5 presents the average AFUE by year filed, year participating (presumably the year the residence was completed) and the average lag time in years between when the Title 24 compliance forms were filed and when the building was complete. As shown in Table 6-5, these lag times vary from roughly half a year to almost three years. Especially in the SDG&E area, these lags might have been lengthened by slowness of the new construction market.

Table 6-4: Gas Furnace Average AFUEs[1,2]

	CEC Data			Building Department Data		
Year	SoCalGas	SDG&E	All	SoCalGas	SDG&E	All
1989	72.3 *(0.21)* *n=6*	73.0 *(na)* *n=2*	72.6 *(0.19)* *n=8*	-	-	-
1990	74.0 *(0.75)* *n=32*	74.5 *(na)* *n=2*	74.0 *(0.71)* *n=34*	-	-	-
1991	74.4 *(0.69)* *n=17*	72.0 *(na)* *n=2*	74.1 *(0.65)* *n=19*	-	-	-
1992	75.0 *(0.47)* *n=16*	72.5 *(0.50)* *n=6*	74.2 *(0.44)* *n=22*	-	-	-
1993	75.4 *(0.69)* *n=32*	74.0 *(na)* *n=2*	75.3 *(0.65)* *n=34*	80.0 *(0.04)* *n=49*	-	80.0 *(0.04)* *n=49*
1994	78.7 *(1.51)* *n=19*	76.0 *(na)* *n=2*	78.5 *(1.43)* *n=21*	79.9 *(0.23)* *n=219*	-	79.9 *(0.23)* *n=219*
1995	-	-	-	80.0 *(0.00)* *n=10*	80.0 *(0.00)* *n=198*	80.0 *(0.00)* *n=208*
1996	-	-	-	79.5 *(0.24)* *n=48*	79.2 *(0.14)* *n=515*	79.2 *(0.23)* *n=563*
1997	-	-	-	80.0 *(0.00)* *n=86*	80.0 *(0.02)* *n=251*	80.0 *(0.02)* *n=337*

1. Average AFUEs are weighted by county building permits.
2. Standard errors are shown in parentheses

Table 6-5: Comparison of Program Participant Average AFUE by Year Filed and Year Built[1]

Year	Filed (AFUE)		Built (AFUE)		Average Lag (Yrs)	
	SoCalGas	SDG&E	SoCalGas	SDG&E	SoCalGas	SDG&E
1989	72.5 *(0.29)* *n=66*	72.0 *(0.00)* *n=13*	-	-	-	-
1990	74.9 *(0.74)* *n=95*	72.0 *(0.00)* *n=81*	-	-	-	-
1991	72.5 *(0.28)* *n=257*	71.8 *(0.10)* *n=290*	72.3 *(0.18)* *n=263*	72.2 *(0.14)* *n=53*	.96	2.30
1992	74.9 *(0.38)* *n=248*	76.0 *(0.02)* *n=106*	73.8 *(0.32)* *n=338*	72.5 *(0.30)* *n=17*	.60	.73
1993	78.1 *(0.19)* *n=283*	76.8 *(0.63)* *n=914*	77.5 *(0.64)* *n=84*	71.9 *(0.13)* *n=493*	1.80	2.90
1994	79.5 *(0.13)* *n=511*	79.7 *(0.21)* *n=1,470*	-	76.5 *(0.70)* *n=121*	-	-
1995	80.0 *(0.00)* *n=719*	-	79.5 *(0.08)* *n=1,513*	76.8 *(0.76)* *n=191*	.72	2.00
1996	-	-	-	79.3 *(0.22)* *n=1,997*	-	2.50

1. Standard errors are shown in parentheses

Measure Baseline. A number of simplifying assumptions were made to estimate the measure baselines for gas furnaces. These assumptions relate to the discrepancies between Title 24 records and actual installations, the lag time between filing Title 24 records and building completion and the results of the 1994 EAH evaluation study.

- The SoCalGas average AFUEs were benchmarked into the results of the 1994 EAH evaluation study (80.6% AFUE).
- The building department average AFUEs were increased by 1.75% (the average of the difference found by the CEC and the difference found in comparison of 1994 SoCalGas homes).
- The building department data were lagged one year in the SoCalGas area and two years in the SDG&E area.

Table 6-6 includes the resulting measure baselines and Figure 6-3 presents the measure baselines together with the national appliance standard for gas furnaces. Maximum and

minimum values of the AFUE for the sample are also provided in Table 6-6 and Figure 6-1. As shown, the minimum AFUEs are driven by the efficiency standards. In particular, the minimum AFUE from the sample equals the standard of 78% after 1994. The maximum value declines sharply in 1995. This can be attributable to the change in data sources for the average AFUEs. That is, the source for the average AFUEs after 1994 are predominately Title 24 documentation. Although these values were calibrated into the available on-site data from the CEC studies, and may on-average be representative, we suspect that the maximum values are understated. This is further evidenced by a review of available equipment efficiencies in manufacturer' s literature and program records that indicate that there were homes that installed gas furnaces with AFUEs higher than 82%.

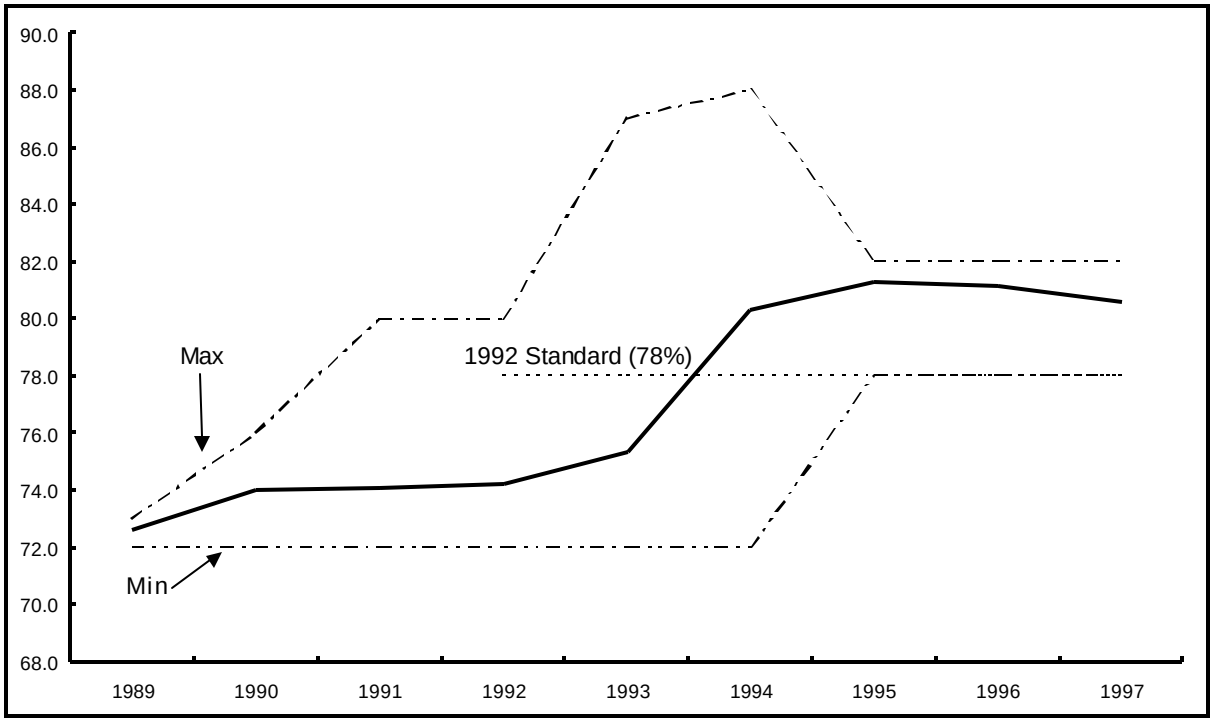
The impact from the appliance standard in 1993 is the most evident feature. In particular, the national standard prohibiting gas furnace manufacturers from producing units with AFUEs less than 78% as of January 1, 1993 shows up as a distinct rise in average AFUEs in 1994 and 1995. The lag in this increase is assumed to be due to the availability of manufacturers' inventory not meeting the new standard. It should also be noted that the implementation of the standard involved a two- to three-year lead in time for manufacturers. This could explain the gradual increase in AFUEs in the years before the standard being adopted.

Impact of RNC Program. Based on the available data, RNC program impacts on average gas furnace AFUEs are unclear. In particular, there is no comparable time period available for which the programs were not operational. Though SDG&E' s program ceased in 1995, there were homes covered by that program that were not completed until 1997. Ideally, the time period since 1995 could offer some insights into the impact of the RNC program since the participation in the SDG&E area is low and the SoCalGas program changed from an incentive program to an informational program in 1995. During this timeframe, the average efficiency levels seemed to have peaked in 1995 with average AFUEs that were 2.5% above the national standard followed by slight decreases in 1996 and 1997. While these average AFUEs have not returned to their mandated minimum, the decline in average AFUEs could suggest that the RNC programs have no long-lasting impact on efficiency levels of installed gas furnace equipment. However, to understand the impact from the RNC programs, further data on 1998 and subsequent years will need to be gathered and analyzed.

Table 6-6: Average Gas Furnace AFUEs by Service Territory and Year

Year	SDG&E	SoCalGas	All
1989	73.0 *min=72.0* *max=73.0*	72.3 *min=72.0* *max=73.0*	72.6 *min=72.0* *max=73.0*
1990	74.5 *min=73.0* *max=76.0*	74.0 *min=72.0* *max=87.0*	74.0 *min=72.0* *max=87.0*
1991	72.0 *min=72.0* *max=72.0*	74.4 *min=72.0* *max=80.0*	74.1 *min=72.0* *max=80.0*
1992	72.5 *min=72.0* *max=75.0*	75.0 *min=71.0* *max=87.0*	74.2 *min=72.0* *max=80.0*
1993	74.0 *min=74.0* *max=74.0*	75.4 *min=72.0* *max=88.0*	75.3 *min=72.0* *max=87.0*
1994	77.8 *min=76.0* *max=78.0*	80.6 *min=78.0* *max=92.0*	80.3 *min=72.0* *max=88.0*
1995	81.3 *min=78.0* *max=92.0*	81.3 *min=78.0* *max=82.0*	81.3 *min=78.0* *max=82.0*
1996	81.4 *min=78.0* *max=82.0*	81.1 *min=78.0* *max=82.0*	81.1 *min=78.0* *max=82.0*
1997	80.6 *min=78.0* *max=82.0*	80.6 *min=78.0* *max=82.0*	80.6 *min=78.0* *max=82.0*

Figure 6-3: Average Gas Furnace AFUEs



High Efficiency Gas Water Heaters

SDG&E and SoCalGas have offered incentives to builders who installed high efficiency gas water heaters for the periods from 1991 to 1994 and from 1990 to 1994, respectively. The incentives were based on the gas water heater efficiencies that exceeded code by some predetermined amount. For instance, the 1994 EAH offered incentives to builders who installed gas water heaters with energy factors above .62 and SDG&E offered incentives for units exceeding the minimum standard by 15%.

Efficiency Rating. The efficiency of a gas water heater is measures as an energy factor (EF). The EF is a unitless number and represents the ratio of delivered heat from the tank (in Btu) to the heat content of fuel input (in Btu).

$$Energy\ Factor(EF) = \frac{Heat\ Delivered\ \ from\ the\ Tank\ (Btu)}{Heat\ Content\ of\ \ Input\ Fuel\ (Btu)}$$

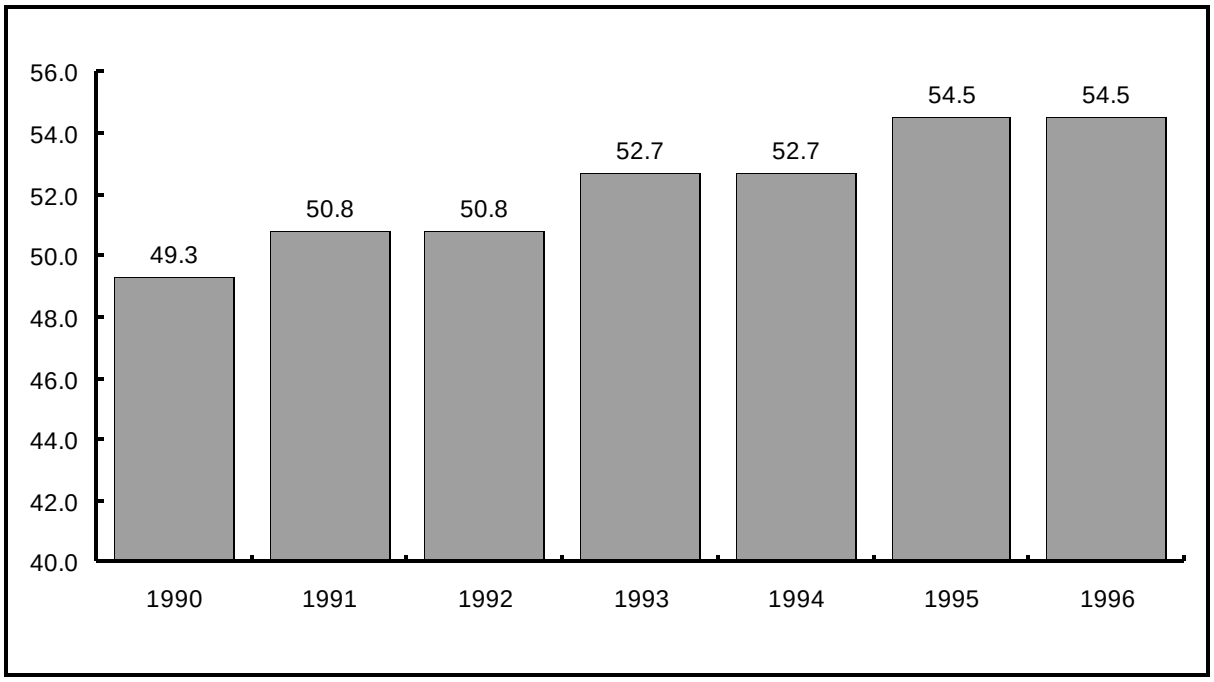
Efficiency Standards. The standards on residential gas water heaters became effective on January 1, 1990. NAECA mandated that all gas water heaters manufactured on or after this date shall not have an EF less than a specified rate dependant on the water heaters rated storage volume. The standards were reviewed in 1991 but no changes were implemented to gas water heaters. Modest improvements in gas standards to .60 EF are scheduled for the year 2001. The formula for computing the EF standard is presented below.

EF ³ 0.62 - (0.0019 ´ the rated storage volume in gallons)

For example, a 40 gallon water heater would have a .54 EF (0.62 - (0.0019 × 40)).

National Shipments. The Association of Home Appliance Manufactures (AHAM) collects data on shipments of new gas water heaters. Figure 6-4 presents a historical perspective of shipments' weighted average EFs for new gas water heaters. As illustrated, there has been a steady increase of the average EF of new units over time.

Figure 6-4: Average Efficiency of National Shipments of New Gas Water Heaters (EF)



Southern California Efficiency Data. Data from CEC studies, building departments, and utility participant files were used to develop the gas water heater measure baseline. Table 6-7 presents a summary of the average EFs by data source, year, and utility. These sources differ by their data collection methods. The CEC data were collected from actual on-site inspections of new residential buildings, and the building department data were gathered from Title 24 compliance records.

Table 6-7: Gas Water Heater Average Energy Factors (EFs)[1,2]

Year	CEC Data			Building Department		
	SoCalGas	SDG&E	All	SoCalGas	SDG&E	All
1989	.583 *(0.0032)* *n=3*	.580 *(0.0000)* *n=2*	.583 *(0.0063)* *n=5*	-	-	-
1990	.589 *(0.0032)* *n=37*	.575 *(0.0250)* *n=2*	.585 *(0.0032)* *n=39*	-	-	-
1991	.590 *(0.0058)* *n=17*	.580 *(0.1730)* *n=3*	.588 *(0.0054)* *n=20*	-	-	-
1992	.602 *(0.0036)* *n=22*	.578 *(0.0065)* *n=6*	.600 *(0.0037)* *n=28*	-	-	-
1993	.597 *(0.0039)* *n=38*	.600 *(0.0000)* *n=2*	.596 *(0.0036)* *n=40*	.600 *(0.0009)* *n=53*	-	.600 *(0.0009)* *n=53*
1994	.602 *(0.0023)* *n=20*	.590 *(0.0153)* *n=3*	.600 *(0.0027)* *n=23*	.605 *(0.0020)* *n=215*	-	.605 *(0.0020)* *n=215*
1995	-	-	-	.597 *(0.0200)* *n=10*	.600 *(0.0000)* *n=198*	.599 *(0.0030)* *n=208*
1996	-	-	-	.560 *(0.0100)* *n=45*	.602 *(0.0018)* *n=515*	.566 *(0.0047)* *n=560*
1997	-	-	-	.600 *(0.0022)* *n=86*	.599 *(0.0022)* *n=251*	.606 *(0.0018)* *n=337*

1. Average Energy factors are weighted by county building permits.
2. Standard errors are shown in parentheses

The CEC Title 24 studies also cite differences in gas water heater efficiency rating in the actual installations compared to those specified in Title 24 compliance forms. However, quantifiable data in terms of differences in energy factors were not available. A review of the differences for homes built in the SoCalGas service territory in 1994 indicated a negligible difference of less than 1% between actual installations and efficiency ratings specified in Title 24 compliance forms (.604 EF in the 1994 EAH Evaluation study versus .600 EF from the Title 24 compliance forms).

Measure Baselines. Two assumptions were to estimate the measure baselines for gas water heaters. These assumptions account for the lag time between filing Title 24 records and building completion and the results of the 1994 EAH evaluation study.

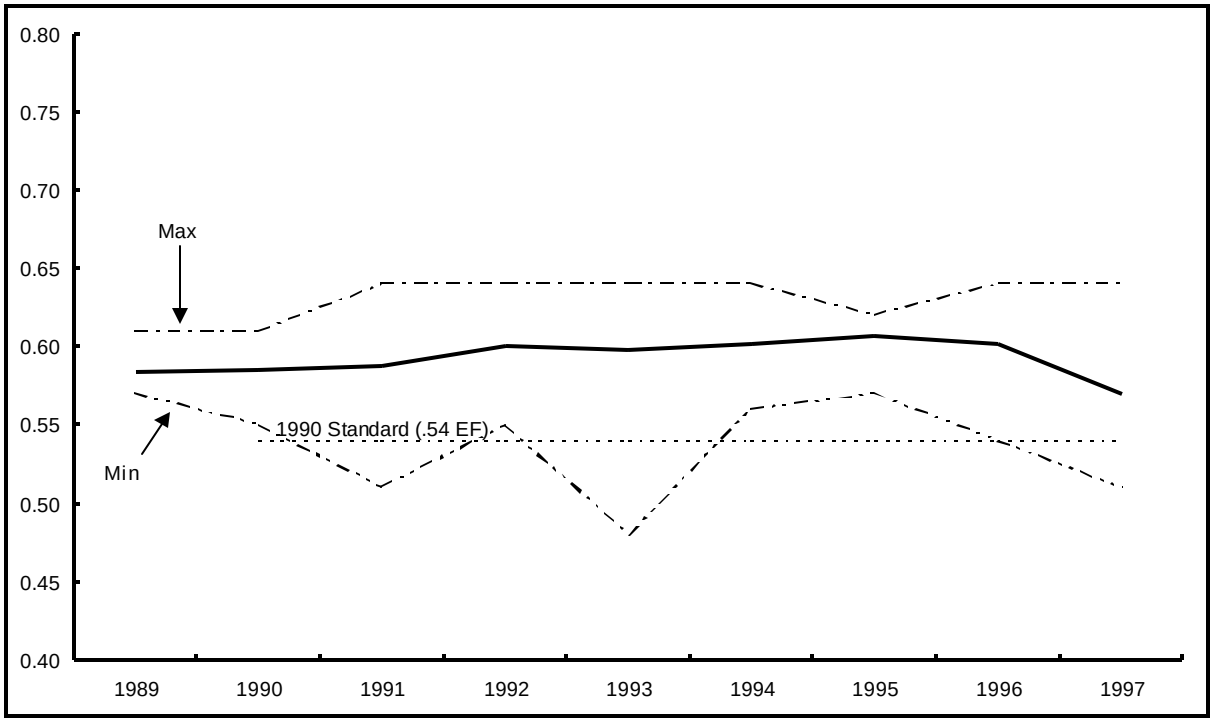
- The building department data were lagged one year in the SoCalGas area and two years in the SDG&E area (this is consistent with the lag times discussed previously in the gas furnace baseline section).
- The SoCalGas average EFs were benchmarked to the results of the 1994 EAH evaluation study (.604 EF), and

Table 6-8 includes the resulting measure baselines and Figure 6-5 presents the measure baselines, sample maximum and minimum EFs from the sample and the national appliance standard for gas water heaters. The impact from the energy efficiency standards is not as obvious as for gas furnaces, partly because of the dependence of the standard on tank size. On average, the efficiency levels for gas water heaters are above standards. The general trend in gas water heater efficiencies is upward and consistent with national shipments data.

Table 6-8: Average Gas Water Heater EFs by Service Territory and Year

Year	SoCalGas	SDG&E	All
1989	.583 *min=.570* *max=.600*	.580 *min=.580* *max=.580*	.583 *min=.570* *max=.610*
1990	.589 *min=.550* *max=.610*	.575 *min=.550* *max=.600*	.585 *min=.550* *max=.610*
1991	.590 *min=.510* *max=.610*	.580 *min=.550* *max=.600*	.588 *min=.510* *max=.640*
1992	.602 *min=.560* *max=.640*	.580 *min=.550* *max=.600*	.600 *min=.550* *max=.640*
1993	.597 *min=.480* *max=640*	.600 *min=.600* *max=.600*	.598 *min=.480* *max=.640*
1994	.604 *min=.570* *max=.640*	.590 *min=.560* *max=.610*	.602 *min=.560* *max=.640*
1995	.609 *min=.590* *max=.620*	.604 *min=.570* *max=.640*	.607 *min=.570* *max=.620*
1996	.601 *min=.540* *max=.640*	.609 *min=.590* *max=.620*	.602 *min=.540* *max=.640*
1997	.564 *min=.540* *max=.640*	.600 *min=.600* *max=.600*	.570 *min=.510* *max=.640*

Figure 6-5: Average Gas Water Heater EFs



*EF minimum standard based on a 40 gallon tank

Impact of RNC Program. Based on the available data, RNC program impacts on average EFs are unclear. Again, as with gas furnaces there is no comparable time period available for which the programs were not operational. However, the time period since 1995 does offer some insights into the impacts of the RNC program. During this timeframe, the average efficiency levels seem to have peaked in 1996 at roughly .62 EF, which is almost 15% above the minimum standard for a 40-gallon tank water heater. Although there appears to be a decline in the average EF in 1997, data for subsequent years will need to be gathered and analyzed before any definitive statements about any long lasting impact of the RNC programs can be made.

High Efficiency Windows

SDG&E offered incentives to builders to install energy-efficient windows through its RNC program. Specifically, builders exceeding Title 24 standards by 5% through the prescriptive- or performance-based methods could apply to receive financial incentives. The installation of high efficiency windows was a method used to improve the energy efficiency of residential new construction. SoCalGas offered similar incentives through its Energy Advantage and Five Star programs. However, these programs did not target high efficiency windows to the same extent as the SDG&E program.

Efficiency Rating. There are two major factors to be considered in evaluating window efficiency. The first is the window' s U-value, which is a measure of the window ability to transmit heat, and the shading coefficient, which is a measure of the window' s ability to control heat gain from *direct sunlight*. [3]

U-Value: The window U-value is a measure of the total fenestration system and represents the heat transfer coefficient in Btu/hr-ft^2-°F that includes conductive, convective, and radiative heat transfer. The inverse of the U-value is the R-value, or the measure of resistance to heat transfer. The National Fenestration Rating Council (NFRC) provides a Certified Product Directory that lists U-values for all NFRC-rated products. A typical U-value for single pane metal fixed windows is 1.19. This value decreases to 0.72 for double pane windows. Further, these values fall to 1.04 and 0.57 for wood framed windows. [4]

Shading Coefficient : The shading coefficient is the measurement used to quantify a fenestration systems ability to control heat gain. The shading coefficient is a number between 0.0 and 1.0, with a lower number indicating a better product for controlling heat gain. A shading coefficient of 0.0 is a wall and a shading coefficient of 1.00 is by definition an unshaded unscreened 1/8" sheet of glass. The use of special tints and Low-E glazing will reduce the shading coefficient. Shading coefficients are particularly important in desert climate zones (CEC zones 14 and 15) and in areas where there is excess glazing on the east, west or south elevations.

Efficiency Standards. The CEC Standards mandate window glazing in Southern California. [5] These standards vary by CEC climate zone and by performance package selected for compliance. The standards are stated as maximum U-values and shading coefficient, together with maximum window area, as a percentage of wall area and maximum and minimum non-south- and south-facing window areas. For instance, in climate zone 14 (San Diego County) the mandated U-value varies from .40 to .65 and the shading coefficient from .15 to .66 (by orientation) across the five alternative compliance packages. Further, the shading coefficient is influenced by the installation of standard shading devices, such as exterior shade screens and enhanced interior window coverings.

Southern California Efficiency Data. The existing data sources that were used to develop baseline AFUE and EF values for gas space and water heating equipment proved to have no usable data on window U-values or shading coefficients. In particular, the data

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[3] The U-value is a measure of a window ability to transmit heat and therefore, a lower U-value represents a more efficient window.

[4] *High Performance Windows, Doors & Title 24, Residential*, Windowmaster Products, El Cajon, CA

[5] *Energy Efficiency Standards for Residential and Nonresidential Buildings*. California Energy Commission. P400-95-001. July 1995

collected on-site contained window types in broad categories but included no detailed information on U-values. Therefore, the Title 24 compliance forms for homes built in recent years (1995-1997) and for those homes that participated in the RNC programs are the only sources for baseline data. Further, only data on U-values were extracted from the hard copy forms. These values were calculated as the area weighted average of reported U-values on the Title 24 compliance forms. Table 6-9 presents the available data from these sources. These data include data from building department Title 24 compliance forms and data from SDG&E and SoCalGas participant records. The participant records are average U-values by the year the Title 24 compliance form was filed and by the year the buildings were built.

Table 6-9: Summary of Data for Window Efficiencies (U-Values[1])

Year	Building Dept.		Participants Filed		Participant Built	
	SoCalGas	SDG&E	SoCalGas	SDG&E	SoCalGas	SDG&E
1989	-	-	.98 *(.052)* *n=32*	-	-	-
1990	-	-	.65 *(.000)* *n=39*	.94 *(.064)* *n=126*	-	-
1991	-	-	.83 *(.110)* *n=40*	.78 *(.016)* *n=89*	.95 *(.044)* *n=64*	.65 *(.015)* *n=53*
1992	-	-	.77 *(.041)* *n=107*	1.10 *(.008)* *n=214*	.76 *(.041)* *n=125*	.81 *(.055)* *n=18*
1993	.84 *(.006)* *n=42*	-	.82 *(.009)* *n=157*	.79 *(.050)* *n=914*	.65 *(.007)* *n=50*	.93 *(.052)* *n=149*
1994	.83 *(.007)* *n=206*	-	.75 *(.038)* *n=93*	1.05 *(.018)* *n=1470*	-	1.07 *(.023)* *n=225*
1995	-	.88 *(.021)* *n=198*	.78 *(.029)* *n=66*	-	.79 *(.016)* *n=307*	.75 *(.022)* *n=191*
1996	.81 *(.004)* *n=38*	.70 *(.034)* *n=507*	-	-	-	.94 *(.025)* *n=1997*
1997	.74 *(.000)* *n=33*	.84 *(.009)* *n=251*	-	-	-	1.24 *(.030)* *n=213*

1. Standard errors are shown in parenthesis

Measure Baselines. Given the problems of collecting adequate data on window U-values, there are no measure baselines for this measure. Considerable more work needs to be done to collect sufficient data to track historic and subsequent years' data.

Wall and Ceiling Insulation

SDG&E has offered incentives to builders to install energy-efficient windows through its RNC program. The installation of additional insulation above minimum standards was a method used to improve the energy efficiency of residential new construction. Specifically, builders who exceeded Title 24 standards by 5% through the prescriptive- or performance-based methods could apply to receive financial incentives. SoCalGas offered similar incentives through its Energy Advantage and Five Star programs. This program targeted wall insulation from 1991 to 1993, but offered no incentives for insulation in subsequent years.

Efficiency Rating. Efficiency levels of wall and ceiling insulation are measured as an R-value. The R-value indicates resistance to heat transfer and is measured in units of hr-ft^2-°F/Btu. As stated earlier, the R-value is the reciprocal of the U-value used to measure window efficiency.

Efficiency Standards. The CEC mandates all standards for wall and ceiling insulation R-values in new construction in Southern California. These standards vary by CEC climate zone and by performance package selected for compliance. The standards are stated as minimum R-values. The mandated R-values vary from 19 to 49 for ceiling insulation and 13 to 21 for wall insulation across CEC weather zone in the study area (weather zones 6, 7, 8, 9, 10, and 14) and the five alternative component packages (A-G).

Southern California Efficiency Data. Data from CEC studies and building departments were used to develop the wall and ceiling insulation measure baseline. Table 6-10 and Table 6-11 present a summary of the average R-values by data source, year, and utility for wall and ceiling insulation, respectively. The primary difference between these sources is that the CEC data were collected from actual on-site inspections of new residential buildings and the building department data is gathered from Title 24 compliance records.

Table 6-10: Summary of Wall Insulation Data (R-values[1])

Year	CEC Data			Building Department		
	SoCalGas	SDG&E	All	SoCalGas	SDG&E	All
1989	13.16 *(0.367)* *n=8*	13.00 *(0.000)* *n=2*	13.11 *(0.270)* *n=10*	-	-	-
1990	13.00 *(0.000)* *n=38*	13.00 *(0.000)* *n=2*	13.00 *(0.000)* *n=40*	-	-	-
1991	13.48 *(0.384)* *n=19*	13.00 *(0.000)* *n=3*	13.41 *(0.331)* *n=22*	-	-	-
1992	13.98 *(0.473)* *n=23*	13.00 *(0.000)* *n=6*	13.73 *(0.371)* *n=29*	-	-	-
1993	14.22 *(0.385)* *n=39*	13.00 *(0.000)* *n=2*	14.15 *(0.368)* *n=41*	13.01 *(0.041)* *n=53*	-	13.01 *(0.041)* *n=53*
1994	13.00 *(0.000)* *n=22*	13.00 *(0.000)* *n=3*	13.00 *(0.000)* *n=25*	13.03 *(0.052)* *n=218*	-	13.03 *(0.052)* *n=218*
1995	-	-	-	13.20 *(0.200)* *n=10*	13.00 *(0.000)* *n=198*	13.03 *(0.068)* *n=208*
1996	-	-	-	13.00 *(0.000)* *n=48*	13.02 *(0.029)* *n=515*	13.00 *(0.009)* *n=563*
1997	-	-	-	13.00 *(0.000)* *n=87*	13.02 *(0.087)* *n=251*	13.00 *(0.020)* *n=338*

1. Standard errors are shown in parenthesis

Table 6-11: Summary of Ceiling Insulation Data (R-values)

Year	CEC Data			Building Department		
	SoCalGas	SDG&E	All	SoCalGas	SDG&E	All
1989	29.59 *(2.336)* *n=6*	30.00 *(0.000)* *n=2*	29.74 *(1.612)* *n=9*	-	-	-
1990	24.81 *(1.600)* *n=25*	30.00 *(0.000)* *n=2*	25.20 *(1.502)* *n=27*	-	-	-
1991	26.26 *(2.398)* *n=17*	32.67 *(2.667)* *n=3*	27.27 *(2.117)* *n=20*	-	-	-
1992	28.95 *(2.287)* *n=19*	34.00 *(1.789)* *n=6*	30.46 *(1.781)* *n=25*	-	-	-
1993	30.64 *(0.643)* *n=34*	34.00 *(4.000)* *n=2*	30.85 *(0.642)* *n=36*	29.98 *(0.216)* *n=53*	-	29.98 *(0.216)* *n=53*
1994	31.71 *(0.937)* *n=16*	35.33 *(2.667)* *n=3*	32.33 *(0.919)* *n=19*	27.87 *(1.257)* *n=218*	-	27.87 *(1.257)* *n=218*
1995	-	-	-	24.20 *(2.245)* *n=10*	25.17 *(3.152)* *n=198*	25.01 *(1.577)* *n=208*
1996	-	-	-	30.30 *(1.590)* *n=48*	19.51 *(0.388)* *n=515*	28.74 *(0.885)* *n=563*
1997	-	-	-	25.88 *(0.822)* *n=87*	29.56 *(0.494)* *n=251*	26.51 *(0.650)* *n=338*

1. Standard errors are shown in parenthesis

Measure Baselines. To estimate the measure baseline for wall and ceiling insulation, the building department data were lagged one year in the SoCalGas area and two years in the SDG&E area (this is consistent with the lag times discussed in the gas furnace baseline section). This assumption is designed to account for the lag time between filing Title 24 records and building completion.

Table 6-12 and Table 6-13 include the resulting measure baselines for wall and ceiling insulation, respectively.

Impact of RNC Program. The data assembled to construct the baselines for ceiling and wall insulation is insufficient to support a conclusion on the impact of the RNC programs. However, as with the other measures, the post 1995 period does offer some insights into the impacts of the programs. In particular, the wall insulation R-values appear to level out at just over 13 from 1994 onward. The ceiling R-values appear to peak in 1994 and decline in 1995

and 1996 and rise again in 1997. It should also be noted that these trend analysis are complicated by the distribution of construction across CEC weather zones. Moreover, the comparison across years is also complicated by the variation in market conditions over this period.

Table 6-12: Average Wall Insulation R-Values by Service Territory

Year	SoCalGas	SDG&E	All
1989	13.00	13.16	13.11
1990	13.00	13.00	13.00
1991	13.00	13.48	13.41
1992	13.00	13.98	13.73
1993	13.00	14.22	14.15
1994	13.00	13.03	13.03
1995	13.03	13.06	13.06
1996	13.14	13.23	13.22
1997	13.11	13.03	13.04

Table 6-13: Average Ceiling Insulation R-Values by Service Territory

Year	SoCalGas	SDG&E	All
1989	29.59	30.00	29.74
1990	24.81	30.00	25.20
1991	26.26	32.67	27.27
1992	28.95	34.00	30.46
1993	30.64	34.00	30.85
1994	31.71	35.33	32.07
1995	27.87	29.98	28.08
1996	24.20	28.87	25.00
1997	30.30	25.17	29.80

Figure 6-6: Average Wall Insulation R-Value

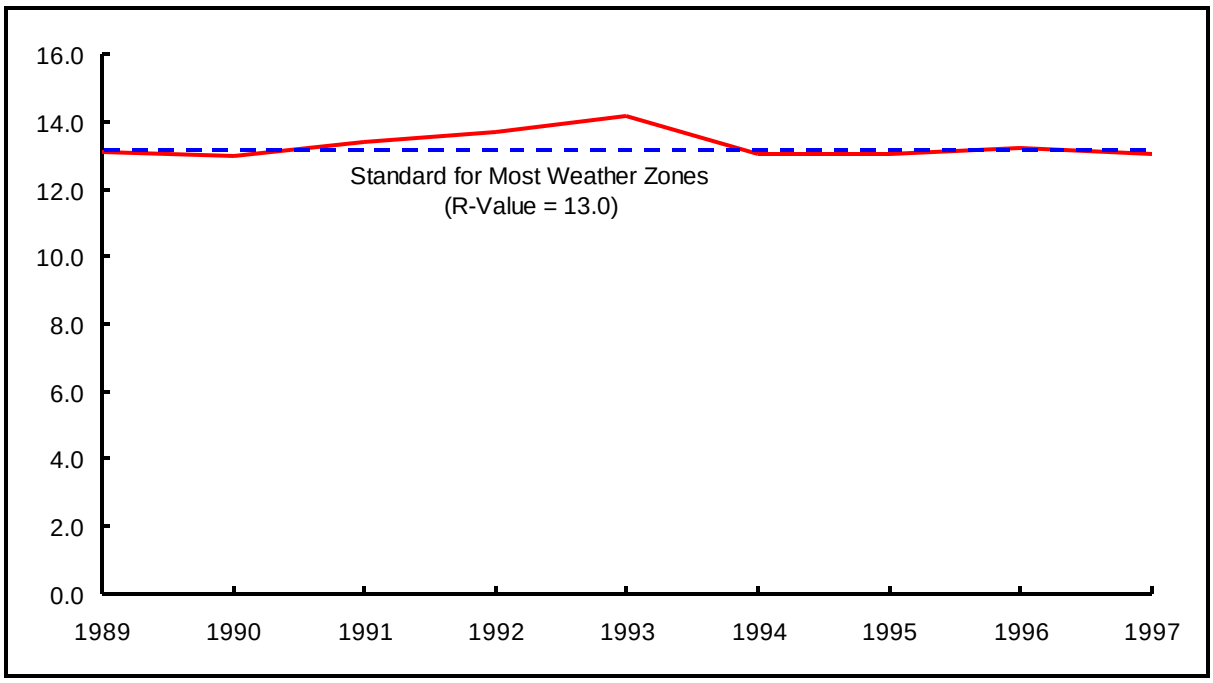
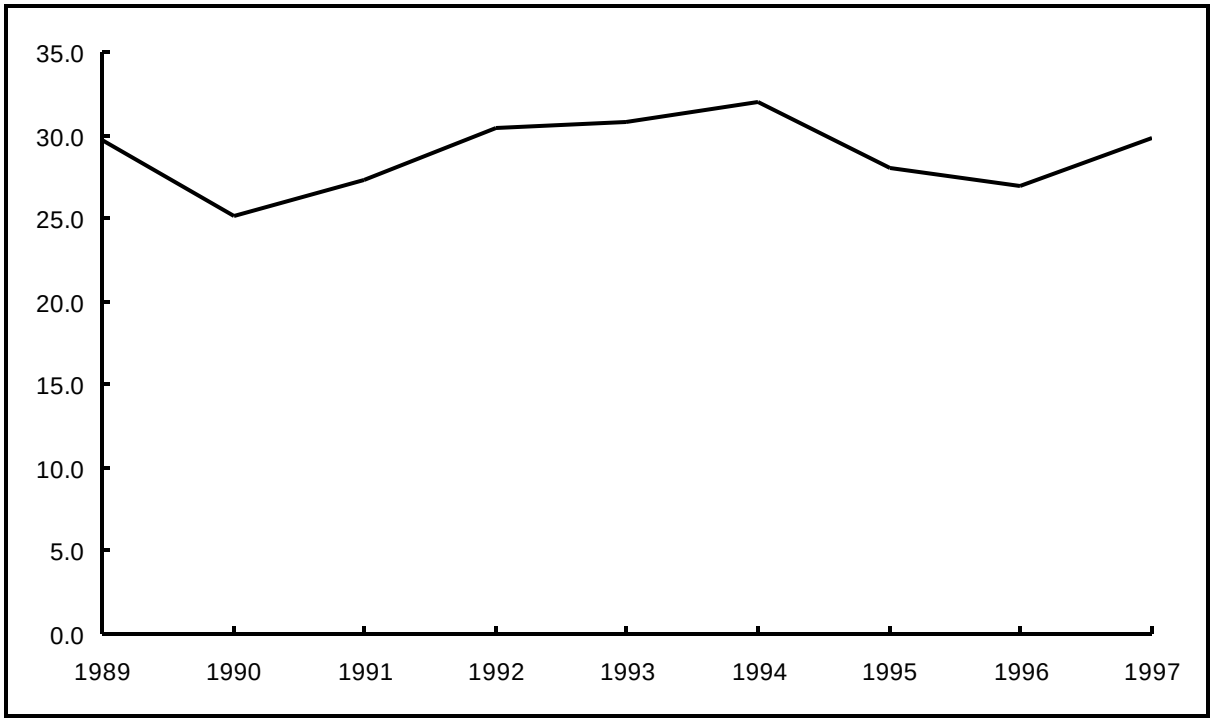


Figure 6-7: Average Ceiling Insulation R-Value



6.4 Summary

Measure baselines were assembled for gas furnaces, gas water heaters and ceiling and wall insulation. The data gathered included average efficiency levels (AFUEs, Efs, and R-values) for the period 1989 to 1997. As was discussed in detail in this section, a significant effort involving data manipulation, assumptions, and calibrating inconsistent data sources were used to develop estimates of measure baselines. This approach produced plausible results for each of the measures covered. However, the data available for gas furnaces and gas water heaters suffer from less inconsistencies and therefore provide more reliable baseline estimates. In the case of insulation values, while the measure baselines seem plausible, the resulting baselines are influenced by the distribution of construction across CEC weather zones.

In general, there is insufficient data for non-program years to support any definitive conclusions on the impacts of the RNC programs. However, the periods from the end of 1995 offers some insights as the SDG&E program diminished significantly to only a maintenance program and the SoCalGas company program changed to an information-only program.

- ***Gas Furnaces.*** The average AFUEs for gas furnaces increased significantly in the early 1990s with a sharp increase in 1992 and 1993. This increase is consistent with the implementation of the 1992 gas furnace minimum efficiency standards. Gas furnace AFUEs peaked in 1995 and have diminished each year since suggesting a lack of long-lasting effects from the RNC program.
- ***Gas Water Heaters.*** Average water heater efficiencies (EFs) have increased steadily since 1990 and leveled off somewhat in 1996 and 1997. The average EFs are significantly higher than mandated appliance standards. More post-program data is needed to analyze the impact from RNC programs.
- ***High Efficiency Windows.*** Given the problems of collecting adequate data on window U-values and shading coefficients, there are no measure baselines for this measure. Considerably more work needs to be done to collect sufficient data to track historic and subsequent years' data.
- ***Ceiling and Wall Insulation.*** The data assembled to construct the baselines for ceiling and wall insulation is insufficient to support a conclusion on the impact of the RNC programs. The wall insulation levels appear to level out at an R-value of just over 13 from 1994 onward. This should not be surprising, given that the installation of grater R-values would most likely involve the use of considerably more expensive 2×6 studs or expensive sheathing. The ceiling R-values appear to peak in 1994, decline in 1995 and 1996, then rise again in 1997. Niether pattern offers compelling evidence with respect to program impacts

In general, the examination of historical efficiency levels does not reveal much about the influences of the RNC programs. To some extent, this is due to the inherent variability of efficiency levels over time and the confounding influences of various other determinants like housing activity, changes in codes, and changes in the mix of new construction across weather zones. This suggests that future attempts to assess the success or failure of market transformation programs on the basis of overall impacts on average efficiency levels will have to be carefully designed to control for these other factors. It may also suggest that market tracking should not rely exclusively on measures of efficiency, but should also be focused on other market features (e.g., attitudes, perceptions, etc.) that will be subject to program influences. That is, monitoring market effects should entail tracking multiple features of the marketplace for efficiency.

7

Market Barriers, Program Stimuli, and Market Effects Hypotheses

7.1 Introduction

This section addresses the key issues in market transformation analysis. The centerpiece of the analysis is a discussion of the evidence obtained to test a variety of hypotheses with respect to RNC program market effects. These hypotheses were tested in two ways. The first approach was to compare the attitudes, perceptions, and behaviors of participants and nonparticipants in these programs, where both builders and households are divided into these two categories. It should be noted that this is a traditional approach to assessing program impacts, and is justified largely by the fact that these programs had fairly traditional designs and were very "participant-focused." With the increased emphasis on market transformation programs, alternative means of assessing market effects will undoubtedly be utilized. These approaches will probably involve more direct comparisons of overall market features with pre-program or control-area features, rather than comparisons of participants and nonparticipants. As we have already seen in Section 6, it may be difficult to assess market transformation in terms of changes in adoption rates over time; however, we should be able to assess these effects indirectly by analyzing a number of other intermediate market effects, such as changes in awareness, alternations in business practices, and shifts in stocking patterns.

The second approach employed to test market effects hypotheses was to compare Southern California with the comparison area, the Austin/San Antonio section of Texas. As will be noted throughout this discussion, the use of the comparison area was not as clean as we would have liked. It was chosen for two major reasons: first, it exhibits heating requirements very similar to those in Southern California; and second, it has no utility DSM programs relating explicitly to gas efficiencies. However, the area proved to be an imperfect comparison area as a result of the following features:

- The comparison area exhibits much higher cooling requirements than Southern California. While we initially felt that this would not be a major problem due to the focus on gas equipment, discussions with market actors revealed that general energy efficiency awareness levels are interdependent across end uses. If contractors are more aware of cooling efficiency, for instance, they also tend to be more aware of measures applicable

to other end uses, including heating and water heating). Furthermore, some measures span end uses, and are even more directly affected by the high cooling requirements. This is true of both window and duct integrities, which influence both air conditioning and space heating.

- Second, while the City of Austin does not have a program analogous to the RNC programs, it does offer what appears to be a very successful information and training seminars for builders, HVAC contractors, inspectors, architects and other market participants. While these sessions do not specifically address gas equipment, they seemed to have increased market actors' overall awareness of energy efficiency and increased support for the need for energy efficiency building standards.
- Third, while equipment efficiency standards are the same in both areas (and all other parts of the nation), local building energy standards are not. Texas has no energy standards, nor does San Antonio. Austin has adopted standards (a modified Model Energy Code), but these differ somewhat from California's Title 24 standards. Of particular note in this regard is the fact that Austin has duct sealing requirments, while Title 24 does not.

This is not to say that the comparison of responses between the study area and the comparison area is useless, but rather that the comparisons presented here need to be made with these differences in mind. Unfortunately, any cross-area comparisons used to assess market transformation programs are likely to be plagued by similar problems. We searched fairly intensively for an area that would mirror Southern California in all respects - save the existence of RNC programs - and found no specific areas superior to the one chosen. Of course, this does not mean that there are no better comparison areas, but it may suggest that finding qualified areas will not be easy. It may also suggest that we may be forced to rely on broad-based comparison areas (like the country as a whole) that reflect the influences of some programs and a wide range of other market conditions. In this event, the broad-based comparison area will reflect not what would exist in the absence of programs, but rather what exists with a different set of programs than promoted in California. At the worst, we may be sometimes be doomed to comparing California's performance to the national average, rather than with a true no-program baseline. At the best, we could be able to develop models to control for differences across a wide range of areas, thereby inferring the market effects associated with California programs.

The rest of this section is organized as follows. Subsection 7.2 discusses the specific market barriers that could hinder the adoption of socially efficient levels of energy efficiency in residential new construction. Subsection 7.3 considers the specific program features that could conceivably diminish these barriers. Subsection 7.4 specifies a series of hypotheses tested in the course of this study to ascertain the presence of these market barriers and if any reductions are attributable to the RNC programs. Finally, subsection 7.5 summarizes the discussion.

7.2 Market Barriers

In general terms, market barriers are defined as factors that prevent the achievement of a socially optimum level of DSM activity in private markets. RER investigated eight specific market barriers:[1]

- Product unavailability,
- Organizational practices,
- Performance uncertainties and perceived risks,
- Information costs,
- Hassle costs,
- Asymmetric information,
- Bounded rationality, and
- Split incentives.

These and other barriers in the context of the theory of market failure in residential new construction are reviewed below.

Product Unavailability

Product availability refers to the extent to which high efficiency products are available to downstream market actors. According to Eto, et al. (1996), the availability of DSM products could be limited because manufacturers, distributors, and retailers might perceive relatively high levels of risk associated with the provision of these products. Some risk is inherent in any marketplace and should not be construed as an indication of market failure *per se*. However, unnecessary risk based on misperceptions of product quality, lack of consumer information, or other inadequacies in the market can be seen as a market barrier and a legitimate target for public intervention.

This market barrier is primarily associated with manufacturers and distributors. In general, manufacturers explained that they can and will produce any product demanded by market actors downstream. Manufacturers and distributors perceive risks in the production or distribution of high efficiency gas equipment if adequate demand for such products is not detected.

Organizational Practices

Organizational practices refer to a company' s standard business practices and decision-making strategies, such as the types of products manufactured, or the efficiency levels of equipment typically

[1] Environmental impacts associated with energy usage constitute another type of market failure. In the absence of public policy, these environmental effects are externalities in the sense that their costs are not considered in decisions relating to energy usage. While environmental benefits of DSM are considered in societal benefit-cost tests, they are not explicitly taken into account in private decisions with respect to energy investments. It can be argued that these environmental externalities constitute a market barrier, in the sense that they prevent the private market from achieving a socially optimum level of efficiency. On the other hand, the types of utility programs considered in this project do not relate directly to the recognition or mitigation of environmental effects.

specified in building plans. Standard organizational practices can be a barrier to the diffusion of DSM technologies and are associated with many market actors, including manufacturers, distributors, builders, Title 24 energy consultants, and HVAC contractors.

At the manufacturing level, there could be considerable inertia in decisions to produce new high efficiency technologies as a result of perceived risk or inappropriate practices relating to management rewards and penalties. Further, distributors will not stock high efficiency gas equipment if they do not detect or anticipate sufficient demand for such products. The majority of builders minimize their construction costs subject to compliance of building code standards. Thus, they rarely specify gas equipment or other shell measures that exceed the minimum requirements.

Performance Uncertainties and Perceived Risks

Performance uncertainties and perceived risks refer to how a market actor perceives the performance and quality of equipment and shell measures with which they are unfamiliar. This market barrier is primarily associated with consumers, but can also pertain to equipment specification and purchasing patterns of builders and HVAC and plumbing contractors. For example, customers typically do not understand or are not aware of the energy savings associated with high efficiency equipment and shell measures. Thus, consumers associate a risk to, or are uncertain as to the benefits of such products.

Information Costs

The standard model of competitive markets assumes that all market participants have full information. However, because not all market actors are "experts," information relating to energy efficiency is neither full nor free. Information costs are those incurred by market actors who need to obtain additional information during the decision-making process. It can be costly for these actors to acquire the necessary information and to conduct an appropriate search for alternative products. Information costs often take the form of time and manpower (and sometimes hassles) required for increasing one's knowledge about a particular subject. In the context of this research, information costs affect nearly every demand-side participant in the residential new construction market.

Hassle Costs

Even with full information and clearly identified options, installing high efficiency measures can entail significant hassle costs. These costs can be very real and consist of disruptions of daily routines and use of personal time. Since the market under examination here is the new construction market, hassle costs are primarily associated with changing standard organizational practices to incorporate high efficiency equipment and shell measures. For example, builders who are familiar with specific equipment, or utilize the same building plans for multiple projects, incur a hassle cost when they "change their normal behavior."

Asymmetric Information

Asymmetric information in the market occurs when market actors who interact have different information or perceptions. In the context of this study, this market barrier is associated with consumers. For example, consumers, by nature, do not have the same information that other market actors have with respect to energy efficiency. This asymmetry affects their decision-making ability and sends signals to other market actors, such as sales agents, that they are not interested in more efficient equipment or shell measures.

Bounded Rationality

According to Eto, et al. (1996), bounded rationality entails the use of heuristics, or simple "rules of thumb," rather than a "thorough analysis" in the decision-making process. This market barrier is associated with any market actor that does not have complete information, such as builders and consumers, and is closely related to the information costs market barrier.

Essentially, individuals use simple rules-of-thumb when they face complex decisions or when they do not have a complete understanding of the issues with which they face. Note that bounded rationality could actually lower information and decision costs because the market actor uses the rule-of-thumb approach to decision making instead of seeking more information and expanding their knowledge. For example, because of their limited knowledge about the energy efficiency of specific equipment and shell measures, consumers have a generic understanding of energy efficiency. Consumers also tend to believe that energy efficiency standards are not minimum requirements and that they do not have options to purchase homes that exceed these standards.

Access to Financing

The RFP mentions access to financing as a separate market barrier. For some DSM products, there might be artificial limits on access to funds for energy efficiency investments. For example, builders and developers might face difficulties in receiving financing to upgrade the efficiency levels of HVAC systems, or consumers might not be able to secure adequate financing to purchase a more energy-efficient home.

Misplaced or Split Incentives

The barrier of split incentives refers to the disparity between consumers' and builders' incentives in market transaction. As noted by Eto, et al. (1996), energy efficiency decision makers might not be direct beneficiaries of energy savings. Builders might determine shell features and equipment efficiencies, for instance, even though home purchasers enjoy the benefits of higher refrigerator efficiency. If the market does not value the benefits of savings fully (i.e., if home prices cannot be raised to reflect the benefits of investments in efficiency), then the market will tend to yield too low a level of investment in efficiency. In the parlance of welfare economics, some or all of the benefit is *nonappropriable* by the decision maker.

This is a classic case of an ownership externality, and is almost surely a major element of market failure in residential new construction markets. This market barrier exists, at least in part, due to the inherent structure of the residential new construction market – the relationship between the builder and the consumer, in particular. Mitigation of this market barrier should take advantage of intermediaries between the builder and consumer to (1) ensure that builders receive the correct market signals with respect to consumer values for energy efficiency and (2) to educate consumers about the benefits of more energy-efficient homes. As explained in Section 5, sales agents serve as the (only) intermediary between builders and consumers and are a likely candidate to be targeted by future RNC programs.

Market Barrier Summary

Three aspects of these barriers are important to keep in mind:

- First, these barriers are clearly interdependent and to some extent overlapping. In a few cases, they might not even be distinguishable from each other. For instance, the split incentive barrier is clearly exacerbated by customers' lack of awareness of the energy savings associated with efficiency measures, and this lack of awareness is strongly related to both performance uncertainties and bounded rationality.
- Second, most of the barriers can be characterized as costs (information costs, decision costs, etc.) or risk perceptions. The mere existence of costs or risks in a marketplace does not necessarily signal market failure or indicate the need for policy. If these costs or risks are misperceived or unnecessary, however, appropriate policies might help to improve market performance.
- The reduction of market barriers does not necessarily yield market transformation in the sense in which that term is used in policy discussions surrounding DSM markets. In this context, market transformation implies the use of policies and programs to secure long lasting reductions in these barriers. While some kinds of program features might diminish barriers for the duration of these programs, it is important to recognize that such features actually cause more or less permanent improvements in market performance.

Table 7-1 and Table 7-2 summarize the discussion of barriers, program features, and hypothesized market effects. Table 7-1 indicates the types of barriers that are most likely to affect decisions made by key actors, while Table 7-2 provides an overview of barriers, actors, interventions (program features), and hypothesized market effects.

Table 7-1: Barriers and Market Actors

Actor	Product Unavail-ability	Organi-zation Practices	Perfor-mance Uncertainty	Information Search Cost	Hassle Cost	Asymmetric Information	Bounded Rationality	Access To Financing	Split Incentives
Manufacturer	x	x	x						
Whls./Dist.	x	x		x					
Builder		x	x	x	x		x	x	x
Sales Agent			x	x		x			
Homebuyer			x	x		x	x	x	x
Lender				x				x	
HVAC Subc.		x	x	x	x				
Title 24 Cons.				x					
Architect				x					
Bldg. Inspector									
Government									

Table 7-2: Overview of Barriers, Actors, Program Intervention, and Effects

Market Barrier	Actor	Description	Program Intervention	Hypothesized Effect
Product unavailability	Manufacturer Wholesaler/Dist.	Manufacturers, distributors, and retailers might be unwilling to stock product that is not high in demand	Cash incentives to builders to include products	Increased availability; changes in manufacturer production mix and distributor stocking patterns
Organizational practices	Manufacturer Wholesaler/Dist. Builder Subcontractor	Traditional systems of practice might not be conducive to additional requirements imposed on actors; builders might belong to unions	Cash incentives to builders to include products	New procedures and practices with lower disincentives for efficiency
Performance uncertainties	Manufacturer Wholesaler/Dist. Homebuyer Realtor/Agent	Consumers might be uncertain of savings associated with these products; producers are uncertain how the market will respond	Cash incentives to builders to include products, educational initiatives	Reduced uncertainties with respect to product performance and acceptability
Information search costs	All	Gaining the information needed to make informed decisions	Educational initiatives	Actors become more informed about products; lower search costs
Hassle costs	Builder Subcontractor	Disruptions of daily routines and extra time and money needed to complete installation or products	Cash incentives to builders to include products	Builders might devise new procedures to avoid or reduce costs in future
Asymmetric information	Homebuyer Realtor/Agent	Homeowners might be misinformed as to the benefits and costs associated with the use of these products	Educational initiatives	Consumers more aware of the value added by these products, begin to have preferences for them
Bounded rationality	Builder Homebuyer	The decision-making process might be overly complex or costly	Cash incentives to builders to include products	Builders and homebuyers base decisions on more complete information
Access to financing	Builder Homebuyer Lender	Financing might be unavailable for additional costs, i.e., Lenders are unwilling to qualify borrowers for increased amounts	Promote energy-efficient mortgages, educational initiatives	Lenders might become more willing to generate mortgages; financial markets more willing to buy/sell them

Table 7-2 (cont'd): Overview of Barriers, Actors, Program Intervention, and Effects

Market Barrier	Actor	Description	Program Intervention	Hypothesized Effect
Split incentives	Builder	Decision makers are not the direct beneficiaries of energy savings and therefore might be motivated by cost minimization rather than overall efficiency or optimum product mix	Cash incentives to builders to include products	Consumers value efficiency more highly and increase willingness to pay; builders perceive return on efficiency investments

7.3 Program Stimuli

Program features that were intended to stimulate the reduction or removal of market barriers in residential new construction include the following:

- Program promotion, which might stimulate builders' tendencies to install efficiency,
- Vendor and customer feedback on product features, which leads to improvements in technology,
- Challenges to current product standards, which promote changes in business strategies, appliance standards, and building codes,
- Technical/economic information and program promotion, which lead to enhanced awareness of and knowledge about energy-efficient appliances and shell measures on the parts of both vendors and customers,
- Customer incentives and manufacturer discounts, which encourage product promotion by vendors and other trade allies, and reduce incremental measure costs,
- Technical assistance, which increases vendor confidence in energy efficiency measures.
- Technical information, which is made available by builder sales personnel and program promotions, increases customer awareness and knowledge of equipment and shell efficiency.
- Builder experience with program measures, which might reduce incremental materials and installation costs.

Clearly, these effects are interdependent and to some extent overlapping. Nonetheless, they give rise to a series of hypotheses about market transformation effects.

7.4 Hypothesized Market Effects

This subsection presents and discusses several hypotheses of the market effects that are attributable to the RNC programs. RNC programs provide financial incentives, informational services, and technical assistance to participating builders. It is hypothesized that these program features have many direct and indirect effects on builders and other participants in the residential new construction market. For example, because the financial incentives increase demand for more energy-efficient products, manufacturers might change their efficiency level product mixes to accommodate increases in demand. Such increases in demand might also encourage manufacturers to change manufacturing practices permanently.

Some of these market hypotheses pertain directly to builders and the market actor directly involved in efficiency level decision making. For instance, builders might emphasize energy efficiency in

marketing and/or continue to specify high efficiency equipment when not required to do so. It is also hypothesized that RNC programs help to increase product awareness for consumers and other demand-side market actors.

Program attribution of awareness levels is difficult to determine for these market actors, since Title 24 consultants, architects, and HVAC contractors were not program participants, *per se*, but were merely employed by either a participant or nonparticipant. One can assume, however, that the behavior of other market actors indicates, to some extent, program effectiveness in increasing awareness levels of other market actors. Because other market actors can neither be considered a participant nor a nonparticipant, the second best alternative is to compare awareness levels of those in Southern California with those in the control region.

Effects on Manufacturers

RNC programs stimulate customer demand for the covered measures and could lead to upstream transformation at the manufacturer level. In our view, these impacts are generally restricted to gas equipment and windows. The manufacturing processes for other shell measures like ceiling, wall and floor insulation, vapor barriers, duct insulation, and infiltration measures are mature and should be relatively unaffected. Given that gas space and water heating equipment and windows must meet stringent minimum standards set by program guidelines, these programs could have the following effects:

1a) RNC programs increase production of the affected measures and improve product availability.

1b) RNC programs change manufacturing practices and stimulate retooling, thus leading to higher efficiency levels in the product mix.

While these hypotheses are closely related, there are some subtle distinctions worth noting. The first hypothesis refers to changes in overall product efficiency mixes, while the second pertains to changes in manufacturing practices that coincide with changes in efficiency mixes. Each of these hypotheses is discussed below.

1a) RNC programs increase production of the affected measures and improve product availability.

By encouraging builders to specify high efficiency gas equipment and windows, RNC programs stimulate demand for more efficient products, thereby encouraging manufacturers to increase the percentage of high efficiency products that they produce. This hypothesis was tested by examining the changes in efficiency levels reported by gas equipment and window manufacturers during the in-depth interviews.

As explained below, all of the manufacturers interviewed for this study indicated changes in their product efficiency levels since 1990. Some manufactures attributed some of these changes to DSM programs, but few were aware of the RNC programs covered in this analysis. Reported changes in efficiency mixes, attribution of changes to RNC programs, and permanence of such changes are discussed below.

Changes in Product Efficiency Mixes. All of the manufacturers interviewed for this study indicated changes in the efficiency levels of units produced since 1990.

- ***Gas Furnaces.*** Essentially, all manufacturers indicated that the proportion of units with less than a .80 AFUE rating is decreasing, while the percentage of units with an AFUE rating above .80 is increasing. One manufacturer explained that it expanded its line of .90+ units in 1996.

  One of the largest producers of heating equipment in the United States indicated that the efficiency levels of their units sold in Southern California are *lower* than those sold elsewhere.[2] This was attributed to the mild climate in Southern California. Compared to other regions in the country, in Southern California the "*emphasis is on cooling efficiency, not heating.*"

  The gas furnace manufacturers interviewed for this study cited several reasons for changes in efficiency level mixes. Though most cited efficiency level mandates, such as NAECA, one manufacturer explained that rebates have significantly affected the proportion of high efficiency units sold in the market.

- ***Gas Water Heaters.*** All water heater manufacturers reported increases in efficiency levels since 1990, and one manufacturer (with a market share of just over 10%) reported a change since 1994. One water heater manufacturer, however, stated that they have actually *decreased* the number of high efficiency products that they offer nationwide, because consumers could not readily recognize the benefits of such units. Thus, the company now only offers the high efficiency units that have benefits that customers can see clearly, such as brass drain valves and self-cleaning features.

  One large water heater manufacturer, with a market share of about 17%, indicated that the efficiency mix of water heaters sold in Southern California differs slightly from those sold nationwide. In particular, this respondent indicated that slightly more units between .60 EF and .69 EF (and fewer having less than a .60 EF) are sold in Southern California than other regions, primarily because of the influence of Title 24 requirements.

  Legislative mandates were cited as the primary reasons for increases in gas water heater efficiency over the years. In particular, insulation changed from fiberglass to foam as a direct result of the implementation of NAECA in 1991.

[2] First-year impact studies have estimated positive net impacts on efficiency levels, thus the efficiency levels of units sold in California are presumably higher than they would have been without the RNC programs.

- ***Windows.*** As with the other equipment manufacturers, all window manufacturers reported changes in efficiency mixes since 1990, and most reported changes since 1994. While the manufacturers could not provide historic data on efficiency levels, all companies explained that efficiency levels have been steadily increasing over the past several years. Essentially, manufacturers have been increasing the quality and materials in windows to increase their overall efficiency (resulting in lower U-values). All manufacturers have significantly decreased the number of single-paned units and increased the proportion of double- and triple-paned units that they produce.[3]

  All of the window manufacturers indicated that the efficiency mixes of windows sold nationwide are representative to those of windows sold in Southern California. However, one of the largest window manufacturers did indicate that "*tinted low-e glass is a better seller in California than in other regions.*"

  Competition among window manufacturers was cited as the primary force behind changes in efficiency levels over the past several years. Manufacturers are very proactive in increasing the quality and efficiency of their products and are well aware of consumer preferences.[4]

Program Attribution. During the in-depth interviews, equipment and window manufacturers were asked about their awareness of utility DSM programs and if any of the changes in their efficiency mixes were directly attributed to any DSM programs and/or specifically to SDG&E' s or SoCalGas' RNC programs. The following summarizes their responses:

- ***Gas Furnaces.*** The majority of gas furnace manufacturers, accounting for about 95% of the market share, are aware of various utility DSM programs. Only the smallest company indicated that increases in efficiency levels of the units produced were attributable to such programs.

  Two of the largest manufacturers, representing about 30% of the gas furnace market share, were aware of both SDG&E' s and SoCalGas' RNC programs. Both companies, however, reported that they did not change manufacturing practices due to either program.

- ***Gas Water Heaters.*** The majority of the major water heater manufacturers, accounting for over 90% of the market share, are aware of utility DSM programs relating to gas water heaters, in general. Two manufacturers reported changing efficiency mixes as a result of these programs.

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3 One of the largest manufacturers explained that all windows produced prior to 1990 were single paned and that they did not produce any single-paned units last year.

4 Recall from Section 5 that consumers are much more interested and concerned with the visible features of the home. Because windows fall into this category, manufacturers explained that they feel strong competitive pressure to continue to offer consumers better quality products.

Two major water heater manufacturers, accounting for about 45% of the market share, were aware of one or both of the RNC programs covered by this study. These manufacturers indicated that changes in the efficiency level mix of their products over the years were not attributable to either program. One manufacturer noted that the "*program requirements were met by existing products.*"

- ***Windows.*** All of the window manufacturers interviewed for this study were aware of utility DSM programs. One of the smaller manufacturers explained that their low-e argon insulated windows are now "standard" as a result of the programs that require particular U-values for windows. One manufacturer was specifically aware of the RNC programs covered by this study but explained that its changes in efficiency levels over the years were not attributable to either program.

Information obtained during the in-depth interviews clearly indicates that the majority of changes in the efficiency mixes were due to legislative mandates and competition among manufacturers rather than influence from builders, or those market actors targeted by DSM programs. As described above, however, some changes in the efficiency mixes of gas equipment and windows were attributable to DSM programs (equipment rebates, in particular), although none of the manufacturers specifically cited either SDG&E's or SoCalGas' RNC program as having any influence. A few manufacturers indicated that there are differences in efficiency mixes of the product sold in Southern California and of those sold nationwide.[5] First, one of the largest water heater manufacturers commented that their units above .60 EF are sold mostly in California. Second, one of the three largest window manufacturers in the country explained that the units sold in Southern California have higher efficiency levels than the national average. The manufacturer attributed this to stricter building codes, higher consumer expectations, and greater consumer awareness in Southern California than the rest of the country.[6] The latter factor could be associated with DSM programs, although manufacturers did not generally suggests such a linkage.

Permanence of Effects. Despite the fact that changes in efficiency mixes were not directly attributed to either RNC program, it is our view that the changes that are facilitated by DSM programs in general are likely to be long lasting – particularly since at least two of the manufacturers interviewed explained that the price differential between higher and lower efficiency units continues to narrow every year (the respondents, however, could not quantify the size of the price differential). Several manufacturers explained that, because manufacturing is a price-driven (and price sensitive) industry, demand for high efficiency products must be sustained in order for manufacturers to continue producing greater proportions of these products. As one water heater manufacturer commented, "*the buyer must want it.*"

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5 Note that the manufacturers interviewed for this study were asked only about their business practices in Southern California, not Northern California or the entire state.

6 Note that even though manufacturers could not attribute changes to RNC programs, one did attribute increases in efficiency mixes to great consumer awareness, which was attributed to RNC programs to some extent. Increased consumer awareness is discussed in a subsequent section.

1b) RNC programs change manufacturing practices and stimulate retooling, thus leading to higher efficiency levels in the product mix.

Because RNC programs stimulate demand for high efficiency equipment, they are also facilitating changes in manufacturing practices and processes. This hypothesis was tested by examining changes in manufacturing practices as reported by gas equipment and window manufacturers during the in-depth interviews. Manufacturers were asked about changes in manufacturing practices that they have implemented over the past several years and if any such changes were a direct result of RNC programs such as those sponsored by SDG&E or SoCalGas. The results of the in-depth interviews reveal that a few manufactures did, in fact, implement changes in manufacturing practices because of DSM programs. While these changes were not directly attributable to either SDG&E's or SoCalGas' RNC program, these programs presumably contributed in a small way to the overall influence of programs across the country.

Most manufacturers reported having implemented changes in their manufacturing practices since 1990. Some of these changes include the following:

- One of the major gas furnace manufacturers developed a multiple position gas furnace that replaced three different products.
- Most window manufacturers have switched to producing multiple-paned windows and have been using a variety of frame and spacer materials to increase the overall quality and energy efficiency of the unit. Many also commented that low-e glass now dominates the industry, whereas prior to 1990, the "standard" windows contained clear glass.[7] They have also begun to produce windows with different insulative materials, such as argon gas, and have substituted aluminum framing materials with less conductive materials, such as vinyl and fiberglass.

Two major water heater manufacturers explained that they did modify some units to qualify for DSM programs, such as adding insulation to increase the unit's efficiency level. The programs responsible for facilitating these changes, however, targeted electric, not gas, units. One of the manufacturers explained that changes in manufacturing practices with respect to gas units is not as likely to occur as a result of such programs:

> *"Electric units are not tough to build because there is no combustion …Gas units have lots of other issues and take five times longer to design and test."*

For the most part, the changes in manufacturing practices are ongoing and were attributed to the company's long-term outlook and competition in the industry, rather than to any specific DSM

[7] For example, one manufacturer noted that the proportion of windows containing low-e glass has increased from 30% to roughly 70% over the past several years.

program(s). In particular, manufacturing changes are implemented to develop better products, to achieve cost reductions, and be more competitive in the industry – basically, *"..to develop innovative manufacturing techniques which lower manufacturing costs without sacrificing quality."*

Permanence of Effects. The changes in window manufacturing practices appear to be a long-term change. If they can be partly attributed to DSM programs in general, it is our view that these programs can be said to have induced a modest amount of upstream transformation.

Effects on Builders and Other Decision Influencers

RNC programs promote products and provide technical assistance and product information to homebuyers, as well as builders, architects, Title 24 consultants, contractors, distributors, and other decision influencers. As a result, we can hypothesize that these programs stimulate the following effects:

2a) RNC programs increase effective product availability by increasing the builders' and other decision influencers' product awareness, therefore, builders face fewer constraints in acquiring efficiency measures.

2b) RNC programs affect the business strategies and standard organizational practices of builders, architects, distributors, and other decision influencers.

2c) RNC programs lead to lower effective DSM prices by lowering information and hassle costs incurred by builders, distributors, and other industry participants.

2d) RNC programs stimulate changes in the promotional practices used by contractors and distributors.

Each of these hypotheses is discussed in detail below.

2a) RNC programs increase effective product availability by increasing the builders' and other decision influencers' product awareness

By providing training and informational services such as seminars and forums with product representatives, it is hypothesized that RNC programs decrease the information costs and bounded rationality on the part of builders and the market actors who influence their decisions. This hypothesis was tested by examining builders' and other market actors' self-reported awareness of the latest high-efficiency technology provided during the in-depth interviews.

The information obtained through the in-depth interviews supports the hypothesis that the RNC programs increased product awareness, thereby reducing these market barriers. Market actors revealed their self-rated awareness of the latest available technologies with respect to gas space and water heating equipment, windows, insulation, and duct testing and sealing methods. A comparison

of the participant, nonparticipant, and control area responses suggests that the builders' increased awareness is at least partly attributable to the RNC programs.

The results for the builders and other primary decision makers (Title 24 consultants, architects, and HVAC contractors) are discussed below.

Builders. Table 7-3 presents builders' self-reported awareness of the latest energy efficiency technologies for gas space and water heating equipment, windows, insulation, and duct testing and sealing methods.[8] For builders, attribution of increased awareness specifically to the programs is ascertained by comparing the results of participants with those of nonparticipants and builders in the control area. On average, program participants reported slightly higher awareness levels for all equipment and measures than nonparticipants for all measures except duct sealing. Participating builders also reported higher awareness levels than builders in the control area for all measures other than windows. The result for windows is undoubtedly attributable to the importance of window efficiencies from the perspective of cooling requirements in the control area.

Table 7-3: Builder Self-Reported Awareness of Latest Technologies[1,2,3]

Group	Gas Furnaces	Gas H_2O Heaters	Windows	Insulation	Duct Testing	Duct Sealing
Participants	4.4 *(0.23)* *n=19*	3.8 *(0.25)* *n=19*	4.4 *(0.22)* *n=19*	4.0 *(0.25)* *n=19*	3.5 *(0.41)* *n=19*	3.5 *(0.40)* *n=19*
Nonparticipants	3.1 *(0.12)* *n=13*	3.1 *(0.18)* *n=13*	3.1 *(0.15)* *n=13*	3.5 *(0.34)* *n=13*	3.1 *(0.50)* *n=13*	3.5 *(0.33)* *n=13*
Control	2.1 *(0.41)* *n=9*	3.2 *(0.17)* *n=8*	4.6 *(0.24)* *n=8*	4.4 *(0.26* *n=8*	2.6 *(0.23)* *n=8*	1.8 *(0.28* *n=8*

1. Each respondent rated their own awareness, with a one 1 meaning "not at all aware," a 3 meaning "somewhat aware", and a 5 indicating "very aware."
2. Means were weighted according to the number of homes each builder reported completing in 1997.
3. Standard errors are included in parentheses.

Interview discussions also revealed that some builders permanently changed their standard business practices because the program helped them become more aware of high efficiency products. For example, one builder in particular now considers higher efficiency HVAC units for marketing

[8] Each respondent was asked "For the following equipment and shell features, do you consider yourself very aware, somewhat aware, or not at all aware of the latest available energy saving/high efficiency technologies?" This question is generic, and did not provide a reference point to which respondents could base answers. As such, responses should be interpreted with caution.

purposes. The builder attributes this to the programs' initiatives to help builders become more aware of energy efficiency and the need for it in new construction. Builders in the control region reported that they were "somewhat aware" of the latest high efficiency gas space and water heating equipment and "very aware" of high efficiency windows. Again, this result is reasonable, considering the high demand for air conditioning, thus a strong awareness of window and insulation efficiency, in the Austin/San Antonio region.

Other Market Actors. Although builders are the ultimate decision makers, Section 5 explains that a builder's decisions with respect to energy-related equipment and measures are strongly influenced by other key market actors. Thus, to examine the RNC programs' effectiveness at reducing information costs and bounded rationality, it is necessary to investigate the product awareness levels of these actors – Title 24 consultants, architects, and HVAC contractors, in particular. Information on the latest technologies and procedures is critical for these actors because they have the most substantial influence on builder decisions and are most affected by product availability.

Program attribution of awareness levels is difficult to determine for these market actors, since Title 24 consultants, architects, and HVAC contractors were not program participants, *per se*, but were merely employed by either a participant or nonparticipant. One can assume, however, that the behavior of other market actors indicates, to some extent, program effectiveness in increasing awareness levels of other market actors.[9] Because other market actors can neither be considered a participant nor a nonparticipant, the second best alternative is to compare awareness levels of those in Southern California with those in the control region.

Table 7-4 presents the mean self-reported awareness levels of Title 24 consultants, architects, and HVAC contractors. As shown, there are differences of product awareness levels between the two regions.

[9] In fact, roughly 50% of HVAC contractors and almost 10% of the architects indicated that they were not aware of either program. Whether or not these market actors were aware of the program does not affect their market behavior. It is merely an indication that participating builders do not always proclaim their participation to other market actors.

Table 7-4: Other Decision Influencers' Self-Reported Awareness of Latest Technologies[1,2,3]

Group	Gas Furnaces	Gas H_2O Heaters	Windows	Insul.	Duct Testing	Duct Sealing
Title 24 Cons.						
	4.9 *(0.15)* *n=11*	4.6 *(0.26)* *n=11*	4.9 *(0.11)* *n=11*	4.9 *(0.11)* *n=11*	3.9 *(0.38)* *n=11*	3.7 *(0.46)* *n=11*
Architects						
S. California	3.7 *(0.36)* *n=8*	3.7 *(0.36)* *n=8*	4.9 *(0.18)* *n=8*	4.9 *(0.18)* *n=8*	1.7 *(0.36)* *n=8*	1.5 *(0.38)* *n=8*
Control	2.9 *(0.25)* *n=5*	2.9 *(0.25)* *n=5*	3.1 *(0.25)* *n=5*	3.1 *(0.25)* *n=5*	1.6 *(0.45)* *n=5*	1.6 *(0.45)* *n=5*
HVAC Cont.						
S. California	3.8 *(0.72)* *n=8*	2.8 *(0.29)* *n=6*	3.1 *(0.54)* *n=6*	3.1 *(0.54)* *n=6*	3.1 *(0.66)* *n=8*	3.5 *(0.72)* *n=8*
Control	5.0 *(0.00)* *n=5*	1.1 *(0.26)* *n=4*	4.8 *(0.40)* *n=4*	5.0 *(0.00)* *n=4*	3.8 *(0.62)* *n=5*	4.7 *(0.52)* *n=5*

1. Each respondent rated their own awareness, with a one 1 meaning "not at all aware," a 3 meaning "somewhat aware", and a 5 indicating "very aware."
2. Means were weighted according to the number of plans reviewed (Title 24 consultants), the number of plans completed (architects), or the number of installations (HVAC contractors) each respondent reported completing in 1997.
3. Standard errors are included in parentheses.

The results suggest the following:

- In general, architects in Southern California are somewhat more aware of the latest technologies of energy-efficient equipment than those in the control region. Unsurprisingly, architects in both regions reported not being very aware of the latest duct testing and duct sealing methods.
- HVAC contractors in Southern California have slightly *lower* awareness levels than their counterparts in the control region for all measures except for water heaters. Because the residential building energy codes in the control region include specific duct sealing requirements, it is not very surprising that the HVAC contractors in the control region are more aware of the latest duct testing and sealing methods. Moreover, the fact that

HVAC contractors in the control area are considerably more aware of window efficiencies than their Southern California counterparts can also be at least somewhat attributed to the importance of air conditioning in the control area. The result for gas furnaces seems anomalous.

- On average, Title 24 consultants are very aware of the latest equipment and shell measure technology, and somewhat aware of the latest duct testing and sealing procedures.[10] Note that no comparisons were made with the control area because none of the builders in the control region reported that they employed an energy consultant.

In summary, the RNC programs seemed to have increased awareness among builders and architects, but there is no evidence that the RNC programs decreased the information costs and bounded rationality of HVAC contractors. Of course, comparisons of HVAC contractor awareness levels across areas are corrupted by major differences in non-program conditions, so this issue should probably be investigated further.

Permanence of Effects. We consider the market effects of product awareness to be long lasting, insofar as the information obtained through the RNC programs is considered to be useful and valuable by the market participants, particularly by builders. Moreover, given that these market actors realize the benefits of increased product awareness, they are likely to have identified new information sources and will continue to seek information on new products and technology when deemed necessary.

2b) RNC programs affect the business strategies and standard organizational practices of builders, architects, distributors, and other decision influencers.

RNC programs offer financial incentives to builders to encourage the installation of more energy-efficient equipment and shell measures. This study hypothesizes that program participation facilitates permanent changes in the builders' standard business practices, thereby decreasing the organizational practices market barrier. This hypothesis was tested by examining changes in business and organizational practices reported by builders during the in-depth interviews. Program attribution to reported changes is determined by comparing responses from participants, nonparticipants, and builders in the control region.

The information obtained through the in-depth interviews supports (to some extent) the hypothesis that the RNC programs permanently affected the business strategies and organizational practices of key market actors. The RNC program effects on business strategies and organizational practices of builders and other market actors are discussed below.

[10] Note that builders in the control region reported that they do not employ energy consultants, thus it would be misleading to have included energy consultants from the control region in this analysis.

Builders. Table 7-5 includes the percentage of participant, nonparticipant, and control area builders that reported changes in business and organizational practices – mainly changes of the builders' relationships with Title 24 consultants and HVAC contractors – over the past several years.

Table 7-5: Changes in Builders' Business and Organizational Practices[1,2]

	Participants	Non-participants	Control
Role of Energy Consultant has changed[3]	80.4% *(0.11)* *n=14*	0.0% *(0.00)* *n=8*	-
Role of HVAC Contractor has changed	57.2% *(0.12)* *n=17*	16.1% *(0.14)* *n=8*	75.2% *(0.12)* *n=13*
Means of meeting code has changed	39.2% *(0.12)* *n=13*	54.3% *(0.35)* *n=13*	67.4% *(0.14)* *n=12*

1. Statistics are weighted according to the number of homes the respondent reported completing in 1997.
2. Standard errors are included in parentheses.
3. About 99% of the participants, 98% of the nonparticipants, and none of the control area builders work with an energy consultant.

As shown, there are some distinct organizational differences between program participants and nonparticipants.

- About 80% of the participating builders employing a Title 24 consultant reported that the role of their Title 24 consultant has changed in recent years, while no nonparticipants reported a change in the role of their Title 24 consultant.[11] In particular, builders explained that they are working more closely with their Title 24 consultant(s) and relying more heavily on them now than in the past to provide cost minimizing options for meeting Title 24 requirements. While this finding is striking, its implications are unclear. On one hand, lowering the cost of efficiency by optimizing shell and equipment design could lead to higher overall efficiency levels. On the other hand, the kinds of fine-tuning offered by Title 24 consultants could also reflect the desire of participants to diminish the effects of prescriptive programs by lowering efficiency of other end uses. The latter would support the finding in Table 7-5, but the relationship between participating and nonparticipating builders needs to be examined more closely in subsequent studies.
- The percentage of builders who reported a change in their relationship with HVAC contractors in the past several years is substantially different between participants and nonparticipants. In particular, over 50% of the participants and just over 15% of the nonparticipants reported a change in the HVAC contractor' s role. As with the Title 24 consultants, builders now depend more on the HVAC contractor during the specification stage than in previous years. Most explained that they rely more heavily on HVAC contractors for input on air distribution system design, product and materials performance issues, and current information on new technologies and materials. Further, changes in design and structural requirements have made air distribution system design more difficult. One of the largest national building corporations no longer employs an HVAC contractor to design the duct systems. The company now has an in-house environmental engineer that designs the systems, works with the architect, and attends all design meetings.
- A greater percentage of nonparticipants indicated that their methods of exceeding Title 24 requirements have changed than did participants. Most of the changes in methods to exceed Title 24 standards pertained to window specifications and window treatments. For instance, some builders are specifying windows with vinyl frames instead of aluminum, or are using a foam sealant around the frame. While some builders mentioned that they are specifying more efficient HVAC equipment, the majority were referring to higher SEER air conditioning units. These changes are logical, considering that most home buyers are more aware of windows and see a greater need for air conditioning than the other measures included in the RNC programs.

[11] Because about the same percentage of participant and nonparticipant builders reported that they employ a Title 24 energy consultant, it does not appear that participants have more of a predisposition to employ consultants than do nonparticipants.

The in-depth interviews also revealed that approximately 8% of the participating builders permanently changed other standard business/building practices as a result of participating in the program. For the most part, builders became accustomed to specifying all gas equipment and appliances. Permanent changes cited by builders were attributable to convenience (it was easier for them to just continue the same practices than to return to previous practices) and increased product awareness. One builder will likely continue some of the practices in custom projects, where the homebuyer is willing to pay the higher costs of upgraded equipment and measures.

Clearly, there are obstacles to major changes in organizational practices by builders. The most obvious deterrent is cost. Another is that upgrading equipment and shell measures might not be consistent with the builder' s corporate policy. For example, one of the largest national builders is implementing a strategy through which all homes have a very basic design and are specified to the absolute minimum. The homeowner, then, is given complete freedom to upgrade. Although this strategy enables the builder to accommodate a broader range of homebuyers, it seems to have counteracted any long-term RNC effects that would have occurred in its absence.

Table 7-6 reports the changes in the proportion of homes built that exceed building standards, as reported by interview respondents. There are several points worth noting regarding these results. First, with respect to the percentage of homes exceeding codes, there is greater difference between responses from builders in Southern California and those in the control area than between participant and nonparticipant builders in Southern California, alone. In particular, about 55% of the homes built by participants and about 45% than half built by nonparticipants in 1997 exceeded Title 24 standards. Builders in the control region reported that over 95% of the homes built in 1997 exceeded building codes.

Second, there are notable differences in the increases and decreases in the percentage homes that exceed code between participant and nonparticipant builders. About 11% of the participants and 4% of the nonparticipating builders reported an *increase* over the past several years in the proportion of homes that exceed Title 24 standards. Over 12% of the participants and none of the nonparticipants or builders in the control area reported a *decrease* in the proportion of homes that exceed standards. Those who indicated a decrease explained that homes they built under the RNC program exceeded the standards. Because high efficiency installations were not continued after participation ended, however, resulted in a decrease in the proportion of homes exceeding code. This is a significant result, clearly indicating that some builders do not sustain high efficiency installation practices after program participation ceases.

Table 7-6: Changes in Proportion of Homes Built That Exceed Standards[1,2]

	Participants	Non-participants	Control[3]
Self Reported Mean percentage of Homes Exceeding Codes	55.3% *(0.11)* *n=18*	44.9% *(0.19)* *n=8*	96.6% *(0.03)* *n=13*
Percentage of Builders That Indicated the Proportion of Homes Exceeding Code Has Increased	11.3% *(0.07)* *n=20*	4.1% *(0.08)* *n=7*	0.03% *(0.02)* *n=14*
Percentage of Builders That Indicated the Proportion of Homes Exceeding Code Has Decreased	12.8% *(0.07)* *n=20*	0.0% *(0.00)* *n=7*	0.0% *(0.02)* *n=14*

1. Statistics are weighted according to the number of homes the respondent reported completing in 1997.
2. Standard errors are included in parentheses.
3. Statistics pertaining to the control area should be interpreted with caution. Builders in Southern California were asked about the homes that exceed Title 24 standards, while builders in the control area were asked about the homes that exceed building codes.

HVAC Contractors. RNC programs to appear to have had most significant effects on HVAC contractors. Roughly 78% of the HVAC contractors interviewed for this study have made substantial changes to their business practices as a direct result of the RNC programs. In particular, two of the largest HVAC contractors in the region explained during the in-depth interviews that they have changed their duct installation and sealing methods as a result of working for builders participating in the programs. Because of the programs' duct testing and sealing requirements, these contractors recognized the importance of improved duct installation methods and high quality duct sealing products.[12,13]

Other Market Actors. The in-depth interviews revealed that the proactive HVAC contractors described above are the exception rather than the rule in the industry. First, neither manufacturers nor distributors indicated that they made any permanent changes to their standard business practices as a direct result of either program. This is not surprising, given that the majority of supply-side market actors were not familiar with either program.

[12] Interestingly enough, one contractor even refuses to work for builders that do not agree with their installation methods. Along with the project bid, the contractor provides heating and air conditioning installations specifications that detail all installation methods and sealing materials. The contractor claimed that they work for less than 10% of the builders in Southern California.

[13] The contractors who have implemented these changes collectively performed installations in over 7,000 homes in Southern California last year, the majority of which were in single family tract developments. These installations represent just over 35% of the total number of installations by all HVAC contractors participating in this study, and both are considered to be major HVAC contractors in the Southern California residential new construction industry.

Second, aside from the builders and HVAC contractors, none of the demand-side market actors (architects and Title 24 consultants) reported permanent changes in their normal business practices that are attributable to either RNC program. As discussed in Section 5, architects, Title 24 consultants, and HVAC contractors provide input during the specification phase. The extent to which the input is considered, however, is conditional upon the builder' s pre-set parameters and budget constraints.

Permanence of Effects. The extent to which changes in standard organizational and business practices are long lasting varies across market actors. The RNC programs reportedly *permanently* influenced some builders and HVAC contractors, but had virtually no long-lasting effects on the others.

2c) RNC programs lead to lower effective DSM prices by lowering information and hassle costs incurred by builders, distributors, and other industry participants.

By providing training and informational services such as seminars and forums with product representatives, it is hypothesized that the RNC programs decrease the information and hassle costs incurred by industry participants. This hypothesis was tested by examining market actor ratings of important reasons for not exceeding building energy codes that were provided during the in-depth interviews. Program attribution is determined by comparing responses from participants, nonparticipants, and builders in the control region and by comparing responses of other market actors in Southern California with responses from their counterparts in the control region. The information obtained during the in-depth interviews does not support the hypothesis that RNC programs have led to lower effective DSM prices.

During the in-depth interviews, builders and other market actors rated the importance of several reasons for not building homes exceed the Title 24 requirements. Table 7-7 presents a comparison of participant and nonparticipant responses regarding the importance of a set of such reasons. Reasons relating directly to this hypothesis include lack of information, availability of energy-efficient products, difficulty in choosing among energy-efficient options, and hassle costs. Costs are also included for reference.

As shown, there are some interesting differences between participant, nonparticipant, and control area builders. The most notable differences are between market actors in Southern California and their counterparts in the control region, not between participant and nonparticipant builders.

Table 7-7: Importance of Reasons for Not Exceeding Standards[1,2,3]

Market Actor	Costs	Lack of Info.	Products Not Available	Choosing Among Options	Hassle
Builders					
Participants	4.8 *(0.14)* *n=19*	3.6 *(0.21)* *n=18*	2.1 *(0.38)* *n=19*	2.5 *(0.29)* *n=18*	2.7 *(0.37)* *n=19*
Nonparticipants	4.4 *(0.17)* *n=9*	3.1 *(0.17)* *n=9*	2.9 *(0.22)* *n=9*	3.2 *(0.30)* *n=9*	2.4 *(0.54)* *n=9*
Control	4.9 *(0.12)* *n=13*	1.8 *(0.39)* *n=13*	1.4 *(0.26)* *n=13*	1.4 *(0.22)* *n=12*	2.2 *(0.22)* *n=13*
Architects					
S. California	5.0 *(0.00)* *n=8*	4.4 *(0.37)* *n=7*	2.4 *(0.49)* *n=8*	2.7 *(0.17)* *n=8*	4.1 *(0.51)* *n=8*
Control	5.0 *(0.00)* *n=5*	4.8 *(032)* *n=4*	3.4 *(0.41)* *n=5*	2.6 *(0.41)* *n=5*	3.4 *(0.41)* *n=5*
Title 24 Cons.					
S. California	4.8 *(0.20)* *n=9*	2.9 *(0.37)* *n=8*	1.7 *(0.24)* *n=9*	1.9 *(0.22)* *n=9*	3.3 *(0.33)* *n=9*
Control	-	-	-	-	-
HVAC Cont.					
S. California	4.8 *(0.17)* *n=7*	3.1 *(0.48)* *n=6*	3.6 *(0.72)* *n=6*	3.2 *(0.42)* *n=6*	3.7 *(0.69)* *n=6*
Control	1.7 *(1.08)* *n=3*	1.0 *(0.00)* *n=2*	1.4 *(0.73)* *n=3*	1.3 *(0.49)* *n=3*	1.0 *(0.14)* *n=3*

1. Each respondent was asked "On a scale of 1 to 5, where a 1 is "not at all important," a 3 is "somewhat important", and a 5 is "very important," how important do you feel are each of the following reasons for building a house that does not exceed Title 24 requirements? (Control area respondents were asked the same question in reference to "local building requirements.")
2. Means were weighted according to the number of homes built in 1997 (builders), the number of plans reviewed (Title 24 consultants), the number of plans completed (architects), or the number of installations (HVAC contractors) each respondent reported completing in 1997.
3. Standard errors are included in parentheses.

- ***Costs.*** First costs constitute the most important reason for building homes to just meet standards. Costs are considered "very important" by all respondents except HVAC contractors in the control area.
- ***Lack of Information.*** Overall, all interview respondents indicated that lack of information on energy-efficient measures was still a fairly important reason for not exceeding the minimum energy efficiency requirements. Participating builders actually rated this reason higher than nonparticipants. Combining this with our earlier results that participants report higher awareness levels than nonparticipants, it seems that RNC programs may improve builder awareness, but that lack of information remains to be an issue. Interestingly, builders in the control region did not consider lack of information a serious reason for failing to exceed code. Lack of information is perceived as quite important by architects, both in California and in the control area. This may signal the need for programs to focus more directly on these actors. Title 24 consultants consider lack of information somewhat important. Finally, HVAC contractors in Southern California also consider this barrier somewhat important, but their counterparts in the control area claim that it is "not at all important."[14]
- ***Unavailability of Products.*** On average, participating builders rated the unavailability of products as slightly less important than did the nonparticipant builders. Only the HVAC contractors in Southern California considered this more than a "somewhat" important reason for not exceeding Title 24. HVAC contractors in the control region considered this factor, like all other covered reasons, as "not at all important."
- ***Difficulty in Choosing Among Options.*** On average, participating builders rated the difficulty in choosing among options as not particularly important, and rated it as less important than did nonparticipating builders. This is consistent with the results of Hypothesis 2a, reflecting that the programs did help builders become more aware of high efficiency equipment, which undoubtedly makes their decision process less confusing. Also note here that the market actors in the control region indicated that difficulty in choosing among options was "not at all important."
- ***Hassle.*** On average, participating builders in Southern California indicated that hassles are "somewhat important" in their equipment and measure specification decisions, while builders in the control region viewed hassles as not particularly important. Such was the case for architects and HVAC contractors, as well. Looking at the builders in Southern California, the average "importance rating" from participants was actually slightly higher than that from nonparticipants.

[14] Part of the reason for the latter finding seems to be that the City of Austin expends considerable efforts to educate HVAC contractors. It may also trace to the need to deal with the more extreme cooling requirements in the control area. Recall from Section 4.2 that the City of Austin is very proactive in informing market actors about energy efficiency, new technologies, and code compliance methods.

The above discussion suggests three general conclusions:

- First, the market actors considered cost to be a far more important reason for not exceeding code than non-cost factors by all actors. One should not to lose sight of the importance of differences between cost and builders' expectation of returns on energy efficiency. While other non-cost factors may be somewhat important, cost is critical.
- Second, participating and nonparticipating California builders have similar perceptions of the importance of non-cost factors as reasons for not exceeding code, although they differ on specific reasons. This suggests that, while programs may have increased builder awareness (as discussed earlier) these factors remain somewhat important in deterring efficiency.
- Third, market actors in Southern California considered information and hassle costs more important than their counterparts in the control region. While this is partly traceable to the extreme cooling requirements in the control area, it also suggests that additional efforts could have substantial impacts on these factors.

Permanence of Effects. The fact that lack of information, hassle(s), and difficulty in choosing among options are still important at all in builders' decisions regarding energy efficiency levels implies that these costs still exist as market barriers. Further, the lack of distinction between participants and nonparticipants indicates that RNC programs did not reduce these effective DSM costs for participants. Had the programs eliminated these costs as a market barrier, the mean values over participants should presumably equal 1 in all categories.[15]

2d) RNC programs stimulate changes in the promotional practices used by contractors and distributors.

Because RNC programs increase product awareness and provide information services to the primary decision maker(s), it is hypothesized that the RNC programs stimulate changes in the promotional practices of builders and equipment distributors, thus reducing the information search costs market barrier. In other words, the RNC programs encourage builders and equipment distributors to emphasize high efficiency homes and equipment in promotional and marketing materials. This hypothesis was tested by examining the information obtained from builders and sales agents during the in-depth interviews regarding their marketing practices of high efficiency homes. A comparison of participant and nonparticipant marketing practices reveals that the RNC programs did not facilitate changes, thus this hypothesis is not supported.

Table 7-8 presents the percentage of builders and sales agents who indicated that they market homes that exceed building energy codes differently than they do for homes that do not. As shown,

[15] It is important to note at this time that these effective DSM costs all ranked considerably lower than the cost itself. In other words, split incentives have not been significantly reduced and are still an important major market barrier, relative to those discussed here.

only 6% of participating builders in Southern California claim to market homes that exceed Title 24 requirements differently than homes that just meet the standards. The percentage is far higher for nonparticipants, but this is attributable to a single large builder who claims to use different marketing practices, and is probably not representative. There are no noticeable differences in marketing strategies between participants and builders in the control area

About 35% of the sales agents in Southern California reported differences in marketing between homes that exceed standards and those that just meet the standards, while fewer than 30% of the agents in the control region reported such differences. Given the small sample sizes, this difference is not significant. Moreover, responses from sales agents should be interpreted with caution. It is not known the extent to which sales agents know with certainty whether or not a home exceeds or just meets the building energy code.

It is important to note that none of the large, national builders of tract developments indicated that they market more energy-efficient homes differently than homes that just meet building energy codes. For the most part, the builders that marketed more energy-efficient homes differently were medium-sized builders that completed fewer than 150 homes in 1997, the majority of which were upper-income tract homes. This is consistent with the characteristics of upper-income and repeat buyers, as described in Section 5. The interviews revealed that upper-income and/or repeat homebuyers tend to be more inquisitive and knowledgeable about energy-related equipment and the operating costs of a home, in general. Thus, it is not surprising that builders take advantage of these traits in marketing more efficient homes.

Table 7-8: Percent That Market High Efficiency Homes Differently Than Homes Just Meeting Building Codes[1,2,3]

Market Actor	Percent Reported a Difference in Marketing
Builders	
Participants	6.3% *(0.07)* *n=13*
Nonparticipants	41.0% *(0.28)* *n=4*
Control	6.4% *(0.08)* *n=11*
Sales Agents	
S. California	32.3% *(0.09)* *n=30*
Control	27.3% *(0.12)* *n=15*

1. Percentages are weighted by the number of homes built (builders) or the number of homes sold (sales agents) in 1997, as reported by each respondent.
2. For builders, the analysis is restricted to those that claim to build at least some homes exceeding code.
3. Standard errors are included in parentheses.

The marketing strategies for selling more energy-efficient homes can be best described as generic and brief, but this is not surprising given that nearly all builders mentioned that energy efficiency is "*low down on the [consumer's] list of reasons to buy*" a home. In general, builders (or builder sales agents) generically refer to the home as being "energy efficient," unless, of course, the homebuyer specifically inquires about the energy efficiency levels of equipment and/or features in the home. Several provide the consumer with brochures that explain available upgrades, and some have "cut-away walls" in model homes so the homebuyer can see insulation and other non-visible features. Only one builder mentioned that they explained to the consumer how increased energy efficiency translates into lower utility bills.

Until now, the discussion has focused on builders and sales agents, who are demand-side market actors. It is also useful to look at the marketing and promotional practices of manufacturers and

distributors, the supply-side participants, although it is not possible to compare supply-side behavior between regions. Overall, the majority of gas furnace, gas water heater, and window manufactures interviewed for this study indicated that they market equipment that exceed the minimum energy efficiency standards differently than "standard" units. In marketing the high efficiency units, usually through the use of sales representatives and trade shows and magazines, the manufacturers will promote cost savings, the unit's premium features, and will make "good-better-best" comparisons for the client.[16]

Comments regarding marketing and promotional practices from distributors varied. The majority of gas space and water heating equipment distributors indicated that they do not market high efficiency equipment differently, while most window distributors do. Recall from Section 5 that manufacturers account for the majority of equipment marketing to contractors and builders. Distributors simply do not do much marketing, regardless of the efficiency level of the product.

In summary, there is no conclusive evidence from the builders or sales agents that suggests the RNC programs stimulated marketing efforts. Although equipment manufactures revealed that they marketed high efficiency units differently than the "standard" products, these differences do not appear to be attributable to RNC programs. Because RNC programs have not stimulated marketing efforts, they have not mitigated the information search cost market barrier.

Effects on Customers

The RNC programs provide product information directly to customers. The SoCalGas Energy Advantage Home Program also provides financing incentives to lower the costs of these measures to customers. These program features lead to the following hypothesized market effects relating to customer behavior:

3a) RNC programs increase customers' awareness of and knowledge about energy-efficient appliances. This lowers information and hassle costs and diminishes asymmetric information barriers,

3b) To the extent that energy-efficient appliances perform well, promotion of their use should improve customers' satisfaction with these products and diminish performance uncertainties.

3c) RNC programs influence customers' decision-making processes relating to the choices of energy efficiency. This might take the form of reductions in the barrier of bounded rationality.

[16] One of the largest water heater manufacturers has a "Performance Club" for plumbers who are the "best in their practice." Essentially, the "Performance Club" members are provided with intense training on how to sell the energy savings benefits of more efficient units to their clients, who include both consumers and builders.

Each hypothesized effect on consumer behavior is discussed below. In this discussion, the terms *participant* and *nonparticipant* have different meanings than when referring to builders, who are actual program participants. While discussing consumers, these terms take on the following meanings.

- ***Participants*** are consumers who live in houses built under an RNC program. They might or might not be aware that their home was built under an RNC program.
- ***Nonparticipants*** are consumers who live in houses built in the same area as participants; however, their houses were not built under an RNC program.

Survey responses from participants and nonparticipants in the sample have been weighted to represent the total population of these groups in their respective service areas.

3a) RNC programs increase customers' awareness of and knowledge about energy-efficient appliances. This lowers information and hassle costs and diminishes asymmetric information barriers,

By providing an opportunity for consumers to use and experience the benefits of energy-efficient appliances, it is hypothesized that RNC programs increase consumers' knowledge of these appliances and thereby decrease the market barrier of asymmetric information. This hypothesis was tested by examining consumer self-reported awareness of energy efficiency standards obtained from the consumer mail surveys. A comparison of participant and nonparticipant awareness levels shows that differences between these two groups are small. As a result, there is no evidence from the survey results to support this hypothesis.

To examine the effect that RNC programs have had on this market barrier, participating and nonparticipating consumers were asked the following questions:

- As far as you know, do California builders have to comply with any energy-efficiency standards relating to appliances, windows, and insulation levels when they construct new homes?
- As far as you know, are there any minimum efficiency standards on gas water heating and space heating equipment?
- Would you say that gas water heaters all have pretty much the same levels of efficiency, differ substantially in efficiency levels, or don' t know?
- Would you say that gas space heaters all have pretty much the same levels of efficiency, differ substantially in efficiency levels, or don' t know?
- Would you say that different kinds of windows all have pretty much the same levels of efficiency, differ substantially in efficiency levels, or don' t know?

Table 7-9 and Table 7-10 include consumer self-reported awareness of minimum energy efficiency standards and differences in energy efficiency level of equipment and shell measures, respectively. As shown in Table 7-9, the percentage of participants exhibiting awareness of the minimum energy efficiency standards for windows and appliances is only minimally higher than that of nonparticipants. However, fewer participants reported being aware of the minimum energy efficiency standards for gas water and space heating equipment than did nonparticipants. More participants reported being aware of the minimum energy efficiency standards for all equipment than did consumers in the control region, though the difference is small.[17]

While Table 7-9 pertains to awareness of energy efficiency codes, in general, Table 7-10 includes self-reported consumer awareness of differences in energy efficiency levels of equipment and shell measures. Several points are worth noting about the data in Table 7-10:

- First, there are no great differences between the percentages of participants and nonparticipants who reported being aware of difference in energy efficiency levels for gas furnaces, gas water heaters, and windows.
- Second, a greater percentage of both participant and nonparticipant consumers in SDG&E's service territory are aware of differences in energy efficiency levels than consumers in SoCalGas' territory.
- Third, the percentage of participants who reported being aware of differences in energy efficiency levels of equipment and shell measures is slightly greater than the percentage of consumers in the control region, except for differences in the efficiency levels of windows, although any differences are small.

[17] Note that the "do not know" responses were quite high for both questions in Table 7-9.

Table 7-9: Self-Reported Consumer Awareness of Minimum Energy Efficiency Standards

	Yes	No	Do Not Know	Did Not Answer
Aware of energy efficiency standards for appliances, windows, and insulation				
Participants *(n = 542)*	**69.0%**	**4.7%**	**23.9%**	**2.4%**
SDG&E *(n = 95)*	84.4%	3.1%	11.5%	1.0%
SoCalGas *(n = 447)*	66.4%	5.0%	25.9%	2.6%
Nonparticipants *(n = 604)*	**65.6%**	**4.4%**	**29.3%**	**0.7%**
SDG&E *(n = 182)*	79.3%	2.2%	17.4%	1.1%
SoCalGas *(n = 422)*	63.8%	4.7%	30.8%	0.7%
Control *(n = 229)*	**64.2%**	**7.0%**	**27.9%**	**0.9%**
Aware of minimum efficiency standards for gas water heaters and furnaces				
Participants *(n = 532)*	**43.5%**	**14.5%**	**37.7%**	**4.2%**
SDG&E *(n = 94)*	68.8%	3.1%	26.0%	2.1%
SoCalGas *(n = 438)*	39.4%	16.3%	39.7%	4.6%
Nonparticipants *(n = 598)*	**48.1%**	**9.0%**	**41.0%**	**1.9%**
SDG&E *(n = 181)*	65.2%	2.2%	31.1%	1.6%
SoCalGas *(n = 417)*	45.9%	9.9%	42.4%	1.9%
Control *(n = 229)*	**31.4%**	**11.8%**	**55.0%**	**1.7%**

Table 7-10: Self-Reported Consumer Awareness of Differences in Energy Efficiency Levels of Equipment and Shell Measures

	Same Levels of Efficiency	Different Levels of Efficiency	Do Not Know	Did Not Answer
Awareness of differences in energy efficiency levels for gas furnaces				
Participants *(n = 542)*	**17.7%**	**44.1%**	**35.8%**	**2.4%**
SDG&E *(n = 94)*	11.5%	54.2%	32.3%	2.1%
SoCalGas *(n = 448)*	18.7%	42.5%	36.4%	2.4%
Nonparticipants *(n = 597)*	**14.1%**	**44.9%**	**39.4%**	**1.6%**
SDG&E *(n = 178)*	6.5%	51.6%	38.6%	3.3%
SoCalGas *(n = 419)*	15.1%	44.0%	39.5%	1.4%
Control *(n = 229)*	**9.2%**	**35.4%**	**53.3%**	**2.2%**
Awareness of differences in energy efficiency levels for gas water heaters				
Participants *(n = 542)*	**23.1%**	**46.4%**	**28.1%**	**2.4%**
SDG&E *(n = 95)*	21.9%	53.1%	24.0%	1.0%
SoCalGas *(n = 447)*	23.3%	45.3%	28.8%	2.6%
Nonparticipants *(n = 601)*	**20.0%**	**47.4%**	**31.3%**	**1.4%**
SDG&E *(n = 182)*	12.5%	53.3%	33.2%	1.1%
SoCalGas *(n = 419)*	20.9%	46.6%	31.1%	1.4%
Control *(n = 229)*	**17.9%**	**42.4%**	**38.9%**	**0.9%**
Awareness of differences in energy efficiency levels for windows				
Participants *(n = 544)*	**10.9%**	**77.7%**	**9.3%**	**2.0%**
SDG&E *(n = 95)*	4.2%	89.6%	5.2%	1.0%
SoCalGas *(n = 449)*	12.0%	75.8%	10.0%	2.2%
Nonparticipants *(n = 602)*	**8.6%**	**81.4%**	**9.3%**	**0.7%**
SDG&E *(n = 179)*	3.8%	84.8%	8.7%	2.7%
SoCalGas *(n = 423)*	9.2%	80.9%	9.4%	0.5%
Control *(n = 229)*	**6.6%**	**89.5%**	**3.5%**	**0.4%**

Permanence of Effects. The lack of evidence to show that consumer awareness of energy-efficient measures has changed significantly as a result of RNC programs implies that RNC programs did not have long-lasting effects on information and hassle costs.

3b) To the extent that energy-efficient appliances perform well, promotion of their use should improve customers' satisfaction with these products and diminish performance uncertainties.

Consumers who experience lower utility bills and increased satisfaction with energy-efficient appliances could be more likely to purchase these products in the future. This experience could lower uncertainties that consumers might have regarding these products and will lead to increased consumer satisfaction. This hypothesis was tested by examining participants reported intentions to replace equipment with high efficiency units, whether or not consumers will consider energy efficiency during their next home purchase, and the types of energy efficiency measures consumers will consider during their next home purchase. Program attribution is determined by comparing participant, nonparticipant, and control-region consumer responses to related questions in the consumer mail survey.

While a high percentage of participants report the intention of purchasing energy-efficient products in the future, a comparison of participant and nonparticipant responses show little difference between these two groups. Therefore, the results are not strong enough to support this hypothesis.

As a first step in examining this hypothesis, *participant* consumers owning their homes were asked if their experiences with their present water and space heaters would increase the likelihood that they would choose high efficiency models when these products need to be replaced.[18] As shown in Table 7-11, over 90% of participants indicated that they would choose high efficiency gas space or water heating equipment in the future. In comparing the two service areas, this percentage is higher for consumers in the SDG&E area (95%) when compared to those in SoCalGas' territory (89%).

[18] Overall, 72% of participants responded that they own their home. This includes 100% of the SDGE sample and 68% of the SoCalGas sample.

Table 7-11: Intention to Replace with High Efficiency Equipment – Participants Only

	Percentage That Will Choose High Efficiency Equipment as Replacement	Percentage That Will Not Choose High Efficiency Equipment as Replacement	Do Not Know	Did Not Answer
All *(n = 239)*	**90.3%**	**1.6%**	**5.5%**	**2.5%**
SDG&E *(n = 60)*	95.1%	1.6%	1.6%	1.6%
SoCalGas *(n = 179)*	89.1%	1.6%	6.5%	2.7%

While at first these self-reported choices appear to show overwhelming satisfaction and demand for high efficiency products, it is important to remember that this response might be susceptible to biases. A more serious test of the hypothesis involves comparisons of participants and nonparticipants.

First, it is interesting to assess whether or not participants realize that they live in energy-efficient homes. When we asked participants if their home exceeded, just met, or fell short of standards, only 48.4% reported that it exceeded standards. When we asked if the gas and water heating equipment home exceeded, just met, or fell short of standards, a similar answer was given (45.3%). While these percentages are higher than reported by nonparticipants (38.1% and 39.3%, respectively), it suggests that occupants of participating homes often do not even realize that their home is efficient. This would appear to curtail any potential for mitigation of barriers for a majority of participating households.

In spite of limited knowledge of their own levels of efficiency and whether or not they have a firm reference point to determine the cause for decreases in their gas bills, both participating and nonparticipating consumers were asked if they would look for energy-efficient measures in the next house they purchase.[19] As shown in Table 7-12, a comparison of participant and nonparticipant survey responses reveals that participants are only marginally more likely to look for energy-efficient measures in their next home. Furthermore, a slightly higher percentage of consumers in the control group reported the intention of looking for energy-efficient measures than consumers in Southern California.

[19] There is a lack of hard evidence from this study that consumers moving into new homes can attribute changes in gas bills to specific equipment and measures. Furthermore, first-time homeowners might not even have such a reference point, though they might have some perception based upon experiences in previous residences. Roughly 34% of the participants, 39% of the nonparticipants, and 30% of the consumers in the control region who responded to the consumer mail survey indicated that they were first-time homebuyers.

Table 7-12: Next Home Purchase[1]

	Participants	Nonparticipants	Control
Energy-Efficient Measures in Next Home	86.3% *(0.01)* *n = 539*	84.6% *(0.01)* *n = 599*	89.1% *(0.02*) *n = 226*

1. Standard errors are included in parentheses.

In addition, consumers who said they would look for energy-efficient measures in a new home were asked to describe what kinds of measures they had in mind. Table 7-13 presents the types of energy-efficient measures consumers indicated that they would look for in a new home. As presented, differences across participants and nonparticipants are marginal. Interestingly, when examining the responses across measures, it is evident that more consumers in all groups would consider windows and insulation more than gas furnaces and water heaters. The majority of respondents indicated that cost saving was the primary reason for seeking more efficient equipment and shell measures.

Table 7-13: Types of Energy-Efficient Measures Consumers Will Look for In Next Home Purchase[1]

	Participants	Nonparticipants	Control
Gas Furnaces	**22.4%** ***(0.02)*** ***n=479***	**17.5%** ***(0.02)*** ***n=519***	**12.3%** ***(0.02)*** ***n=204***
SDG&E	15.5% *(0.04)* *n=84*	14.9% *(0.03)* *n=161*	-
SoCalGas	23.5% *(0.02)* *n=395*	17.9% *(0.02)* *n=358*	-
Water Heater	**13.8%** ***(0.02)*** ***n=479***	**13.2%** ***(0.01)*** ***n=519***	**7.4%** ***(0.02)*** ***n=204***
SDG&E	14.3% *(0.04)* *n=84*	9.9% *(0.02)* *n=161*	-
SoCalGas	13.7% *(0.02)* *n=395*	13.7% *(0.02)* *n=358*	-
Windows	**44.3%** ***(0.02)*** ***n=479***	**52.8%** ***(0.02)*** ***n=519***	**50.5%** ***(0.04)*** ***n=204***
SDG&E	59.5% *(0.05)* *n=84*	50.9% *(0.04)* *n=161*	-
SoCalGas	41.8% *(0.02)* *n=395*	53.1% *(0.03)* *n=358*	-
Insulation	**35.6%** ***(0.02)*** ***n=479***	**41.4%** ***(0.02)*** ***n=519***	**46.1%** ***(0.03)*** ***n=204***
SDG&E	44.0% *(0.05)* *n=84*	37.9% *(0.04)* *n=161*	-
SoCalGas	34.2% *(0.02)* *n=395*	41.9% *(0.03)* *n=358*	-

1. Standard errors are included in parentheses.

It was expected that RNC programs would help consumers become more aware of and/or satisfied with the performance and monetary savings to be gained from the use of more efficient gas space and water heating equipment. However, the results presented above indicate that the programs do not significantly increase consumers' satisfaction with these measures beyond the level already found in the market.

The lack of evidence that consumer satisfaction with energy-efficient measures has significantly changed intentions to purchase energy-efficient equipment implies that RNC programs did not reduce the market barrier of product uncertainty effectively for participating households.

3c) RNC programs influence customers' decision-making processes relating to the choices of energy efficiency. This might take the form of reductions in the barrier of bounded rationality.

RNC programs provide an opportunity for consumers to use and experience the benefits of energy-efficient appliances. This study hypothesized that this experience will influence consumers' decision-making processes by reducing the barrier of bounded rationality. Possible conditions in which bounded rationality exists might include prohibitive information costs and product uncertainty. This hypothesis was tested by examining how important consumers rated energy efficiency to them now and in the past. Program attribution was determined by comparing participant, nonparticipant, and control area consumer responses.

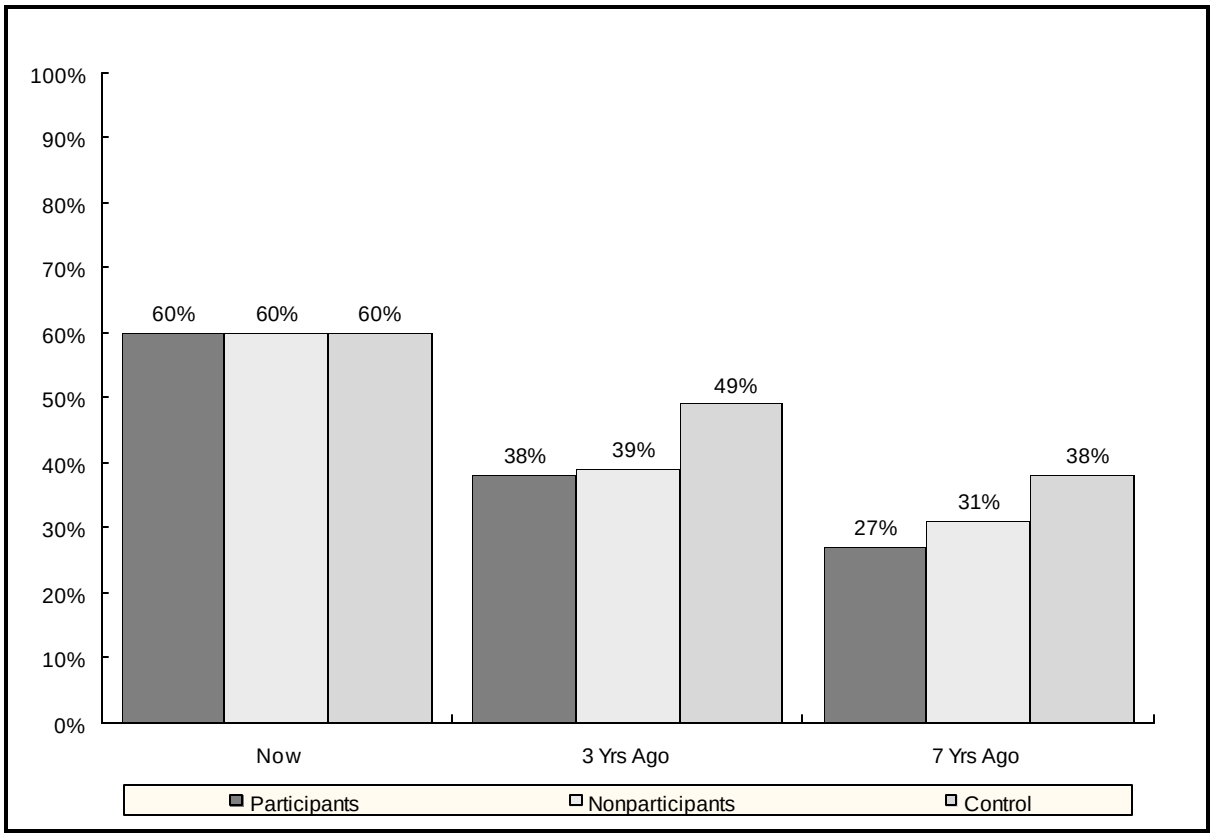
As explained above, evidence was not found to support the hypotheses that RNC programs effectively lowered information search and hassle costs and increased consumer awareness and satisfaction of energy-efficient products. Therefore, it is not likely that the market barrier of bounded rationality has been reduced as a result of the programs. Moreover, the nature of the home building and buying process precludes most consumers from being able to manage effectively the information and coordination needed to complete the process on their own. It is, therefore, unreasonable to expect RNC programs to reduce this barrier significantly.

As discussed in the previous hypothesis, consumers were first asked if they would look for energy-efficient measures in the next house they purchase. As was seen in Table 7-12, a comparison of participant and nonparticipant survey responses showed that participants are only marginally more likely to look for energy-efficient measures in their next house.

Consumers were also asked how important energy efficiency was to them over time (i.e., "now," "three years ago," and "seven years ago"). As shown in Figure 7-1 and Table 7-14, a comparison of responses from participants, nonparticipants, and control area consumers illustrates that all consumers reported that energy efficiency is very important to them now and is more important to them now than three and seven years ago. Furthermore, the same percentages of participants and nonparticipants indicated that energy efficiency is very important to them now (60%) and more

nonparticipants than participant reported that energy efficiency was very important to them three and seven years ago. One explanation might be that nonparticipants experience higher utility bills than participants and, as a result, attach greater importance to energy conservation.[20] It is interesting to note that the rate of change over time in percentages is very similar between the two groups.

Figure 7-1: Energy Efficiency is "Very Important"…Over Time



[20] In fact, nonparticipant respondents reported higher typical electric and gas bills than did participants. Means of typical utility bills (as reported by consumers) are as follows:

participants:	electric $66	(std. error = 2.10, n=480)
	gas $31	(std. error = 0.96, n=477)
nonparticipants:	electric $72	(std. error = 3.87, n=531)
	gas $33	(std. error = 1.0, n=529)

Table 7-14: Importance of Energy Efficiency to Consumers[1,2]

	Participants	Non-participants	Control
Importance of energy efficiency to me now …	**4.0 *(0.03)* n=551**	**4.0 *(0.04)* n=603**	**4.0 *(0.05)* n=228**
SDG&E	4.0 *(0.07)* *n=95*	5.0 *(0.05)* *n=179*	-
SoCalGas	4.0 *(0.04)* *n=456*	4.0 *(004)* *n=424*	-
Importance of energy efficiency to me three years ago …	**4.0 *(0.05)* n=550**	**4.0 *(0.05)* n=603**	**4.0 *(0.10)* n=228**
SDG&E	4.0 *(0.10)* *n=95*	4.0 *(0.08)* *n=180*	-
SoCalGas	4.0 *(0.06)* *n=455*	4.0 *(0.06)* *n=423*	-
Importance of energy efficiency to me seven years ago …	**3.0 *(0.06)* n=548**	**3.0 *(0.06)* n=599**	**4.0 *(0.10)* n=227**
SDG&E	3.0 *(0.13)* *n=95*	3.0 *(0.10)* *n=179*	-
SoCalGas	3.0 *(0.07)* *n=453*	3.0 *(0.07)* *n=420*	-

1. Consumers were asked to rate how important energy efficiency is to them now, how important it was to them three years ago, and how important it was to them seven years ago. Importance rating were on a scale of 1 to 5 with a 1 meaning "not at all important," a 3 meaning "somewhat important," and a 5 meaning "very important."
2. Standard errors are included in parentheses.

While the results presented here indicate that energy efficiency is becoming more important to consumers, it is our view that comparisons between participants and nonparticipants reveal that this change is not attributable to RNC programs. Again for most consumers, bounded rationality is a permanent characteristic of their interaction in this market, since it is unlikely that all consumers will become energy efficiency experts.

Effects on Split Incentives

Split incentives are considered to be the central market barrier in residential new construction. Evidence of the presence of split incentives in the market was detected from information obtained from the in-depth interviews with builders and from data collected with the consumer surveys. Builders in Southern California predominantly felt consumers would be unwilling to pay for energy-efficient upgrades in a new house, even though the majority of consumers surveyed responded that they would be willing to do so.

It is unclear whether to categorize program effects on this barrier as builder effects or as customer effects; hence, they are listed here as a separate set of hypotheses. Because the market does not correctly value the benefits of efficiency in new homes, builders do not receive correct pricing signals to guide their own choices of efficiency levels. As a result, they tend to use a simple rule of minimization of first cost (subject to compliance with applicable codes) to guide efficiency choices. Two hypotheses were investigated in relation to split incentives:

4a) Program promotions make consumers aware of the energy savings associated with shell and equipment efficiencies, and increase the prices these customers are willing to pay.

4b) Program participation makes customers more aware of the benefits of efficiency, and makes them more likely to opt for high efficiency levels when they purchase another home.

4a) Program promotions make consumers aware of the energy savings associated with shell and equipment efficiencies, and increase the prices these customers are willing to pay.

It is hypothesized that RNC programs promote energy efficiency, thereby increasing consumers' awareness of the savings to be gained from high efficiency equipment and measures. The increased awareness could translate into their willingness to pay more for these measures. This hypothesis was tested by examining consumer' s self-reported willingness to pay for increased energy efficiency of their home as well as builders' perceptions of consumer willingness to pay. Program attribution is determined by comparing participant, nonparticipant, and control area market-actor responses from the consumer survey and in-depth interviews with builders.

Note that this hypothesis is closely linked to consumer Hypothesis 3a discussed above, and is to some extent testable with the same information. Recalling our earlier discussion, we concluded that

the RNC programs do not appear to increase consumers' awareness of energy savings significantly. Participants and nonparticipants have roughly the same awareness of standards and codes, as well as differences in efficiency levels for either gas equipment or windows. Moreover, as we observed during our discussion of Hypothesis 3c, participating households do not generally even know that they have high efficiency equipment or shells. Therefore, there is little reason to believe that the current programs, as they are designed, will have a significant impact on consumers' willingness to pay for increased efficiency. Nonetheless, it is probably useful to review the survey results most directly related to the issue of willingness to pay. We examine at this issue from two perspectives: the view of the consumer and the perspective of the builder.

Consumers. While the majority of consumers affirm a willingness to pay more for energy-efficient measures, a comparison of participant and nonparticipant survey responses reveals that this is not attributable to RNC programs. Therefore, this hypothesis is not supported by survey results. Consumers surveyed were asked if they would be willing to pay more for a home with energy efficiency options that would save them $10 a month on their gas bill. Those who indicated that they would be willing to pay more were then asked how much more they would pay for such options. As shown in Table 7-15, a higher percentage of nonparticipants than participants reported they were willing to pay more for energy-efficient options. This indicates that consumers living in homes built by participating builders are not any more aware of the benefits of high efficiency equipment and measures than nonparticipants.

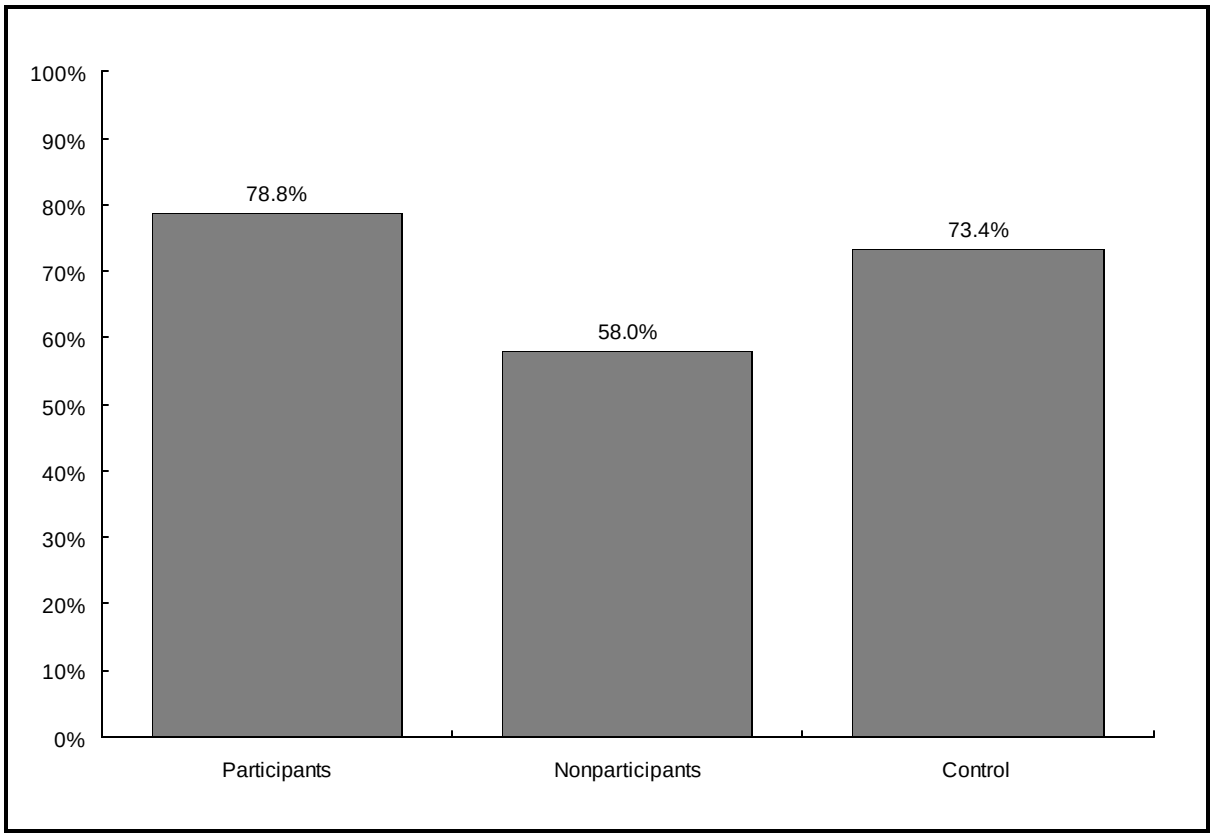
Of those willing to pay more, consumers living in participant homes are willing to pay more for the options than nonparticipants. The mean willingness to pay for increased energy efficiency over consumers in the control group is greater than that stated by nonparticipants but less than that provided by participants.

Table 7-15: Willingness to Pay for Increased Energy Efficiency[1]

	Participants	Non-participants	Control
Willing to pay more for a house that saved them $10 a month on their gas bill [2]	**55.7%** ***(0.03)*** **n=379**	**60.2%** ***(0.02)*** **n=450**	**53.5%** ***(0.03)*** **n=213**
SDG&E	65.9% *(0.05)* *n=91*	69.9% *(0.04)* *n=163*	-
SoCalGas	53.1% *(0.03)* *n=288*	58.5% *(0.03)* *n=287*	-
Mean of amount willing to pay	**$2,971** ***(247.0)*** **n=126**	**$1,767** ***(145.1)*** **n=160**	**$2,446** ***(328.4)*** **n=64**
SDG&E	$2,356 *(459.4)* n=36	$1,855 *(189.5)* n=72	-
SoCalGas	$3,162 *(291.2)* n=90	$1,745 *(201.9))* n=88	-

1. Standard errors are included in parentheses.
2. Note that about 41% of the participants, 46% of the nonparticipants, and 44% of the control area consumers did not provide a willingness to pay value that should have.

Figure 7-2: Percentage of Consumers Willing To Pay At Least $1,000



When comparing the two service areas in Southern California, participants in both SDG&E and SoCalGas territories claimed to be willing to pay more than their nonparticipant counterparts. Although participants in the SoCalGas area appear to be willing to pay more for energy-efficient options than nonparticipants and the control group, this result is not observed of consumers in SDG&E' s service area. Given these inconsistent results, it is our view that evidence of consumer willingness to pay for increased efficiency does not support the hypothesis.

Builders. In-depth interviews with builders revealed that builders in Southern California do not perceive much demand from consumers for high efficiency equipment and features in new homes. In particular, 74% of participant and 80% of nonparticipant builders indicated that demand for high efficiency equipment and shell measures from homebuyers was *very little* to *some*. Interestingly, 69% of the builders in the control area reported that they observed *a lot* of demand from homebuyers. Once more, this result is probably the result of high cooling requirements in the control area.

Builders were also asked about the cost of adding features to a home that would use 10% less energy than a similar home built to meet Title 24 standards. In addition, they were asked what percentage of this cost they thought homebuyers would be willing to pay. As shown in Table 7-16, participant builders in Southern California felt consumers would be willing to pay on average less

than 4% of the additional cost. One possible explanation for the difference in responses between participant and nonparticipant builders is that participant builders, who are more likely to have attempted to charge more for energy-efficient options and failed, are less optimistic. The extreme difference between the responses between the control sample and the Southern California sample could be due to climate differences between the two regions.

Table 7-16: Builders' Perceptions of Consumers' Willingness to Pay[1,2,3,4]

	Participants	Non-participants	Control
Mean Percentage of Additional Cost the Builder Perceives the Buyer is Willing to Pay	3.9% *(0.03)* *n=12*	15.0% *(0.07)* *n=7*	84.3% *(0.13)* *n=8*

1. Builders were asked how much extra it would cost (the builder) to build a home that used 10% less energy than one that just meet building codes, and what percentage of that amount the home buyer would be willing to pay. The percentages presented here represent the mean percentage of this additional cost that the builder' s thought the homebuyer would be willing to pay.
2. Note that 24.3% of the builders interviewed did not provide an answer to this question. Of those who responded, 53.9% thought that the consumer would not be willing to pay any portion of the additional cost.
3. Percentages are weighted according to the number of homes built in 1997, as reported by each respondent.
4. Standard errors are included in parentheses.

The results described above indicate that a discrepancy in the market exists between consumers' attitudes regarding the value of energy-efficient measures and builders' perceptions of those attitudes, especially in Southern California. Buyers appear to be willing to pay more for energy-efficient features, but this willingness is not attributable to RNC programs. Furthermore, builders, especially those participating in RNC programs, are not aware of consumers' willingness to pay more (or, more likely, are simply very skeptical of this stated willingness). The split incentives market barrier appears extremely important, and does not appear to have been reduced by the RNC programs.

4b) Program participation makes customers more aware of the benefits of efficiency, and makes them more likely to opt for high efficiency levels when they purchase another home.

While living in homes built under an RNC program, consumers are able to experience the benefits of energy-efficient appliances. It is hypothesized that this increased awareness will influence their decision to buy a high efficiency level home in the future. This hypothesis was tested by examining the effect that energy efficiency measures have had on lowering consumer gas utility bills and builder perceptions of consumer demand for energy efficiency. Program attribution is determined by comparing responses from participants, nonparticipants, and market actors in the control region.

Information pertaining to consumers and builders is presented below.

Consumers. This hypothesis relates strongly to one of the consumer hypotheses investigated earlier. We have already seen that households do not generally understand whether or not the efficiency of their current home exceeds standards. We have also seen that awareness of standards and variable energy efficiency levels is roughly the same for participants and nonparticipants. Moreover, participants and nonparticipants appear to have the same intentions for the choice of efficiency when they next purchase a home.

To obtain additional information on this issue, participants were asked to assess the effect that the energy efficiency measures installed in their homes had on their gas bills. Roughly 35% responded that they decreased gas bills "a lot" and 36% felt they had decreased bills "a little". Another 7% responded that such measures had "no effect" on their bills, and about 22% did not know or did not respond to the question. This suggests that there is some recognition of the savings potential of efficiency measures, but that consumers' perception of this potential is modest.[21]

Builders and Sales Agents. While examining consumer awareness of the benefits of energy efficiency is directly useful in testing this hypothesis, it is also quite insightful to learn how builders and sales agents perceive consumer demand for high efficiency equipment and measures. During in-depth interviews with builders' sales agents, 40% of agents interviewed in Southern California rated energy efficiency as *very important* in the marketability of a new house. In the control area, 67% of sales agents rated energy efficiency as *very important* in the marketability of a new house.

Builders were asked if consumer demand for energy saving features had changed since 1990. As shown in Table 7-17, 62% of participant builders felt demand had increased since 1990. This percentage is significantly higher than that of nonparticipants but quite a bit lower than that of builders in the control area. One might expect that participant builders would have this response, as they have been selling homes with energy-efficient features as a result of their program participation.

[21] It should be noted here that it is not known whether or not consumers who purchased homes built by a participating builder were aware of the installation of high efficiency equipment and/or measures. If the consumer was unaware of this prior to completing the survey for this study, the only knowledge of these installations were from the question, itself. Furthermore, the consumer' s reference point to whether or not the high efficiency installations reduced their gas bills is unclear.

Table 7-17: Builders' Perceptions of Consumer Demand[1]

	Participants	Non-participants	Control
Customer Demand for Energy Saving Features Increased Since 1990	62.2% *(0.12)* *n=18*	3.1% *(0.06)* *n=8*	91% *(0.08)* *n=15*

1. Standard errors are included in parentheses.

Furthermore, about 29% of participant builders felt that the features homebuyers look for in a new home have changed since 1990, compared to 21% of nonparticipant and 16% of control builders. This result gives some evidence that participating in RNC programs have increased builders' perceptions of the importance of efficiency to customers (thus narrowing the split incentives gap); however, this result is inconsistent with evidence discussed earlier that participating builders estimate that consumers are willing to pay less than 4% of the cost of additional efficiency (an estimate that is considerably lower than the one advanced by nonparticipant builders).

In summary, the evidence in support of this hypothesis is mixed. Some households in participating homes feel that they save a lot on their gas bills, but some still disagree or do not know. Moreover, occupants of participating homes generally do not even know that their homes exceed standards, nor are they any more aware of standards or variations in efficiency. While sales agents claim that efficiency is important to customers, few report emphasizing efficiency in their marketing efforts. While participating builders have observed as stronger increase in the demand for efficiency than nonparticipants, they nonetheless more pessimistic about consumers' willingness to pay for the costs of added efficiency.

Effects on Government

The RNC programs raise the overall level of energy efficiency in new construction. By demonstrating the feasibility of increases in efficiency, they might stimulate the following market effects on government standards:

5a) RNC programs lead to improvements in appliance efficiency standards and building codes.

5b) RNC programs encourage greater enforcement of appliance standards and building codes.

Each of these hypotheses are discusses below.

5a) RNC programs lead to improvements in appliance efficiency standards and building codes.

To the extent that RNC programs increase baseline efficiency levels of energy-related equipment and shell measures in new construction and that revisions of energy efficiency standards incorporate baselines efficiencies, it is hypothesized that RNC programs can encourage improvements in appliance efficiency standards and building codes. This hypothesis was tested by reviewing information obtained during the in-depth interviews with representatives of government agencies who are directly involved in energy efficiency code development and/or revision processes.

It is important to note here the difficulty in approaching and testing this hypothesis. As will be explained below, there are many influences and interactions among many different individuals and organizations in the code revision process. This, and the fact that any influences RNC programs might have on the code revision process are likely to be *indirect*, made it difficult, if not impossible, for the interview respondents to attribute any portion of the revision process specifically to RNC programs. Essentially, it must be recognized that any market actor who is not directly involved in (or even unaware of) the RNC programs will have difficulties attributing any changes in the marketplace to the programs.

The approach taken here is not to determine if the programs have directly influenced energy code revisions but to examine influences on the code revision process and see where RNC programs may exert an indirect influence. Given the difficulties that the interview respondents had in discussing RNC program influences on energy codes, we also examine this hypothesis from both an historical as well as a forward-looking perspective. In other words, both past influences and potential for future influences are discussed.

So, the key question to answer here is - *Do current efficiency levels in the marketplace influence energy efficiency codes?*

First, a simplified explanation of the code revision process is presented along with a discussion of the primary influences on this process, as revealed during the in-depth interviews with government agency representatives. Second, the relationship that RNC programs have with those influences is explained. Included in this second step is a summary of responses from discussions regarding the role of RNC programs in the in-depth interviews.

The Code Revision Process. The revision processes for energy efficiency standards and building code standards, in general, are as democratic as possible. Agencies try to incorporate recommendations and information from all parties affected by the codes, as well as the public in general. While there are differences in the processes for updating the Title 24 codes, the MEC, and the national appliance efficiency standards (NAECA), the procedures are generally the same:

1. Issue notice to the public stating the intent to revise code (a Notice of Public Rulemaking in the case of NAECA standards, for example) and assemble staff to solicit and review proposals,
2. Solicit recommendations from the public,
3. Hold public meetings and hearings to review and discuss proposed revisions and submit recommendations for code revisions, and
4. Make final decision and publish amendments to the code.

The revision process for the Title 24 energy efficiency standards is administered by the California Energy Commission' s Energy Efficiency Standards Office and usually takes about two to three years. The team of CEC staff responsible for soliciting feedback for the revisions notifies the public about what they are doing and about meetings and hearings at which the public can attend and submit proposal and feedback.[22] Typically, builders, building departments, and utility companies attend these meetings. Other information obtained throughout this process pertains to the technical aspects of energy efficiency standards, including cost effectiveness test results and testimony from organizations that conduct end-use energy efficiency research.[23] The team then forwards their recommendations to the CEC Commissioners who make the final decisions.

The revision processes for the MEC and NAECA are very similar, as they incorporate proposal, recommendations, and information from a variety of sources in the decision process, though they operate on different time lines. The MEC revision process is annual, while the revision process for the national appliance efficiency standards takes about three years and is often delayed.

Primary Influences on Code Revisions and the Role of RNC Programs. The interviews with government agencies revealed many influences during the revision process for energy efficiency standards. The influences mentioned during the interviews, which occur during steps 1 and 2 above, can be categorized as engineering analysis, marketplace, or market actor influences. Each of these is described below.

- ***Engineering Analysis Influences.*** Engineering analysis influences refer to all research and testing information that is incorporated into the code decision process and typically includes energy-use analysis and cost-effectiveness tests conducted by national laboratories.[24]

[22] During the last revision process, about 300 people were kept notified of all CEC team actions and who provided feedback to the team.

[23] One such organization is the California Institute for Energy Efficiency of the Lawrence Berkeley National Laboratory, which testifies at standards hearings and helps create reports and ASHRAE standards that are referenced by Title 24 code makers.

[24] For example, for MEC revisions CABO hires the Pacific Northwest National Laboratory (PNNL) to analyze buildings and equipment and shell measures and determines what level of energy efficiency is cost effective. To accomplish this, they use parameters set by the Department of Energy and consider different climate

- ***Marketplace Influences.*** Information obtained from the interview process revealed that the decision-making process of developing and revising these standards includes consideration of market conditions. However, the information provided from interview respondents regarding marketplace influences varied among agencies. For example, a CEC representative explained that the evolution of products in the marketplace has a considerable influence on the final outcome.[25] In contrast, a CABO representative explained that the level of equipment efficiencies in the market did not have any influence on the 1993 national appliance efficiency standard revisions (i.e., the gas furnace AFUE revision to a minimum of 78% AFUE).
- ***Market Actor Influences.*** A large portion of the revision process described above involves the solicitation and review of proposals and recommendations from the public. Understandably, those who become involved in the process are those who are most directly effected by the codes.[26] Interviews with government agency representatives revealed that builders, building department officials, and utility companies comprise the majority of public representation in these processes. In the opinion of one government agent, builders have the greatest influence on code revisions and thus their interests are strongly represented in the codes - Title 24, in particular.[27] According to information obtained from the interviews, few builders view energy efficiency as a marketing benefit and their focus is on cost; therefore, they push to make the standards easier to implement or to relax the compliance requirements.

  Building department officials provide input regarding areas of the code that are difficult to comply with or what simply will not work, in terms of design or construction characteristics. Other industry participants that provide feedback mentioned during the interviews include concrete and steel industry representatives, manufacturers (for national appliance efficiency standards, in particular), environmental organizations, and state energy representatives.

The above discussion provides a backdrop to help determine the role of baseline efficiencies and RNC programs in energy efficiency standards. Information about the baseline efficiencies seems to enter into the process as a marketplace influence. At least one government agency representative (of the CEC) explained that marketplace conditions are considered for code revisions. Baseline

zones and energy prices. Different models are implemented to determine how various areas of homes can be more energy efficient. Essentially, PNNL looks at various technologies, and models how much energy its use will reduce peak load. PNNL also collects information from builders and building officials during conferences and workshops about "what won't work." This feedback is then forwarded to CABO who consider it during the revision process.

[25] For example, because of developments in the window industry, standardized testing is now being incorporated into the codes.

[26] Incidentally, despite the fact that consumers are presumably most effected by the codes, it was the opinion of many interview respondents that consumer interests are not fairly represented in the revision processes.

[27] A CHEERS representative noted that the California Building Industry Association has a strong presence and is very influential in the revision process.

efficiencies might also enter into the equation as a market actor influence – from the equipment manufacturers, in particular.[28]

Note that interview respondents were, in fact, directly asked whether they were aware of RNC programs and if such programs influenced standards. While most government agency representatives reported awareness of RNC programs in general, they did could not attribute changes in efficiency standards to them.[29] One agency representative commented that they were aware of such programs, but found it difficult to comment on their influence on standards. The respondent noted that such programs have probably had some influence, but not enough to satisfy stakeholders.

Given that marketplace conditions are considered and the fact that RNC programs are long-lived, the hypothesis that RNC programs could influence improvements in appliance and building energy efficiency standards can be at least weakly supported. By nature, influences on codes can be expected to be long-lasting. The results of this study presented up to this point indicate that RNC programs have had only modest market effects. Recall that one of the most permanent market effects directly attributable to RNC programs was in the area of duct sealing methods. It is quite possible that *a priori* acceptance of more stringent duct sealing methods and material by industry participants could lead to inclusion of such practices in future code revisions.

In summary, program attribution with respect to energy efficiency standards is difficult for several reasons. First, there is not direct link between the code revision process and RNC programs. As such, interviews with government agency representatives revealed that RNC programs have no direct influence on energy efficiency standards. Second, there are many influences during the code revision process. At least one of these influences, however – the marketplace, or baseline efficiencies – provide some indication that RNC programs could indirectly influence appliance and building energy efficiency standards.

5b) RNC programs encourage greater compliance/enforcement of appliance standards and building codes.

The extent to which RNC programs require or increase compliance with appliance and building energy efficiency standards, and the extent that they influence the behavior of the market actors who enforce the standards, RNC programs could encourage greater compliance and enforcement of appliance efficiency standards and building codes. With respect to compliance issues, this

[28] While equipment manufacturers were not asked whether or not they provided such information or even provided input during meetings and hearings, there is a potential for them to do so in the future.

[29] Most respondents answered that they did not know if RNC programs had any influence on the energy codes. However, one respondent affirmed their influence and described it as a negative one; in this representative' s opinion, RNC programs caused builders to focus on areas other than those in which consumers are voicing concerns. For example, many consumers calling government hotlines ask about moisture and ventilation problems.

hypothesis was tested by examining RNC program requirements for proof of Title 24 compliance and various information sources regarding common violations of Title 24. General enforcement procedures and the information obtained during interviews with building department officials helped to examine program influences on code enforcement.

The following discussion and testing of this hypotheses includes the following:

- A brief summary of Title 24 compliance requirements and enforcement procedures,
- The role of RNC programs in the incidence of compliance, and
- A discussion regarding RNC program influences on enforcement.

As with the previous hypothesis, the following discussion includes RNC program influences on compliance and enforcement to date, as well as the potential for influence in the future.

The Compliance and Enforcement Process. Even though the promulgation and revision of energy efficiency standards is conducted by state and federal agencies, proof of compliance and enforcement of Title 24 occurs at the local level through municipal building departments.[30] This process occurs during two stages of development: before construction through building plans examination and during construction through building field inspection. Interviews with both plans examiners and field inspectors revealed that the majority of enforcement occurs at the plans examination stage. Before a building permit is issued the building plans along with the necessary Title 24 Certificate of Compliance form (the CF-1R) must be submitted to and approved by the appropriate official.[31] As explained in Section 5, code enforcement also occurs during several stages of construction, but interview respondents explained that field inspectors are rarely responsible for ensuring Title 24 compliance, if at all.

Program Influences on Code Compliance. Program influences on code compliance specifically refer to the extent to which RNC programs increase compliance with energy efficiency standards. Given that RNC programs offer incentives for both prescriptive and performance-based installations, it is necessary to discuss possible influences in both respects.

- ***Influence of Performance Incentives.*** Performance-based incentives specifically require Title 24 compliance because incentive payments are based upon the enhancement of energy efficiency relative to the initial Title 24 run. Because of this feature, by design, RNC programs directly encourage compliance with Title 24 standards.

[30] It is useful to note here that, at least in the context of this study, compliance refers specifically to the act of being lawful, while enforcement refer to the act of ensuring lawfulness.

[31] The extent to which plans examiners verify Title 24 calculations (and therefore compliance) varied across building departments. Some explained that they review and check calculations, while others reported that compliance documentation is closely scrutinzed only when one of the required signatures is not recognized.

- ***Influence of Prescriptive Incentives.*** Unlike performance-based incentives, prescriptive incentives are paid based upon fulfilling specific criteria on a per-measure basis. Program influences on compliance vary between equipment and shell measure installations:
    - **Equipment installations:** Programs cannot encourage greater Title 24 compliance through equipment installations, because all gas space and water heating equipment available in the market must satisfy NAECA minimum energy efficiency requirements.
    - **Shell measure installations:** RNC programs can encourage greater compliance through shell measures installation incentives, but the extent to they can do so depends upon the programs' ability to induce builders to opt for prescriptive shell measure incentives. In other words, the more builders opting for prescriptive incentives who install shell measures the more the RNC programs will influence compliance.

Discussion surrounding compliance and RNC program influences on compliance in the future should necessarily include mention of compliance incidence rates. First, results of the CALRES Energy Simulation Program implemented by the CEC found that 38% of the residences throughout California complied with Title 24 prior to occupancy. The incidence of compliance in CEC climate zones located in SoCalGas' and SDG&E' s service territories ranged from 0% to 83%.[32] Second, annual studies implemented by the CEC to monitor compliance and enforcement problems associated with Title 24 standards include incidences and types of violations. Review of these annual reports reveals that common violations pertain to measures covered by RNC programs, such as glazing type, duct insulation, duct construction (incorrect installation), and water heater tank insulation.[33]

The point here is that there is potential for RNC programs can encourage or increase the incidence of compliance with energy efficiency standards by inducing participants to install such measures. Furthermore, many violations are detected during the field inspection, which implies that actual installations do not correspond to building plan specifications. Verification of installations through RNC programs could also encourage compliance in this respect. Sustainability of this effect is another matter. It is unclear that any effect on compliance would persist if these programs were to be discontinued.

Program Influences on Enforcement. As noted above, the investigation into RNC program influences on enforcement of energy efficiency standards involved a review of information obtained during the in-depth interviews with building plans examiners and field inspectors. Building plans examiners explicitly stated that RNC programs and any increase in the utilization of energy

[32] California Energy Commission, Post Occupancy Residential Survey, March 1997, P400-94-015CN.

[33] See, for example, California Energy Commission' s 1994-1995 Monitoring Final Report, June 1995, 044-93-022.

efficient measures would not affect their behavior. Essentially, all plans must be reviewed and field inspectors approve all homes. Based on these results, it is reasonable to conclude that RNC programs have not influenced enforcement of energy codes and standards. Particularly since all building plans must be reviewed and all buildings must be inspected, regardless of compliance, it is our view that RNC programs will not influence enforcement practices in the future.

In summary, it is our view that RNC programs could influence the incidence of Title 24 compliance, particularly through performance-based incentives, but are not likely to have any effect on enforcement practices, thus this hypothesis is weakly supported. As with Hypothesis 5a, the fact that these programs are long-lived supports the notion that they encourage compliance through performance-based and prescriptive (shell measure) incentives *during* program years. RNC programs could increase the incidence of compliance to the extent that they result in long-lasting market effects. This could certainly be the case in future for duct installation methods, as we have found some evidence of long-lasting market effects in this area.

8

Summary and Conclusions

8.1 Overview

This study examined the extent to which DSM programs have transformed the market for gas equipment efficiency and shell measures in the Southern California residential new construction market. The study was designed to address five key questions:

- What changes in the market shares of the covered technologies have taken place over recent years?
- To what extent have utility programs influenced these changes in market shares?
- To what extent are these impacts of program stimuli long lasting?
- What market barriers were diminished by the programs in question?
- Which program features contributed to the mitigation of market barriers?
- To what extent are these impacts of program stimuli long lasting?

The study had three major elements:

- The characterization of the market for residential new construction market, including a full description of the relationships among market actors.
- The development of baselines for the measures covered by the study: gas space heating, gas water heating, windows, and ceiling insulation and wall insulation.
- Interviews with a variety of market actors and the use of these interview results to test a series of hypotheses about the market transformation effects of RNC programs.

This section summarizes the findings that have emerged from this study. Subsection 8.2 summarizes the characteristics of the residential new construction market, focusing on the roles and perceptions of key market actors. Subsection 8.3 discusses the measure baselines developed and their use to considers the market transformation effects of RNC programs. Subsection 8.4 summarizes the results of the interviews and surveys in the context of our tests of several hypotheses relating to market effects. Finally, subsection 8.5 offers some general conclusions concerning the prospects for market transformation in the RNC market.

8.2 Key Actors in the Residential New Construction Market

One of the primary products of this research effort was an in-depth characterization of the key market actors and their interactions in the residential new construction market. The market for shell measures and high efficiency gas equipment consists of exchange transactions between a variety of actors, some acting as suppliers to the market and others acting to create demand for these products. The *supply side* of the market consists of equipment manufacturers and distributors and wholesalers. The *demand side* is comprised of the remaining market participants, including builders, HVAC and plumbing contractors, architects, Title 24 energy consultants, building inspectors, real estate and sales agents, lending institutions, and, of course, residential consumers. Builders are linked to nearly every key market actor and have the most influence and make nearly all final decisions pertaining to the energy efficiency levels of equipment and shell measures of new homes.

Key results relating to key market actors are summarized below.

Supply-Side Market Actors

- Gas space and water heating *equipment manufacturers* are sensitive to demand from market actors downstream, mainly distributors and builders. The efficiency levels of the equipment they produce are most strongly influenced by equipment efficiency standards mandated by government agencies and by competition among manufacturers.
- *Equipment distributors* have little influence in the market and are not a primary source of information for other market actors.
- The strongest link between the supply- and demand-side market actors is the information flow from manufacturers to builders, contractors, and other industry participants.

Demand-Side Market Actors

- *Builders* are the primary and central decision makers in all aspects of product development, including specification of energy efficiency levels of gas space heating equipment and shell measures. Because tract developers' objectives are to minimize construction costs subject to building code compliance, tract homes rarely exceed the minimum Title 24 requirements.
- Builders rely on the expertise of other market actors in the decision-making process. During the specification stage of product development, *architects*, *Title 24 energy consultants*, and *HVAC contractors* participate in and influence the builder's decisions regarding equipment and shell measure specification. In some cases, these market actors might make the final decision regarding energy efficiency levels. However, decisions made by other market actors must be made within the builder's parameters, such as the project's budget.

- Builders' *sales agents* are the only link between builders (the central decision maker) and consumers. They not only work with consumers in finding a home that satisfies their lifestyle, but provide input to builders regarding consumer preferences during the preliminary stages of development as well.
- The extent to which sales agents provide information to consumers on energy efficiency levels of new homes is limited by the builders' willingness to train the agents and supply such information as well as consumers' interest in energy efficiency levels of new homes.
- Sales agents are very influential in helping consumers purchase homes that exceed minimum energy efficiency standards, but not very influential in helping builders develop homes that exceed the minimum energy efficiency standards.
- *Lenders* play no meaningful role at all in influencing efficiency choices. They do not generally consider efficiency levels in the process of qualifying buyers for loans, and do not feel qualified to provide advice on efficiency.
- *Consumers* expect homes to be energy efficient, and tend to think that if a home meets building code requirements then the home is as energy efficient as possible. Consumers rarely opt to upgrade the energy efficiency levels of a new home. (It is also important to note that builders rarely offer upgrades of energy-related equipment and features.)
- Consumers have little influence on the energy efficiency levels of new homes. Even though consumers indicated that energy efficiency is more important now than in the past, consumers have little influence on the energy efficiency levels of new homes. The flip side of this point is that most builders do not give consumers the opportunity to choose the efficiency of the equipment installed in their new home. Most builders explained that while they offer upgrades to the consumers, these upgrades rarely pertain to energy-related features, especially gas space and water heating equipment. (Most energy upgrades offered by builders are for air conditioning units with a higher SEER rating.) Even though builders explained that they are willing to build anything the consumer wants, homebuyers rarely request energy efficiency upgrades, even for insulation or more efficient windows.

Government Agencies and Nongovernment Organizations

- The quality and extensiveness of building plan review and field inspection varies among municipalities. Interviews with building departments throughout Southern California revealed that the "quality" or extensiveness of plan review and inspection varies. For example, one department explained that all Title 24 calculations are thoroughly inspected, while another merely looks at the signature on the compliance forms. If the signature is recognizable and the preparer is a reputable firm or consultant, the compliance package is not reviewed more thoroughly. The same inconsistencies are also evident in building field inspections.

- Although RNC programs could potential influence building energy code revisions, builders typically have a strong presence in energy efficiency code revision processes and generally lobby for the maintenance and simplification of standards.
- Nongovernment organizations provide informational services to consumers and other market actors about the energy efficiency of residential buildings. These organizations are reactive rather than proactive. In particular, their strategy is to "fit into" the market mechanism (i.e., the home purchasing process), rather than target a specific market actor. As such, they respond to questions and requests for information rather than disseminate information to industry participants.

While the discussion points presented above are generalizations about the residential new construction market, and the residential tract development market in particular, it is important to highlight some exceptions, as well. This study has identified differences in the functions and influences of some key market actor according to the following market segments:

- ***Project Type.*** Unlike tract developments, the consumer is the primary decision maker in custom home projects and relies heavily on the expertise of other market actors in decisions related to energy equipment and measures.
- ***Project Value.*** Homes of higher value are more likely to be specified with high efficiency features than those of lower value (sometimes for energy conservation purposes and sometimes for other reasons, such as aesthetics, noise mitigation, and just for "higher quality").
- ***Residence Type.*** The goals and objectives of multi-family housing regarding energy-related features are often different than those of single family homes. For example, property management representatives are likely to participate in the product development process, and equipment quality and maintenance costs are a very important factor in equipment purchasing decisions.
- ***Consumer Type.*** Finally, there are differences between first-time homes buyer and repeat buyer preferences for energy efficiency. First-time homebuyers generally do not consider the operating costs of a new home, while repeat buyers are more likely to conceptualize (or have experienced) the benefits of high efficiency equipment. Repeat buyers are also more likely to ask sales agents questions about the energy-related features of a home. Such inquiries send signals to the sales agents (and therefore the builder) that homebuyers are interested in energy efficiency.

8.3 Measure Baselines

Overall Efficiency Histories

Measure baselines were derived for gas furnaces, gas water heaters, and ceiling and wall insulation. Gathering historical data on the efficiency levels of installed equipment and shell measures in residential new construction was the most difficult challenge of this study. The

measure baselines developed for this study were derived from four primary information sources, including the following:

- The California Energy Commission' s Post-Occupancy Residential survey project,
- SDG&E and SoCalGas residential new construction DSM program records,
- The RER Study Database from the analysis of the 1994 Southern California Gas Company Energy Advantage Home Program, and
- Title 24 compliance forms obtained from building departments throughout the SDG&E and SoCalGas service areas.

In general, these sources provided an adequate historical gas furnace, water heater, and shell insulation efficiency level data. However, historical data from existing sources on high efficiency windows (U-values) were sparse, at best.

The measure baselines for gas space and water heating equipment, windows, and wall and ceiling insulation reveal the following trends:

- The average gas furnace annual fuel utilization efficiency rating (AFUE) steadily increased from the late 1980s and early 1990s, with a sharp increase observed in 1993 due to the increase in the AFUE standard to 78%. The AFUE peaked at just above 80% in 1995 and has decreased slightly since then.
- The average gas water heater energy factors (EF) has been historically well above the national standard of .54. The average EF has increased from .58 in 1989 to .61 in 1997.
- The average wall insulation R-value ranged from 13.11 in 1989 to 13.04 in 1997. Aside from a noticeable dip from 1993 to 1994, efficiency levels of wall insulation have remained somewhat constant over the past nine years.
- The average ceiling insulation R-value ranged from 29.74 in 1989 to 29.81 in 1997. Efficiency levels dropped significantly between 1989 and 1990, increased and peaked at 32.07 in 1994, then decreased again thereafter.

As this effort is the first attempt to integrate baseline data from several sources, it is imperative that efforts continue to derive more accurate measure baselines. The most logical options for data collection are to either continue gathering data from Title 24 compliance forms, or from building inspectors. There are several advantages in having building inspectors collect measure baseline data. First, building inspectors are the most "neutral" market actor in the industry and have no influence during equipment specification decisions. Second, recording data on installed equipment avoids the problems of accounting for discrepancies between the efficiency levels specified in Title 24 compliance forms and those of equipment actually installed. Third, requiring building inspectors to record efficiency level data might also increase the quality and consistency of inspections. If this route is

taken, the approach should be simple (i.e., a short and simple survey form) to minimize the inspectors' already burdensome workloads.

Program Influences on the Market

One application of the efficiency histories is the assessment of overall effects of the RNC programs on efficiency levels. First-year impact studies have been done for both of the programs in question, and we made no attempt to replicate these evaluations. Instead, we focused on the more central question relating to the *permanence* of these program impacts, the characteristic that distinguishes market transformation programs from their traditional predecessors. There are two ways to attempt to address this fundamental question. First, we can attempt to correlate changes in efficiency levels with the absence/presence of the program. In this approach, we essentially attempt to observe directly whether or not lasting changes in market shares have occurred. Second, we can look for some intermediate indicators that programs have changed basic attitudes, perceptions and behaviors in a way that can be assumed to have lasting impacts. This approach is often called the analysis of market effects. These market effects will be considered below in the next section. Here, we focus on the observed changes in overall market efficiency over time.

While the true test of market transformation is a more or less permanent change in the efficiency levels targeted by a program, it is difficult to observe such changes directly. Unfortunately, the data for non-program years is insufficient to support any definitive conclusions on the impacts of the RNC programs. However, changes in efficiency levels since the end of 1995 may offer some insights with respect to permanence, insofar as the SDG&E program was converted to a maintenance program and the SoCalGas program was changed to an information only program at that time. As noted in Section 6, the following changes occurred after 1995:

- ***Gas Furnaces.*** Gas furnace AFUEs peaked in 1995 and have diminished slightly each year since then. While these AFUEs have not yet returned to their mandated minimum, there does appear to be some attrition in the program impacts over time. Clearly, though, more data need to be collected before this slight trend can be interpreted more clearly.
- ***Gas Water Heaters.*** Average water heater efficiencies (EFs) continued to rise in 1996, then fell slightly in 1997. They continue to remain considerably higher than the standard, but it is unclear that this is a long-lasting situation or that it attributable to the programs in question. Again, more data need to be collected over time before we will be able to see a clearer picture.
- ***High Efficiency Windows.*** Given the problems of collecting adequate data on window U-values, there are no measure baselines for this measure. Considerably more work needs to be done to collect sufficient data to track historic and subsequent years' data. On the other hand, our interviews with manufacturers and

builders did suggest that significant improvements in window U values have occurred. Moreover, some respondents indicated that these impacts were at least partly attributable to DSM programs in general, and that the improvements are probably more or less permanent.

- ***Wall Insulation.*** The wall insulation baselines suggest that wall insulation has never exceeded standards significantly. The overall average R-value has stayed very close to R-13, the minimum requirement in most weather zones. This should not be surprising, given that the installation of greater R-values would most likely involve the use of considerably more expensive 2×6 studs or expensive sheathing. When given the option, builders typically find other less costly ways to increase efficiency.
- ***Ceiling Insulation.*** Ceiling insulation levels appear to have dipped in 1996 but to have risen in 1997. No clear tendencies have emerged to suggest that program effects have been short-lived. Again, more data will have to be collected to ascertain any such tendencies.

It should be noted that all of these trend analyses are complicated not only by the short period of post-program experience, but also by the inherent variability in the distribution of construction across CEC weather zones. Moreover, comparisons across years are also complicated by the variation in market conditions over this period. As noted in Section 2, construction activity started to pick up in 1997 and may have influenced efficiency choices.

8.4 Tests of Market Effects Hypotheses

As noted above, another means of assessing the market transformation effects stimulated by RNC programs is to examine induced changes in market barriers, or market effects. While these effects are only intermediate indicators of program success, they nonetheless offer useful insights into the permanence of program impacts as well as the mechanism through which permanent impacts are promoted. The market barriers investigated in this study include product unavailability, organizational practices, performance uncertainties, information costs, hassle costs, bounded rationality, and split or misplaced incentives. Impacts on these barriers were assessed using information obtained from surveys completed by consumers, and in-depth interviews with builders, manufacturers, distributors, sales agents, and a variety of other market actors. Surveys were conducted in three areas: the SDG&E service area, the SoCalGas service area, and a control area consisting of the Austin/San Antonio corridor.

Our conclusions with respect to the effects of the RNC programs on these barriers are not particularly positive. They are presented below, organized by major classes of market actors as well as specific hypotheses.

Effects on Manufacturers

- ***Hypothesis 1a:*** RNC Programs increase production of affected measures and improve product availability.

  Conclusion: This hypothesis is not generally supported by the manufacturer interviews. While the efficiency mixes of both water heaters and furnaces have improved considerably over time, these improvements are primarily attributable to standards rather than DSM programs. Manufacturers also report fairly dramatic improvements in window efficiencies, but they attribute these changes to "competition among manufacturers." On the other hand, the fact that efficiency is perceived as a competitive tool may indicate that efficiency programs have been somewhat responsible for this trend. If programs have been partly responsible for improvements in windows, though, there is no guarantee that these improvements will be permanent. Interviewees emphasized that the demand for high efficiency products must be sustained in order for manufacturers to continue to offer them.

- ***Hypothesis 1b:*** RNC programs change manufacturing practices and stimulate retooling, thus leading to higher efficiency levels in the product mix.

  Conclusion: This hypothesis is not strongly supported by the data. For the most part, changes in manufacturing practices are ongoing and reportedly attributable to the manufacturers' long-term outlooks and competition in the industry, rather than to DSM programs. Manufacturing changes are made to develop better products, to achieve cost reductions, and to be more competitive. However, it is possible that some changes in practices relating to gas heaters and windows could be attributed to DSM programs in general.

Effects on Builders and Other Decision Influencers

- ***Hypothesis 2a:*** RNC programs increase the effective product availability by increasing builders' and other decision influencers' product awareness.

  Conclusion: These programs do seem to have increased builders' awareness of efficiency options. Southern California participants appear to be significantly more aware of these options than Southern California nonparticipants and (with a couple of exceptions) builders in the control area. The programs also seem to have increased awareness levels of architects. There is no evidence to suggest that programs have made HVAC contractors more aware, but comparisons with the control area were confounded by differences in weather conditions between Southern California and the control area.

- ***Hypothesis 2b:*** RNC programs affect the business strategies and standard organizational practices of builders, architects, distributors, and other decision influencers.

  Conclusion: Participation in the RNC programs does seem to have affected some organizational practices of builders and HVAC contractors.

- ***Hypothesis 2c:*** RNC programs lead to lower effective DSM prices by lowering information and hassle costs incurred by builders, distributors and other industry participants.

  Conclusion: The results do not support this hypothesis. Participating builders are generally no less likely than either nonparticipating builders or control area builders to consider lack of information, unavailability of products, difficulty of choosing among options, or hassle costs important. HVAC contractors in Southern California are also more likely to consider these barriers important than their counterparts in the control area. Results for architects are mixed.

- ***Hypothesis 2d:*** RNC programs stimulate changes in the promotional practices used by contractors and distributors.

  Conclusion: Again, we find no real support for this hypothesis. Participating builders are actually less likely than nonparticipants to market high efficiency homes differently than homes that just meet code. On the other hand, both participants and nonparticipants from Southern California are more likely than control area builders to do so. Nearly all builders expressed the opinion that energy efficiency is "low down on the [consumer' s] list of reasons to buy [a home]."

Effects on Customers:

- ***Hypothesis 3a:*** RNC programs increase customers' awareness of and knowledge about energy-efficient appliances. This lowers information and hassle costs and diminishes asymmetric information barriers.

  Conclusion: The customer survey results suggest that participants are only slightly more aware of energy efficiency standards than Southern California nonparticipants, but considerably more aware of efficiency standards on gas equipment than control area respondents. They are also only marginally more aware of energy efficiency options than nonparticipants. In comparison to control area respondents, California participants are considerably more aware of differences in available efficiency levels for gas furnaces, but less aware of differences in window efficiencies. This latter result is undoubtedly related to the importance of window integrities for cooling requirements in the control area.

- ***Hypothesis 3b:*** To the extent that energy-efficient appliances perform well, promotion of their use should improve customers' satisfaction with these products and diminish performance uncertainties.

  Conclusion: While the data are somewhat mixed on this issue, we conclude in general that the RNC programs have had limited effects on consumers' perceptions. First, households in participating homes are only slightly more likely to think their homes are energy efficiency than households in nonparticipating homes. Second, perceptions of energy savings are relatively modest. Third, participating and nonparticipating consumers express very similar intentions to purchase energy efficiency in their next homes.

- ***Hypothesis 3c:*** RNC programs influence customers' decision-making processes relating to the choices of energy efficiency. This might take the form of reductions in bounded rationality.
- ***Conclusion:*** Again, the survey data reveal no evidence that consumers' decision-making processes have been affected by the programs.

Effects on Split Incentives

- ***Hypothesis 4a:*** Program promotions make consumers aware of the energy savings associated with shell and equipment efficiencies, and increase the prices these customers are willing to pay.

  Conclusions: At best, the evidence offers only weak support for this hypothesis. Households now living in participating homes are actually less likely to be willing to pay for increased energy efficiency in their next home, although those who are willing express greater willingness to pay. Moreover, builders (especially participating firms) are very skeptical of consumers' willingness to pay for a significant portion of the cost of efficiency.

- ***Hypothesis 4b:*** Program participation makes customers more aware of the benefits of efficiency, and makes them more likely to opt for high efficiency levels when they purchase another home.

  Conclusions: The data do not support this hypothesis. Participating and nonparticipating consumers express roughly equal willingness to purchase opt for high efficiency when they purchase their next home.

Effects on Government:

- ***Hypothesis 5a:*** RNC programs lead to improvements in appliance efficiency standards and building codes.

  Conclusions: This hypothesis is weakly supported. Assuming that RNC programs increase baseline efficiency levels of equipment and shell measures in the marketplace, RNC programs could influence energy efficiency standards to the extent that market conditions are accounted for in the revision process.

- ***Hypothesis 5b:*** RNC programs encourage greater compliance and enforcement of appliance and building energy efficiency codes.

  Conclusions: Again, this hypothesis is weakly supported. While RNC programs can encourage compliance by offering performance-based and prescriptive-base (for shell measures) incentives, the extent of the influence depends upon whether the programs induce long-lasting market transformation. There is no evidence that RNC programs encourage enforcement of energy codes.

8.5 General Conclusions

It should be clear that this study focused only on market transformation induced by the RNC programs, not on their current year impacts on adoptions. These latter impacts have already been assessed by first-year load impact studies, and we have made no attempt to replicate or assess these studies. Our conclusions with respect to transformation are not particularly positive. Although there is some evidence of partial market transformation attributable to these RNC programs, the overall transformation effects of the programs appear to have been minimal. It is important to recognize, however, that these RNC programs were not designed for market transformation *per se*, and they were designed primarily to influence builders. While focusing on builders may have been the most effective means of inducing significant changes in installed efficiencies during the program period, long-term market transformation will clearly require significant changes in the perceptions and behavior of other market actors.

This study suggests that, in general, the more distant market actors are from the targeted decision point, the less likely they are to be aware of the program and the less likely they are to be affected by it. While builders (and probably HVAC contractors) exhibited some potentially long-lasting changes in behavior as a result of participation in these programs, other actors do not seem to have been influenced in any significant way. The most significant and notable permanent affects attributed to the programs pertained to duct sealing practices. Some of the HVAC contractors interviewed for this study recognized the importance of improved duct sealing methods and the use of high quality sealing materials in helping homes become more energy efficient. Regardless, even the observed changes in builder and HVAC contractor awareness and organizational practices are unlikely to be strong enough to sustain the effects of these programs on efficiency levels. Only a handful of participating builders reported that they continued to install high efficiency measures after program participation ended.

It seems clear that programs designed specifically for market transformation should target all market participants driving demand for high efficiency features in the market. It is especially important that these programs focus on the consumer, whose behavior tends to drive the actions of all other actors. Split incentives and asymmetric information are almost certainly the most significant (and the most difficult to mitigate) market barriers to the installation of high efficiency equipment and shell measures in residential new construction. These barriers exist primarily because builders (the primary decision maker) and consumers (the primary market driver) have different incentives in their market transactions and have different levels of and sources for information. As such, these barriers will be difficult to reduce. Because they are the only direct link between builders and consumers, and because they are fairly influential with consumers with respect to energy-related features in new homes, sales agents could play a pivotal role in future programs.

Market transformation may be particularly difficult to induce in Southern California, where weather conditions are mild. The majority of builders, architects, HVAC contractors, building plans examiners, and other market participants cited the moderate climate in Southern California as a major reason for complacency toward increasing energy efficiency, and the reason why consumers do not appear to be more concerned. While the measures covered by this study have been shown to be cost-effective in Southern California, their returns to consumers reflect local weather conditions. A comparison of attitudes toward energy efficiency of market actors in Southern California and those in the control region illustrates this point. The greater cooling requirements in the control area seem to have fostered a proactive environment for increased energy efficiency in residential buildings. Overall, market actors in the control region reported being more aware of high efficiency technologies relating to air conditioning (windows and insulation). Results also imply that the market barriers that are somewhat substantial in the Southern California market are considered fairly insignificant in the control area market. In particular, decision makers and influencers in the control region indicated that information costs, hassle costs, product unavailability, and difficulty in choosing among options were not important reasons for building homes that do not exceed energy codes. Essentially, market actors in the control region—including, perhaps most importantly, consumers—better recognize the *need* for energy efficiency than their counterparts in Southern California, because the need is greater. This does not mean that it is not important to reduce barriers in Southern California, but rather that the lower returns to efficiency will require more significant reductions in these barriers than would otherwise be the case.

Appendix A

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