- Final Report -

RESIDENTIAL NEW CONSTRUCTION: MARKET TRANSFORMATION STUDY

Prepared for:
Shahana Samiullah
SOUTHERN CALIFORNIA EDISON COMPANY
and
Kirsten Stacey Mounzih
PACIFIC GAS & ELECTRIC COMPANY

Prepared by:
Patricia Herman
Dr. M. Sami Khawaja
Jennifer Stout
BARAKAT & CHAMBERLIN, INC.
and
Dr. Shel Feldman
SHEL FELDMAN MANAGEMENT CONSULTING
and
Dr. Jamshid Hosseini
MARQUETTE UNIVERSITY
and
Lisa Heschong
Doug Mahone
HESCHONG MAHONE GROUP

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CONTENTS

EXECUTIVE SUMMARY

Substantial opportunities remain for increased energy efficiency in residential new construction (RNC) through the use of higher SEER air conditioners sized to home needs, better installation of ductwork, and other such measures. To help obtain the additional savings associated with such measures, Southern California Edison (Edison) and Pacific Gas & Electric (PG&E) have conducted important demand-side management (DSM) RNC programs through the early years of this decade.

PROGRAM DESCRIPTION

Edison's *Welcome Home* program and PG&E's *Comfort Home* program included advertising and information packets directed at increasing the energy efficiency information available to homeowners and realtors, and promotion of energy-efficient mortgages. In addition, the programs worked directly with builders and subcontractors, offering incentives for the use of energy-efficient measures and setting standards for ductwork installation, among other efforts. As DSM resource acquisition programs, these programs were successful in increasing awareness of energy efficiency, attracting builder-participants, and increasing the stock of homes built to exceed Title 24.

METHODS

Previous evaluations of the RNC market and of the impact of utility programs have not sought to determine whether these programs have had any effects on the market beyond the immediate purchase of a specified number of energy-efficient homes, or—if they did—whether such changes were likely to last once the utility programs ended. This study was designed to help fill this gap in the evaluation of the utility RNC programs.

This report follows an earlier report from this project (the "Residential New Construction Market Characterization" report), which described the structure of the RNC market, including the key market actors, their interactions, the decisions or transaction points at which the energy efficiency of new homes is determined, the key market barriers affecting these decisions, and the market effects that would evidence reductions in these barriers.

Taking into account this characterization of the RNC market, we designed a retrospective study of changes in the critical barriers to energy efficiency. For this

investigation, then, we gathered data on the present and past states of each of 14 indicators from key actors in the Edison and PG&E RNC markets. Given the nature of the indicators, much of the data was qualitative in nature and was obtained from individual depth interviews of a nonprobability sample of 49 builders, HVAC subcontractors, Title 24 consultants, sales agents for builders, and realtors. Related quantitative data were also obtained, regarding such issues as the relative importance of energy efficiency in the marketability of a home and the relative efficacy of different methods of exceeding Title 24, using the implicit tradeoff methods of the Analytic Hierarchy Procedure.

Limitations of this study should be noted. First, any reported changes in indicators of barriers to energy efficiency—the possible market effects of utility programs—represent recall rather than direct observation. Second, although the sample was drawn to represent a wide variety of market actors in each service territory, including both builder-participants and nonparticipants, it was, of necessity, a relatively small and nonprobabilistic sample. Third, and most important, it must be remembered that the programs under consideration were designed for resource acquisition; they were not designed or implemented to achieve market effects or to create a lasting transformation of the market. For these reasons, the results should be interpreted as offering a qualitative baseline for future studies of RNC market barriers, not projectable, quantitative estimates of market transformation.

FINDINGS

Overall, the qualitative interviews indicate that none of the barriers considered have been fully removed from the RNC market over the past five years. However, although the 14 market indicators considered all show that relevant market barriers remain in place, they also indicate that some reductions have occurred. Table ES-1 provides a summary of our findings.

CONCLUSIONS AND IMPLICATIONS FOR FUTURE MARKET TRANSFORMATION PROGRAMS

Although the Edison *Welcome Home* Program and the PG&E *Comfort Home* Program were not designed as market transformation programs, they did have several market transformation effects. This study shows evidence of some level of reduction (although in most cases, slight) in the information-related barriers of home buyers, builders sales agents and realtors, and builders (having to do with subcontractor selection), and in the

HVAC subcontractor barrier of poor ductwork installation practices. The study also shows evidence of limited reduction in what we believe to be the main barrier in the residential new construction market: builder split incentives.

In terms of the application of our findings to future market transformation programs, we make the following points:

- Incentives have some effect, but may not be the best way to transform the market for energy efficiency in new homes.
- The need for more work with potential third-party partners is likely to be a critical distinction between resource acquisition and market transformation programs.
- The improvement of code compliance would likely have a large impact on energy savings in this market.
- Liability issues have a large impact on builder and subcontractor decisions in this market both as an incentive for quality practices and as a deterrent to the provision of valuable information to home buyers.
- There is hope for ductwork installation standards and training.
- Information on the existence of measures seems to be effective in this market, but trade-off analysis of measure impacts is needed.
- Builders prefer energy-efficiency measures that directly increase marketability through nonenergy benefits.
- Future evaluations of market transformation efforts will likely have to accept an even lower ability to claim causality because of multiple agencies being involved.
- Future research in this area should include an analysis of the impact on the resale value of an energy-efficient home.

Table ES-1
SUMMARY RESULTS FOR EACH KEY MARKET BARRIER

Actor and Market Barrier	Interventions	Hypothesized Market Effect	Existence and Magnitude	Change in Market Barrier	Permanence	Attribution
Homeowner information-related barriers	· Advertising · Information packets · Incentives (coupons)	Increased homeowner demand for energy efficiency, especially with respect to other desirable home characteristics.	Some indirect[1] evidence of increase in buyer demand for energy saving features in general based on perceptions of respondents and builders' actions; little evidence of buyer demand for EE features that exceeds code.	Slight reduction	Likely permanent	Two of 15 PG&E respondents attributed increased buyer demand to PG&E's program. One Edison respondent attributed it to the utility's advertising. For the two builders building to exceed code (described in this section), the actions of one can be directly attributed to the program; the actions of the other can be partially attributed.
Builder Sales Agent/Realtor information-related barriers	· Information packets · Training	Builder Sales Agent/ Realtor knowledge with regard to energy efficiency and its benefits.	Some evidence. Respondents said they have: (1) good access to general information on homes' energy saving features (2) some access to information on equipment efficiency ratings but it is more difficult to obtain; (3) rarely have access to information on ductwork installation methods; (4) no access to information on payback for specific features.	Slight limited reduction	Likely permanent	Program played some role since builders sales agents were selling the homes directly.
		Builder Sales Agent/ Realtor promotion of energy efficiency.	Some limited[2] evidence for builder sales agents. Agents have not had the opportunity to promote homes exceeding code outside of the programs. No evidence for realtors who say topic rarely comes up.			

Actor and Market Barrier	Interventions	Hypothesized Market Effect	Existence and Magnitude	Change in Market Barrier	Permanence	Attribution
Lender practices barrier	· Promotion of energy-efficient mortgages · Discounts off closing costs	Increased awareness of energy efficiency mortgages.	Some indirect evidence. Four of nine builder sales agents and three of ten realtors had heard of them.	Some reduction	Awareness will likely last. Unclear if current levels of use & availability will last if PG&E's program were to end.	Program played a role in increased awareness and use of the higher efficiency of program homes to obtain a better loan ratio.
		Increased availability of energy efficiency mortgages.	Some indirect evidence. Two PG&E builder sales agents said energy efficiency is now routinely used as a tool in selling program homes. One realtor said his coworkers have used energy-efficiency mortgages.			
		Increased sales of energy efficient mortgages.	Some indirect evidence (see box above).			

Actor and Market Barrier	Interventions	Hypothesized Market Effect	Existence and Magnitude	Change in Market Barrier	Permanence	Attribution
Builder split incentives	· Incentives · Standards for ductwork installation	Builder belief that energy efficiency increases a home's marketability enough to justify its additional costs.	Some limited evidence. Two PG&E builders (PG&E-P-2 & 5) and two Edison builders (SCE-P-1 & 4) are building homes to exceed code outside of the program. All but SCE-P-4 say they are doing so as a result of the program. SCE-P-4 says he "benefitted from dialogue with Edison," so his actions were partially attributed to the program. None of the nonparticipants showed evidence, and Title 24 consultants say builders they work with rarely exceed code. The relative importance of EE in home marketability compared to other home attributes increased 5.9% based on participants' perceptions as measured by the AHP. Their relative importance decreased 4.0% based on nonparticipants' perceptions.	Slight limited reduction	Likely permanent	Can be attributed to the program for all builders building to exceed code, except SCE-P-4, whose actions were partially attributed to the program (see discussion).
		Builders designing and building homes more energy-efficient than Title 24 on own.	Some limited evidence. The actions of four PG&E builders (PG&E-P-1,2,3 & 5) and two Edison builders (SCE-P-1 & 4) suggested some limited evidence. None of the nonparticipants showed evidence.			
		Builders marketing homes as energy-efficient homes on own.	Little limited evidence. Two builders (SCE-P-1 and 4) are using the fact they exceed code in their marketing. None of the non- participants do.			

Actor and Market Barrier	Interventions	Hypothesized Market Effect	Existence and Magnitude	Change in Market Barrier	Permanence	Attribution
		Title 24 consultants now report percent efficiency above Title 24 rather than simple pass/no pass.	No evidence of effect.			
Builder information/ bounded rationality barrier with regard to subcontractor selection	· Incentives · Standards for ductwork installation	Builders have more information and experience with the ways subcontractors do or do not deliver on energy efficiency.	Some evidence of an increase in information.	Slight reduction	Likely permanent	Increased awareness and information attributable to PG&E's and So. Cal. Gas's duct blasting programs.
		Builders are aware of the ways subcontractors cut corners and have developed safeguards against.	Some limited evidence. A few participating builders appear to be using their information to make better subcontractor selections.			
Subcontractor lack of coordination barrier	· No direct intervention	Changes in practices which allow for better subcontractor coordination.	No evidence.	No change	N/A	N/A
HVAC subcontractor practices barrier	· Standards for ductwork installation · Training · Testing	Changes in ductwork installation practices.	Some evidence of market effect for PG&E's program. One PG&E contractor (PG&E-H-1) had changed their methods to include better sealing as result of program. Three PG&E participants (PG&E-P-2, 3 and 5) said they would continue using mastic sealant even if the program ended. In Edison's territory, two contractors had started using mastic sealant as a result of So. Cal Edison's program (SCE-H-1 and 3)	Some reduction	Likely permanent	Evidence of change in subcontractor installation methods are largely attributable to PG&E's and So. Cal. Gas's duct blasting programs.

[1]We use the term "indirect" when the evidence was obtained from sources other than the actor discussed.
[2]We use the term "limited" when the evidence or reduction seems to be confined to participants.

STUDY SUMMARY

California's Title 24, supported by the state's major utilities, helps to ensure the construction of new homes that are reasonably energy efficient, compared with earlier practice. Nonetheless, substantial opportunities remain for increased energy efficiency in residential new construction (RNC) through the use of higher SEER air conditioners, better installation of ductwork, and other such measures. To help obtain the additional savings associated with such measures, Southern California Edison (Edison) and Pacific Gas & Electric (PG&E) have conducted important demand-side management (DSM) RNC programs through the early years of this decade.

Edison's *Welcome Home* program and PG&E's *Comfort Home* program included advertising and information packets directed at increasing the energy efficiency information available to homeowners and realtors, and promotion of energy-efficient mortgages. In addition, the programs worked directly with builders and subcontractors, offering incentives for the use of energy-efficient measures, and setting standards for ductwork installation, among other efforts. As DSM resource acquisition programs, these programs were successful in increasing awareness of energy efficiency, attracting builder-participants, and increasing the stock of homes built to exceed Title 24.

PURPOSE OF THIS STUDY

Previous evaluations of the RNC market and of the impact of utility programs have not sought to determine whether these programs have affected the market beyond the immediate purchase of a specified number of energy-efficient homes, or—if they did—whether such changes are likely to last once the utility programs end. These issues are particularly important, both to the utilities and to the regulatory community, as the structure and regulation of the electric industry change over the next few years. Ideally, the programs of the utilities will have helped stimulate the critical actors in the RNC market (including builders, subcontractors, realtors, and home buyers) to insist upon the maximum economically feasible levels of energy efficiency. If so, the private market will ensure that level of efficiency, and societal investments in improving RNC construction can be used in other areas of need.

This study was designed to help fill this gap in the evaluation of the utility RNC programs. It follows an earlier report (the "Residential New Construction Market Characterization" report) from this project, which described the structure of the RNC

market, including the key market actors, their interactions, and the decisions or transaction points at which the energy efficiency of new homes is determined. This Market Characterization report also identified the barriers to increasing energy efficiency at each of those transaction points, as well as their relative importance (based on the degree to which removing that barrier would or would not allow energy efficiency to flow freely through that node), and the market effects that evidence their reduction. Taking into account this characterization of the RNC market, we designed a retrospective study of changes in the critical barriers to energy efficiency. We sought to identify market changes (called "hypothesized market effects" in this report), and to assess the likelihood that reported changes are attributable to the utility programs (i.e., that they are market effects), and that they will last beyond the withdrawal of the current programs.

METHODS

As described in the market characterization report, we identified one or more hypothesized market effects (indicators) of each market barrier selected for study. In this investigation, we gathered data on the present and past states of each of 14 indicators from key actors in the Edison and PG&E RNC markets. Given the nature of the indicators, much of the data was qualitative in nature and was obtained from individual depth interviews of a nonprobability sample of 49 builders, HVAC subcontractors, Title 24 consultants, sales agents for builders, and realtors. Related quantitative data were also obtained, regarding such issues as the relative importance of energy efficiency in the marketability of a home and the relative efficacy of different methods of exceeding Title 24, using the implicit tradeoff methods of the Analytic Hierarchy Procedure (AHP).

Limitations of this study should be noted. First, any reported changes in indicators of barriers to energy efficiency—the possible market effects of utility programs—represent recall rather than direct observation. Where possible we have compared reports of current practice with earlier contemporaneous accounts, drawing on previous surveys by Edison and PG&E; however, few such analyses could be conducted, given the lack of baseline studies of the RNC market (resulting from the radically different focus of earlier evaluations).

Second, although the sample was drawn to represent a wide variety of market actors in each service territory, including both participating and nonparticipating builders, it was, of necessity, a relatively small and nonprobabilistic sample. For these reasons, the

results cannot be generalized to the entire set of market actors with a known degree of statistical confidence.

Finally, and most important, it must be remembered that the programs under consideration were designed for resource acquisition; they were not designed or implemented to achieve market effects or to create a lasting transformation of the market. For these reasons, the results should not be interpreted as offering projectable, quantitative estimates of market transformation or measuring the *success* of earlier programs. They provide a qualitative baseline for future studies of RNC market barriers, useful retrospective accounts of the market effects of past resource acquisition programs, and possible directions for future efforts targeted more explicitly at achieving market transformation.

It should also be understood that the market transformation objective of RNC programs is not a simple one. Given the level of energy efficiency already built into Title 24, and the improvements it embodies compared to earlier codes, finding ways to exceed that level in a cost-effective manner requires some effort. Overcoming the barriers to improving efficiency in the RNC market—and doing so in a lasting manner—through utility programs presents a significant challenge.

FINDINGS

Table SS-1 provides a tabular summary of the study's findings. The textual columns describe the barriers that were considered, aspects of the utility RNC programs that addressed those barriers, and the market effects that were assessed to determine reductions in each barrier. The remaining columns include judgments of the degree to which market actors reported effects, the likelihood that those effects were attributable to the utility programs, and the likelihood that reported effects will last.

Market Effects and the Reduction of Market Barriers

Overall, the qualitative interviews indicated that none of the barriers considered have been fully removed from the RNC market over the past five years. Although the 14 market indicators considered all show that relevant market barriers remain in place, they also indicate that some reductions have occurred.

This study shows evidence of some level of reduction (although in most cases, slight) in the information-related barriers of home buyers, builders sales agents and buyers' realtors, and builders (having to do with subcontractor selection), and in the HVAC subcontractor barrier of poor ductwork installation practices. The study also shows evidence of limited reduction in what we believe to be the main barrier in the residential new construction market: builder split incentives.

The qualitative information indicating some reductions in market barriers is supported by the AHP quantitative results, summarized in Table SS-2. Across all respondents energy efficiency is rated as relatively more important in making a home marketable today than five years ago. (Note that this is a change in *relative* importance: Of the factors considered—sales price, location, style, floor plan, square footage, and energy efficiency—efficiency is still rated lowest.) The consistency of the qualitative and quantitative results, and their emergence across various types of market actors, supports the conclusion that the RNC market has shown small but real movement toward energy efficiency.

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Table SS-2
PERCENTAGE CHANGE IN IMPORTANCE WEIGHTS—PAST TO PRESENT

Market Actor	Service Territory	Program Status	Percent Change in Perceptions of Home Marketability Criteria						
			Sales Price	Location	Style	Floor Plan	Square Footage	Energy Eff.	n
Builders	Edison	Participants	15.49	-16.21	3.27	22.44	-22.68	7.83	4
		Nonparticipants	27.86	8.25	-11.79	-7.15	-7.15	-7.31	1
		Overall Edison	**16.81**	**-10.06**	**-0.79**	**16.53**	**-19.84**	**4.69**	**5**
	PG&E	Participants	21.35	-4.74	-0.90	-1.11	-1.49	3.26	3
		Nonparticipants	33.05	-32.66	-0.65	-3.22	1.09	-3.16	4
		Overall PG&E	**28.44**	**-17.94**	**-0.70**	**-2.28**	**0.00**	**0.00**	**7**
	Overall Builders—Both Companies		**23.24**	**-14.57**	**-0.73**	**4.99**	**-8.98**	**2.24**	**12**
Title 24 Consultants	Edison		-11.46	8.94	11.00	6.61	-0.27	6.91	2
	PG&E		-13.31	35.64	-8.41	-3.41	-4.02	3.61	2
	Overall Title 24 Consultants		**-12.27**	**21.44**	**-2.12**	**1.81**	**-2.37**	**5.43**	**4**
Sales Agents	Edison		16.63	-19.60	-14.57	17.01	0.18	-4.56	3
	PG&E		-1.88	5.06	-10.96	0.28	0.64	0.41	4
	Overall Sales Agents		**7.23**	**-3.54**	**-12.97**	**7.59**	**0.11**	**-1.90**	**7**
Realtors	Edison		-4.76	11.80	0.35	1.02	-9.37	-5.76	4
	PG&E		5.21	3.27	-7.75	-5.67	1.85	7.05	4
	Overall Realtors		**2.73**	**6.93**	**-3.64**	**-2.21**	**-4.27**	**1.04**	**8**
Overall Edison Service Territory			***5.25***	***-3.13***	***-2.97***	***10.75***	***-10.76***	***0.00***	***14***
Overall PG&E Service Territory			***9.41***	***-1.75***	***-5.31***	***-2.56***	***0.28***	***2.23***	***17***
Overall Across All Market Actors			***7.33***	***-2.31***	***-4.25***	***3.38***	***-4.80***	***1.47***	***31***

Other AHP results provide additional support for this conclusion. In validation of our conclusion in the market characterization study, builders report that the availability of energy-efficient products is relatively less important as a barrier to exceeding Title 24 today than it was five years ago. However, they also report little change in the relative importance of split incentives, and increases in that of bounded rationality and lack of information regarding the selection of measures to install. The AHP results also show an interesting lack of agreement among various market actors as to the relative effectiveness of different options for building to exceed Title 24. Builders rank efficient windows as the measure they prefer most to increase a home's energy efficiency, while Title 24 consultants say ductwork is more important. It seems that builders want a "showy" way to increase energy efficiency—one that potential home buyers can see and likely recognize—while Title 24 consultants are looking at actual energy-savings impacts.

Finally—in support of our other results—the AHP results indicate that market actors are not confident that building to exceed Title 24 will result in significant energy savings, let alone savings that are cost-effective. As noted earlier, Title 24 sets what many market actors see as an already high minimum level of energy efficiency; the market actors appear to require specific and compelling information as the options, costs, and benefits for exceeding code.

Attribution

To some degree, the Edison and PG&E programs appear to have stimulated, or at least helped to cause, the market effects observed. Of particular interest and importance, builders who have participated in recent utility RNC programs indicate that energy efficiency has become relatively more important to home marketability, while nonparticipating builders indicate that energy efficiency has become *less* important.

However, utility programs are not the only, or necessarily the major factor, in all market effects observed. For example, as noted earlier, builders and HVAC subcontractors have become more aware of the importance of proper ductwork installation and sealing practices, and several have already changed their practices to improve energy efficiency in this area. The qualitative interviews indicate that PG&E's ductwork requirements played a major part in making market actors aware of the issue, and the utility's training program was also important for some in improving their skills. While Edison's program did not include a ductwork component, Southern California Gas's did, and this program also played a major part in changing some subcontractor's

practices. At the same time, the interviews also indicate that a critical stimulus to change has been fear on the part of both builders and subcontractors of facing litigation over the use of lower quality methods.

Lastingness

Given the short time that the utility programs have been in the field, and the even shorter time that has elapsed since their scope has been reduced, we cannot provide detailed, independent judgments regarding the degree that the observed market effects have lasted or are likely to last. Where information-related barriers are involved, we can assume market actors will retain what they have learned, and that pertinent barriers have been reduced more or less permanently (but not that the market actors will necessarily learn additional information).

For changes in practices and other behavior, we must rely on predictions by respondents as to whether they will continue improvements stimulated by the utility programs. The results for this are spotty, but support the conclusion that changes that have occurred may be lasting.

Note that since one program has ended (Edison) and the other has significantly reduced its incentives (PG&E), and since we carefully defined reductions in the builder split incentives barrier as being evidenced by changes in beliefs as well as changes in the number of homes built that exceed code, we were able to extract information on the small but likely lasting impacts of the incentives offered.

Other Issues

The results also provide insights into some of the underlying dynamics and problems of the RNC market. A brief list of these include the following:

- According to two Title 24 consultants, a number of consultants are poorly trained in determining if homes will meet the Title 24 energy requirements, and as a result, an estimated 50% of all homes do not comply. Because of the time and budgetary pressures on enforcement officials, moreover, according to these two consultants, the homes involved are not identified as failing to meet code.

- Moreover, Title 24 consultants are motivated, in the great majority of cases, to help builders *meet* code in the most cost-effective manner possible; they are not paid to help exceed code within some incremental budget. Accordingly, they report suggesting to builders ways to *decrease* efficiency in some areas where measures are not prescribed, as long as the total energy budget is not exceeded.

- For fear of opening themselves to later litigation for nonperformance, builders and their sales agents are hesitant to offer payback information to support the case for including energy-efficient options to convince prospective buyers of their value. On the other hand, this same fear of litigation can be (and has been shown to be) a powerful motivator for improvements in building practices such as ductwork installation.

- Sales agents and realtors report that new home buyers interested in energy efficiency tend to believe Title 24 provides an adequate level of efficiency. Home buyers demand energy efficiency in general, but do not have the information or ability to identify the benefits of exceeding code. Furthermore, realtors report that first-time buyers lack both the experience and the motivation to inquire into efficiency, and—given the dearth of efficient homes from which to choose—have little opportunity to learn and compare.

- Builders seem to be confused as to whether they are exceeding Title 24. We had builders report they were building above code, but upon further questioning we discovered they were only meeting code. These respondents thought that exceeding a mandatory baseline for AC SEER, for example, translated as "exceeding code," even though they were not coming in below energy budget requirements.

IMPLICATIONS

The findings of this study suggest several guidelines for future programs intended to transform the RNC market.

Incentives have some effect, but may not be the best way to transform the market for energy efficiency in new homes.

Our survey results show some limited reductions in several key market barriers for the RNC market. A portion of these reductions can be attributed to the *Welcome Home* and *Comfort Home* programs, and most are likely to be lasting. However, focusing a program solely on monetary incentives to builders bypasses the split incentive barrier, but does relatively little to overcome this barrier. Other approaches show promise for larger impacts on this market. See the discussions of liability and of code inspections, below.

More work with potential third-party partners is essential to success.

One critical distinction between resource acquisition programs and market transformation programs may be found in the level of the market actors at which those programs are directed. For the most part, resource acquisition programs focus on individual actors, partly because it is relatively easy to follow up on their activities and to measure changes in their behaviors, purchases, and attitudes. However, this approach is comparable to attempting to convert voters to favoring a candidate exclusively through door-to-door visits. In contrast, the market transformation strategy includes, as a major component, the use of top-down activities, comparable to securing the endorsement of a voter's key reference groups.

To provide a specific example, the data suggest that utility RNC programs may have helped increase perceptions of the relative importance of energy efficiency among participating builders. However, these perceptions have not spilled over to nonparticipating builders. They seemed to be unaffected by program interventions. In the future, it may be useful to increase efforts to work with trade associations to enable broader coverage while continuing to provide some level of information and support to individual builders.

The improvement of code compliance would likely have a large impact.

The California Energy Commission study on Title 24 compliance shows that half the new homes in California failed to meet the standards.[1] Our interviews with Title 24 consultants support this finding. One consultant in particular believed the lack of compliance was because of "builders hiring cheap Title 24 consultants." That is, they unknowingly hired Title 24 consultants that were not properly trained. The

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[1]California Energy Commission, *Energy Characteristics, Code Compliance and Occupancy of California 1993 Title 24 Houses* (May 1995).

determination of code compliance is complex, and as building departments tend to do only spot checks for compliance, many homes are built that do not meet code. The suggestion here is to either promote stricter licensing (requiring more training) of Title 24 consultants, or somehow ensure better policing of compliance.

Liability issues have a large impact on the market.

The threat of liability is a powerful motivator, and seems to have had a significant impact on the adoption of better ductwork installation practices. The threat of liability also seems to keep builders from providing information on likely energy-savings tradeoffs between various home designs, specifically for components that would exceed Title 24. We offer two suggestions here. First, future market transformation efforts might consider harnessing the threat of litigation to push better (more efficient) building practices such as ductwork installation. Second, as it is unlikely that consumers will be able to obtain this information elsewhere, future market transformation efforts should consider some type of home rating system that gives something like energy cost per square foot and total energy estimates for all new homes. Possibly, this rating could be generated through the Title 24 compliance analysis performed for each home design. One example of an existing home energy rating system is the California Home Energy Rating System (CHEERS).

There is hope for ductwork installation standards and training.

Our study results show that there has been an increase in the use of the better ductwork standards by at least some of the HVAC subcontractors and builders. These actors like the standards and recognize the improvement in work quality (and reduction in the threat of liability) those lead to. Further efforts in this area, especially with an end goal of their incorporation in an enforceable Title 24 update, seems to be warranted.

Information on the existence of measures seems to be effective in this market, but trade-off analysis of measure impacts is needed.

Our study shows evidence of some reduction in all the information-related barriers (homeowners/buyers, realtors, and builders). Therefore, it seems the general advertising offered by the programs was successful. However, the aspect of this set of barriers that was not effectively addressed is that relating to bounded rationality;

homeowners/buyers and realtors (and to some extent, builders) are aware of energy-efficiency measures, but are not able to directly tie the existence of these measures to likely energy savings and payback information. As discussed above, future market transformation efforts in this market must seriously consider a home energy rating system.

Builders prefer energy efficiency measures that directly increase marketability through nonenergy benefits.

The AHP results show that builders rank efficient windows as the measure they prefer most to increase a home's energy efficiency, while Title 24 consultants say ductwork is more important. We believe that this result, as well as information from the direct elicitation portion of the survey, provides evidence for the existence of the split incentives barrier for builders. Builders want a "showy" way to increase energy efficiency that potential home buyers can see and likely recognize. Title 24 consultants are looking at actual energy-savings impacts. The more market transformation efforts can promote the marketability aspects of energy-efficiency measures other than energy efficiency, the more likely builders will adopt these measures.

Future evaluations of market transformation efforts will likely have to accept an even lower ability to claim causality because of multiple agencies being involved.

Several of these recommendations indicate the need to work with other agencies to promote energy efficiency in the RNC market, both to create changes in the barriers and to lock in those changes. It must be acknowledged that, to the extent these recommendations are followed, it becomes more difficult for future evaluations to allocate sole credit for changes that occur to the utility programs, or even to ascertain empirically the proportion of credit that should be assigned to those programs. In other words, a sort of Heisenberg principle appears to be operating: efficacy and certainty of causal origins cannot be achieved simultaneously. Either utilities can act alone and claim sole credit, with some certainty, for whatever effects are achieved, or utilities can work with other agencies to create what are likely to be larger, more lasting effects at the cost of sharing a relatively indeterminate amount of credit. Though it may not be possible to resolve this dilemma empirically, it might be resolved through prior negotiation of goals and targeted actions as part of policy agreements.

Future research in this area should include an analysis of the impact on the resale value of an energy-efficient home.

One argument for the economic value of energy-efficiency options in new homes is their impact on the home's resale value. We do not know of any empirical evidence for this, and it would be useful to test this proposition and publicize positive results. If an impact is not found, there is a strong case for targeting realtors in the resale market to support the value of energy efficiency.

CONCLUSIONS

In conclusion, past utility RNC programs appear to have not only increased the stock of housing that exceeds Title 24, but also to have helped reduce barriers to continuing such activities for at least some market actors.

Although the Edison *Welcome Home* Program and the PG&E *Comfort Home* Program were not designed as market transformation programs, they did have several market transformation effects. This study shows evidence of some level of reduction (although in most cases, slight) in the information-related barriers of home buyers, builders sales agents and buyers' realtors, and builders (having to do with subcontractor selection), and in the HVAC subcontractor barrier of poor ductwork installation practices. The study also shows evidence of limited reductions in what we believe to be the main barrier in the residential new construction market: builder split incentives.

Finally, it should be noted that the major value of this study lies not in providing judgments of the market transformation effects of earlier resource acquisition programs, but in suggesting a baseline for future programs directed specifically at market transformation, and in providing lessons as to effective program designs and evaluation.

I. INTRODUCTION

Southern California Edison (Edison) and Pacific Gas and Electric (PG&E) retained Barakat & Chamberlin to conduct a study to evaluate the market effects of the Edison's *Welcome Home* and PG&E's *Comfort Home* program. These programs were offered to promote energy efficiency in the residential new construction markets in each service territory.

The purpose of this report is to present the data collection and analysis portion of the study. Two previous reports have been delivered as part of this project. The first was the "Residential New Construction Market Characterization Report" (enclosed as Appendix C of this report). This report described the residential new construction market (RNC) structure and identified market effects to measure. The second report, "Residential New Construction Research Plan" (Appendix D), described our approach to evaluation of these hypothesized market effects in detail.

BACKGROUND AND PROGRAM DESCRIPTION

On December 20, 1995, the California Legislature passed Assembly Bill 1890, which, among other things, requires California utilities to collect a certain percentage of total revenues as a public goods charge (PGC). These funds are to be used for several purposes, including energy efficiency through market transformation. Market effects are the evidence of market transformation.

The *Welcome Home* and *Comfort Home* programs were designed and operated as demand-side management (DSM) programs (i.e., they were intended as a means to directly acquire demand and energy savings). Even though DSM programs can also have market transformation effects, this is not their main purpose. Programs that are specifically designed to transform markets are fundamentally different. They focus on market structure rather than direct acquisition. Edison and PG&E requested and received permission to fund an evaluation of the market effects of the *Welcome Home* and *Comfort Home* programs in preparation for future market transformation efforts.

Table 1 lists measures promoted by the programs during various time periods, roughly defined as before and after the 1992 Title 24 revisions went into effect. (A check mark in a cell indicates the measure was promoted at some time during the period indicated, not necessarily for the entire period.)

Table 1
MEASURED PROMOTED BY EACH PROGRAM

Measures Promoted by the Programs	Edison		PG&E	
	1990–1992	1993–1994	1992–1993	1994-1996
AC efficiency upgrades	✓	✓	✓	✓
AC downsizing			✓	
Ductwork installation			✓	✓
Insulation	✓		✓	
Windows	✓	✓		
Shade trees		✓		
Gas cooktops or ranges			✓	✓
Gas dryer stub			✓	✓
Gas furnace efficiency upgrades			✓	
Gas WH efficiency upgrades			✓	

The *Welcome Home* and *Comfort Home* programs consisted of a number of different market interventions for the promotion of these measures. These are presented below, categorized by the market actor upon whose barriers the intervention is believed to be focused.

Interventions focused on homeowner market barriers:

- Advertising to home buyers (both programs)
- Funds for builder advertising (Edison 1990–1992)
- Point of sale information packets (both programs)
- Incentives (coupons for discounts on efficient appliances) to buyers (PG&E 1994–1996)

Interventions focused on realtor/seller market barriers:

- Seller information packets (both programs)
- Training for builders' sales staff (Edison 1993–1994, PG&E 1996)

Interventions focused on lender market barriers:

- Promotion of energy-efficient mortgages, including a discount on closing costs (PG&E 1995–1996)

Interventions focused on builder market barriers:

- Incentives to builders (both programs)

Interventions focused on builder and HVAC subcontractor market barriers:

- Standards for ductwork (PG&E)
- Training for contractors (PG&E 1995–1996)
- Test each house for correct installation (PG&E)

STUDY OBJECTIVES

As mentioned above, the purpose of this study was to determine the market transformation effects of the *Welcome Home* and *Comfort Home* programs. The specific objectives of the study are shown in Section II.

In the project kick-off meeting, it was agreed to adopt a more prospective or forward-looking focus for the project—that of better program design for market transformation—instead of undertaking a completely retrospective study emphasizing the impacts of past efforts. The *Welcome Home* and *Comfort Home* programs were used as a "study ground" to identify the interventions that work and can offer lasting effects, study how these effects can be measured, and identify the limitations of these interventions. That is, we used information provided by this program experience to determine how better market transformation programs can be designed in the future, and to test a methodology to measure the effects of these future programs.

Though we measured the market effects of the *Welcome Home* and *Comfort Home* programs, as they were not developed as market transformation programs. We recognized market effects may be limited.

INDICATORS OF MARKET EFFECTS

This subsection briefly reiterates the rationale for investigating of critical changes in the RNC market, rather than focus strictly upon demonstrated energy savings of homes built under the Edison and PG&E programs.

Both evaluators and proponents of market transformation as a utility program strategy would agree the ultimate benefits of such efforts lie in energy and demand savings. They would also agree that sales or market penetration may be reasonable proxies for the savings achieved. Ideally, then, assessments of market transformation programs would measure either or both of these effects, just as assessments of resource acquisition programs do. For several reasons, however, neither the measurement of energy and demand savings nor the measurement of sales or penetration rates are generally feasible within the time frame or other parameters normally associated with energy program evaluations. These reasons are discussed at length in a number of publications by Prahl & Schlegel[2] and by Feldman,[3] and will not be revisited here. It may be useful, however, to summarize the challenges to standard evaluation approaches described by Eto, Prahl, & Schlegel in a recent report that offers recommendations designed to increase support for market transformation programs in California.[4] As these authors point out, important, *intrinsic* characteristics of markets complicate the measurement problem, including the following:[5]

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[2]See, for example, Prahl, R., & Schlegel, J. (1993). Evaluating Market Transformation. Energy Program Evaluation: Uses, Methods, and Results. *Proceedings of the 1993 International Energy Program Evaluation Conference*. Pp. 469-477. Chicago, IL. and Prahl, R., & Schlegel, J. (1994). DSM Resource Acquisition and Market Transformation: Two Inconsistent Policy Objectives? American Council for an Energy-Efficient Economy. *Proceedings of the ACEEE 1994 Summer Study on Energy Efficiency in Buildings*. (Pp. 6.157-6.166). Washington, DC.

[3]See, e.g., Feldman, S. (1995a). How Do We Measure the Invisible Hand? Energy Program Evaluation: Uses, Methods, and Results. *Proceedings of the 1995 International Energy Program Evaluation Conference*. Pp. 3-8. Chicago, IL and (1995b). Measuring Market Effects: Sales Data Are the *Last* Thing You Should Look At. Competition: Dealing With Change. *Proceedings of the 1995 AESP Annual Meeting* 83-90). Boca Raton, FL.

[4]Eto, J., Prahl, R., & Schlegel, J. (1996). *A Scoping Study on Energy-Efficiency Market Transformation by California Utility DSM Programs*. Lawrence Berkeley National Laboratory (LBNL-39058; UC-1322). Berkeley, CA.

[5]Ibid., pp. 88-89.

- ***Markets are interactive.***

  Changes in the behavior of one group of market actors can and do lead to changes in the behavior of other groups. Accordingly, it is difficult to isolate the effects of successful transformation efforts.

- ***Markets are dynamic.***

  Markets are constantly changing and evolving. This complicates efforts to define a baseline—or what would have occurred in the absence of a market transformation program.

- ***Fundamental changes in market structures and functioning may occur only slowly.***

  Changes are likely to require far more than a few months or a year. However, the longer evaluators wait to assess hypothesized effects, the more likely it becomes that nonprogram factors may have intervened between the presumed cause and those effects.

- ***Markets tend to be regional and national—not defined by service territories.***

  Manufacturers and distributors of energy-efficient equipment are seldom affected directly by the programs of one or two utilities. Moreover, the macroeconomy, state laws, and other broad forces are likely to be critical determinants of market movements, are not under the control of market transformation programs, and are only poorly understood by market actors themselves.

For all these reasons, the evaluators and theorists cited have argued the importance of focusing on market effects, which are proximate indicators of changes in the structure or functioning of markets, or of reductions in the market barriers that inhibit the achievement of energy efficiency. As summarized in a recent presentation by Schlegel,[6] this alternative focus offers the following advantages:

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[6]Schlegel, J. (1997). *Evaluating market transformation initiatives: Issues, challenges, and state-of-the-art.* Presented to ACEEE Market Transformation Workshop. Washington, DC.

- Timeliness.
- Observability.
- Provision of ongoing feedback to program managers.
- Closer linkage to the specific activities of an initiative.
- Lower potential for the intervention of confounding factors and alternative explanations.

Moreover, several recent program evaluations have shown the feasibility of this approach.[7] Perhaps the most difficult requirement for the use of market indicators is selecting just those indicators that are pertinent, credible, and persuasive indices of changes in markets are likely to presage later changes in energy efficiency. Herman et al. note, "First you need a story...."[8] As Schlegel has pointed out,[9] a "story" provides:

- Evidence of the changes in the market caused by the market transformation initiative.
- Logical analysis of why and how the initiative caused the changes.
- Rationales for the assessment of confounding factors and alternative explanations.

The "story" for this study is provided by the earlier market characterization (MC) report, which was based on a review of the literature and expert interviews (this report is included in Appendix C of this document). In that report, we have identified the key actors in the RNC market, and the decisions and transactions that determine the level of energy efficiency achieved. The report further describes the barriers to the downstream

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[7]See, e.g., Rosenberg, M. (1995). Strategies to Quantify Market Transformation and Spillover Effects of DSM Programs. *Energy Services Journal* (Vol. 1, pp. 143-157) and Lee, A.D., & Conger, R. (1996). Market transformation: Does it work?—The Super-Efficient Refrigerator Program. American Council for an Energy-Efficiency Economy: *Proceedings of the ACEEE 1996 Summer Study on Energy Efficiency in Buildings* (Pp. 3.69-3.80). Washington, DC.

[8]Herman, P., Feldman, S., & Samiullah, S. (1997). Measuring Market Transformation: First You Need a Story ..." In *Energy Program Evaluation: Uses, Methods, and Results. National Energy Program Evaluation Conference*. Chicago, IL. (In preparation.)

[9]Op. cit.

flow of energy efficiency, and specifies which of those barriers are the most critical at each decision point. Finally, the MC report enumerates market indicators relevant to each of the market barriers of interest.

In summary, we have undertaken to assess the market-transformation results of RNC programs by Edison and PG&E through a determination of their market effects. We have chosen this approach because of the conceptual and practical difficulties attending the use of energy and demand savings or market penetration as measures of market transformation, and the value of increased timeliness and proximity to program activities offered by the measurement of market indicators. We have addressed the critical need for tying the particular market indicators assessed to an understanding of the relevant market structures, processes and important market barriers in a comprehensive analysis of the RNC market based on the literature and expert interviews.

ORGANIZATION OF THIS REPORT

Section II presents the objectives of the study. Section III describes the methodology used in conducting the analysis. The study's findings are presented in Sections IV and V, and Section VI presents the study's implications to future program design as well as for future research avenues. Section VII presents the study's overall conclusions.

The Appendices contain information on secondary sources, the survey instruments, and the two previous reports in this study. Appendix A contains a list of secondary data sources used along with a brief summary and comparison to this study. Appendix B contains the questionnaires administered to different market actors along with the letters sent to them. Appendix C contains the market characterization report, and Appendix D contains the research plan report.

II. OBJECTIVES OF THE STUDY

Based on the findings of the market characterization (MC) Study, the following objectives determined the data collection and analysis:

- Determine the existence of market effects identified in the MC Study;
- Determine the magnitude of these effects;
- Estimate a hypothesized baseline for establishing attribution;
- Specify whether the market barriers have been reduced, eliminated, or bypassed;
- Assess the permanence of the observed changes; and
- Determine the implications of the results on future market transformation program design.

III. METHODOLOGY

This section of the report describes the approach we developed to achieve the objectives previously described. It draws heavily from the "Residential New Construction Research Plan," which is included in Appendix D of this report.

THE USE OF QUALITATIVE/QUANTITATIVE DATA

Previous studies have not directly addressed the identification and presence of barriers to energy efficiency in the residential new construction (RNC) market, nor have they examined changes in the nature or magnitude of those barriers. Accordingly, this project emphasized the collection of primary data regarding market actors' perceptions of the baseline levels associated with energy efficiency in the RNC market, the existence (and magnitude) of market effects in recent years, the relationship of these effects to Edison's and PG&E's programs, and the likelihood that such effects would be lasting.

As indicated in the earlier market characterization (MC) report, our analysis of the literature and our expert interviews suggested the presence of a number of critical barriers as well as certain indicators of those barriers. Most of these indicators refer to transactions between market actors—transactions whose outcomes are not recorded in any direct or readily accessible form for auditing or summary collection.

For example, contractors do not formally or consistently record their awareness of the ways subcontractors may cut corners, nor do they record which changes in practice improve coordination among subcontractors. For these reasons, the best information sources regarding the indicators of interest are the market actors themselves.

We collected two types of information from the market actors interviewed:

- Qualitative indicators of market barriers and changes; and
- Quantitative measures of the perceived importance of energy efficiency, the relative efficacy of various methods of achieving energy efficiency in RNC, and related data.

This information was obtained through detailed, individual, in-depth interviews (direct elicitation) regarding present practices, changes observed over the past five years, and reasons for these changes. These were supplemented by responses to a systematic measure—the AHP—of perceptions regarding determinants of home marketability, energy efficiency, etc. Where appropriate, the analyses of these data were supplemented by comparisons with data collected on similar measuring instruments in Edison's and PG&E's earlier surveys of builders (see Appendix B for a list of these sources). Table 2 provides a summary of study objectives and the methods by which pertinent data were collected.

Table 2
SUMMARY OF APPROACH

Objective	Data Collection/ Analysis Method
Determine the existence of the market effects identified in the market characterization study.	Direct Elicitation
Determine the magnitude of these effects.	Direct Elicitation and AHP
Estimate a hypothesized baseline to assess attribution.	Direct Elicitation and AHP
Specify whether the market barriers have been reduced, eliminated, or bypassed.	Direct Elicitation
Assess the permanence of the observed changes.	Direct Elicitation
Determine the implications of the results on future market transformation program design.	Direct Elicitation and AHP

As noted, in addition to identifying market effects, we sought to assess both the likelihood these effects could be attributed to the utility programs conducted over the past several years, and the likelihood that the observed effects would be lasting. As with the market effects themselves, direct measurements largely were not available, and qualitative information and analysis were required.

In brief, attribution of market effects to the pertinent utility program was done by making expert judgments informed by the following qualitative observations:

- **The design of one or both utility programs (and what was known about their implementation) offered a logical connection between program**

activities and the bypassing, reduction, or removal of specific market barriers.

For example, the preparation and distribution of information packets regarding energy efficiency to realtors was a reasonable precursor to reducing the barrier of realtor ignorance concerning those issues. Conversely, neither utility's program appeared to directly address the barrier of poor coordination among subcontractors.

- **Market actors were likely to cite pertinent utility programs as influencing their attitudes, perceptions, or behavior.**

  This proved important in context; by itself, it was neither necessary nor sufficient. On one hand, the programs could have major effects that did not appear obvious to the market actors, as they may have been unaware of how particular programs affected other actors whose actions actually provided the proximate causes of their own behavior changes. On the other hand, market actors might have cited utility programs that were consistent with changes in their behavior, but these changes actually occurred in response to broader changes in the economy.

- **No other explanations of changes appeared reasonable.**

  For example, if increased awareness of energy-efficiency mortgages were observed when they were promoted by utility programs, but were not advertised by lenders or the state, it would seem appropriate to credit these programs for the observed change.

Some quantitative information may remain available for assessing certain market effects among builders. Specifically, some comparisons of AHP results can be made between builders who have or have not participated in recent utility programs. The existence of reliable differences between these two groups offers evidence that programs play a causal role.[10] Nonetheless, the qualitative analysis described above remains necessary to further analysis and understanding of such differences.

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[10]Ideally, market transformation efforts would also affect nonparticipants. However, since these programs were not market transformation programs, and, in the absence of good baseline data, we assume these differences show evidence of the programs' direct effect.

In this study, assessing the likelihood that observed market effects would last also had to be based on expert judgments. The utility programs whose market-transforming effects were being reviewed here were not designed or implemented for the purpose of creating permanent change. Rather, they were designed to acquire certain resource levels. Moreover, too little time had elapsed since the implementation of these programs or the programs were so reduced in scope that any direct observation of the degree market effects remained or disappeared proved impossible. Accordingly, the available evidence regarding whether or not any market effect was lasting consisted of declarations by pertinent market actors that they would or would not continue to manifest the new attitude or behavior observed. Again, market actors may not necessarily be accurate judges or predictors of their own behaviors. Nonetheless, it proved valuable to examine their predictions and rationales.

One other line of evidence was considered in judging whether market effects were likely to last: would the intervention actually reduce a market barrier? Generally, if a market effect lasts, the pertinent intervention must directly address and reduce a barrier rather than simply help actors to bypass it. For example, if one of the programs provided homeowners and realtors with new, understandable facts regarding energy-efficiency options and results, and if that information were learned and retained, it proved reasonable to argue the pertinent information-related barrier was lowered in a lasting manner. Similar results might be expected if HVAC subcontractor and sales agent training were successful and that knowledge was retained. In contrast, market effects caused solely by incentives to builders or homeowners (e.g., the access to financing barrier) were unlikely to last beyond the withdrawal of incentive programs, unless the program led to additional changes that solidified effects stimulated by the incentives.

SAMPLE DESIGN

The sample design was not intended to be statistical. Rather, it was qualitative in nature. Table 3 shows a list of market actors, the associated number of these planned for surveys and the number actually surveyed.

We drew equal samples from Edison and PG&E's service territories. Builders were divided into participants and nonparticipants. We also interviewed realtors, builders' sales agents, Title 24 consultants, and HVAC subcontractors from both service territories. In total, we planned to conduct 50 in-depth interviews; 49 were actually conducted.

Participating builders were contacted using lists provided by PG&E and Edison. The sample was selected randomly from both service territories, and several attempts were made to contact each selected builder before they were replaced by another builder from the list.

Nonparticipant builders were selected from the 1996 NYNEX Information Technologies Company's nationwide list of builders obtained via the Internet. The list was screened for the largest 400 builders nationwide, for the two service territories, and to exclude participants. The final list contained 19 builders in Edison's service territory and 17 in PG&E's. The goal was to complete 10 surveys (5 per territory). Some of the remaining builders turned out to be participants, resulting in 7 participants and 4 nonparticipants in Edison's sample (Table 3 below). Due to scheduling difficulties, we were unable to complete the fifth nonparticipant interview.

We obtained the names of Title 24 consultants, HVAC contractors, and builders' sales agents to interview from builders. The realtors were recruited from lists obtained via the Internet (i.e., the 1996 NYNEX Information Technologies Company).

Table 3
SAMPLE DESIGN

Market Actor	Number of Surveys			
	Edison		PG&E	
	Planned	Surveyed	Planned	Surveyed
Participating Builders	5	7	5	5
Nonparticipating Builders	5	4	5	4
Realtors	5	5	5	5
Sales Agents	5	4	5	5
HVAC Subcontractors	3	3	3	3
Title 24 Consultants	2	2	2	2
Total	25	25	25	24

DATA COLLECTION

Three methods were used for collecting the data required:

(1) Secondary Sources: Some previous studies had conducted surveys similar to ours. We included several questions in our surveys similar (or in some cases the same) to those surveys as to compare results upon completion of data collection. Appendix A contains a list of all sources considered.

(2) Direct Elicitation (Qualitative): Information on many of the market effects was elicited directly from market actors.

(3) Analytic Hierarchy Procedure (Quantitative): Information on some of the market effects was obtained through indirect trade-off assessment.

Respondents were provided with letters that explained the data collection process. These letters specifically addressed how the AHP questions were going to be conducted. Sample surveys and letters are contained in Appendix B.

DATA ANALYSIS

As originally introduced in the MC study and the research plan, Table 4 contains the market effects that would show a reduction or elimination in the key market barriers. The table also contains program interventions directed at each barrier.

Table 4
MARKET EFFECTS TO MEASURE FOR EACH KEY MARKET BARRIER

Market Barrier	Interventions	Hypothesized Market Effect
Homeowner information-related barriers	• Advertising • Information packets • Incentives (coupons)	• Homeowner demand for energy efficiency, especially with respect to other desirable home characteristics.
Realtor information-related barriers	• Information packets • Training	• Realtor knowledge with regard to energy efficiency and its benefits. • Realtor promotion of energy efficiency.
Lender practices barrier	• Promotion of energy-efficient mortgages • Discounts off closing costs	• Increased sales of energy-efficiency mortgages. • Increased awareness and availability of energy-efficiency mortgages. • Lender belief in the resale value of energy-efficiency mortgages.
Builder split incentives	• Incentives • Standards for ductwork installation	• Builder belief that energy efficiency increases a home's marketability enough to justify its additional costs. • Builders designing homes more energy efficient than Title 24 on their own. • Builders marketing homes as energy-efficient homes on their own. • Title 24 consultants now report percent efficiency above Title 24 rather than simple pass/no pass.
Builder information/ bounded rationality barrier with regard to subcontractor selection	• Incentives • Standards for ductwork installation	• Builders have more information and experience with the ways subcontractors do or do not deliver on energy efficiency. • Builders are aware of the ways subcontractors cut corners and have developed safeguards against this practice.
Subcontractor lack of coordination barrier	• No direct intervention	• Changes in practices which allow for better subcontractor coordination.
HVAC subcontractor practices barrier	• Standards for ductwork installation • Training • Testing	• Changes in ductwork installation practices.

DATA COLLECTION METHODS

Direct Elicitation

Appendix B contains the questionnaires used for the direct elicitation portion of this study. In the research plan, we began with a long list of issues we most wanted to investigate. To keep the interviews to a reasonable length, this list was shortened through consultation with the project team.

We applied a survey instrument (shown in Appendix B) that utilized numerous open-ended questions, which allowed the interviewer to probe and further investigate responses.

Analytic Hierarchy Procedure (AHP)

The AHP evaluated how the various attributes of new homes made these homes more marketable, ranking these attributes by their level of importance (see below). Market actors were asked to compare meeting Title 24 standards to exceeding them in terms of "cost" and "energy efficiency." The results of this analysis produced *importance weights* for each attribute (cost, location, etc.), and preference weights for "meeting Title 24" and "exceeding Title 24."

Analytic Hierarchy Procedure Scales

Please consider the relative importance of the following items on each end of the accompanying chart. Using the scale below, select **one** number for the relative importance of each pair of items. Please indicate the item that you consider more important and then select a number. The scale is 1 to 9, with the following interpretation of the specific numbers.

1 = One item is EQUALLY as important as the other
3 = One item is MODERATELY more important than the other
5 = One item is STRONGLY more important then the other
7 = One item is VERY STRONGLY more important than the other
9 = One item is EXTREMELY more important than the other
2, 4, 6, and 8 are intermediate values

AHP is a technique that has been successfully applied for similar purposes in several hundred industry applications (including a number of utility load forecasting and rate-setting applications). AHP involves three basic elements:

- Describe a complex, multi-criteria problem with objective or subjective elements as a hierarchy;
- Estimate the relative importance weights for various criteria (or subcriteria) on each hierarchy level; and
- Integrate the relative weights to evaluate the hierarchy with respect to the program's overall objectives.

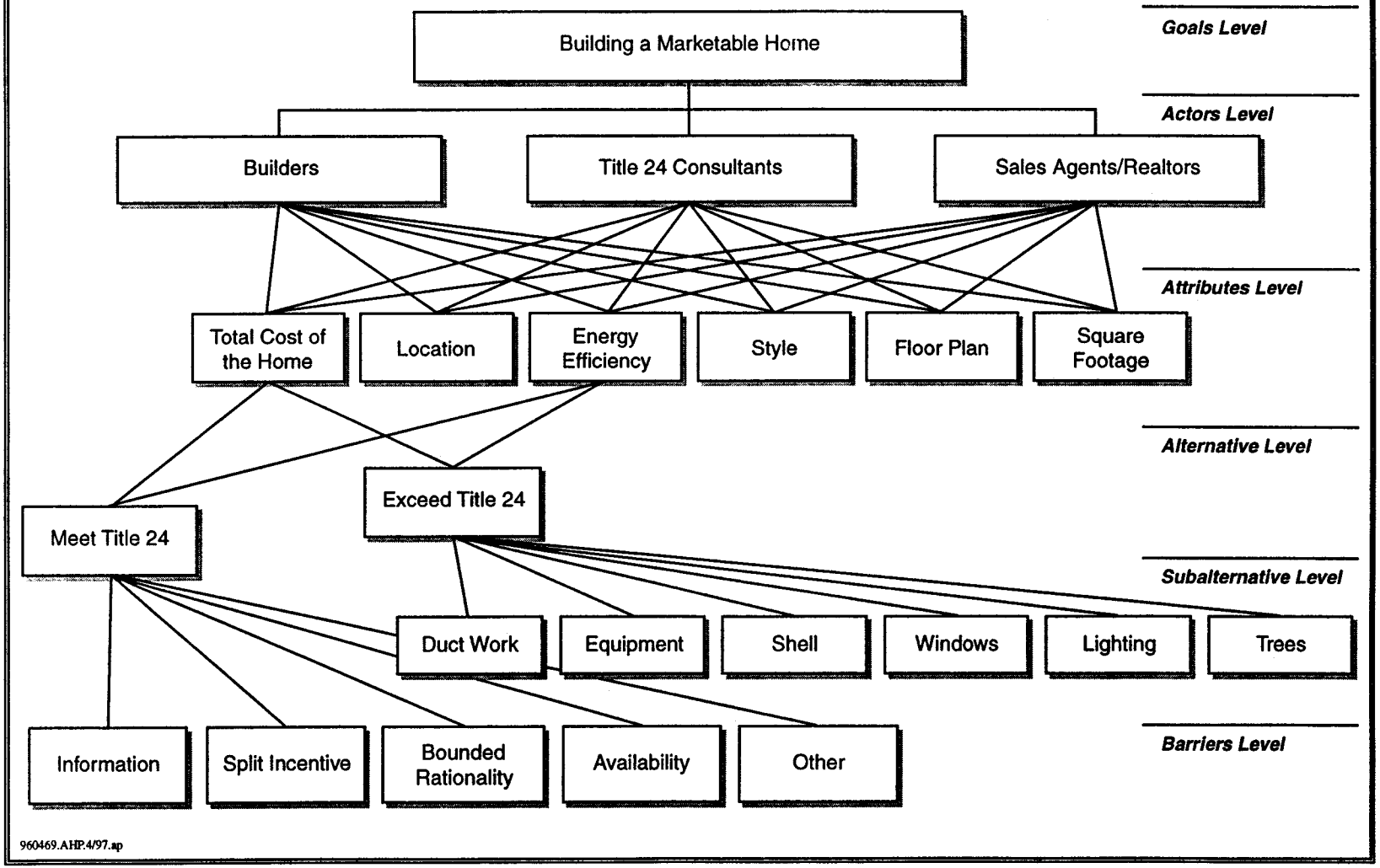
AHP uses ratios as a measure of comparative judgments. Specifically, pairwise comparisons are used to estimate the relative importance of specific criteria within each hierarchy level. A popular commercial software program (Expert Choice™) performs all these computations and provides detailed reports for the generated weights of the criteria and alternatives.

In conducting the AHP analysis, the following steps were taken:

(1) **Build an Overall AHP Structure.** The project was broken down into a hierarchy, comprised of an overall goal (building a marketable home), a set of actors (builders, realtors, Title 24 consultants, and sales agents), a set of decision criteria (home attributes), a set of decision alternatives (meeting or exceeding the standards), subalternatives for choosing to exceed standards (specific end uses), and barriers for choosing not to exceed standards (information, split incentives, etc). The structure is shown in Figure 1. Each alternative (e.g., split incentives) was described to respondents in simple terms.

Figure 1

AHP Structure



(2) **Estimate Attributes' Importance Weights.** Starting with an overall goal of "Building a Marketable Home," each actor was asked to assess the importance of the various attributes in making the house more marketable. This evaluation was performed based on pairwise comparisons using a 1–9 ratio scale, where 1 meant equal importance/preference and 9 indicated extreme importance/preference of one item (e.g., location) over another (e.g., energy efficiency). The pairwise comparisons did not have to be exhaustive (i.e., not all pairs of the criteria, subcriteria, or choices had to be considered).

(3) **Estimate Alternatives' Preference Weights.** For two of the attributes (cost and energy efficiency), actors were asked to conduct pairwise comparisons between meeting or exceeding the standards. This process generated the first level "preference weights." The preference weights for the alternatives and for attributes were integrated by Expert Choice into a single set of overall preference weights for the alternatives. Preferences were elicited between these alternatives with respect to each attribute, and attributes were evaluated with respect to the overall goal (making the home more marketable). The integration process resulted in one set of overall values (called global priorities for the alternatives).

(4) **Estimate Subalternatives' and Barriers' Weights.** When exceeding standards, actors were asked to state the preference weights (via pairwise comparisons) between different methods (i.e., a mix of energy-saving measures) of exceeding code. When choosing not to exceed code, actors were asked to rate the impact of expected market barriers. The derived weights from this step were integrated up the hierarchy using Expert Choice.

The AHP also provided a means of assessing the consistency of a respondent's judgments with respect to his or her evaluations. For example, if respondents believed A was more important than B, and B was more important than C, then they must have felt A was more important than C. The AHP's consistency analysis quantified this concept, and provided a means of assessing the overall consistency of the process. This led to the calculation of a measure called the "inconsistency ratio." It is empirically shown that if an inconsistency ratio is more than .10, the overall consistency is unacceptable. In this case, Expert Choice identified the most inconsistent judgments and eliminated them to achieve acceptable consistency.

In summary, the main results produced by the AHP included three sets of weights based on responses by each key actor:

- Importance weights for the overall attributes (i.e., location, cost, energy efficiency, style, floor plan, and square footage);
- Preference weights for meeting or exceeding Title 24; and
- Preference and importance weights for methods of exceeding Title 24 (i.e., windows, HVAC, lighting, planting trees, insulation, and duct work), and barriers for not exceeding Title 24 (i.e., lack of information, split incentives, bounded rationality, and availability of measures for exceeding code).

Establishing the Baseline

Two comparisons were made to determine the hypothesized baseline:

(1) Participating builders were compared to nonparticipating builders; and

(2) Builders and other actors were asked to reconsider the AHP questions from the point-of-view of "the past" (i.e., 1990).

The difference between the energy efficiency "importance weights" of the past and the present were used as an indicator of changes in attitudes among the different actors.

Data Attrition

AHP questions were to be asked in 44 of the 50 planned surveys. The 6 HVAC contractors were deemed inappropriate candidates for these questions. As mentioned, 49 surveys were completed. Of these, 43 had AHP questions. Unfortunately, due to delays in procuring a response to the surveys and due to our desire not to delay the analysis (and thus the report), we proceeded with 40 AHP respondents. The 3 respondents not included consisted of 1 participating builder and 2 nonparticipating builders in Edison's territory. The loss of the participating builder did not cause a significant problem. However, the loss of 2 nonparticipating builders (50% of sample of 4) means caution has to be exercised in examining the associated results.

Some respondents were also removed from the AHP analysis when their inconsistency ratios exceeded 0.10 or the changes in their past to present attitudes were too anomalous. (Outliers were defined based on standard statistical procedures.)[11] Table 5 presents a breakdown of respondents in each category before and after the screening process.

Table 5
DATA ATTRITION FOR AHP ANALYSIS

Market Actor	Service Territory	Program Status	Before	After
			n	n
Builders	Edison	Participants	6	4
		Nonparticipants	2	1
		Overall/Edison	**8**	**5**
	PG&E	Participants	5	3
		Nonparticipants	4	4
		Overall/PG&E	**9**	**7**
	Overall Builders		**17**	**12**
Title 24 Consultants	Edison		2	2
	PG&E		2	2
	Overall Title 24 Consultants		**4**	**4**
Sales Agents	**Edison**		**4**	**3**
	PG&E		**5**	**4**
	Overall Sales Agents		**9**	**7**
Realtors	Edison		5	4
	PG&E		5	4
	Overall Realtors		**10**	**8**
Overall All Actors			**40**	**31**

[11]One of the respondents, a PG&E-area sales agent, evaluated all of the AHP criteria as equally important in providing pairwise comparisons. This case was deleted because it would provide no discrimination among criteria. Because the main focus of the study was on assessing the role of energy-efficiency criterion, data screening, and cleanup focused on this variable.

LIMITATIONS OF THE STUDY

Certain limitations of this study should be noted:

- Any reported changes in indicators of energy-efficiency barriers (the possible market effects of utility programs) represents the respondent's recall, not their direct observation. Although, when possible, we have compared reports of current practice with earlier contemporaneous accounts, drawing on previous surveys by Edison and PG&E, few such analyses could be conducted, given the lack of baseline studies for the RNC market (resulting from the radically different focus of earlier evaluations).

- Although the sample was drawn to represent a wide variety of market actors in each service territory (including both builder participants and nonparticipants), it proved to be a somewhat small and nonprobabilistic sample. Hence, these results cannot be generalized to the entire set of market actors with a known degree of statistical confidence.

- Finally, and most important, the utility RNC programs under consideration were resource acquisition programs; they were not designed or implemented to achieve market effects, nor to create a lasting transformation of the market. For these reasons, the results should not be interpreted as offering projectable, quantitative estimates of market transformation, nor measuring the *success* of earlier programs. Rather, they provide a qualitative baseline for future RNC market barrier studies, a useful retrospective account of market effects for past resource acquisition programs, and indicators for possible directions of future efforts targeted more explicitly at achieving market transformation.

It should also be understood that the market transformation objective sought by the RNC programs is not a simple one. Given the level of energy efficiency already built into Title 24, and the improvements it embodies compared to earlier codes, finding ways to exceed those levels in a cost-effective manner requires substantial effort. Overcoming these barriers in a lasting manner remains a significant challenge.

IV. QUALITATIVE RESULTS

This section presents the results of our analysis of the in-depth interviews. We begin by presenting a profile of builder respondents for ease of reference and then proceed to address each market barrier.

Note that in interpreting these results, we need to define energy efficiency or an energy-efficient home as exceeding Title 24 for purposes of this study. As you will see, we ask about energy efficiency in general, and then specifically ask about energy efficiency that exceeds code.

You will also note that some builders have difficulty defining what it means to exceed code. This is discussed in detail under "Other Issues" at the end of this section.

BUILDER PROFILE

Table 6 profiles builders who were interviewed for the report. As we believe the builders surveys are important, and since they represent the largest number of respondents, this information is presented in tabular form for ease of reference as we discuss the results.

Table 6
BUILDER PROFILE
Note: Answers are self-reported from the survey

Builder ID	Year(s) Reported to Have Participated	Number of Homes Total Built Each Yr	Dominant Price Range of Homes Built	Dominant Square Footage Range of Homes Built	Included in AHP?[1]
PARTICIPANTS					
SCE-P-1	1990–1994	1000	$200–300k (50%)	No dominant range.	✓
SCE-P-2	1992–1994	2000	$300–400k (40%)	2,000-3,000 sq.ft. (50%)	✓
SCE-P-3	1990–1994	500	DK	<2,000 sq.ft. (50%)	
SCE-P-4	1993–1994	250	<$200k (55%)	<2,000 sq.ft. (75%)	
SCE-P-5	1990–1994	600	<$200k (45%)	<2,000 sq.ft. (45%)	✓
SCE-P-6	DK	500	$200–300k (70%)	<2,000 sq.ft. (60%)	✓
SCE-P-7	DK	550	$200–300k (60%)	2,000-3,000 sq.ft. (50%)	
PG&E-P-1	1990–1997	200	<$200k (90%)	<2,000 sq.ft. (50%)	✓
PG&E-P-2	1993–1996	180	<$200k (90%)	<2,000 sq.ft. (50%)	✓
PG&E-P-3	1995–1997	130*	$200–300k (75%)	2,000-3,000 sq.ft. (85%)	✓
PG&E-P-4	1995–1996	60	<$200k (100%)	<2,000 sq.ft. (100%)	✓
PG&E-P-5	1994–1997	50	<$200k (100%)	<2,000 sq.ft. (100%)	✓
NONPARTICIPANTS					
SCE-NP-1	N/A	700	<$200k (80%)	<2,000 sq.ft. (70%)	✓
SCE-NP-2	N/A	169	< $200k (100%)	<2,000 sq.ft. (100%)	✓
SCE-NP-3	N/A	50	<$200k (100%)	<2,000 sq. ft. (60%)	
SCE-NP-4	N/A	50	$200–300k (75%)	2,000-3,000 sq. ft. (100%)	
PG&E-NP-1	N/A	1200	$200–300k (100%)	<2,000 sq. ft. (70%)	✓
PG&E-NP-2	N/A	200	$200–300k (65%)	<2,000 sq. ft. (75%)	✓
PG&E-NP-3	N/A	450	$200–300k (60%)	<2,000 sq. ft. (60%)	✓
PG&E-NP-4	Other division does participate	600	$200–300k (95%)	2,000-3,000 sq. ft. (70%)	✓

[1]Check marks do not reflect the fact that some builders were subsequently eliminated from the analysis because of inconsistent or missing data.

HOMEOWNER INFORMATION-RELATED BARRIERS

Hypothesized Market Effect: Increased homeowner demand for energy efficiency, especially with respect to other desirable home characteristics.

In the market characterization report, we described the key market barriers for homeowners as information-related: lack of awareness, insufficient information, and bounded rationality. The specific program interventions undertaken by the utilities to reduce those barriers were: advertising, information packets, and incentives (coupons). The hypothesized market effect that would indicate a reduction in the homeowner information-related barrier would be respondents reporting an increase in homeowner demand for energy efficiency, especially in comparison with other desirable home characteristics.

While we did not interview homeowners directly, we did ask each group of respondents a number of questions pertaining to homeowner awareness of, demand for, and understanding of energy-saving features in general, and of energy-saving features exceeding Title 24. In addition, as discussed in a later section of this report, we obtained a quantitative estimate of the relative importance of energy efficiency in home marketability, both today and five years ago. All respondents either worked directly with home buyers or were familiar with issues related to home marketability. These included builders, builders' sales agents, realtors, and Title 24 consultants.

In the qualitative elicitation, all respondents were asked a series of questions in three areas concerning their perceptions of buyer demand for energy efficiency:

- Based on your experience, generally how much demand is there from home buyers for energy-saving features? Would you say a lot, some, little, very little, or none?

- How much buyer demand would you say exists for energy-saving features that exceed Title 24? (This is regardless of whether the buyer is aware of the code requirements. For example, do buyers ever ask about high-efficiency air conditioning systems?)

- Would you say customer demand for energy-saving features has generally increased, decreased, or stayed the same over the last five years?

If the responses to the first two questions were little, very little, or none, we asked why the respondents thought that was. If demand increased or decreased in the third question, we also asked why.

Table 7 summarizes the results of the series of questions described above for each respondent group. Table 8 provides a summary of the open-ended responses.

Over half of all respondents (53%) believed there was "a lot" or "some" buyer demand for general energy-saving features.

Regarding buyer demand for energy-saving features exceeding code, only 27% of respondents believed there was "a lot" or "some" buyer demand.

Regarding whether general demand for energy-saving features has increased, decreased, or stayed the same over the last 5 years, 63% said that they thought demand had increased. The remainder (except for one respondent) thought it had stayed the same. The exception was a respondent who said that it decreased and also said people assumed new homes were energy efficient since they are presumably built to code, and hence did not ask about energy-saving features.

Nine of twelve participating builders thought demand had increased while only two of eight nonparticipating builders did. Also, seven of nine builder sales agents say they think demand has increased versus only five of ten realtors. This difference is likely because all the builder sales agents had worked with participating builders and this may have influenced their perceptions.

Table 7
PERCEPTIONS OF BUYER DEMAND FOR ENERGY EFFICIENCY

General Buyer Demand for Energy-Saving Features

Participating Builders	Nonpart. Builders	Builder Sales Agents	Realtors	Title 24 Consultants	TOTAL
A lot 4	A lot 3	A lot 6	A lot 0	A lot 0	A lot 13
Some 2	Some 1	Some 1	Some 3	Some 3	Some 10
Little 3	Little 2	Little 1	Little 3	Little 1	Little 10
V.Little 2	V.Little 2	V.Little 1	V.Little 3	V.Little 0	V.Little 8
None 0	None 0	None 0	None 1	None 0	None 1
Don't know 1					DK 1

Buyer Demand for Energy-Saving Features that Exceed Code

Participating Builders	Nonpart. Builders	Builder Sales Agents	Realtors	Title 24 Consultants	TOTAL
A lot 1	A lot 1	A lot 1	A lot N/A	A lot 0	A lot 3
Some 3	Some 1	Some 1	Some N/A	Some 1	Some 6
Little 1	Little 1	Little 0	Little N/A	Little 1	Little 3
V.Little 5	V.Little 2	V.Little 4	V. Litt. N/A	V.Little 2	V.Little 13
None 1	None 3	None 2	None N/A	None 0	None 6
Don't know 1		No ans. 1			DK/NA 2

Change in Demand for Energy-Saving Features Last Five Years

Participating Builders	Nonpart. Builders	Builder Sales Agents	Realtors	Title 24 Consultants	TOTAL
Incr. 9	Inc. 2	Incr. 7	Incr. 5	Inc. 4	Inc. 27
Dec. 0	Decr. 1	Decr. 0	Decr. 0	Decr. 0	Decr. 1
Same 3	Same 5	Same 2	Same 5	Same 0	Same 15

Table 8
OPEN-ENDED RESPONSES CONCERNING BUYER DEMAND FOR ENERGY EFFICIENCY

Respondent Perception of Why Little to No Buyer Demand for Energy-Saving Features
Buyers only concerned about price of house (i.e., monthly payment). (6)
Buyers choose "tangibles" or "glitzy" options at time of purchase. (5)
Buyers do not understand or lack concrete information on the relationship between high efficiency and bill savings (and the related issue of payback). (3)
Buyers lack general awareness of energy-saving features or are not informed about them (3)
Buyers assume new homes are energy efficient. (3)
Climate very mild (Edison respondents). (2)
Buyer not willing to pay. (2)
Respondent Perception of Why Little to No Buyer Demand for Energy-Saving Features that Exceed Code
Buyers lack general awareness of high-efficiency features or are not informed about them. (7)
Buyers do not understand or lack concrete information on the relationship between high efficiency and bill savings. (6)
Buyers assume new homes are energy efficient. (5)
Buyers only concerned about price of house (i.e., monthly payment). (4)
Buyers choose "tangible" or "glitzy" options at time of purchase. (3)
Climate very mild (Edison respondents). (2)
Other programs in area (e.g., SMUD program), so people expect this. (1)
Buyer not willing to pay. (1)
Why Respondents Thought Demand for Energy-Saving Features Had Increased the Last Five Years
"General increase in awareness." (9)
Energy bills or energy prices. (8)
Media. (4)
Buyers more educated, knowledgeable. (4)
Increased environmental awareness. (3)
PG&E program (2)
People like energy-efficient products like dual-paned vinyl windows (i.e., for aesthetic reasons). (2)
Higher expectations of building industry. (2)
Energy-efficiency mortgages open discussion. (2)
Retrofit of existing homes raising awareness. (2)
PG&E bill stuffers (1)
Edison advertising (1)
Utility programs in general. (1)
Economy better. (1)
Issue of value—savings over time. (1)

As shown in the first box of Table 8, buyer concern about the price of the house was mentioned most frequently as a reason for the lack of demand for general energy-saving features. (Note that we included a separate cost-related category "buyer not willing to pay" as we felt this was categorically different from saying buyers focused on home price because of concern about monthly payment.) Second, respondents said buyers selected tangible or "glitzy" home items over energy-efficiency options. Third, were the buyer's lack of understanding or information on the relationship between efficiency and cost savings, and the lack of general buyer awareness (both with three responses).

The reason most frequently cited for a lack of demand for features exceeding code was buyer lack of awareness and information. A close second was buyer lack of understanding or information on the relationship between efficiency and cost savings, and a close third was buyers assuming homes were efficient (i.e., meeting code was sufficient). Fourth and fifth, respectively, were concerns about price and buyers opting for tangible or glitzy items. (As noted, we also included a separate cost-related category "buyer not willing to pay" as we felt this was different than saying buyers were focused on home price because of concern about monthly payments.)

The third part of Table 8 shows the reasons that respondents thought homeowner demand for energy-saving home features generally had increased over the last five years. Two of 15 PG&E respondents who said demand had increased mentioned PG&E's program and one mentioned PG&E's bill stuffers. None of the 13 Edison respondents who said demand increased mentioned their utility's program. However, Edison's advertising efforts were mentioned by one respondent. A "general increase in awareness" is cited most frequently as the reason respondents believed homeowner demand for energy-saving home features increased over the last five years.

Another indicator of buyer demand for energy-saving home features exceeding code would be how much buyers are willing to pay for these features. While we did not talk to buyers directly, we elicited responses from interviewees on their *perceptions* of customers' willingness to pay. Builders, builder sales agents, and Title 24 consultants were first asked how much they thought it would cost to increase a home's efficiency by 10% over code, then how much of this additional cost they thought buyers would be willing to pay.

The range of cost estimates was fairly broad. Six respondents said the additional cost to exceed code (by 10%) would be under $500. Five estimated $500 to $1,000. Seven

estimated from $1,000 to $1,500. Five estimated over $2,000, and one guessed $5,000 to $10,000. The five higher estimates were all made by builders.[12]

Of the 29 respondents who answered the question regarding buyers' willingness to pay:

- Seven (all builders) said they thought buyers would not be willing to pay any of the additional amount. (Their estimates of incremental costs ranged from $150 to $3,000.)

- Five (three builder's sales agents, one Title 24 consultant, and one builder) said they thought buyers would pay 100% of the additional cost. The Title 24 consultant's and one sales agent's 100% were contingent on the buyer having accurate savings and payback information for a $500 incremental cost. The builder responding 100% estimated an incremental cost of $50 to $250, while all three of the builders sales agents estimated $1,000 to $2,000.

- Five respondents (four builders and one sales agent) said buyers would be willing to pay 25% or less. Three respondents (all builders) said they would pay 50%. Nine said they did not know.

While a number of builders said they did not think buyers would pay much if any of the additional costs of higher efficiency, two builders and several other respondents said buyers would often pay for home options they considered more "tangible" or "glitzy." One of the Title 24 consultants remarked that buyers will not uncommonly "drop [$2,000] without batting an eyelash" on something like French doors, at least in the higher-end homes. This last comment suggests, as discussed in the market characterization report, *that cost is not the barrier to higher efficiency*. In other words, there are factors other than cost that bear on buyers' decisions about what features they decide to include in their homes.

These findings seem consistent with the available secondary sources (see Appendix A). In Northern California, 73% of new home buyers stated that they wanted an "environmentally friendly" home, but only 22% said they would be willing to pay more. The same figures for Southern California are 66% and 19%.

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[12]See the "Other Issues" section for a discussion of how participants and nonparticipants compared in their estimates of incremental cost.

Our findings regarding whether builders were building to exceed code were also an indirect indication of builders' perception that there is increased buyer demand for energy efficiency with respect to other desirable home characteristics. We describe two builders below whose decisions to build homes exceeding code are, we believe, indicative of a belief that buyer demand has increased and will last. While other builders were also building to exceed code, as is described below in the section on builders' split incentives, these two particular builders are the only ones whose stories appeared to speak directly to buyer demand. We will describe these stories in detail in this section, and then refer to them later.

One builder (SCE-P-1) reported that in the early 1990s, he surveyed buyers who had purchased his company's homes in the past. In 1993, based on the survey results, the builder completely redesigned its homes, creating what the company calls the "Custom New Value Series." The company currently builds a little over 700 of its 1,000 homes under the new design; by 1999, the company plans to build all its new homes based on this design. According to the builder, the homes cost the same as his competitors', but use 11% less than the allowed energy budget (as measured by the company's own monitoring results).

Apparently, the company's survey of former buyers revealed that they wanted "quality and functionality." While this would seem to be a given, according to the respondent the features requested were quite different in some ways from homes currently on the market. For example, buyers said they wanted standard eight-foot rather than vaulted ceilings for comfort (i.e., reduced drafts, easier heating). They also did not want a third garage because it ended up being cluttered; rather they wanted workshop space. Although this was a survey of his own customers, he must believe their opinion is fairly representative of customers in general as he designed his new homes around the survey results.

It is not clear whether this builder asked survey respondents directly about specific energy-efficiency features. The builder did say the new home design includes higher levels of wall insulation, SEER 12 air conditioning, higher AFUE furnaces, water heater blankets, more insulation on water pipes than required, ceiling insulation to exceed code (R-30), extra duct insulation (similar to a thin R-11 insulation) and butyl tape, additional foundation insulation, and a method of installing fiberseal around the windows that allows for the application of a continuous bead of material. The respondent also said that the eight-foot ceilings helped make the homes efficient.

When asked what the main reason was that he included the energy-saving features described above, he said "to market to the prospective buyer an energy-efficient

home." The builder said the homes were not redesigned as a direct result of the program and that his company's homes exceeded code even before the program started. However, he commented that he had "learned from the dialogue with Edison."

The builder said that despite the addition of these energy-saving features, the overall cost per square foot was kept competitive through innovative design that streamlined production. For example, the company only uses two sizes of large windows plus a smaller window for bathrooms. If a buyer wants larger windows, the builder puts two of the large windows together. Specialized exterior features such as bay windows are eliminated to reduce costs. The home plans are designed to accommodate only complete, 4-foot by 8-foot sheets of exterior sheathing; so custom cuts do not have to be made on site. Ceilings are made a standard 8-feet in response to buyers saying they did not want vaulted ceilings. Bathrooms are "stacked" one above the other; they are built in the same location on both the first and second floors, so they can share plumbing lines and vent stacks.

The respondent said that, because the homes cost the same as their competitors' and yet were more energy efficient, "buyers' perception is that they are getting something extra at no extra price." He said the company specifically markets the energy-efficiency features by effectively communicating how much the buyer will save in the long run. Further, he said that even if the homes were to cost $50 to $250 more at savings of 10% more than code, buyers would be willing to pay 100% of that additional cost. However, as his homes did not cost more, he had obviously not put this theory to the test.

Does this builder's belief that buyers will purchase these new homes provide evidence of an increase in buyer demand for energy efficiency? Clearly, this builder believed energy efficiency and comfort (reduced drafts) were home characteristics his buyers wanted, and a characteristic he believed would sell well. If this was not the case, he would probably just meet code and either reduce the price of the homes or sell them at the same price and pocket the profit. He said the extra energy efficiency was part of a larger strategy to market the homes as "high value." This interview also challenged what most other builders believed about buyers in terms of their sole focus on "tangible" home features.

One other builder (SCE-P-4) was also designing, marketing, and selling homes that exceeded code. Again, we will describe this builders actions in detail in this section and then refer back to them. Over the last two years, his company has constructed about 50 homes per year (25% of the company's total homes) that include a number of features beyond code. The company is building these homes in Rancho Santa Margarita and Del

Mar, two new areas the company is developing. The respondent did not know the percentage of savings above code, but the features included were:

- SEER 12 A/C;
- Argon-filled vinyl windows;
- Ductwork in the insulated spaces;
- R-15 in the walls; and
- "Good job management" including duct blasting.

The respondent estimates the additional measures cost the buyer about $1,000 to $1,500. The company markets the homes by setting up displays in the model homes that describe the features. They also provide buyers with payback tables and talk with them directly about the home's energy-saving features. They said buyers seem "pleased but aware of the extra cost."

He says the company's decision to develop a higher-efficiency home was influenced by the Edison's program, which raised their awareness. He anticipates they will continue installing SEER 12 equipment and the ductwork in the insulated space.

This same builder has also just completed one a pilot home in a subdivision that exceeded code. The pilot home exceeding code includes:

- SEER 13 A/C;
- 90% AFUE furnace;
- Azure light windows;
- Ductwork in the insulated spaces;
- Furnace in the insulated space;
- R-15 in the walls; and
- Good job management (including duct blasting).

According to the respondent, these measures would add $2,000 to $3,000 to a home's cost. However, in terms of overall cost, if these pilot homes go into production, he says they will not be high-end homes. They will average about 1,500 square feet at a cost of about $105 per square foot, for a total of about $158,000. One way the builder is trying to keep overall costs down is by teaming with an HVAC manufacturer willing to offer a lower price on high-efficiency HVAC equipment if it is purchased in bulk.

The pilot home that exceeds code was built next to another home that only meets. The latter has a 71% AFUE furnace, a 10 SEER air conditioner, and the duct system installed in the attic. An independent company is conducting testing in each home,

including duct blasting and monitoring of energy usage. A study comparing the two homes' performance will be available shortly. For future reference, the builder is also having his Title 24 consultant (one that we interviewed) look at the ductwork configuration from a "theoretical perspective," using modeling to see what additional savings might be achieved. He says so far, "We like what they're coming up with."

Because this is still in the testing phase, the company does not yet know how many, if any, of these more advanced homes they will develop. The company is looking into the possibility of offering the high-efficiency features as an option, or using energy-efficiency mortgages as a tool. However, he said he is "very wary" of energy-efficiency mortgages because they require the homes be certified. He says this is costly and means getting state and federal governments involved.

In talking to the two builders whose stories are described above (SCE-P-1 and SCE-P-4) we believe they perceived sufficient current or potential demand from home buyers for homes that exceeded code to justify taking some calculated risks to see how buyers responded.

Finally, we should also mention that four of six HVAC subcontractors said they installed air conditioning equipment that exceeded code in a very small number of high-end tract homes and custom-built homes each year. (One subcontractor said he did 10 per year out of 2,200 installations; another said he did 50, but did not know the total number of installations his company does per year).

A summary of these findings as they pertain to the homeowner information-related barrier is provided below.

Summary of Findings for Homeowner Information-Related Barriers

Hypothesized Market Effect:
Increased homeowner demand for energy efficiency, especially with respect to other desirable home characteristics.

Existence and Magnitude:
There is some indirect evidence of a market effect. The evidence is indirect because we did not talk to buyers themselves. While surveys results indicated that respondents perceive buyer demand for features exceeding code as weak (only 27% of respondents believed there was "a lot" or "some"), two builders were moving aggressively toward exceeding code as part of a larger marketing strategy (SCE-P-1 and SCE-P-4). 63% of respondents indicated that they thought buyer demand for energy-saving features has generally increased over the past five years, although this result does not specifically concern measures that exceed code.

Change in Market Barrier:
Slight reduction. Respondents said buyer awareness had increased over the last five years but that demand for features exceeding code was weak. Respondents indicated buyers still did not have access to information to determine the actual energy and savings benefits from particular measures.

Likelihood of Lasting:
Likely permanent. If even two builders are doing long-term planning of homes that include features exceeding code, they likely believe buyer demand for homes with energy-efficiency features exceeding code will last.

Attribution:
Two of 15 PG&E respondents who said general buyer demand for energy-saving features had increased, attributed it to PG&E's program. One also mentioned PG&E's bill stuffers. None of the Edison respondents mentioned Edison's program, although one mentioned Edison's advertising. For the two builders' building to exceed code (SCE-1 and SCE-4), one said the Edison program had increased their awareness of energy-saving features and led them to explore incorporating energy-saving features exceeding code. The second said his dialogue with Edison generally had been helpful, but did not attribute his decision to design high-efficiency homes directly to the program. Thus, we assigned partial attribution to this builder's actions.

BUILDER SALES AGENT/REALTOR INFORMATION RELATED BARRIERS

In the market characterization report, we identified the key market barriers for realtors and sales agents as: lack of awareness, insufficient information, and bounded rationality. The specific program interventions undertaken to reduce those barriers were: (1) information packets; and (2) training.

Hypothesized Market Effect: Increase in builder sales agent realtor knowledge with respect to energy efficiency and its benefits.

One hypothesized market effect indicating a reduction in the builder sales agent/realtor information related barrier would be an increase in these players' knowledge concerning energy efficiency and its benefits.

Based on our interviews, builder sales agents have easy access to basic information on a home's energy-saving features and often share this information with home buyers. This information can come from the builder's company, and can be contained in the sales contract, the features sheet, or the homeowners manual. The information can also come from PG&E as the Comfort Home program is still operating. Four builders sales agents mentioned their source of information was the building company, while two mentioned using PG&E's brochure. They did not have as easy access, however, to some of the more technical information, such as SEER levels and AFUE. They also didn't share this more technical information very often with buyers. Several of the builder sales agents said they would have to look up this information or call the subcontractor. Finally, sales agents indicated they rarely had access to information on the duct installation methods used, and do not share it with homeowners.

These conclusions were drawn from a series of questions we asked builders sales agents and realtors about energy-related information. We asked a series of three questions:

(1) How often they had access to certain categories of energy related information

(2) How often they shared that information with buyers

(3) How often buyers asked about various energy related information before the agent had brought it up

These questions were asked about each of the following:

- The home's energy-saving features, such as double-paned windows and insulation;
- Efficiency rating of the air conditioning system;
- Efficiency rating of the heating system; and

- Techniques used to install the ductwork for the heating and cooling systems.

A summary of responses is provided in Table 9 below.

Table 9
BUILDER SALES AGENT AND REALTOR ACCESS TO ENERGY-RELATED INFORMATION

Information	How often do you have easy access to info?	How often do you tell the buyer?	How often does buyer ask before you've discussed?
Home's energy-saving features	Almost always	Almost always	Occasionally
Efficiency rating of A/C	Information usually available but more difficult to obtain	Infrequently	Very rarely
Efficiency rating of heating system	Information usually available but more difficult to obtain	Infrequently	Very rarely
Techniques to install the ductwork	Information rarely available and very difficult to obtain	Almost never	Never

In addition, we asked builder sales agents if they had access specifically to written information on the home's energy-saving features. Of the four sales agents in PG&E's territory, all said they did. Two said the information is in PG&E's brochure; the other two said the information comes from their own company. Three of the Edison sales agents said they have written information. Two said the information was provided in their company brochure, while one said the information was provided in the homeowner's manual.

The main source of information for realtors is in the multiple listings. The listing has, in some areas, recently added lines for energy-related items such as insulation, double-paned windows, solar water heating, and dual-zone A/C. Eight of ten realtors were aware that this information was available. The information listed likely varies by area.

Based on our conversations with builders, one potentially important piece of information realtors and sales agents do not have is on payback for energy-saving

features that exceed code (i.e., information directly relating the incremental cost of a measure and its expected impact on energy bills). Yet this is a source of information cited by three builders and one Title 24 consultant as critical to persuading the buyer to buy energy-saving features that exceed code.

There are two reasons this information is not readily available. First, builders are reluctant to provide those kinds of absolute savings projections to customers because there are a number of confounding variables, such as the number of occupants and their behavior. Second, few builders design to exceed code so builder sales agents have little occasion to use such information.

We also noted that while PG&E has builder sales agent training available, none had heard of it or participated in it.

Hypothesized Market Effect: Increase builder sales agent and realtor promotion of energy efficiency.

A second hypothesized market effect that would indicate a reduction in the builder sales agent and realtor information-related barrier would be an increase in these players' promotion of energy efficiency.

The builder sales agents do discuss the homes' energy-related features with buyers. However, because few builders design to exceed code, sales agents have had limited opportunity to market features that exceed code, except within the context of utility programs. Therefore, it is difficult to assess whether there is clear evidence of any change in the degree to which they promote energy efficiency to buyers.

A summary of these findings as they pertain to the homeowner information-related barrier is provided below.

Summary of Findings for Sales Agent & Realtor Information-Related Barrier

Hypothesized Market Effects:
(1) Builder sales agent and realtor knowledge with respect to energy efficiency and its benefits.
(2) Builder sales agent and realtor promotion of energy efficiency.

Existence and Magnitude:
(1) Some evidence. Both builder sales agents and realtors have access to information on basic energy-saving home features. For builder sales agents, some of the information includes program literature (i.e., the program brochure). They do not have as easy access to more technical information on efficiency levels and ductwork installation methods, and have no access to information on payback.
(2) Some evidence for builder sales agents. Builder sales agents we talked to have not had the opportunity to actively promote homes outside the program that exceed code because there are few being built at this time. However, they say the concept of energy efficiency has become more integral to their sales pitches. Realtors we talked to (as well as realtors in general) tend to focus on selling existing homes and said the issue of whether a home exceeds code or not rarely comes up.

Change in Market Barrier:
Slight limited reduction.

Likelihood of Lasting:
Likely permanent. These changes are likely to last given the sense respondents have that general awareness of energy-saving features has increased, and the fact that a few builders are building homes to exceed code. Also, the multiple listing now including some energy-saving features is another indication of permanence.

Attribution:
The responding builder sales agents were all program participants. Thus, it is reasonable to attribute some of their current knowledge of energy-saving features to the program as they are selling program homes and distributing program brochures. We could not say with confidence the program has influenced how sales agents sell homes outside the program. We do have evidence that both participating and nonparticipating builders usually provide information on the home's energy-saving features in their general informational brochures.

LENDER PRACTICES BARRIERS

In the market characterization report, we identified the key market barriers for lenders as being practice-related. The specific interventions undertaken to reduce those barriers were promotion of energy efficiency mortgages, and discounts off closing costs. The hypothesized market effect that would indicate a reduction in these barriers would be the increased awareness of, availability, and sales of energy-efficiency mortgages.

Although we did not talk to lenders directly, we did ask realtors and builders' sales agents about energy efficiency mortgages.

Hypothesized Market Effects: Increased awareness of, availability, and sales of energy-efficiency mortgages.

We initially defined an energy-efficiency mortgage as a specific product of the mortgage company, and is sold as such.

Among the nine builders sales agents, four (two from each utility's territory) indicated they had heard of energy-efficiency mortgages. Upon closer questioning, we discovered the two agents in PG&E's territory were referring to using the higher efficiency of PG&E's program homes as a way to get buyers a better loan ratio on standard mortgages. We decided to broaden our definition of energy efficiency mortgages to include this approach since both allow buyers to borrow more money in the assumption that energy bills will be lower.

One respondent—a builder sales agent from PG&E—reported that while they had not been involved directly, they were aware that a lender in one of their company's areas was using the strategy described above (getting a better loan ratio on a standard mortgage) for buyers of program homes in 1994 to help them qualify in one particular geographic area. The respondent did not know how many sales of this type were transacted and did not know whether the use of this approach had increased.

A second builder sales agent in PG&E's territory said they had heard of energy-efficiency mortgages, again using the same description as above. He said all of his company's sales of program homes were transacted this way. Regarding whether the use of this approach had increased, he said yes, in the sense that the PG&E program has not always been available.

One builder sales agent in Edison's territory said a lender had called randomly this year on one sale to suggest an energy-efficient mortgage of some kind, allowing for a discount on the loan to help a buyer qualify. He was not able to provide further details.

A second sales agent in Edison's territory said he'd heard of energy-efficiency mortgages "in the sense that our homes qualify for FHA loans and get a lower ratio because they meet certain energy-saving criteria." He did not know what those criteria were, but suggested we call the mortgage company his builder works with. We did so, and the lender explained that in California, the home simply has to meet code to meet

the FHA "energy-saving criteria." It does not have to exceed code presumably because California's code is relatively strict compared to other states. The home also has to be priced at less than $158,000. (When asked whether she had ever used an energy-efficiency mortgage that allowed the buyer to qualify for a larger loan, she said she had not).

The type of FHA loan described above became available in 1992. The sales agent said they had only started using them over the last two years or so because his builder is repositioning the company to sell lower-priced starter homes. He said they had sold 100 to 200 such homes over that two-year period. We consider this evidence of increased awareness of the use of energy efficiency as a lending tool. However, because the homes do not have to exceed code to qualify, we do not consider this to be evidence of increased sales or availability of energy efficiency mortgages even using the broader definition described above.

Among the ten realtors, three had heard about energy-efficiency mortgages. None had directly used them in transactions, but one said his co-workers had. None knew whether their availability had increased, although one guessed it had. They did not provide details on how those mortgages were structured.

We also talked to one builder (SCE-P-4, mentioned in the previous discussion about buyer demand) who said they were considering using energy-efficiency mortgages in selling their new line of high-efficiency homes. However, he said he is "very wary of energy-efficiency mortgages" because, to qualify, the home must be certified. He says this requires state and federal involvement and adds to the cost of the transaction.

A summary of these findings as they pertain to the homeowner information-related barrier is provided below.

Summary of Findings for Lender Practices Barrier

Hypothesized Market Effects:
(1) Increased awareness of energy-efficiency mortgages.
(2) Increased availability of energy-efficiency mortgages.
(3) Increased sales of energy-efficiency mortgages.

Existence and Magnitude:
The followings findings reflect our decision to broaden our definition of energy efficiency mortgages to include the use of the higher efficiency of program homes as a way to get buyers a better loan ratio on standard mortgages.
(1) Some indirect evidence of increased awareness of energy-efficiency mortgages. Four of nine builder sales agents, and three of ten realtors, had heard of them. The evidence is indirect because we did not talk to lenders.
(2) Some indirect evidence of increased availability as two PG&E builder sales agents said energy efficiency is now routinely used as a tool in selling program homes, and one Edison sales agent was contacted by a lender regarding energy-efficiency mortgages. One realtor said his co-workers have used energy efficiency mortgages. (Also, the FHA reportedly started using energy efficiency in 1992 as a tool to qualify buyers, although in California homes only need to meet code to qualify rather than exceed, presumably because the code is relatively strict compared to that of other states.)
(3) Some indirect evidence of increased sales of energy-efficiency mortgages (see [2] above).

Change in Market Barrier:
Some reduction.

Likelihood of Lasting:
We believe that awareness of using energy efficiency as a tool to get a better loan ratio will likely last because even larger agencies such as the FHA are now using this strategy (although, as pointed out, homes need only meet code to qualify). It is unclear whether the use of energy efficiency *over* code as a qualifying tool for buyers will continue after PG&E's program ends, as the only reported use of this practice was in the sale of program homes.

Attribution:
We can attribute some of the increased awareness and use of energy-efficiency mortgages, as more broadly defined above, to PG&E's program. Two builder sales agents report that the energy efficiency of program homes is routinely used to help buyers qualify through an improved loan ratio.

BUILDER SPLIT INCENTIVES WITH REGARD TO SPECIFYING ENERGY EFFICIENCY IN HOME DESIGN

The key barrier to builders' specifying energy efficiency in home design were split incentives. That is, builders do not see financial benefits from installing measures that

exceed code. The specific interventions undertaken to reduce those barriers were builder incentives, and standards for ductwork installation.

The hypothesized market effects that would evidence the reduction in these barriers would be:

- Builder belief that energy efficiency increases a home's marketability sufficiently to justify its additional cost.
- Builders designing and building homes on their own that are more energy efficient than Title 24.
- Builders marketing homes as energy-efficient homes on their own.
- Title 24 consultants reporting percentage efficiency above Title 24 rather than simple pass/no pass.

Hypothesized Market Effect: Builder belief that energy efficiency increases a home's marketability enough to justify its additional cost.

We looked for evidence of this hypothesized market effect both in builder's reported perceptions of buyer demand, and in builder's actions.

We asked builders about their perceptions of buyer demand for energy-saving features in general and about energy-saving features that exceed code. While the sample is small, respondents believe buyer demand for energy-saving features in general is higher than buyer demand specifically for energy features that exceed code.

When asked whether buyer demand for energy efficiency in general had increased, decreased, or stayed the same over the past 5 years, nine out of twelve participants interviewed said demand had increased. However, only two of the nine nonparticipants said it had increased. Five said demand had stayed the same, and one said it had decreased.

In examining builders' actions, we found some limited evidence of this market effect among participating builders in Edison's and PG&E's territories. Nonparticipating builders showed no evidence of such an effect. Title 24 consultants in both territories confirmed that very few builders are building to exceed code because they are extremely cost-sensitive due to the recent recession (see "Other Issues" section).

These findings are supported by the AHP results. The relative importance of energy efficiency in home marketability, compared to other home attributes, increased 5.9% based on participants' perceptions, as measured by the AHP. Their relative importance decreased 4.0%, based on nonparticipants' perceptions.

PG&E Territory

Participants

We asked the first builder (PG&E-P-1) whether his company, which builds about 200 homes per year, had ever built homes that exceeded code outside the program. He said that before his company began participating in the program, they started installing R-19 rigid foam insulation in their homes walls to exceed code as a marketing tool at a cost of about $200 per home. This provides evidence of a market change but not a market effect as we have defined it, as the change could not be attributed to the program.

This builder also said that as a result of the program, he switched from using rooftop units to using a dual zone system. However, he says he made the change because the dual zone system was less expensive than the rooftop units, not because it was more energy efficient. The hypothesized market effect as stated above is change in builder belief that energy efficiency increases a home's marketability sufficiently to justify its additional cost. This builder's actions do not show evidence of this market effect because the builder reported that (1) the decision to install R-19 insulation was made before he participated; (2) the switch to a dual-zone system did not involve any additional cost.

The second builder (PG&E-P-2) said that as a result of the program he had started installing stubs for a gas stoves in all the homes he builds. While he said the feature was offered as an amenity to improve marketability, not because it saved energy, it nevertheless was adopted as a result of the program and costs the buyer an additional $30 per unit. Therefore, we consider this evidence of a market effect, albeit limited because the additional cost is relatively minor. He also said he would continue the program duct installation methods even if the program was discontinued. He was not specific about the costs involved.

We should also note that this builder at first said he was building to exceed code outside the program. However, upon closer questioning, it turned out this was only for the more favorable geographic orientation in a particular project. That is, in order for the builder's plan to comply with code in the worst orientation, the energy-saving

features had to be enhanced. As result, the homes in the other three orientations exceeded code by some amount, although he did not know how much. This issue is discussed in more detail in the section "Other Issues."

A third builder (PG&E-P-3) said they had changed their duct installation methods as a result of the program, although said the change did not cost them anything extra. We happened to interview this builder's HVAC contractor. The HVAC contractor said that builders had been very resistant to paying the additional incremental cost for mastic sealing (about $100), but the HVAC subcontractor had been concerned about liability issues, and so had decided to cover the additional cost himself. It is unclear why the HVAC contractor decided to do this, although perhaps because this builder is one of the largest builders in the country, and the HVAC contractor did not want to lose them as a customer.

A fourth builder (PG&E-P-4) also said they had changed their ductwork installation methods. However, the respondent said his company would not continue to use these methods if the program ended, so this does not provide evidence of a market effect.

The fifth participating builder we talked to (PG&E-P-5) said his company built a total of 50 homes each year. He said each year 25 of those were built and rebated under the PG&E program because they are in PG&E's territory. The other 25 were built in a different utility's territory, and therefore cannot be builder under the program. Nonetheless, the company is still building these homes to PG&E's program standards for consistency.

The respondent said the company was not passing the additional costs of meeting the program standards outside PG&E's territory on to buyers (estimated by the builder to be $1,000), but was absorbing the cost. When asked if he would continue to build homes that exceeded code if the PG&E program were to end, he said he would, but would still not pass the cost along to buyers. We were surprised by this assertion, but when we made a follow-up call to the builder, he confirmed his statement. He also mentioned that since 1990, the company's HVAC contractor had made changes to the way duct work is installed in the homes, switching to butyl tape and using mastic to seal the ducts. He indicated he will continue all these practices in the future.

A summary of the above discussion is provided in Table 10. As shown, two builders, PG&E-P-2 and PG&E-P-5 suggest evidence of this market effect.

Table 10
PG&E BUILDERS—SUMMARY OF MARKET EFFECT
Builder Belief that Energy Efficiency Increases a Home's Marketability Enough to Justify its Additional Cost

Builder ID	Change in Practices[1]	Evidence of Market Effect?	Likely to Last?
PG&E-P-1	R-19 rigid foam in walls to exceed code	No-practice change not program-induced	N/A
	Change from roof A/C to dual system	No-although he learned of the measure through the program, it did not involve additional cost	N/A
PG&E-P-2	Installing gas stove stubs	Yes-says he started installing as result of program; costs $30 more per home	Yes-as reported by the respondent
	Using program duct installation methods	Unclear; builder was not specific about costs involved	
PG&E-P-3	Change to mastic sealant in ductwork install	No-change made a result of program but builder is not paying for this service	N/A
PG&E-P-5	Building to program standards outside PG&E's territory	Yes-change made because of program and involved additional cost	Yes-as reported by the respondent

[1]"Changes in practices" for purposes of this summary table are defined as the installation of measures exceeding code in homes built outside the program, or the implementation of duct sealing and testing, and gas hookup installation, measures promoted by PG&E's program but not currently covered by code.

Nonparticipants

Among the five nonparticipants in PG&E's territory interviewed, representing about 3,250 new homes built per year, none expressed a belief that energy efficiency increases a homes marketability sufficiently to justify additional cost, and none reported building homes that exceeded code.

However, similar to the case described above, one builder (PG&E-NP-1) at first said he was building to exceed code by installing R-30 ceiling insulation. Upon closer

questioning, it turned out the home overall still only met code in terms of the allowed energy budget.

When asked why they had never built homes to exceed code, the nonparticipants all said because of cost. As one builder remarked, "The market is too price sensitive. Everything's a trade-off when you're meeting code." Another said, "[The builder] can't recover his cost [to exceed code] through an increased sales price."

These results are supported by secondary data sources reviewed. For example, the 1996 Customer Decision Study (Edison) revealed that "high-efficiency options are valued by builders comparatively little. This result reflects the fact that builders generally do not obtain the savings that accrue after the building is sold."

Edison Territory

Participants

Among the seven Edison builders interviewed who had participated in the program, the practices of two showed evidence of change in builder belief that energy efficiency increases a home's marketability sufficiently to justify its additional cost.

One respondent in Edison's territory, SCE-P-1 (described at length in the report section titled "Home Owner-Information Related Barriers") presents a challenge in determining whether it provided evidence of this particular market effect. We concluded the builder did provide evidence of this market effect, although we assigned only a partial attribution to the program for his actions.

To recap, SCE-P-1 began building homes in 1995 based on a completely new design called the "Custom New Value Series." The design was strongly influenced by the results of surveys conducted in the early 1990s of the company's previous home buyers. According to the builder, the new home design is no more expensive on a per square foot basis than those of competitors; yet, based on his company's monitoring of usage, it uses 11% less energy. The company currently builds a little over 700 of its 1,000 homes based on this new design. By 1999, it will build all its homes under this design. The builder said the homes were not redesigned as a direct result of the program, and that his company's homes exceeded code even before the program started. However, he commented that he has "learned from the dialogue with Edison."

One might conclude that the builders' actions were not evidence of a market effect because the respondent said his homes did not cost more than his competitors' on a per square foot basis. Therefore, one could argue it did not appear to show "Builder believes energy efficiency increases a home's marketability enough to justify its additional cost." However, in asking about the design of the home in more detail during a follow-up call, it became clear that through innovative design, the company has been able to cut other material and production costs, so high-efficiency features could be added to the overall design package without adding to the price.

Hence, we concluded this did show evidence of this market effect in a sense there was certainly an additional "cost" for the added energy-saving features, but the builder reduced costs in other areas to keep the overall cost low.

The other builder that showed evidence of this market effect is SCE-P-4. This builder is described at length in the report section titled "Home Owner-Information Related Barriers." To recap, each year this builder is building 25% of their 250 homes to exceed code, including SEER 12 furnaces, argon-filled windows, R-15 wall insulation, ducting in the heated space, and duct blasting. They estimate the additional measures cost buyers $1,000 to $1,500 more per home. They are also pilot testing an even more efficient home that includes SEER 13 A/C, a 90% AFUE furnace, and azure light windows at an additional cost of $2,000 to $3,000. He says the company's decision to develop higher efficiency home was influenced by dialogue with Edison, thus we said his actions were partially attributed to Edison's program.

A summary of the above discussion is provided in Table 11.

Table 11
EDISON BUILDERS—SUMMARY OF MARKET EFFECT
Builder Belief that Energy Efficiency Increases a Home's Marketability Enough to Justify its Additional Cost

Builder ID	Change in Practices[1]	Evidence of Market Effect	Likely to Last?
SCE-P-1	Exceed: New home design w/ many features exceeds by 11%	Yes-cut costs elsewhere to include energy efficiency features; partial attribution (dialogue with Edison)	Yes-as reported by builder
SCE-P-4	Exceed: SEER 12, ducts in insul. space, etc.	Yes-involved additional cost and changes made as result of program	Yes-as reported by builder

[1]"Changes in practices" for purposes of this summary table are defined as the installation of measures exceeding code in homes built outside the program.

SCE-P-3 showed evidence of market change, but not market effect, as the practice changes were not program-induced. The builder reported that they install dual-paned windows on all their rather than just some of their homes' windows, a practice acceptable under Title 24 requirements.

We should also point out that two builders (SCE-P-6 and SCE-P-7) at first said they were building to exceed code outside the program. However, upon closer questioning, it turned out that one builder did this because he had several designs he was using for one development. One did not meet code, so energy-saving features had to be upgraded. For consistency within the development, he upgraded the other designs as well. As result, technically speaking, the other two designs exceeded code by some amount.

Nonparticipants

Among the four Edison territory nonparticipants interviewed (representing about 1,000 new homes built per year), none expressed a belief that energy efficiency increases a homes marketability sufficiently to justify additional cost, and none reported building homes that exceeded code.

Hypothesized Market Effect: Builders are designing and building more energy-efficient homes Title 24 requires.

PG&E Builders

Participants

Most of the results pertinent to this market effect are discussed in the section above on change in builder belief (see Table 10). However, we came to a different conclusion regarding this market effect for PG&E-P-1 and PG&E-P-3. As this market effect does not speak to the issue of builder belief regarding additional cost, we considered these builders' adopting measures that were more energy efficient evidence of this market effect, even if they did not cost the builder more. The summary of our findings for this market effect is shown in Table 12 below. Changes from Table 10 above are indicated in italics.

Table 12
PG&E BUILDERS—SUMMARY OF MARKET EFFECT
Builders are designing and building more energy-efficient homes than Title 24 requires.

Builder ID	Change in Practices[1]	Evidence of Market Effect?	Likely to Last?
PG&E-P-1	R-19 rigid foam in walls to exceed code Change from roof A/C to dual system	No—practice change not program-induced *Yes—reports he learned about system through program*	N/A Yes—builder says he will continue
PG&E-P-2	Installing gas stove stubs Using program duct installation methods	Yes—says he started installing as result of program; cost $30 more Yes—unclear on costs but learned about methods through the program	Yes—as reported by the respondent
PG&E-P-3	Changed to mastic sealant in ductwork install	*Yes—change made as result of program*	Yes—as reported by the respondent
PG&E-P-5	Building to program standards outside PG&E's territory.	Yes—change made because of program	Yes—as reported by the respondent

[1]"Changes in practices" for purposes of this summary table are defined as those resulting in homes constructed outside the program that exceeded code overall, or duct sealing and testing, and gas hookup measures promoted by PG&E's program not currently covered by code.

Nonparticipants

Among the five nonparticipants in PG&E's territory interviewed, representing about 3,250 new homes built per year, none reported building homes that exceeded code.

Edison Builders

Participants

Two builders (SCE-P-1 and SCE-P-4) showed evidence of this market effect (see the previous section for more detail).

Nonparticipants

Among the four Edison territory nonparticipants interviewed (representing about 1,000 new homes built per year), none reported building homes that exceeded code.

Hypothesized Market Effect: On their own, builders are marketing homes as energy-efficient homes.

Two builders, SCE-P-1 and SCE-P-4, were specifically marketing homes as energy efficient on their own.

SCE-P-1, who designed the "Custom New Value Series" described in the sections above, was marketing his homes as having certain "value-oriented" features, some of which are its energy-saving features which exceed code. Thus, although the builder is not marketing the homes as energy efficient per se, he is marketing energy efficiency as one of their important features.

The homes built by SCE-P-4 which exceeded code were also being marketed as energy efficient by the builder. The builder marketed the homes by setting up displays in their model homes describing the energy-saving features. The builder also provided buyers with payback tables and talk with them directly about the home's energy-saving features.

This builder was also in the process of building a pilot home to look at the salability of measures that exceed code. If the builder decides to develop the home as one of his designs, he will market these homes as energy efficient. He is considering using energy-efficiency mortgages in selling the homes.

A third builder, PG&E-P-1, who builds his homes with R-19 insulation in the walls, said he uses this as a "marketing tool" when selling the homes. However, this cannot be attributed to the program as he said he started this practice before PG&E's program started.

The other builders, even if they exceeded code, did not report specifically marketing this fact.

Hypothesized Market Effect: Title 24 consultants now report percentage efficiency above Title 24 rather than simple pass/no pass.

None of the Title 24 consultants interviewed said they report percentage efficiency above Title 24, although some said their computer equipment is capable of doing so. All asserted their role is to help the builder meet code in the least costly way. If a builder exceeds code on one home feature, the consultants said, they will tell the builder where he can cut down on another feature to save money.

For example, if a builder installs vinyl-framed windows rather than aluminum-framed windows for marketing purposes (so the windows save more energy), the Title 24 consultant will tell him whether he can reduce the R-value in the ceiling insulation and still meet the energy budget.

A summary of these findings as they pertain to the homeowner information-related barrier is provided below.

Summary of Findings for Builders Split Incentives with Regard to Specifying Energy Efficiency in Home Design

Hypothesized Market Effects:

(1) Builders believe energy efficiency increases a home's marketability enough to justify its additional cost.
(2) Builders designing homes more energy efficient than Title 24 on their own
(3) Builders marketing homes as energy-efficient homes on their own
(4) Title 24 consultants report percentage efficiency above Title 24 rather than simple pass/no pass.

Existence and Magnitude:

(1) Some limited evidence of an increase in belief. The actions of two PG&E builders (PG&E-P-2 and 5) and two Edison builders (SCE-P-1 and 4) suggested evidence of this market effect. None of the nonparticipants showed evidence. The relative importance of energy efficiency in home marketability compared to other home attributes increased 5.9%, based on participants' perceptions, as measured by AHP. Their relative importance decreased 4.0%, based on nonparticipants' perceptions.
(2) Some limited evidence. Four PG&E builders (PGE-P-1, 2, 3, 5) and two Edison builders (SCE-P-1 and 4) showed evidence of this. None of the nonparticipants showed evidence.
(3) Little limited evidence of builders actively marketing homes more energy efficient than Title 24 on their own. Two builders reported this activity (SCE-P-1 and 4). A third (PG&E-P-1) was also marketing his homes as energy efficient but had not made the changes as a results of the program. None of the participants showed evidence.
(4) No evidence of market effect.

Change in Market Barrier:

Slight limited reduction.

Likelihood of Lasting

Likely to be permanent. All builders who show evidence of these market effects indicated they plan to continue to do so in the future. The only uncertainty emerged around a builder who built a high-efficiency pilot home; he is not sure his company will actual develop and sell it. Future changes to Title 24 could also impact builders' plans.

Attribution

Can be attributed to the programs for all builders that build to exceed code, except SCE-P-4, whose actions were partially attributed to the program (see discussion).

BUILDER INFORMATION/BOUNDED RATIONALITY BARRIER WITH REGARD TO SUBCONTRACTOR SELECTION

In the market characterization report, we identified the key market barrier for builders with regard to subcontractor selection as information and bounded rationality. The

specific interventions undertaken to reduce those barriers were incentives and standards for ductwork installation. The hypothesized market effects that would show a reduction in these barriers were:

(1) ***Builders have more information and experience with the ways subcontractors do or do not deliver on energy efficiency.***

(2) ***Builders are aware of the ways subcontractors cut corners and have developed safeguards against.***

Hypothesized Market Effects:

Assessing the evidence for these hypothesized market effects is somewhat complicated by the revised Title 24 standards going into effect in 1992. The code was made substantially stricter at that time, and required homes to meet a maximum energy budget. According to both builders and Title 24 consultants, builders consequently began working much more closely with their Title 24 consultants in assessing the various tradeoffs involved among measure options for meeting the code.

Builders began to incorporate new measures (such as tinted and vinyl windows, higher SEER A/C [usually SEER 12], etc.) as ways to meet code if, for example, they wanted to install extensive glazing or were building in a difficult climate zone. It would follow they would have gained new experience with subcontractors in developing these measures. Thus, it is difficult to discern how much of this effect (if evidence of it appears) is program induced.

However, because Title 24 does not specify how ducts are installed (and because PG&E's program does), we can isolate program-induced effects more easily. Based on discussions with HVAC contractors, PG&E's duct blasting and installation requirements have definitely helped increase builders' understanding of how their subcontractors' installation methods can affect energy efficiency. Southern California Gas's program has done the same in Edison's area.

Nevertheless, the subcontractors who have changed to duct sealing with mastic reported that most builders have been resistant to adopting this method because it costs an estimated $100 to $150 per home. In fact, some builders have simply said they would not pay for it. Rather than lose these builders as customers or risk liability from leaky ducts, one major HVAC contractor we interviewed has opted to cover the extra cost for mastic installation.

Even the possibility of liability has not swayed some builders. To provide some background, one HVAC contractor told us about a case in Southern California where a single-family homeowner successfully brought suit against a builder for not building to meet Title 24 standards. The homeowner apparently provided the court convincing proof of this and won a lump sum payment for 30 years of the incremental utility bill increase (plus inflation) that was estimated from having failed to meet code. However, the far more common type of lawsuits are those filed almost in a procedural manner to supposedly protect buyers even if no evidence of faulty construction appears. For example, suits have been brought against builders by condominium associations as a matter of course to keep the condominium owners from suing the association for not looking out for their best interests, even when there is no reason on the part of the association or the owner to believe something was wrong with the construction. One Title 24 consultant interviewed was hired by a group of builders to put on a training conference on liability issues that might arise with Title 24.

Four out of six HVAC contractors we talked to said they have talked to builders extensively about possible liability implications of leaky duct installations. They are highly motivated to inform builders of this, first because they want builders to cover the additional cost, and second because HVAC contractors themselves run the risk of possibly being sued. Nevertheless, contractors say builders continue to have an attitude of "out of sight, out of mind" when it comes to ductwork. He contended a lot of poor installation is done, but "builders just don't care." This was echoed by two other contractors we interviewed.

Among the 20 or so participating and nonparticipating builders we talked to our findings were:

- Two PG&E participants (PG&E-P-1 and 2) were using the program installation methods, but were not sure whether they would continue if the program were to end; so we did not consider them evidence of a market effect.

- One participant (PG&E-P-4) said his company definitely would not continue if the program were to end.

- Three respondents (PG&E-P-2, 3, and 5) indicated they would continue using the more advanced duct sealing methods. One respondent (PG&E-P-3) said the contractor had made the change "of their own volition," and the builder was not paying for any additional cost.

The fact that 3 out of 20 builders actually adopted new methods reflects 1 HVAC contractor's estimate that only 10% of builders he worked with in Southern California were willing to continue to pay for mastic sealing after the Southern California Gas program ended.

Thus, we conclude that builders have more information on and experience with duct installation methods as a result of their subcontractors experience with PG&E's and Southern California Gas's duct blasting program. Some builders are acting on that information by permanently adopting mastic duct installation methods.

Summary of Findings for Builder Information/Bounded Rationality Barrier with Regard to Subcontractor Selection

Hypothesized Market Effects:

(1) Builders have more information and experience with the ways subcontractors do or do not deliver on energy efficiency.

(2) Builders are aware of the ways subcontractors cut corners and have developed safeguards against these.

Existence and Magnitude:

(1) Some evidence of an increase in information. According to HVAC contractors in both territories builders do have more information at least on duct work installation methods.

(2) Some limited evidence of builders acting on this information. Three participating builders we talked to said they use tighter duct installation methods (PG&E-P-2, 3, and 5). Based on our conversations with HVAC contractors, it has been difficult to convince builders to change their practices and builders sometimes will simply not pay for the changes. This is confirmed by our finding that none of the nonparticipating were using these new methods.

Change in Market Barrier:

Slight reduction.

Likelihood of Lasting:

Likely to be permanent. For subcontractors who have adopted the methods, they will not or cannot go back to their old installation methods because of liability risks. Therefore, builders who have adopted the new methods will likely stick with them.

Attribution:

We can attribute increased awareness directly to PG&E's duct blasting program, based on what subcontractors have told us. In southern California, HVAC subcontractors attributed the increased awareness and any practice changes to the Southern California Gas program. We should also attribute some of permanence to the threat of liability.

SUBCONTRACTORS' LACK OF COORDINATION BARRIER

In the market characterization report, we identified a lack of coordination as a key barrier to energy efficiency. There were no specific program interventions undertaken to reduce these barriers. The market effect that would show a reduction in these barriers would be changes in practice that allow for better subcontractor coordination.

Hypothesized Market Effect: Changes in practices that allow for better subcontractor coordination.

In the following two critical areas, a lack of coordination can affect home efficiency:

- Providing adequate space for duct work
- Sizing the air conditioner

Obtaining and installing higher-efficiency HVAC equipment does not appear to present a coordination problem. If the builder specifies higher SEER equipment, it is specified in the contract, and the subcontractor simply obtains the equipment and installs it. The interviews confirmed the conclusions drawn that the ability to obtain energy equipment is not a problem. Note that in the AHP results there is an improvement in availability over the last five years.

Providing Adequate Space for Duct Work

Our interviews with HVAC contractors revealed some serious coordination issues around builders not providing adequate space for duct installation. If severe, these constraints can affect the overall efficiency of a system.

One contractor in PG&E's territory said 50% of homes have this problem. A second contractor from Edison said lack of space is an issue in "100%" of installations. He reports having to meet with the builder and architect to persuade them to make framing changes to allow for adequate space and is successful about 60% of the time. A third contractor from Edison's territory indicated that space is a problem in 80% to 90% of homes where he does installations. He said that lack of space was a "constant battle.... Everyone [i.e., other tradespeople] gets mad at HVAC subs because they want to use the spaces [needed for the ductwork] for plumbing and wiring. What if I told the plumber he'd have to squish his pipes down to one-half their size and the buyer would be taking cold showers?"

He said that the framers are slowly learning that they need to think about this when they frame, but the coordination needs to start from the beginning of the design stage with the architect, and this is not happening. He said his installers have to figure out how to get around the problems on a case-by-case basis. One of the PG&E contractors said, "The contractor makes the builder provide a way." This implies the builder must be prodded into providing adequate space.

Although we did not ask contractors if this problem had improved at all, the fact that they are reporting problems in 80% to 100% of cases suggests the problem is chronic and has not improved.

Sizing the Air Conditioner

Title 24 (engineered) calculations are a key issue, according to an HVAC contractor we interviewed. The builder works with the architect within his firm, who is then responsible for having the engineer do the calculations. Those calculations are passed to the Title 24 consultant. Sometimes the calculations are wrong, so the consultant has to check them. The Title 24 consultant may not notice these errors because many are undertrained; the state does not require them to be permitted. If the calculations are wrong but not noticed or corrected by the Title 24 consultant, the HVAC contractor can dispute them. If the HVAC contractor does not check them and they are included in the blueprints, the builder (and potentially the HVAC contractor) can end up being sued by the buyer.

Because this HVAC contractor was one of the last to be interviewed, we were not able to explore this issue with other respondents. However, a number of other comments related to coordinating the sizing. One HVAC contractor said that if drapes are assumed but the builder does not install them or the buyer does not use them, the air conditioning system, sized assuming drapes, will potentially be undersized. Similarly, if the builder changes the amount of glazing and does not adjust the calculations, final energy efficiency can be impacted. However, the Title 24 consultant should theoretically pick up on this, unless they are simply never consulted (which seems unlikely).

While we did not actually ask respondents how often this particular coordination problem came up, the sheer number of parties involved in a task such as sizing air conditioning may pose a threat to optimally sizing systems.

A summary of these findings as they pertain to the homeowner information-related barrier is provided below.

Summary of Findings for Subcontractor Lack of Coordination Barrier

Hypothesized Market Effects:
Changes in practices allow for better subcontractor coordination.

Existence and Magnitude:
No evidence of any market effect.

Change in Market Barrier:
No evidence of any change.

Likelihood of Lasting:
Not applicable.

Attribution:
Not applicable.

HVAC SUBCONTRACTORS PRACTICES BARRIER

In the market characterization report, we identified HVAC subcontractor practices as a barrier. The specific interventions undertaken to reduce those barriers were standards for ductwork installation, duct testing, and contractor training. The market effect that would indicate a reduction in these barriers would be changes in ductwork installation practices. As the interventions were undertaken only with PG&E's program, we would expect any evidence of market effects to be in their territory.

Hypothesized Market Effect: Changes in ductwork installation practices.

There was some evidence of this market effect in PG&E's territory. PG&E's program required participants to meet ductwork installation standards which, starting in 1993, included duct-blast testing. PG&E also offered HVAC subcontractor training in duct testing and installation methods. Edison's program did not require any specific practice changes. Accordingly, more evidence of relevant market effects might be expected in PG&E's territory than in Edison's. However, Southern California Gas's duct blasting

program ran from 1992 through 1994 and offered a $250 rebate for duct-blast testing and sealing to 100 CFM or less. Evidence exists that this program produced a result.

HVAC contractors said duct blasting was key to compelling them to improve their duct-sealing methods. The blast tests clearly showed that the ductwork, even when installed to code, was leaky. Based on respondents' comments, this realization amid subcontractors appeared to have had two effects:

(1) Respondents were surprised and perhaps a bit taken aback. They wanted to improve their installation methods, if for no other reason than as a quality issue. As one contractor said, "(We) felt word was out that old standards were substandard and should be corrected." They also remarked on the energy-efficiency implications. As one contractor said, "Can you believe that we lose billions through leaky ducts in this country every year?"

(2) Given some of the recent lawsuits in the building industry, the respondents said the results of the duct-blast tests raised the specter of liability. One respondent remarked that he felt "exposed" legally after the results of the blast tests.

Interviews indicated that the most common change in practices included the use of mastic sealing in conjunction with duct taping, and, sometimes, the adoption of duct blast testing. The use of sealant is the most critical change because, when applied correctly in conjunction with tape, it dramatically reduces duct leakage.[13]

PG&E

One of the PG&E contractors (PG&E-H-1 in Table 13), whose company does 9,000 installations per year, said they have adopted PG&E's program duct installation methods of using sealant and butyl tape, and now use it in all new installations. He reported they made the change in 1995 directly as a result of doing duct blast testing under the program. (Altogether, the company has done an estimated 1,000 installations under the program.) This respondent also had participated in training offered by PG&E.

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[13]Based on interviews with contractors, the use of zip ties is not an important indicator of a market effect. According to one contractor, the ties do not necessarily reduce duct leakage. Rather, duct manufacturers have started to require their usage because they are finding duct connections are vulnerable as installers do not use enough tape. Hence, the manufacturers are requiring zip ties to protect themselves from litigation.

Regarding the results of the testing, the respondent said his company "felt the word was out that the old standards were substandard and should be corrected" to include mastic sealing. He noted that builders were resistant to the additional $100 cost at first, eventually agreed to cover it even without program incentives. When asked what the builders' motivation was to adapt the more costly new methods, the contractor replied that his company expressed concerns about liability, and this usually convinced the builder.

A second contractor (PG&E-H-2) was contacted as the result of a reference from a builder who had not participated in the program. Although the subcontractor had heard of PG&E's program, he had never done any program installations, and had not heard of PG&E's training for subcontractors. When asked if he had ever made any changes to his practices, he reported that he had changed to the UL-approved closure system on his 1993 installations because it was less expensive.

The third PG&E contractor (PG&E-H-3), who does about 2,000 installations per year including program and nonprogram installations, only uses the new duct installation methods, but in program installations only. He estimates he has done a total of 3,000 program installations since participating. He indicated he likes the new methods, even though they were more time consuming at first. However, he does not believe any builder will continue using the methods if the program rebates are ended because the methods add about $125. He noted that, as it is, the rebate is less than the incremental cost of higher SEER A/C units alone. However, in both program and nonprogram homes, his company has made one minor modification to sealing with mastic between the plenum and ductwork at a cost of about $5 per home. He said this was because the program's demonstrated the importance of good sealing. This respondent had also participated in PG&E's training which, he said, "taught them a lot about things they hadn't thought about, like loss through the duct system."

To summarize for PG&E contractors, one of three respondents (PG&E-H-1) demonstrated clear evidence of this market effect. He has adopted what he indicates are permanent methods for all new installations as a direct result of PG&E's program.

Edison

Two of the three Edison contractors interviewed (SCE-H-1 and 3) changed their installation methods, providing some evidence of market effects. However, it appears these changes resulted from Southern California Gas's program rather than Edison's.

The two contractors reported switching from using only duct tape to using both tape, mastic sealant, and—most recently—zip ties. They currently use these methods on all new installations—about 2,000 tract homes per year for each company.

According to these respondents, the changes were a direct result of Southern California Gas's duct-blasting program, not of Edison's program. One contractor (SCE-H-3) said the testing was an "instrumental change in the industry" in terms of educating contractors about duct leakage. However, he also indicated that, with the exception of his company and one other (SCE-H-1), contractors returned to their old installation methods after the program ended. His company and the other exception now install all new ductwork to these specifications.

SCE-H-3 reported that, upon learning how leaky conventionally-installed ductwork can be, his company felt "exposed" with respect to liability. He asserted they offered the mastic sealing to builders as an option after Southern California Gas's program ended. Although the builders would not pay the additional costs, his company was sufficiently concerned about liability that they used the mastic anyway and "ate the cost." He noted builders are still resistant to this, and "not one will pay to this day" for the extra $100 to $150 it costs for the sealing. Yet, he pointed out that paying the extra money is still far less expensive for his company than carrying liability insurance.

SCE-H-1 reported his company offered the mastic sealing as an option after the Southern California Gas program ended in 1994. As only 10% of builders elected to pay for it, the company reverted to installing ductwork without mastic in most cases. About a year ago, however, the company began simply telling builders they were using these methods and incorporating these additional costs up front due to liability concerns.

A third contractor (SCE-H-2), whose company does over 10,000 installations annually, changed to a prefabricated system in the late 1980s. This system saves money by reducing the connections the installation crew must make in the field. Moreover, he believes the factory has a better ability to seal the ducts, although they use tape rather than mastic. He also changed to fiberglass plenums to cut noise. He mentioned that, as furnace and coil manufacturers do not seal their equipment, during the program he

taped everything on the furnace side as well. He also installed hard-ducted return air systems. He remarked that he believed hard-ducting and equipment taping was a better way to reduce duct leakage than sealing with mastic. He said duct blasting his company conducted last year showed the system to be about 99% sealed. When the program was withdrawn, the company had to eliminate the equipment taping and the hard-ducts. To still cut leakage a little bit, he has asked the company that manufacturers its heating registers to do more quality control.

To summarize the data for HVAC contractors in Edison's territory, there is evidence of market effects in duct installation practices, but the changes appear to have been influenced by Southern California Gas's program, not by Edison's. Also, based on reports from the two contractors using the mastic sealant method, they may be the only companies currently doing this. This seems plausible, given the reported resistance of builders and that one subcontractor (SCE-H-3) is absorbing some of the installation costs.

Table 13 summarizes the results of the previous discussion for contractors showing evidence of a market effect attributable to PG&E's and Southern California Gas's program.

Table 13
SUMMARY OF HVAC CONTRACTOR DUCT INSTALLATION MARKET EFFECT

Contractor ID	Change in Practice[1]	Program Induced?	Evidence of Market Effect (i.e., convinced builders?)	How Convince Builder?
PG&E-H-1	Yes—1995 started using mastic and butyl tape to seal	Yes—PG&E	Yes—100% with new install methods	Brought up liability issue
SCE-H-1	1995 mastic sealant, zip tie, duct tape, hard-ducted return air.	Yes (SCG[2])	Yes—100% with new install methods	Brought up liability issue
SCE-H-3	1995 mastic sealant, zip tie, duct tape, silver tape on plenums	Yes (SCG)	Yes and no—says does in 100% new installs but builders do not pay for it	Has not convinced them to pay

[1]For purposes of this summary table, "changes in practices" are defined as changes in ductwork installation methods outside of any program.
[2]Southern California Gas.

Note that when HVAC contractors were asked if they had ever installed HVAC equipment with a higher SEER than required by code in homes that were not part of a utility program, four said they had, but only in very small numbers of custom or high-end tract homes, or in townhouses where quieter units were needed.

A summary of these findings as they pertain to the homeowner information-related barrier is provided below.

Summary of Findings for HVAC Subcontractors Practices Barrier

Hypothesized Market Effects:
Changes in ductwork installation practices. As the interventions only were undertaken with PG&E's program, we expect any evidence of market effects would be in their territory.

Existence and Magnitude:
Some evidence for PG&E's program. One contractor (PG&E-H-1) made changes to his installation methods in nonprogram homes as a result of the program. Two contractors in Edison's territory (SCE-H-1 and 3) made changes to their practices but reported they did not because of Edison's program but because of Southern California Gas's program.

Change in Market Barrier:
Some reduction. However, subcontractors report that builders are very resistant to pay the additional costs of mastic seal, so much so that, in one case, a contractor is simply absorbing the cost to avoid potential liability issues.

Likelihood of Lasting:
Likely permanent. For subcontractors who have adopted the methods, they will not or cannot go back to their old installation methods because of liability risks. Builders who have adopted the new methods will also likely stick with them.

Attribution:
Evidence of this market effect in PG&E's territory can be attributed to the utility's duct blasting program, based on what subcontractors have said. In Southern California, HVAC subcontractors attribute changes in their practices to Southern California Gas's program.

OTHER ISSUES

The following is a discussion of additional issues which do not readily fit into the context of the report, but enhance and provide important contextual background to our findings. The transcripts of the surveys have been provided to Edison if readers wish to study the direct responses of various groups in more detail.

Effect of Recession on Builder Market

From every group we interviewed, we heard extensively about the recession in California and how it impacted the building industry. While we cannot speak to its quantitative effects (i.e., impact on sales), the consensus among respondents was the recession, which apparently started in the early 1990's, greatly increased competition among builders in terms of home price. While builders of tract homes are always competitive and cost-conscious, as one Title 24 consultant said because of the recession, builders are "cost conscious to the nth degree. It makes your head spin." Title 24 consultants say builder's objective is to meet code requirements in the least expensive way possible. One consultant remarked that "all builders care about is their bottom line, it's so competitive out there." Another consultant said that when he started in the business 17 years ago, "the market was booming so no one cared about cost." In 1990 the market slowed down and people became more conscious of cost.

A participating builder (SCE-P-2) remarked that "Buyers today are focussed on cost. 'What is the square footage and what is the monthly payment.'" He remarked that even amenities that buyers can see and touch are "not enough." A participant in PG&E's territory (PG&E-P-4) said even an extra $6 to $8 per month is a lot for his market segment (first-time buyers of homes under $200,000). "Currently, buyers are just trying to figure out how to qualify, so anything that affects monthly payment is an issue."

The vice president of one building company we talked to (SCE-NP-2), said in 1990 the economy got so bad that they actually shut down their building operations. They recently started it up again and are currently working on one project with 169 homes.

Builder Perceptions of Incremental Cost

We noted a difference between participating builders and nonparticipating builders in their estimates of incremental cost for exceeding Title 24 by 10%. Again, while the sample size is small, there are noticeable differences between the two groups. Below are the results.

Participants	Nonparticipants
$1,200-1,500	$5,000-10,000 ("I'm just guessing.")
$1,000-1,500	$2,000-5,000
$1,000	$2,000-3,000
$900-1,400	$1,500
$600-700	$300-500
$400-600	$250
$500	Don't Know
$300-400	Don't Know
$50-250	Don't Know
$150	N/A

One thing noteworthy is how much higher the estimates are of the first three nonparticipants listed. While the first was admittedly guessing, his perception that the incremental cost would be so high is worth noting.

What is also noteworthy is the range of estimates among both participants and nonparticipants. Granted some of this variation could be attributed to differences in how respondents define cost, but there is still a big difference.

Issue of Builder Misperception of Whether They are Exceeding Code

One important finding from our interviews relates to the definition of "exceeding code." When builders were asked whether they were building homes on their own that exceeded code, that is without receiving any rebates, several of them said yes and then proceeded to describe measures such as SEER 12 air conditioners, R-30 insulation in the ceiling and so on.

Later, in the interviews with the Title 24 consultants, it became clear that there are two elements to meeting code. One is that homes must comply with the "Mandatory Measure Checklist," a list of prescriptive minimums for things like insulation. For example, ceiling must have a minimum of R-19 insulation. However, beyond meeting these minimums, the home can also not use more energy per square foot allowed given the particular climate zone in which it is located or its orientation on the lot. Whether or not the home complies in this respect is determined by computer modeling done by the Title 24 consultant.

If the modeling in fact shows the home uses more than the allowed budget, the builder must enhance some of the measures to bring the home into compliance. The Title 24

consultant will offer the builder several options for measure upgrades, among which may very well be a SEER 12 A/C system and or R-30 insulation in the ceiling, for example. However, even though R-30 and SEER 12 is "higher" than the minimum mandated levels, the home still is not exceeding code.

Conversely, if the Title 24 consultant found that the home used less than the allowed budget, they would offer the builder options for cutting or reducing certain measures so as to cut costs but still be in compliance.

We made calls back to some of the builders who had said they were exceeding code in homes outside the program, and questioned them more closely as to whether their homes were in fact using less than the allowed energy budget or whether they were actually still just complying. Four builders turned out to be only just complying, or exceeding only because of design consistency or orientation issues. One builder, a PG&E program participant (PG&E-P-2) was currently only building 10% of homes under the program because the incentives had been lowered. For the remaining homes built outside the program, he at first said he was exceeding code, but it turned out it was only because the efficiency of his design had to be increased to comply in the worst orientation, and, therefore, exceeded somewhat in the more favorable orientations. Two builders in Edison's territory who had been participants in Edison's program in the past also at first said they were currently exceeding code. However, one (SCE-P-6) turned out to be exceeding on some home designs only because their equipment was upgraded to be consistent with one design in the same development that otherwise would not have complied. The second Edison builder (SCE-P-7) turned out to be upgrading some measures, but downgrading others so overall he was only meeting budget. One nonparticipant in Edison's territory (SCE-NP-1) also turned out to only be meeting budget by making measure trade-offs.

V. QUANTITATIVE RESULTS

This section describes findings from the quantitative measures of market actor beliefs and attitudes regarding energy efficiency, as drawn from the Analytic Hierarchy Procedure (AHP) questions and analyses. We first describe the data covering the perceived importance of energy efficiency in making a home marketable, then examined the reported changes in perceived importance over the last five years.

We also assess the preferences for meeting or exceeding Title 24 standard, then consider perceptions as to the relative effectiveness of several options (measures) for exceeding Title 24.

Finally, we review perceptions regarding the relative importance of key market barriers to building homes exceeding Title 24 requirements, and report changes in this measure's relative importance.

IMPORTANCE OF ENERGY EFFICIENCY AND OTHER HOME MARKETABILITY CRITERIA

Before the Program

As noted, each respondent was asked a series of questions regarding the relative importance of several factors believed to affect a home's marketability. These included sales price, location, style, floor plan, square footage, and energy efficiency. To estimate the changes in the relative importance of these factors, each respondent was asked these questions about the "past" and present sales situations.

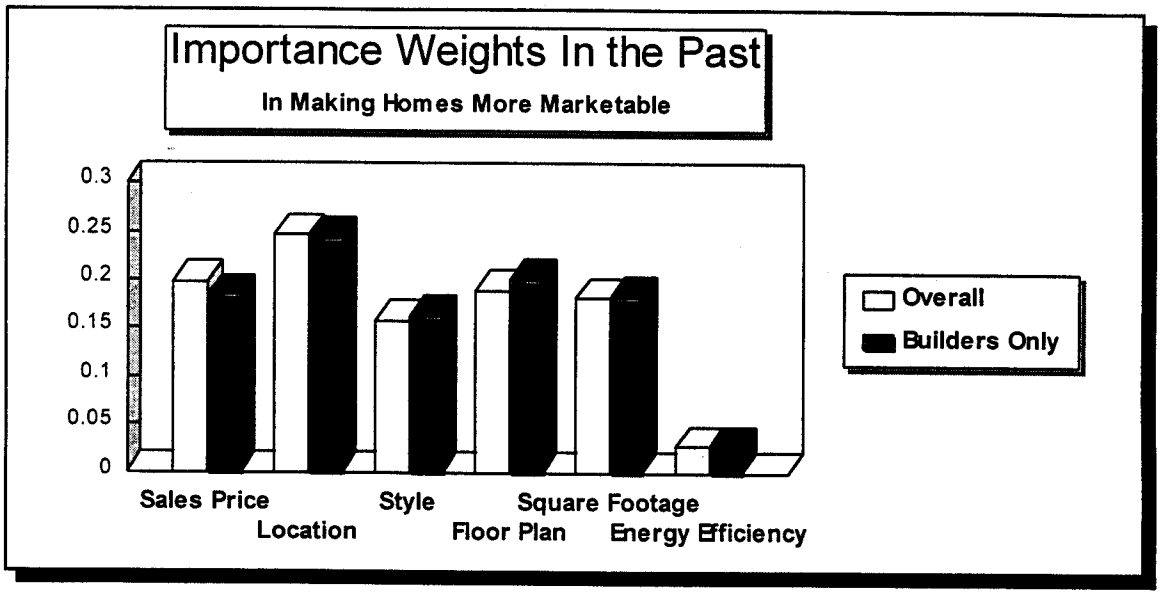
Table 14 shows the AHP-generated importance weights by different "market actors," "service territory," and (in the case of builders) by "program participation status." The magnitude of the AHP-generated importance weight for "energy efficiency" relative to other home marketability criteria [such as "selling price," "location," "style" (e.g., ranch versus Tudor), "floor plan" (e.g., number of bedrooms), and "square footage,"] is not large.[14] For example, examining overall importance weights across all market actors reveals the most important home attribute (in making a home more marketable)

[14]AHP does not estimate variance, hence no statistical statements can be made in absolute terms regarding the significance of the findings. However, we feel small differences (i.e., less than 5% in absolute terms) should be treated with caution. Differences more than 5% are probably significant.

is location, with an importance weight of 0.2465, followed by price, with an importance weight of 0.1979. Energy efficiency received the lowest importance weight of only 0.0273.[15]

As a group, builders perceived location to be the most important criterion (0.2430), followed by floor plan (0.2003), sales price (0.1837), square footage (0.1826), style (0.1633), and, finally, energy efficiency (0.0268). However, looking at the builders' responses by service territory and participation status reveals that the participating builders generally placed higher importance on energy efficiency than did the nonparticipating builders.

The figures below provide a graphical representation of data. The group labeled "Overall" includes all actors. The group labeled "Builders Only" includes both participating and nonparticipating builders.



[15]We realize that with such small sample sizes, carrying these weights out to four decimal places creates a sense of false accuracy. However, we chose to maintain this precision level to show differences that otherwise are not apparent.

Table 14
IMPORTANCE WEIGHTS OF HOME ATTRIBUTES IN THE PAST

Market Actor	Service Territory	Program Status	PAST Perceptions of Home Marketability Criteria						
			Sales Price	Location	Style	Floor Plan	Square Footage	Energy Eff.	n
Builders	Edison	Participants	.2195	.2264	.1378	.1863	.2019	.0281	4
		Nonparticipants	.1005	.3020	.2052	.1831	.1831	.0260	1
		Overall/Edison	**.1957**	**.2415**	**.1513**	**.1857**	**.1981**	**.0277**	**5**
	PG&E	Participants	.1616	.2447	.1548	.2262	.1674	.0276	3
		Nonparticipants	.1852	.2624	.1845	.1990	.1746	.0253	4
		Overall/PG&E	**.1751**	**.2447**	**.1718**	**.2107**	**.1715**	**.0263**	**7**
	Overall/Builders Both Companies		**.1837**	**.2430**	**.1633**	**.2003**	**.1826**	**.0268**	**12**
Title 24 Consultants	Edison		.3717	.2036	.0891	.1967	.1114	.0275	2
	PG&E		.2869	.1807	.1842	.1787	.1418	.0277	2
	Overall Title 24 Consultants		**.3293**	**.1922**	**.1367**	**.1877**	**.1266**	**.0276**	**4**
Sales Agents	Edison		.2267	.2102	.1840	.1840	.1665	.0285	3
	PG&E		.1760	.2967	.1223	.1778	.2025	.0246	4
	Overall Sales Agents		**.1977**	**.2597**	**.1488**	**.1805**	**.1877**	**.0263**	**7**
Realtors	Edison		.1658	.2314	.1705	.1857	.2189	.0278	4
	PG&E		.1419	.3026	.1652	.1765	.1840	.0298	4
	Overall Realtors		**.1538**	**.2670**	**.1678**	**.1811**	**.2015**	**.0288**	**8**
Overall Edison Service Territory			*.2189*	*.2265*	*.1549*	*.1869*	*.1849*	*.0278*	*14*
Overall PG&E Service Territory			*.1806*	*.2630*	*.1601*	*.1911*	*.1782*	*.0269*	*17*
Overall Across All Market Actors			*.1979*	*.2465*	*.1577*	*.1892*	*.1812*	*.0273*	*31*

After the Program

Table 15 corresponds to Table 14, but provides AHP-generated relative importance weights for home marketability criteria in the present. As shown, the overall perception of the importance of sales price has increased over time, while the other criteria have not changed as profoundly. The importance of floor plan has increased, and location and energy efficiency have gained somewhat. On the other hand, style and square footage have lost ground slightly.

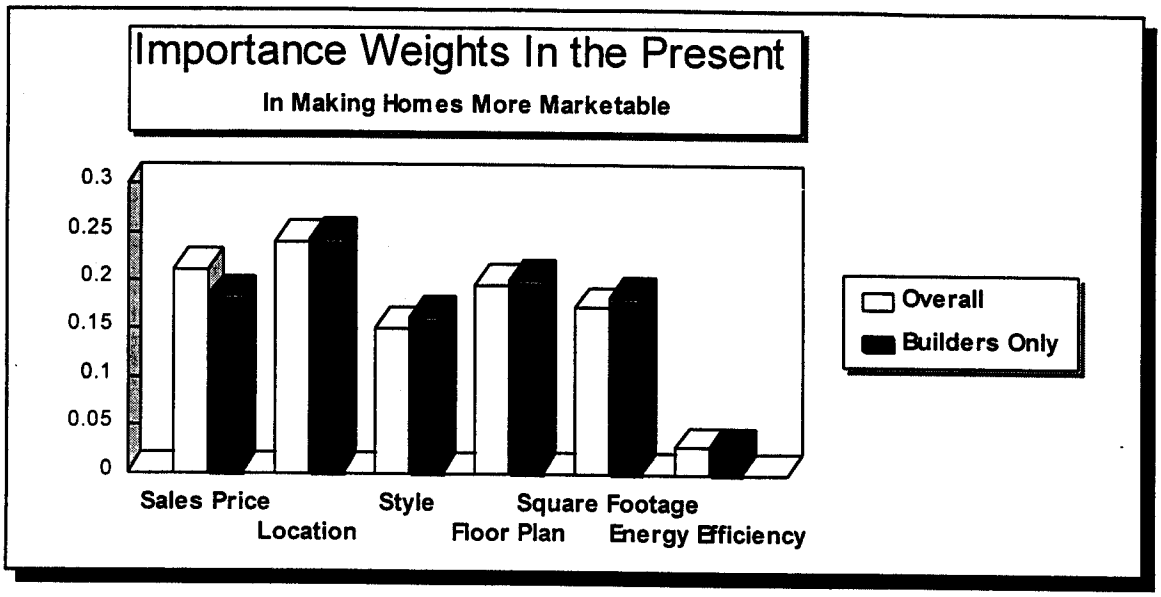

Importance Weights In the Present
In Making Homes More Marketable
0.3
0.25
0.2
0.15
0.1
0.05
0
Sales Price
Location
Style
Floor Plan
Square Footage
Energy Efficiency
Overall
Builders Only

Table 15
IMPORTANCE WEIGHTS OF HOME ATTRIBUTES IN THE PRESENT

Market Actor	Service Territory	Program Status	Present Perceptions of Home Marketability Criteria						
			Sales Price	Location	Style	Floor Plan	Square Footage	Energy Eff.	n
Builders	Edison	Participants	.2535	.1897	.1423	.2281	.1561	.0303	4
		Nonparticipants	.1285	.3269	.1810	.1700	.1700	.0241	1
		Overall/Edison	**.2286**	**.2172**	**.1501**	**.2164**	**.1588**	**.0290**	**5**
	PG&E	Participants	.1961	.2331	.1534	.2237	.1649	.0285	3
		Nonparticipants	.2464	.1767	.1833	.1926	.1765	.0245	4
		Overall/PG&E	**.2249**	**.2008**	**.1706**	**.2059**	**.1715**	**.0263**	**7**
	Overall/Builders—Both Companies		**.2264**	**.2076**	**.1621**	**.2103**	**.1662**	**.0274**	**12**
Title 24 Consultants	Edison	.	.3291	.2218	.0989	.2097	.1111	.0294	2
	PG&E		.2487	.2451	.1687	.1726	.1361	.0287	2
	Overall Title 24 Consultants		**.2889**	**.2334**	**.1338**	**.1911**	**.1236**	**.0291**	**4**
Sales Agents	Edison		.2644	.1690	.1572	.2153	.1668	.0272	3
	PG&E		.1727	.3117	.1089	.1783	.2038	.0247	4
	Overall Sales Agents		**.2120**	**.2505**	**.1295**	**.1942**	**.1879**	**.0258**	**7**
Realtors	Edison		.1579	.2587	.1711	.1876	.1984	.0262	4
	PG&E		.1493	.3125	.1524	.1665	.1874	.0319	4
	Overall Realtors		**.1580**	**.2855**	**.1617**	**.1771**	**.1929**	**.0291**	**8**
Overall Edison Service Territory			*.2304*	*.2194*	*.1503*	*.2070*	*.1650*	*.0278*	*14*
Overall PG&E Service Territory			*.1976*	*.2584*	*.1516*	*.1862*	*.1787*	*.0275*	*17*
Overall Across All Market Actors			*.2124*	*.2408*	*.1510*	*.1956*	*.1725*	*.0277*	*31*

The findings based on trade-off analysis in the present and in the past are in line with findings of other studies (for more information, see the secondary data discussion in Appendix A). For example, Edison's 1994 "Customer Decision Study" found that (1) builders are "most influenced by the cost of each design option"; and (2) "The energy savings from high-efficiency options are valued by builders comparatively little." PG&E conducted surveys of participating and nonparticipating builders in 1996. When respondents were asked to rank the importance of several factors on what they install in their new construction, both participants and nonparticipants indicated cost to be the most important. Southern California Gas's 1996 "Energy Advantage Home' Advertising Tracking Study" showed cost to be a close second to location in home

buyers' minds when purchasing a home. The same study showed that in builders' minds, energy efficiency adds little or no selling advantage (76% of respondents).

Table 16 focuses on the "change" in AHP-generated importance weights between the past and the present.

Table 16
PERCENTAGE CHANGE IN IMPORTANCE WEIGHTS—PAST TO PRESENT

Market Actor	Service Territory	Program Status	Percent Change in Perceptions of Home Marketability Criteria						
			Sales Price	Location	Style	Floor Plan	Square Footage	Energy Eff.	n
Builders	Edison	Participants	15.49	-16.21	3.27	22.44	-22.68	7.83	4
		Nonparticipants	27.86	8.25	-11.79	-7.15	-7.15	-7.31	1
		Overall Edison	**16.81**	**-10.06**	**-0.79**	**16.53**	**-19.84**	**4.69**	**5**
	PG&E	Participants	21.35	-4.74	-0.90	-1.11	-1.49	3.26	3
		Nonparticipants	33.05	-32.66	-0.65	-3.22	1.09	-3.16	4
		Overall PG&E	**28.44**	**-17.94**	**-0.70**	**-2.28**	**0.00**	**0.00**	**7**
	Overall Builders—Both Companies		**23.24**	**-14.57**	**-0.73**	**4.99**	**-8.98**	**2.24**	**12**
Title 24 Consultants	Edison		-11.46	8.94	11.00	6.61	-0.27	6.91	2
	PG&E		-13.31	35.64	-8.41	-3.41	-4.02	3.61	2
	Overall Title 24 Consultants		**-12.27**	**21.44**	**-2.12**	**1.81**	**-2.37**	**5.43**	**4**
Sales Agents	Edison		16.63	-19.60	-14.57	17.01	0.18	-4.56	3
	PG&E		-1.88	5.06	-10.96	0.28	0.64	0.41	4
	Overall Sales Agents		**7.23**	**-3.54**	**-12.97**	**7.59**	**0.11**	**-1.90**	**7**
Realtors	Edison		-4.76	11.80	0.35	1.02	-9.37	-5.76	4
	PG&E		5.21	3.27	-7.75	-5.67	1.85	7.05	4
	Overall Realtors		**2.73**	**6.93**	**-3.64**	**-2.21**	**-4.27**	**1.04**	**8**
Overall Edison Service Territory			***5.25***	***-3.13***	***-2.97***	***10.75***	***-10.76***	***0.00***	***14***
Overall PG&E Service Territory			***9.41***	***-1.75***	***-5.31***	***-2.56***	***0.28***	***2.23***	***17***
Overall Across All Market Actors			***7.33***	***-2.31***	***-4.25***	***3.38***	***-4.80***	***1.47***	***31***

Overall, sales price seems to have become considerably more important over time (increasing by 7% overall and 23% for builders). All other attributes have witnessed very modest changes.

Although not directly comparable, a 1988 national survey of home buyers showed even more extreme trends. The survey results showed energy efficiency losing ground as an important attribute in the home buying decision-making process. Size of home and location showed steady inclines in importance. Edison's 1996 "'Energy Advantage Home' Advertising Tracking Study" showed a small increase in "concern with buying an energy-efficient home."

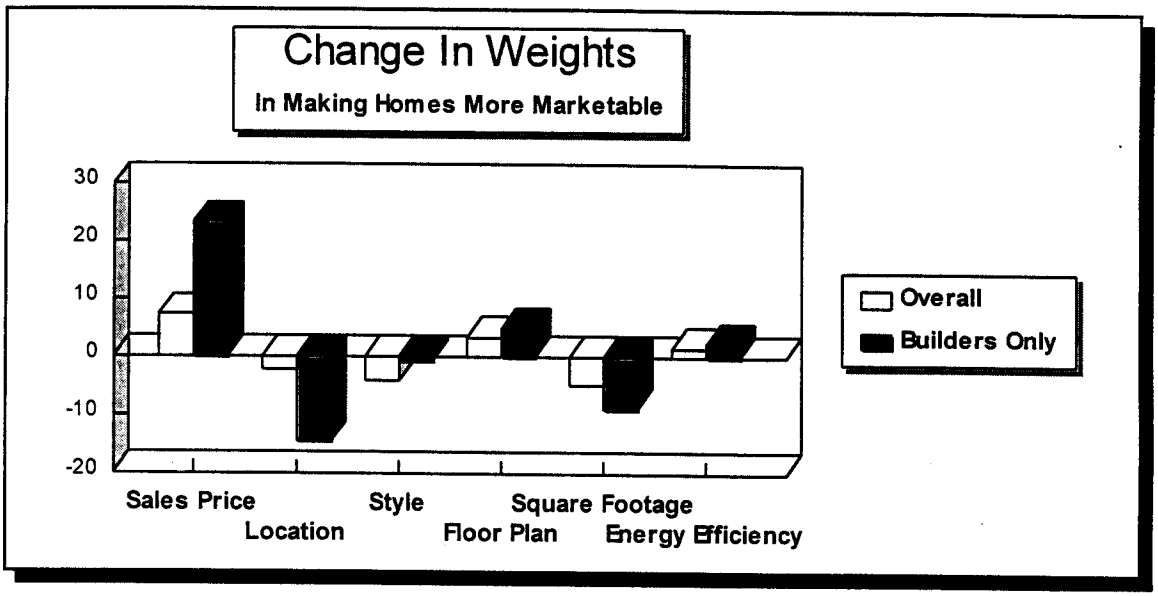


Table 17 strictly focuses on the perceived importance of energy efficiency. It summarizes the average AHP-generated importance weights for energy efficiency as perceived in the past and present, as well as the percentage change in the importance weights. A detailed review of this table reveals the following:

- Most respondents in various market actor and service territory categories perceived energy efficiency to be more important presently than it was previously.

- Participating and nonparticipating builders showed different degrees of change in the perceived importance of energy efficiency.

In both Edison's and PG&E's service territories, participating builders showed an increase in the perceived importance of energy efficiency over other marketability factors. Nonparticipants showed change in the opposite direction. The differences between the two percentage changes were approximately 15% in Edison's service territory and about 9% in PG&E's service territory. In the absence of other

explanations for these differences, the apparent impacts of new construction programs were considerable, but only for participants.

Title 24 consultants also demonstrated a noticeable increase (5%) in their perception of the importance of energy efficiency.[16]

[16]Both sales agents and realtors in Edison's territory show contrary movement (of 4% to 5%). An examination of changes in the relative importance of other factors for these respondents offers no consistent explanation; neither does a comparison of ratings of those other factors by sales agents and realtors in PG&E's territory.

Table 17
CHANGE IN ENERGY EFFICIENCY IMPORTANCE WEIGHTS

Market Actor	Region	Program Status	Average Importance of Energy Efficiency			
			Past	Present	% Change	n
Builders	Edison	Participants	2.81	3.03	7.83	4
		Nonparticipants	2.60	2.41	-7.31	1
		Overall Edison	**2.77**	**2.90**	**4.69**	**5**
		PROGRAM IMPACT Edison			**15.14**	**5**
	PG&E	Participants	2.76	2.86	3.26	3
		Nonparticipants	2.53	2.45	-3.16	4
		Overall PG&E	**2.63**	**2.62**	**0.00**	**7**
		PROGRAM IMPACT PG&E			**6.42**	**7**
	Overall Builders		**2.68**	**2.74**	**2.24**	**12**
	PROGRAM IMPACT ACROSS TWO COMPANIES				**9.86**	**12**
Title 24 Consultants	Edison		2.75	2.94	6.91	2
	PG&E		2.77	2.88	3.61	2
	Overall Title 24 Consultants		**2.76**	**2.91**	**5.43**	**4**
Sales Agents	Edison		2.85	2.72	-4.56	3
	PG&E		2.46	2.47	0.41	4
	Overall Sales Agents		**2.63**	**2.58**	**-1.90**	**7**
Realtors	Edison		2.78	2.62	-5.76	4
	PG&E		2.98	3.19	7.05	4
	Overall Realtors		**2.88**	**2.90**	**1.04**	**8**
Overall/Edison			**2.78**	**2.78**	**0.0**	**14**
Overall/PG&E			**2.69**	**2.75**	**2.23**	**17**
Overall Across All Market Actors			***2.73***	***2.77***	***1.97***	***31***

PREFERENCE FOR MEETING OR EXCEEDING TITLE 24

As noted in the Methodology section of this report, the AHP task can produce not only importance ratings, but also preference ratings. This was done for both the builders and the Title 24 consultants with respect to the costs of and the ability to save energy through exceeding code. Table 18 presents the pertinent results. As in earlier tables and figures, the preferences of market actors are further broken down by service territory and, in the case of builders, by participation status.

Overall, the results show that neither the builders nor the Title 24 consultants believed that exceeding the Title 24 code was preferable with respect to either cost[17] or energy savings. In other words, the results indicate that when considering the cost of construction *or* energy efficiency, meeting code was much preferred to exceeding it. This was true for Title 24 consultants regardless of service territory and for each group of builders in each of the territories regardless of their participation status. (However, comparisons across groups indicated that participating builders in Edison's territory were somewhat less intense in their preference for achieving energy savings by meeting code than were other market actors.) These overall results could be interpreted as indicating one of the reasons builders did not participate in programs or did not exceed Title 24 was that they believed it would cost more and did not provide sufficient benefits in terms of increases in the marketability of the home. The Title 24 consultants seemed to be even less convinced that exceeding Title 24 led to sufficient increases in energy savings to increase the marketability of the home, particularly among consultants in Edison's territory.

[17]We did not expect any respondents to say exceeding Title 24 would be "preferable" to meeting it in terms of cost. Rather, we sought an estimate of how much additional cost the respondent believed was required to exceed code.

Table 18
PREFERENCE FOR MEETING OR EXCEEDING TITLE 24

Market Actor	Service Territory	Program Status	Cost Energy Savings					
			Meet Title 24	Exceed Title 24	n*	Meet Title 24	Exceed Title 24	n*
Builders	Edison	Participants	0.7833	0.2167	4	0.6611	0.3389	6
		Nonparticipants	0.7917	0.2084	2	0.7500	0.2500	1
		Overall Edison	**0.7861**	**0.2139**	**6**	**0.6738**	**0.3262**	**7**
	PG&E	Participants	0.7648	0.2352	5	0.7981	0.2019	5
		Nonparticipants	0.8143	0.1857	4	0.8000	0.2000	4
		Overall PG&E	**0.7868**	**0.2132**	**9**	**0.7989**	**0.2011**	**9**
	Overall Builders—Both Companies		**0.7865**	**0.2135**	**15**	**0.7442**	**0.2558**	**16**
Title 24 Consultants	Edison		0.7917	0.2084	2	0.8375	0.1625	2
	PG&E		0.7917	0.2084	2	0.7333	0.2667	2
	Overall Title 24 Consultants		**0.7917**	**0.2084**	**4**	**0.7854**	**0.2146**	**4**
Overall Across All Market Actors			*0.7876*	*0.2124*	*19*	*0.7524*	*0.2475*	*20*

** Missing cases were deleted on a question-by-question basis.*

PROGRAM MEASURES

The study included six program measures or means available to builders choosing to exceed Title 24. These were presented to the builder and Title 24 consultants. The measures included:

(1) Installing more efficient HVAC equipment
(2) Improving duct work (better duct sealing)
(3) Installing more insulation
(4) Installing efficient windows
(5) Installing efficient lighting
(6) Planting shade trees

Respondents were asked to provide AHP-formatted pairwise comparisons regarding the effectiveness of these measures with respect to building an energy-efficient home exceeding Title 24 requirements.

Table 19 provides AHP-generated effectiveness weights for these criteria. The results indicate respondents perceived the installation of efficient windows as the most effective single method of building energy-efficient homes (0.28). The remaining means of ensuring energy-efficient homes, in the order of their perceived effectiveness, were: installing more insulation (0.20), improving the duct work (0.17), installing efficient HVAC equipment (0.16), and planting shade trees (0.13). The heavy weight given windows was largely due to the ratings of the builders; Title 24 consultants focused almost equally on improved duct work, the planting of shade trees, and windows.

Table 19
EFFECTIVENESS WEIGHTS OF VARIOUS MEASURES

Market Actor	Service Territory	Program Status	HVAC	Duct Work	Insul-ation	Wind-ows	Lighting	Trees	n
Builders	Edison	Participants	.1780	.2078	.1470	.2737	.0812	.1123	6
		Nonparticipants	.1578	.0878	.2630	.4389	.0149	.0376	2
		Overall Edison	**.1729**	**.1778**	**.1760**	**.3150**	**.0646**	**.0936**	**8**
	PG&E	Participants	.1655	.1497	.2585	.2122	.0617	.1524	5
		Nonparticipants	.1120	.1313	.2470	.3606	.0984	.0507	4
		Overall PG&E	**.1417**	**.1415**	**.2534**	**.2782**	**.0780**	**.1072**	**9**
	Overall Builders—Both Companies		**.1564**	**.1586**	**.2170**	**.2955**	**.0717**	**.1008**	**17**
Title 24 Consultants	Edison		.3266	.2022	.1653	.2471	.0201	.0389	2
	PG&E		.0086	.2776	.0586	.2086	.0086	.4380	2
	Overall Title 24 Consultants		**.1676**	**.2399**	**.1119**	**.2278**	**.0144**	**.2384**	**4**
Overall Across All Market Actors			***.1585***	***.1741***	***.1970***	***.2826***	***.0608***	***.1270***	***21***

Note that nonparticipating builders placed a higher effectiveness weight on windows than did participating builders. In the case of Edison's territory, participating builders placed duct work at a close second; for PG&E, they placed insulation as the most effective means of exceeding Title 24. Title 24 consultants thought duct work was the most effective.

The direct elicitation portion of the study indicated that customers were aware of windows more than other measures, and that they often asked about them. Also,

builders indicated concern over issues related to liability with duct work. These findings mesh well with the AHP findings.

ASSESSMENT OF BARRIERS

Builders and Title 24 consultants were asked to provide AHP-formatted pairwise comparisons among four of the reasons that would explain why builders do not build homes exceeding Title 24 requirements. Table 20 presents the AHP-generated prioritization of these barriers to market transformation. The same results are provided in Tables 21 and 22, but are broken down by group.

Table 20
RANKING OF MARKET BARRIERS

Time Period	Split Incentives	Lack of Information	Bounded Rationality	Availability
Past	0.5237	0.1582	0.1789	0.1393
Present	0.5334	0.1791	0.1895	0.0980
% Change	1.9	13.2	5.9	-29.7

The barriers include:

(1) Builders focusing on home marketability rather than energy savings [i.e., not believing the additional cost of building homes to levels exceeding code would be offset by an increase in marketability (split incentives)].

(2) Lack of information regarding energy-saving technologies or techniques.

(3) Limited ability to analyze alternatives or lack of an easy approach for analyzing different options for achieving energy efficiency (bounded rationality).

(4) Energy-efficient equipment availability.

When interpreting the results presented in Table 20, it should be remembered that these barriers' importance weights are computed relative to the other barriers. In this case,

for example, the fact that split incentives numbers were similar (past and present) would not mean that the barrier had not changed, only that it maintained its relative importance. Therefore, one should view these trends with caution. However, if we had found that the proportion of homes exceeding Title 24 had significantly increased, we would have concluded that barriers (as whole) have been reduced. Instead, the direct elicitation portion of the study indicated the proportion of homes exceeding title 24 witnessed only a slight increase. Therefore, we can conclude that the barriers have not been significantly lowered as a whole and direct across-time comparisons can be made - e.g., the split incentive has not been lowered significantly.

By examining Table 20, it becomes evident that split incentives were perceived to be the most important barriers to building homes exceeding Title 24 requirements.[18] As mentioned above, this perception did not change with time (i.e., the market barrier was not lowered).

Difficulty in the choice of options was a distant second to split incentives. Lack of information was third. In fact, these two barriers have increased in importance.

Finally, respondents indicated that the "lack of availability" importance has actually declined as a barrier, indicating equipment availability no longer is viewed as a problem.

This finding validates the results of the market characterization study indicating availability is not a key market barrier any longer. The market characterization study further stated that split incentives were likely to be the main barriers. Even though it might not at first seem so, the fact that the split incentives barrier has not changed is readily apparent in the direct elicitation portion of this study.

Both builders and Title 24 consultants answered this question. During the direct elicitation, Title 24 consultants indicated that they did not believe this barrier had changed for builders. Our conclusion from both these analysis is that there is evidence for a limited reduction in this barrier.

Tables 21 and 22 display the AHP results in detail for the Builders and the Title 24 Consultants.

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[18]This finding is in agreement with Edison's 1994 "Customer Decision Study." One of the findings there was that "[the energy savings from high efficiency options are valued by builders comparatively little. This result reflects the fact that builders generally do not obtain the savings that accrue after the building is sold."

Table 21
RANKING OF MARKET BARRIERS (PAST)

Market Actor	Service Territory	Program Status	Split Incentives	Lack of Information	Bounded Rationality	Availability	n
Builders	Edison	Participants	0.3912	0.3227	0.1279	0.1582	6
		Non-Participants	0.4038	0.1048	0.4691	0.0223	2
		Overall Edison	**0.3943**	**0.2683**	**0.2132**	**0.1242**	**8**
	PG&E	Participants	0.5477	0.0940	0.1741	0.1842	5
		Non-Participants	0.6180	0.0813	0.1009	0.1999	4
		Overall PG&E	**0.5789**	**0.0884**	**0.1415**	**0.1912**	**9**
	Overall Builders—Both Companies		**0.4920**	**0.1730**	**0.1753**	**0.1597**	**17**
Title 24 Consultants	Edison		0.6700	0.0978	0.1945	0.0378	2
	PG&E		0.6462	0.0923	0.1939	0.0676	2
	Overall Title 24 Consultants		**0.6581**	**0.0950**	**0.1942**	**0.0527**	**4**
Overall Across All Market Actors			***0.5237***	***0.1582***	***0.1789***	***0.1393***	***21***

Table 22
RANKING OF MARKET BARRIERS (PRESENT)

Market Actor	Service Territory	Program Status	Split Incentives	Lack of Information	Bounded Rationality	Availability	n
Builders	Edison	Participants	0.3986	0.3886	0.1369	0.0759	6
		Non-Participants	0.4038	0.1048	0.4691	0.0223	2
		Overall Edison	**0.3999**	**0.3177**	**0.2200**	**0.0625**	**8**
	PG&E	Participants	0.5705	0.1016	0.1968	0.1311	5
		Non-Participants	0.6288	0.0828	0.1146	0.1738	4
		Overall PG&E	**0.5964**	**0.0933**	**0.1603**	**0.1501**	**9**
	Overall Builders—Both Companies		**0.5039**	**0.1989**	**0.1884**	**0.1089**	**17**
Title 24 Consultants	Edison		0.6700	0.0951	0.1945	0.0378	2
	PG&E		0.6472	0.0924	0.1946	0.0658	2
	Overall Title 24 Consultants		**0.6586**	**0.0951**	**0.1945**	**0.0518**	**4**
Overall Across All Market Actors			***0.5334***	***0.1791***	***0.1985***	***0.0980***	***21***

VI. STUDY IMPLICATIONS

This section presents both the implications of this study in terms of future market transformation program design and the implications of our findings on future studies of this type. Each is discussed in a separate subsection below.

IMPLICATIONS FOR FUTURE PROGRAM DESIGN

As discussed in the introduction, the purpose of this study was to evaluate the market transformation effects of the *Welcome Home* and *Comfort Home* residential new construction programs. Also as mentioned above, participants in the kick-off meeting for this project agreed that since these programs were not designed to be market transformation programs, we should not overly focus on measurement of every possible market effect of these programs. We decided instead to adopt a more prospective or forward-looking focus which would allow better market transformation program design in the future. There were three main implications of this decision for this study:

- We focused more of our attention on those measures whose promotion is still likely to be cost-effective—i.e., the cost of promoting these measures would likely be more than made up in their energy savings over present standards. For example, we did not examine insulation measures in detail because it was felt that the 1992 Title 24 revision made further upgrades in insulation non-cost-effective.

- We focused on market effects that would evidence the reduction of only those market barriers that were still in effect in the market—e.g., while the availability of efficient windows may have been a barrier in the earlier years of the programs, no one believes it is any longer. Also, the program may have had an effect on the implementation of the Title 24 standards, but since those standards are now in place, we did not explore this potential program impact.

- We have included this section in this report.

The following are the implications of our findings for future market transformation programs.

Incentives have some effect, but may not be the best way to transform the market for energy efficiency in new homes.

Our survey results show some limited reductions in several key market barriers in the RNC market. A portion of these reductions can be attributed to the *Welcome Home* and *Comfort Home* programs and most are likely to be lasting. However, focusing a program solely on monetary incentives to builders bypasses the split incentive barrier, but does relatively little to overcome this barrier. Other approaches show promise for larger impacts on this market. See the discussions of liability and of code inspections below.

More work with potential third-party partners is essential to success.

One critical distinction between resource acquisition programs and market transformation programs may be found in the level of the market actors at which those programs are directed. For the most part, resource acquisition programs focus on individual actors, in part because it is relatively easy to follow up on their activities and to measure changes in their behavior, their purchases, and their attitudes. But this approach is comparable to attempting to convert voters to a candidate exclusively through door-to-door visits. In contrast, the market transformation strategy includes, as a major component, the use of top-down activities, comparable to securing the endorsement of a voter's key reference groups.

To provide a specific example, the data suggest that utility RNC programs may have helped to increase perceptions of the relative importance of energy efficiency among participating builders. At this time, however, these perceptions have not spilled over to nonparticipating builders. It may be useful to increase efforts to work with trade associations while continuing to provide some level of information and support to individual builders.

The improvement of code compliance would likely have a large impact.

The California Energy Commission study on Title 24 compliance shows that half the new homes in California fail to meet standards.[19] Our interviews with Title 24 consultants support this finding. One consultant in particular believes that the lack of

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[19]California Energy Commission, *Energy Characteristics, Code Compliance and Occupancy of California 1993 Title 24 Houses* (May 1995).

compliance is because of "builders hiring cheap Title 24 consultants." That is, unknowingly hire Title 24 consultants that are not properly trained. The determination of code compliance is complex, and since building departments tend to only do spot checks for compliance, many homes are built that do not meet code. The suggestion here is to either promote stricter licensing (requiring more training) of Title 24 consultants or to somehow ensure better policing of compliance.

Liability issues have a large impact on the market.

The threat of liability is a powerful motivator and seems to have had a significant impact on the adoption of better ductwork installation practices. The threat of liability also seems to keep builders from providing information on the likely energy-savings tradeoffs between various home designs, specifically for those components that would exceed Title 24. We have two suggestions here. First, future market transformation efforts might consider harnessing the threat of litigation to push better (more efficient) building practices such as ductwork installation. Second, since it is unlikely that consumers will be able to obtain this information elsewhere, future market transformation efforts should consider some type of home rating system that gives something like energy cost per square foot and total energy estimates for all new homes. Possibly this rating could be generated through the Title 24 compliance analysis performed for each home design. One example of an existing home energy rating system is the California Home Energy Rating System (CHEERS).

There is hope for ductwork installation standards and training.

Our study results show that there has been an increase in the use of the better ductwork standards by at least some of the HVAC subcontractors and builders. These actors like the standards and recognize the improvement in work quality (and reduction in the threat of liability) that results. Further efforts in this area, especially with an end goal of their incorporation in an enforceable Title 24 update, is warranted.

Information on the existence of measures seems to be effective in this market, but trade-off analysis of measure impacts is needed.

Our study shows evidence of some reduction in all the information-related barriers (homeowners/buyers, realtors, and builders). The aspect of this set of barriers that was not effectively addressed is that relating to bounded rationality—i.e.,

homeowners/buyers and realtors (and to some extent, builders) are aware of energy efficiency measures, but they are not able to directly tie the existence of these measures to likely energy savings. As discussed above, future market transformation efforts in this market must seriously consider a home energy rating system.

Builders prefer energy-efficiency measures that directly increase marketability through nonenergy benefits.

The AHP results show that builders rank efficient windows as the measure they prefer most to increase a home's energy efficiency while Title 24 consultants say that ductwork is more important. We believe that this result as well as information from the direct elicitation portion of the survey provide evidence for the existence of the split incentives barrier for builders. Builders want a "showy" way to increase energy efficiency; one that potential home buyers can see and likely recognize. Title 24 consultants are looking at actual energy-savings impacts. The more market transformation efforts can promote the marketability aspects of energy efficiency measures other than energy efficiency, the more likely builders will adopt these measures.

Future evaluations of market transformation efforts will likely have to accept an even lower ability to claim causality because of multiple agencies being involved.

Several of these recommendations indicate the need to work with other agencies to promote energy efficiency in the RNC market, both to create changes in the barriers and to lock in those changes. It must be acknowledged that, to the extent these recommendations are followed, it becomes more difficult for future evaluations to allocate sole credit for changes that occur to the utility programs, or even to ascertain empirically the proportion of credit that should be assigned to those programs. In other words, a sort of Heisenberg principle appears to be operating: Efficacy and certainty of causal origins cannot be achieved simultaneously. Either utilities can act alone and claim sole credit, with some certainty, for whatever effects are achieved; or utilities can work with other agencies to create what are likely to be larger, more lasting effects, at the cost of sharing a relatively indeterminate amount of credit. It may be possible to resolve this dilemma, not empirically, but through prior negotiation of goals and targeted actions, as part of policy agreements.

Future research in this area should include an analysis of the impact on the resale value of an energy efficient home.

One argument for the economic value of energy efficiency options in new homes is their impact on the home's resale value. We do not know of any empirical evidence of this and it would be useful to test this proposition and publicize positive results. If no impact is found, there is a strong case for beginning to target realtors in the resale market to support the value of energy efficiency.

IMPLICATIONS FOR FUTURE RESEARCH

This section discusses the implications of this project for future projects of this kind—i.e., for future studies of market effects. We discuss three major topics in this section: the importance of a market characterization study, the use of qualitative data, and the benefits of the AHP approach.

The Importance of a Market Characterization Report

We highly recommend that every future effort to measure market transformation effects start with a study of the structure of the market in question—what we in this project called a market characterization report. This report identifies the actors in the market, their interrelationships and defining decisions, and the key market barriers (or significant points of influence). Once the key market barriers have been identified, the market effects that would evidence a reduction in each of these barriers can be hypothesized.

Explicitly defining the structure of a market is important for several reasons. First, it ensures that the market effects to be measured are explicitly tied to specific market barriers, and to the interventions aimed at those barriers. This aids in the attribution of causality and in the determination of the permanence of the changes identified.

Second, a market characterization allows the remainder of the study to focus on measuring the market effects related to *key* market barriers. Every market has a number of what we have called market barriers. Certain of these barriers limit a significant portion of the market's potential benefits, while others have little impact. Studies of market effects, especially these early studies, will be most efficient if they focus on the source of the largest potential benefits.

Third, the removal of certain key barriers may or may not result in a significant increased adoption of energy efficiency in a market depending on the relationships between barriers. A study of a market's structure can reveal whether two or more key barriers are related in a way such that the benefits of the reduction of one barrier are limited by the continued existence of the others. In this way the market characterization study aids in determining the likely final impacts on energy efficiency adoption.

Finally, we believe these types of studies are going to be essential for the future oversight of market transformation activities. Activities designed to influence a market structure, even if successful, will generate significant changes in measure adoption only after a period of several years. This time lag from intervention to final results, along with the large number of other uncontrollable influences on a market, make it infeasible for the agencies intervening in the market to be judged by end results. Instead, these groups' efforts will likely be judged by their impacts on market indicators much closer to their interventions—what we have called market effects. If so, program administrators and other interested parties must agree as to the appropriate market indicators to measure to determine success. This will require this group's agreement regarding something like a market characterization for the market of interest.

The Importance and Inevitability of Qualitative Data

As elaborated in the Methods section, we emphasized the collection and analysis of qualitative information in this study because most indicators of the market barriers selected for consideration refer to transactions between market actors—transactions whose outcomes are not recorded in any direct or readily accessible form for auditing or summary collection. For this reason, the best sources of information regarding the indicators of interest are the perceptions and reports of the market actors themselves, supplemented where possible with tradeoff analyses and quantitative measures of attitudes and beliefs.

Having had the experience of this initial research on barriers to energy efficiency in the RNC market, we are in a position to review the decision to emphasize the qualitative research and to consider future research tactics. First, we conclude that the qualitative approach was appropriate: The majority of the issues addressed did not lend themselves to a priori construction of objective indices, the development of averages and confidence intervals, and the creation of numeric measures of effects. Moreover, the complexity of the market, and the variety of actors and their interactions demanded in-

depth exploration rather than elicitation of structured responses that fit a neat, but Procrustean set of response categories.

Second, our experience indicates that future research in this area can be improved by incorporating the perceptions of market actors themselves into the development of the measuring instruments, and sharpening the design to permit some increase in the representativeness of the sample groups as well as greater comparability of responses among respondents. Some specific suggestions include the following:

(1) Employ focus groups to identify key attributes, measures, barriers, etc., as perceived by the market actors, and use the group to build the AHP hierarchy. Furthermore, use focus groups as "expert witnesses" to test and validate the current findings and to modify the approach and build an improved hierarchy where necessary.

(2) Estimate absolute as well as relative changes in perceptions and attitudes. Use the current data as a baseline against which to measure future perceptions and attitudes.

(3) Within budgetary guidelines, increase sample sizes to improve the representativeness of the sample groups and better assess their variability. If possible, collect a minimum of 20 cases per analytic group, following standard statistical guidelines.

It is worth noting that this study also suggests a number of specific research issues for future consideration. For example, as noted above, we believe that an important contribution to the RNC market would be an empirical study of the value of energy-efficient measures on the resale value of homes.

The Benefits of the AHP Approach

Finally, we recommend that future studies utilize the AHP to analyze at least some of the data collected.

Compared to other methods for analyzing surveys, AHP offers four distinct advantages:

- It provides a logical and systematic framework for structuring the decision problem. (This is consequential given the importance of decisions in the market structure and the large number of decisions involved.)

- It can generate quantitative measures (weights) from responses to qualitative questions.

- It can identify inconsistencies in preferences and decision criteria, which aids in the interpretation of qualitative data.

- It produces composite indexes of criteria used by different players, thus measuring the results of their combined preference and giving an indication of market-wide results.

VII. CONCLUSIONS

Although the Edison *Welcome Home* Program and the PG&E *Comfort Home* Program were not designed as market transformation programs, they did have several market transformation effects.

In terms of its objectives, this study shows evidence of some level of reduction (although in most cases, slight) in the information-related barriers of home buyers, builders sales agents and buyers' realtors, and builders having to do with subcontractor selection and in the HVAC subcontractor barrier of poor ductwork installation practices. The study also shows evidence of limited reduction in what we believe to be the main barrier in the residential new construction market: builder split incentives.

Due to the lack of useable data on past levels of various market indicators, we used actors' perceptions of the past as our baseline and to attribute market changes to the programs. Our assessment of the permanence of changes was also based on actors' perceptions and on whether a barrier was simply bypassed or was directly reduced.

In terms of the application of our findings to future market transformation programs, we make the following points:

- Incentives have some effect, but may not be the best way to transform the market for energy efficiency in new homes.

- The need for more work with potential third-party partners is likely to be a critical distinction between resource acquisition and market transformation programs.

- The improvement of code compliance would likely have a large impact on the energy savings in this market.

- Liability issues have a large impact on builder and subcontractor decisions in this market both as an incentive for quality practices and as a deterrent to the provision of valuable information to home buyers.

- There is hope for ductwork installation standards and training.

- Information on the existence of measures seems to be effective in this market, but trade-off analysis of measure impacts is needed.

- Builders prefer energy efficiency measures that directly increase marketability through nonenergy benefits.

- Future evaluations of market transformation efforts will likely have to accept an even lower ability to claim causality because of multiple agencies being involved.

- Future research in this area should include an analysis of the impact on the resale value of an energy-efficient home.