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BARAKAT & CHAMBERLIN

RESIDENTIAL NEW CONSTRUCTION MARKET CHARACTERIZATION

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APPENDIX A List of Interviews Used in Market Characterization Report

1. INTRODUCTION

The purpose of this report is to provide a basis for the identification and estimation of the market effects of the *Welcome Home* and *Comfort Home* programs. These programs were offered to promote energy efficiency in the residential new construction markets in the Southern California Edison (Edison) and Pacific Gas and Electric (PG&E) service territories, respectively.

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 for the purpose of market transformation 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.

PURPOSE OF THIS REPORT

The goal of this study is to identify and estimate market effects—not so much to determine the market transformation caused by these programs, but to learn how to evaluate and design good market transformation programs. This report is the first in this study and its purpose is to define the characteristics of the residential new construction market. This definition is needed to identify key market barriers. The remainder of the study can then be focused on the appropriate market effects.

ORGANIZATION OF THIS REPORT

Section 2 discusses the definitions used for key market transformation terms and the refinements to those definitions that became necessary through the process of writing this report. The next section defines the scope of this study based on these definitions,

the goals of the project, and the decisions made in the project kick-off meeting. Section 4 presents an overview of the main topics covered in this report and a summary of our approach. Section 5 presents the market structure, decisions, and key market barriers for each category of market actors. Section 6 presents the market effects that we recommend be considered to measure the reduction of the key market barriers identified.

2. DEFINITIONS

We based this report on the definitions of key market transformation terms developed in the Eto, Prah, and Schlegel scoping study.¹ In practice—as we prepared this report—we discovered that we needed several refinements to these definitions. We discuss the key definitions and our refinements below.

Market Barrier. The scoping study defined a market barrier as follows:

Any characteristic of the market for an energy-related product, service, or practice that helps to explain the gap between the actual level of investment in or practice of energy efficiency and an increased level that would appear to be cost beneficial.

As we identified and defined the market barriers in the residential new construction (RNC) market, we realized that the above definition was too inclusive. The problem we encountered is that something can “appear to be cost beneficial” and not be. Costs can be higher than expected. Benefits may not last as long as expected or be as large as expected. If a closer examination of a market reveals that a particular energy-related product, service, or practice is not cost beneficial, the cost that has been left out (or the reduction in benefits from what they first appeared to be) should not be considered a market barrier.

The goal of market transformation is an efficient market for energy efficiency—one where all the transactions that are cost beneficial to society are made. Of course, we are not going to be able to determine *exactly* which transactions are cost beneficial or not because of the variety of situations facing customers and the difficulty in measuring exactly the value of some cost and benefit components. Also, many transactions that appear to be cost beneficial can turn out, in practice, to be not so, and others that actually are cost beneficial may not seem to be.

Therefore, it is possible that the authors were referring to the difficulty in determining actual costs and benefits when they wrote “appear to be cost beneficial.”

Nevertheless, during the preparation of this market characterization, we found it extremely helpful to modify the above definition by replacing the phrase “would

¹A Scoping Study on Energy-Efficiency Market Transformation by California Utility DSM Programs by Joseph Eto, Ralph Prah, and Jeff Schlegel, for The California Demand-Side Measurement Advisory Committee (CADMAC) Project 2091T, July 1996.

appear to be” with the word “is”—recognizing that actual net benefits to society are the goal even though they are not always accurately measurable.

In this vein, it should be noted (as discussed in the scoping study) that cost is *not* a market barrier. The term “market barrier,” by definition, implies that a measure is cost beneficial. Therefore, we have already determined that the benefits outweigh the costs, i.e., the costs are not too large when compared to benefits, and thus, something else must be the reason for non-adoption.

Market Effect. The scoping study defined a market effect as:

A change in the structure of a market or the behavior of participants in a market that is reflective of an increase in the adoption of energy-efficient products, services, or practices and is causally related to market intervention(s).

In general, this definition seemed to work well for us. The one enhancement we made in use is to explicitly tie market effects to market barriers. This definition refers to the need to causally relate market effects to market interventions. The definition for market interventions in the scoping study states that they are efforts to reduce market barriers. Therefore, a market effect is causally related to an effort to reduce particular market barriers. We interpreted the use of the word “reflective” to allow market effects to exist that do not result in actual changes in energy efficiency adoption because of other key market barriers not being reduced.

We also found it useful to define whether a market effect was created by an intervention that reduced, eliminated, or bypassed a market barrier. A bypassed market barrier still exists. It can be overcome by a market intervention and a temporary market effect can result, but if that intervention is removed, the market barrier remains and the market effect disappears. Therefore, a market effect caused by an intervention that bypassed a market barrier is not likely to be a lasting effect, while one caused by an intervention that eliminated a market barrier is likely a lasting effect. A market effect caused by an intervention that reduced a market barrier will lie somewhere in between.

Market Transformation. The scoping study defined market transformation as:

A reduction in market barriers resulting from a market intervention, as evidenced by a set of market effects, that lasts after the intervention has been withdrawn, reduced, or changed.

Several concepts are key in this definition:

- Market transformation is a method to promote economic energy efficiency (see the definitions of market barrier and market effect).
- It is targeted at energy efficiency measures that are cost beneficial, but not being adopted by customers (see the definition of market barrier).
- It is focused on the market structure for the measure (see the definition of market effect).
- Its goal is to achieve lasting changes in the market structure (see the definition of market transformation).
- Its effects are not normally limited/confined to a particular area or service territory (implied by the focus on a market structure).

This definition does not, however, provide information by which to determine when market transformation activities are justified, or when market transformation is complete, i.e., a market should be considered transformed. This information is provided by the scoping study text after the definition. The text explicitly says that:

. . . if there are lasting effects and the most important and relevant market barriers have been reduced to the point where further intervention is no longer deemed to be net beneficial to society, then the market has been completely transformed.

This implies that market transformation activities are justified as long as they provide net benefits to society, i.e., the net benefits to society from the market effects are large enough to cover the cost of the market intervention(s).

3. SCOPE OF THIS STUDY

The definitions above and several decisions made during the kick-off meeting for this project define the scope of this study.

THE MEASURES ON WHICH TO FOCUS

During the kick-off meeting for this project, the team decided that this study should have a forward-looking goal of better design of future market transformation programs. This goal was given priority over the more backward-looking goal of the measurement of the actual market effects of the *Welcome Home* and *Comfort Home* programs. Since future market transformation programs will be, by definition, focused on measures that are cost beneficial, we will put more emphasis in this project on those measures that remain cost beneficial, i.e., those measures where intervention would be cost beneficial.²

When Title 24 was revised in 1992 (and went into effect January 1993), many of the measures promoted by the earlier versions of the programs were incorporated into the new standards. Whether intervention to promote a measure is cost beneficial or not depends on whether the value of the energy savings and other benefits of that measure over those of *the standard in the market at that time* exceed the costs of that measure over the costs of *the standard at that time*. If the 1992 Title 24 standards are the new standard, then the incremental benefits of a measure over Title 24 must exceed the incremental costs over Title 24 plus the cost of the intervention.³

Therefore, an "energy-efficient home" is defined for this report as one that uses less energy than (is more efficient than) Title 24 would require. The market is transformed for all measures already required by Title 24. The measurement of market effects for measures whose markets are transformed are of interest to better market transformation program design only to the extent that the cause and effect is transferable to a nontransformed measure's market. Therefore, we plan to focus more of our efforts on the markets for measures that are still cost beneficial beyond Title 24.

²Our definition of measures for this study will, where possible, include the installation of measures and acknowledge the energy-efficient implications of incorrect installation.

³Actually, the appropriate focus is on measures that are more efficient than what *would have been installed* under Title 24. Where possible, we will acknowledge this distinction between the standard and expected compliance.

Table 1 lists the measures promoted during the *Welcome Home* and *Comfort Home* programs before and after the Title 24 revisions went into effect. In general, we will focus more on the measures that are checked in the second column for each utility. These are the measures that remained cost beneficial and that continued to be promoted after the 1992 Title 24 standards went into effect. As can be seen, insulation was dropped from both programs, and gas furnace and water heater efficiency upgrades were dropped from PG&E's program. The exception is air conditioner downsizing. This measure was dropped because of low participation and to simplify the program, not because it was no longer cost beneficial.

**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 measures that were still considered cost beneficial after the 1992 Title 24 revisions went into place are not necessarily the measures that will or should be targeted with future market transformation efforts. Utility resource costs have changed since 1993 and will continue to change, possibly causing some measures to no longer be cost beneficial to society and others to become so. There also may be new technologies introduced into the market that were not considered before. One example is the aerosol sealing technologies being developed for HVAC ductwork by Lawrence Berkeley Laboratories. Therefore, where possible, we will give attention or more

attention to those measures likely to be the focus of future market transformation efforts.

THE MARKET BARRIERS ON WHICH TO FOCUS

Another implication of our forward-looking goal is the focus on remaining market barriers. Certain market barriers in existence when the *Welcome Home* and *Comfort Home* programs were designed and put in place no longer exist. For example, energy-efficient windows were in shorter supply in the late 1980s and early 1990s than they are now. The availability of these windows was a market barrier for the earlier years of these programs. Now due to a variety of factors including huge efforts in the Northwest and the Title 24 labeling requirements, efficient window availability is no longer a problem. Therefore, again where possible we will give more attention to those market barriers that are likely to affect future market transformation in the residential new construction market.

THE DEFINITION OF A "LASTING" MARKET EFFECT

In our project kick-off meeting we defined "lasting" to mean that the effect will remain after the removal of the intervention *ceteris paribus*—i.e., all else equal. For example, this means that any changes in subcontractor practices that reduce market barriers are considered lasting market effects if these changes can be assumed to remain after the removal of builder incentives—assuming a continuance of the present overall technical and economic conditions and assuming no major natural disasters. For example, if a major economic slump halts all but a minor portion of residential building, the fact that a market effect would not continue during this period does not preclude it from being defined as lasting.

THE SEGMENT OF BUILDERS TO STUDY

We also made the decision in the project kick-off meeting to limit our study to tract builders. A small number of these builders build the vast majority of new homes, and it was believed that our limited project dollars would be best spent on this segment of the market.

4. OVERVIEW OF OUR APPROACH

Our approach to developing a characterization of the RNC market began with a detailed, validated description of the market structure. This description served as the basis for our identification of the market effects to study in the remainder of the project. The description of the market structure included identifying all relevant market actors, their decisions and the influences on those decisions, and the market barriers they face in those decisions.

Our approach to identifying market barriers moved up the delivery chain from homeowners to equipment manufacturers because this proved to be the easiest way to identify the barriers for each actor. In order to identify the market barriers for a particular actor, we assumed that the market downstream from that actor was completely efficient—i.e., that the downstream actors faced no market barriers. For example, we determined the market barriers for builders by assuming that homeowners faced no market barriers—i.e., they demanded of builders exactly the level of energy efficiency that would be cost beneficial to society. We then identified builders' market barriers by asking the question: If the message was getting to builders, what would keep them from passing it on?

Our definition of market structure was developed and validated through a number of interviews. Appendix A contains a list of the people interviewed for this report.

We then developed our list of market effects to consider based on the key market barriers in the market. There were several dimensions to our subjective assessment of whether a market barrier should be considered "key." These are discussed below.

We based the information in this report on project team expertise, other studies of the RNC and other markets, and interviews with market experts.

THE BENEFITS OF AN "UPSTREAM" APPROACH TO THE IDENTIFICATION OF MARKET BARRIERS

Our approach of moving "upstream" from homeowners to manufacturers allowed us to clearly identify, differentiate between the characteristics of, and acknowledge the interrelationships between the barriers for each actor. For example, both builders and their subcontractors face "split incentives"-type market barriers. Neither sees the direct benefits of energy efficiency—lower energy bills. However, both see alternative, but different possibly-energy-efficiency-related benefits. Using this

approach instead of simply listing “split incentives” as a barrier for each, we were able to more specifically determine what was happening.

The “split incentives” barrier is structured similarly for both actors, but the barrier’s reductions would be evidenced by different market effects. One of the key influences on builders’ decisions regarding home design is marketability. It is possible that energy efficiency (or at least the appearance of energy efficiency) would improve a home’s marketability. One implication is that it would be useful to measure builder perception of homeowner desires to estimate the reduction of this barrier.

Subcontractors, on the other hand, are strongly motivated toward keeping the builder happy. If the builder is asking for energy efficiency, the subcontractor will deliver to the point of builder satisfaction—which may or may not result in actual energy efficiency. Changing builder/subcontractor relationships and practices would be indicators of this barrier’s reduction.

The “upstream” approach also illuminates the hierarchy of market barriers. The removal of a downstream actors’ market barriers is necessary for market efficiency since that barrier also controls all upstream actors’ actions. But the removal of the downstream actors’ barrier is not sufficient for market efficiency, since a remaining upstream barrier will then take its turn to block the market’s flow.

For example, the builder’s split incentives barrier dilutes the impact of the subcontractor’s decisions and barriers on the market for energy efficiency. The ideal situation would be to eliminate both barriers. However, if only one is targeted, the largest market impact would come from removing the builder’s barrier. This is because removal of the subcontractor’s barrier without removing the builder’s barrier would do little to improve the market for energy efficiency.

Finally, our “upstream” approach allows us to better target where a barrier actually exists in a market. The fact that HVAC subcontractors may oversize an air conditioner is not in itself a market barrier. It is only a barrier if the builder specifically requests a particular sized air conditioner and then the subcontractor still finds a way to oversize it. In the most efficient market, the subcontractor will still respond to what is requested by the builder. That is the market mechanism. The barriers that result in air conditioner oversizing most likely lie with the builder, either in terms of not choosing to build an energy-efficient house, or in terms of not conveying the desired sizing in the specifications to the contractor.

THE DIMENSIONS OF THE DEFINITION OF "KEY" MARKET BARRIERS

The set of market barriers we discuss in this report is not exhaustive. We took a subjective approach to limiting the barriers included to those we considered to be "key." In general, we considered a key market barrier to be one that prevents a large portion of what would be an efficient (cost beneficial to society) stream of energy efficiency from getting to the end user. There are several dimensions to our definition of a key market barrier.

First, what is considered a "large portion" is entirely subjective. We tried to prioritize potential impacts at least conceptually, and to focus on the largest ones.

Second, some market barriers may have been key in the earlier years of the programs, but are no longer considered important. Given our forward-looking focus, we decided not to concentrate on these already overcome barriers.

For other barriers, the impact of the barrier depends on the current cycle of the market. For some "practices" market barriers, the barrier is actually the "lumpiness" of the practice. For example, some upgrades in window efficiency require manufacturer retooling (e.g., the injection of argon gas). Some require entirely new plants (e.g., vinyl window frames). The impact of the barrier increases with the resistance to change as practices move toward the need for quantum leaps.

Finally, some market barriers may cost so much to overcome that their reduction is not worthwhile. If there is little hope of generating net benefits to society from a barrier's reduction, why spend a lot of effort on it? This problem is directly analogous to the problem the industry faced when it first started to address externalities with regard to energy production (e.g., air emissions). Externalities have damage costs—the cost or reduction in benefits to society from allowing the externality to happen. There are also control costs—the cost to society of preventing the externality from happening. The ideal balance for society is to reduce externalities to the point where the damage costs equal the control costs—where the elimination of one more unit of the externality would cost more than the benefits it would create.

The situation is the same when addressing market barriers. The damage costs of market barriers are the lost benefits to society of allowing the barrier to continue—the lost energy savings and other benefits net of the measure costs. The control costs of market barriers are the cost of the market interventions. Again, the ideal balance is the point where the damage costs equal the control costs—i.e., reduce market barriers only to the point where the benefits no longer exceed the costs of intervention.

The lack of coordination barrier is an example of a barrier that may have a large impact on the market, but would be extremely expensive, and thus, possibly not worthwhile, to eliminate. One of the ways home costs are kept down in the residential new construction market is through the practice of bringing in one trade after another to build a home, letting each deal with the results of the previous contractors' work. Good coordination would require more up-front planning and design—including, for example, the use of a mechanical engineer to lay out the HVAC system ahead of time—and more ongoing on-site management. Both of these would add significantly to home costs. In this study, if we believe a barrier has a large impact, but are not sure that the size of the likely costs to reduce the barrier are within reason, we will flag it for further study.

A NOTE ON THE CATEGORIES USED TO DEFINE MARKET BARRIERS

Different sources use different categorization schemes for market barriers.⁴ In general, we based our market barrier categories on those developed in the scoping study. We believe, however, that future studies will need to fine-tune these categorizations.

At base, what we and others refer to as market barriers are directly related to the market imperfections and failures of neoclassical economic theory: externalities, imperfect information, and nondivisible goods. A significant number of what we term to be market barriers are variations of the failure of the assumption of perfect information in markets.

Neoclassical economics assumes all market participants to be omniscient or all knowing. We humans are not. We sometimes lack the awareness of a measure that would benefit us through energy savings; we may not know the extent of the benefits; we may not know where to find the measure; our known contractor may not know

⁴Sutherland, Ronald J. "Market Barriers to Energy-Efficiency Investments," *The Energy Journal*, Vol. 22, No. 3, July 1991, pp. 15-31.

Sutherland, Ronald J. "Market Barriers, Market Failures and Energy Issues," paper prepared for presentation to the California Energy Commission, July 23, 1992.

McMahon, James E. "Imperfect Markets and Energy Efficiency," prepared for the California Energy Commission, July 9, 1992.

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Sanstad, Alan H. and Richard B. Howarth 1994. "'Normal' Markets, Market Imperfections, and Energy Efficiency." *Energy Policy*.

Sanstad, Alan H., and Richard B. Howarth, "Consumer Rationality and Energy Efficiency", *Proceedings: ACEEE 1994 Summer Study on Energy Efficiency in Buildings*, pp. 1.175-1.183.

how to install it; we may have misinformation regarding its attributes; we may not know how to (or be able to) process all the information available (bounded rationality); we may have less information than the seller (asymmetric information); we may not believe the claims made; etc.

It is beyond the scope of this study, but it would likely provide significant benefits to the future of market transformation to delve into the study of information, its dimensions, and how it is communicated. The communications industry (and possible contracts theory) should be a good source for this work.

Figure 1 provides a schematic picture of the market structure. Table 2 summarizes the actors, measures, decisions, and market barriers discussed in this report. The next section presents these market characteristics in more detail by category of market actor.

Figure 1
Market Structure of the Residential New Construction Market

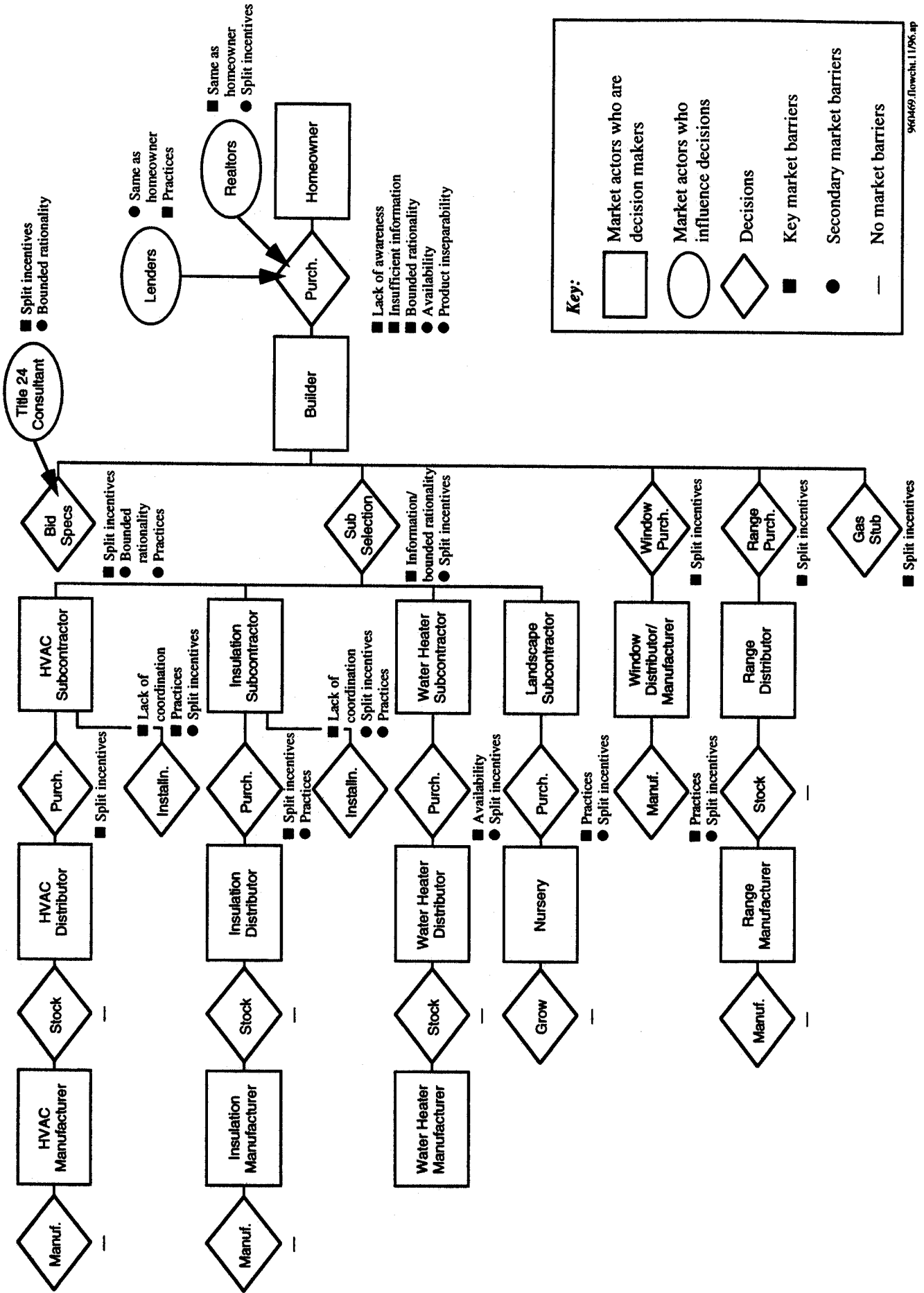


Table 2
SUMMARY OF THE CHARACTERIZATION OF THE
RESIDENTIAL NEW CONSTRUCTION MARKET

(Italics indicate the key market barriers for each actor.)

| Actor | Measures | Decisions | Market Barriers |
|--------------------------------------|---|--|---|
| Homeowner | All | Home "package" to purchase | <ul style="list-style-type: none"> • <i>Lack of awareness</i> • <i>Insufficient information</i> • <i>Bounded rationality</i> • Availability • Product inseparability |
| Realtor/builders' sales staff | All | Influences homeowner decision | <ul style="list-style-type: none"> • Same as homeowner (<i>same key market barriers</i>), plus • Split incentives |
| Lender/builders' financing dept | All | Influences homeowner decision | <ul style="list-style-type: none"> • Same as homeowner, plus <i>Practices</i> |
| Builder/general contractor/developer | Efficient HVAC systems, windows, insulation, water heaters, and shade trees | Specifications to bidders and window manufacturers | <ul style="list-style-type: none"> • <i>Split incentives</i> • Bounded rationality • Practices |
| | Efficient HVAC systems, insulation, water heaters, and shade trees | Subcontractor selection | <ul style="list-style-type: none"> • <i>Information/bounded rationality</i> • Split incentives |
| | Efficient windows | Manufacturer/distributor from which to purchase windows | <ul style="list-style-type: none"> • <i>Split incentives</i> |
| | Gas range | Whether to put in a gas range or cooktop versus electric | <ul style="list-style-type: none"> • <i>Split incentives</i> |
| | Gas dryer stub | Whether to put in a gas stub for a gas clothes dryer | <ul style="list-style-type: none"> • <i>Split incentives</i> |

| Actor | Measures | Decisions | Market Barriers |
|--------------------------------------|---|--|---|
| Title 24 consultant | All | Influences builder "spec" decisions | <ul style="list-style-type: none"> • <i>Split incentives</i> • Bounded rationality |
| HVAC subcontractor | Efficient HVAC, ductwork, and duct insulation | <ul style="list-style-type: none"> • Distributor from which to purchase HVAC equipment and actual equipment to purchase • Distributor from which to purchase insulated ductwork and the size of the ductwork | <ul style="list-style-type: none"> • <i>Split incentives</i> |
| | | Installation of ductwork | <ul style="list-style-type: none"> • <i>Lack of coordination</i> • <i>Practices</i> • Split incentives |
| Insulation subcontractor | Insulation: wall, ceiling, and floor | Distributor from which to purchase insulation and actual insulation to purchase | <ul style="list-style-type: none"> • <i>Split incentives</i> • Practices |
| | | Installation of insulation | <ul style="list-style-type: none"> • <i>Lack of coordination</i> • Split incentives • Practices |
| Water heater subcontractor (plumber) | Efficient gas water heater | <ul style="list-style-type: none"> • Distributor from which to purchase water heater and actual water heater and size to purchase • Installation of water heater and pipes | <ul style="list-style-type: none"> • <i>No key barrier</i> • Split incentives |
| Landscape subcontractor | Shade trees | <ul style="list-style-type: none"> • Nursery from which to purchase trees • Actual placement and planting of trees | <ul style="list-style-type: none"> • <i>Practices</i> • Split incentives |
| HVAC system distributor | Efficient HVAC system | <ul style="list-style-type: none"> • Efficiency levels to stock • Manufacturer from which to purchase HVAC | None |

| Actor | Measures | Decisions | Market Barriers |
|-------------------------------------|---------------------------------------|---|------------------|
| Ductwork distributor | HVAC ductwork and ductwork insulation | <ul style="list-style-type: none"> • R-values and types of ductwork to stock • Manufacturer from which to purchase ductwork | None |
| Window distributor/ manufacturer | Efficient windows | Types of windows to manufacture and stocking practices | <i>Practices</i> |
| Insulation distributor | Insulation: walls, ceiling, and floor | <ul style="list-style-type: none"> • R-values and types of insulation to stock • Manufacturer from which to purchase insulation | None |
| Gas water heater distributor | Efficient gas water heater | <ul style="list-style-type: none"> • Efficiency levels of gas water heaters to stock • Manufacturer from which to purchase gas water heater | None |
| Gas range distributor | Gas range | Manufacturer from which to purchase gas range | None |
| Nursery | Shade trees | Types of trees to stock | None |
| HVAC manufacturer | Efficient HVAC system | Efficiency levels of HVAC systems to manufacture | None |
| Ductwork manufacturer | HVAC ductwork and ductwork insulation | R-values and types of ductwork to manufacturer | None |
| Insulation manufacturer | Insulation: walls, ceiling, and floor | R-values and types of insulation to manufacturer | None |
| Gas water heater manufacturer | Efficient gas water heater | Efficiency levels of gas water heaters to manufacture | None |
| Gas range manufacturer | Gas range | Types of gas ranges to stock | None |

5. MARKET STRUCTURE BY MARKET ACTORS

HOMEOWNERS

Homeowner Decision to Purchase Home "Package"

When homeowners purchase a house they actually purchase a "package" of characteristics including energy efficiency.⁵ Homeowners are influenced in their decision by a variety of factors and actors. It is likely that they entered the home-buying market with their own set of values, perceptions, and information regarding energy efficiency. They also arrived with their own priorities and trade-offs (whether implicit or explicit) between energy efficiency and other desirable housing characteristics such as location, number of bedrooms and bathrooms, square footage, lot size, style, etc. In the home buying arena, they were also likely influenced by other market actors such as realtors (or the builder's sales agents) and potential lenders.

Homeowners' incentives to purchase an energy-efficient home are that the savings in energy bills will more than pay for the higher up-front cost of the home. They are also influenced by any other indirect benefits of energy efficiency, such as increased comfort from the reduction of drafts, the ability to have more control of the home's indoor environment, the perception of a higher quality home, and the satisfaction of an interest in technological solutions or concern for the environment.

Homeowners face a number of potential market barriers to their decision to purchase an energy-efficient home. These are:

- **Lack of awareness.** Homeowners simply do not know that energy efficiency measures exist.
- **Insufficient information.** Homeowners do not know enough about energy efficiency measures to know their special characteristics, their benefits, that their benefits exceed their cost, how to obtain these measures, how to identify whether a home they are considering contains these measures, how to determine whether the information they are given is credible (asymmetric information), how to correctly assess their risks, the effect on resale values, etc.

⁵We use the term "homeowners" in this report to refer to potential home buyers, actual home buyers, and the homeowner after the purchase.

- **Bounded rationality.** Homeowners are unable in their decision processes to perform the analysis needed to understand and make trade-offs between the various combinations of technologies that result in energy efficiency, or to trade off lifetime savings against first costs.
- **Availability.** Homeowners desire energy-efficient homes, but these homes are not available to them. That is, in the case of this study, tract home builders are not building energy-efficient homes. [The availability market barrier is an indication of other actors' market barriers farther upstream in the delivery chain.]
- **Product inseparability.** Homeowners desire energy-efficient homes. Energy-efficient homes are available, but efficiency is packaged with other characteristics that homeowners find undesirable—e.g., no energy-efficient homes are available in close proximity to a desired school. [Product inseparability is related to the availability barrier, and may also be an indication of other upstream market barriers.]

We believe the key market barriers for homeowners are the information barriers: lack of awareness, insufficient information, and bounded rationality.

Realtors' Influence on Homeowner Energy Efficiency Decisions

Realtors and the sales staff for housing developments can strongly influence homeowner decisions regarding energy efficiency. They are often homeowners' only source of information regarding the characteristics of the homes they are considering and the value of those characteristics. They also often control the sample of homes from which the homeowner chooses to purchase.

Realtors' incentives in their influence on homeowners revolve around their commission and their reputation. Higher housing costs increase their commissions. A higher sales volume and faster sales translate into a higher salary. Energy efficiency can increase the cost of a house, and if energy efficiency is a desirable marketing characteristic it may increase realtors' sales and salaries.

Realtors face similar market barriers to homeowners in their influence of homeowners. The differences include the fact that realtors will be less affected by the insufficient information barrier because they have more information on homes and home value than homeowners. However, this remains a barrier. In addition, realtors face the following market barrier:

- **Split incentives.** Homeowners have the incentive of lower energy bills from purchasing an energy-efficient home. Realtors do not pay these bills, therefore, the incentives they have to promote energy-efficient homes have to do with increases to their commission, reductions in the amount of time it takes to sell a home, the volume of homes sold, and enhancements to their reputation.

We believe the key market barriers for realtors are the information barriers: lack of awareness, insufficient information, and bounded rationality.

Lenders' Influence on Homeowner Energy Efficiency Decisions

Mortgage lenders can influence homeowner decisions regarding energy efficiency. An energy-efficient home will cost more than an otherwise equal standard efficiency home. Mortgage lenders control the amount a homeowner can borrow. Homeowners tend to want to purchase "as much home" as they can afford. Therefore, if a lender does not recognize that the energy bill savings from the efficiency measures will increase the homeowner's ability to pay higher mortgage costs, homeowners will be faced with the hard choice of a smaller house (or less desirable location) or less energy efficiency.

Lenders' incentives in their influence on homeowners revolve around their desire for a low-risk borrower, the ability to resell the mortgage, and the up-front points and fees that can be charged on a larger mortgage. Energy efficiency can increase the cost of a house—and thus, its mortgage—and can lower monthly costs and reduce the risk of nonpayment. If the secondary market does not recognize the cost savings of energy efficiency, the lender's ability to profitably resell the mortgage will be reduced.

Lenders face similar market barriers as homeowners in their influence on homeowners. The main difference is that in addition, lenders face the following market barrier:

- **Practices.** Lenders most commonly resell mortgages, and even if they do not, they value the ability to resell the mortgage if needed. There is at present only a weak secondary market for energy efficiency mortgages in California consisting of a FHA program and two large lenders: Country Wide and Norwest.

We believe the key market barrier for lenders is practices.

BUILDER/GENERAL CONTRACTOR/DEVELOPER

Builder/General Contractor/Developer's Decision Regarding the Specifications Given to HVAC, Insulation, Water Heater, and Landscape Subcontractor Bidders and the Specifications for the Windows and Ranges Installed

The builder/general contractor/developer (hereafter, the builder) effectively makes all key decisions regarding the energy efficiency of tract housing. The energy efficiency of a house is determined by a combination of factors. The builder must make trade-offs in packaging these energy efficiency factors so as to ensure sale to the target market at acceptable levels of investment and profit. For the most part, the builder installs those energy-efficient options that satisfy code (Title 24) or the efficiency requirements of its market at the lowest total up-front cost.

However, not all the "costs" considered by the builder are directly quantified—i.e., they are not explicitly contained in the purchase price of the equipment and materials. These other costs include:

- Whether the subcontractors they normally work with are familiar with the equipment, its availability, and any special installation needs;
- The risks involved with any new efficiency measures, their installation, potential for "call backs," and likelihood of subcontractor's "gaming" the bids; and
- Whether the builder knows enough about the measures to know how to evaluate their benefits and installation requirements correctly.

The key costs revolve around the cost of delays. Most builders operate on borrowed funds, whether directly from a lender or from a corporation or partnership. Accordingly, their profit is reduced by late deliveries of materials or complex construction labor that increases the time required to repay those loans. By the same token, any other impediment to quick sales—such as features or costs that reduce customer interest—are critical. Builders seek to transfer ownership (and the accompanying burden of debt) as soon as possible. A builder with 30 homes under way can lose more than \$1,000 per day through construction (or sales) delays.⁶ The cost can be higher if a crew is kept waiting for work.

⁶This estimate is based on an example shown in PG&E's 1996 *Comfort Home* brochure for builders: a price per home of \$150,000, a builder margin of 7%, and a construction loan cost of 9% annual.

Once the desired set of specifications has been determined, the builder puts out for bid the HVAC, insulation, water heater, and shade tree installation work.

Overall the incentives to the builder in making this decision (of the mix of measures that will determine the energy efficiency of the home) are to minimize total costs (including the costs of construction delays) and the risk of "call backs" and to maximize the marketability of the home. Energy efficiency options will likely increase total costs, but may also increase the marketability of the home and reduce "call backs."

Builders face a number of market barriers in their decision regarding the mix of energy efficiency measures to install in a home. These market barriers include:

- **Split incentives.** Homeowners receive the energy bill reductions from the efficiency measures. Builders do not have energy bill reductions as an incentive to install efficiency. Instead, they value what will make their homes most easily completed and marketable. Even if energy efficiency is seen to be key to marketability, this barrier can be compounded through a lack of enforcement regarding energy efficiency claims.
- **Bounded rationality.** Builders are somewhat limited in their ability to analyze the trade-offs among the various options available to achieve energy efficiency. Most of this analysis seems to be performed on software designed to evaluate Title 24 compliance by Title 24 consultants. Builders' evaluation abilities are limited by the software itself (e.g., Title 24 and the software does not address the effects of shade trees), and the practice of Title 24 consultants of only giving a yes/no answer to code compliance.
- **Practices.** Builders are limited in their ability to detail specifications to bidders. For example, it is extremely difficult to specify good ductwork installation.

We believe the key market barrier for builders with regard to this decision is split incentives.

Title 24 Consultant's Influence on Builder Specification Decisions

Builders tend to work with Title 24 consultants to make the trade-offs among the various options available to meet Title 24 requirements. We believe that these same

consultants would work with builders who want to make their homes more efficient than Title 24 requirements.

In their influence on builders' specification decisions, Title 24 consultants have the incentive of pleasing builders to ensure repeat business, while meeting their professional obligations. If energy efficiency is what the builder wants, the Title 24 consultant will at least try to appear to satisfy that demand.

Title 24 consultants face the same types of split incentives and bounded rationality market barriers as builders in their decisions regarding the specifications of equipment, materials, and labor desired. An exception lies in the degree to which they suffer from these barriers. With regard to split incentives, one of the Title 24 consultant's jobs is to ensure that code or other energy efficiency specifications are met. Therefore, any lack of enforcement would give builders much more freedom to stray than the consultants would have.

With regard to bounded rationality, although they are also stuck with the software limitations discussed above, Title 24 consultants should also have the benefit of a much broader experience base. Furthermore, their interaction with peers and with code officials, as well as their professional training, should reduce the degree to which they suffer from bounded rationality.

We believe the key market barrier for Title 24 consultants is split incentives.

Builder Decisions Regarding Subcontractor Selection

Once the builder has put out the HVAC, insulation, water heater, and shade tree specifications to bid, he or she faces the challenge of bidder selection.

Subcontractor bids are evaluated based on whether they meet the specifications and on the following three criteria (listed in descending order of importance):

- **Cost.** In most cases the subcontractor with the lowest total bid wins, given they meet at least acceptable levels of the following two criteria.
- **Timing.** A subcontractor must be able to meet the time schedule of the developer. Every component of the house must be installed during its own particular window of time. Delays are very costly, as described above.

- **Low hassle.** A subcontractor must be able to work without causing the builder any undue hassle, must be able to work with minimum oversight, and must cause minimal “call backs.”

Energy efficiency will likely increase costs, may affect timing if availability is a problem, and can increase or decrease hassle depending on the measure and the practices required.

Builders face the following market barriers in making subcontractor selection decisions for energy efficiency:

- **Information/bounded rationality.** Builders may not have the information needed, or may not be able to guess at or evaluate the variety of ways the subcontractor can cheat on their bids or on the delivery of the services promised.
- **Split incentives.** Builders do not see bill savings, and thus, do not choose subcontractors on the basis of their ability to deliver actual energy efficiency. Instead, they value what will make their homes most easily completed and marketable. Even if energy efficiency is seen to be key to marketability, this barrier can be compounded through a lack of enforcement regarding energy efficiency claims.

We believe the key market barrier for builders with regard to this decision is information/bounded rationality.

Builder Decisions Regarding Efficient Window Purchases and Installation

Large builders tend to buy efficient windows directly from local manufacturers who can offer “as needed” delivery.

The builder’s motivations in deciding on the windows to purchase and install include cost minimization and timing and availability. Delays in window availability (as with all construction delays) are extremely costly to the builder, and stockpiling windows at the job site is problematic due to potential breakage. Energy-efficient windows likely cost more than standard windows.

Builders face the following market barrier in their decisions regarding the efficient windows they purchase and install:

- **Split incentives.** Builders do not see the energy bill reductions, therefore, actual energy efficiency is not their goal. Home marketability is closer to the builder's goal and energy-efficient equipment is only considered in that it helps meet this goal. Even if energy efficiency is seen to be key to marketability, this barrier can be compounded through a lack of enforcement regarding energy efficiency claims.

We believe the key market barrier for builders with regard to this decision is split incentives.

Builder Decisions Regarding Gas Range Purchases and Installation

Builders tend to install gas ranges or cooktops in mid- to higher-priced homes, and offer them as an upgrade in production homes.

When considering whether to install a gas range a builder is balancing between cost minimization and home marketability. It costs the builder extra to extend the gas line to the kitchen for the installation of a gas range. Not all homeowners prefer gas ranges, and there is value in offering homeowners an option.

Builders face the following market barrier in making the decision to purchase and install a gas range:

- **Split incentives.** Builders do not see the energy bill reductions, therefore, actual energy efficiency is not their goal. Home marketability is closer to the builder's goal and the installation of a gas range to reduce energy costs is only considered in that it helps meet this goal.

We believe the key market barrier for builders with regard to this decision is split incentives.

Builder Decisions Regarding the Installation of a Gas Stub for a Gas Clothes Dryer

Builders do not usually run a gas line into the laundry room so that the homeowner can easily install a gas clothes dryer.

When considering whether to install a gas stub in the laundry room, the builder is balancing between cost minimization and home marketability. It costs the builder

extra (approximately \$50 per home) to extend the gas line to the laundry room for the future installation of a gas clothes dryer.

Builders face the following market barrier in making the decision to install a gas stub for a gas clothes dryer:

- **Split incentives.** Builders do not see the energy bill reductions, therefore, actual energy efficiency is not their goal. Home marketability is closer to the builder's goal and the installation of a gas stub to reduce energy costs is only considered in that it helps meet this goal.

We believe the key market barrier for builders with regard to this decision is split incentives.

HVAC SUBCONTRACTOR

HVAC Subcontractor Decisions Regarding HVAC Equipment Purchases

The HVAC subcontractor determines the specific HVAC equipment and insulated ductwork to purchase from distributors that will meet the specifications of the bid accepted by the builder.

The HVAC subcontractor's motives in this decision are balanced between getting the job, the size of the profit expected from the job, and his or her reputation and relationship with the builder for repeat business.

Getting the job requires being the lowest cost bidder while meeting the builder's other requirements of timing and minimal hassle. Profits are enhanced by installing more expensive equipment because the contractor usually takes a percent mark-up on equipment costs. Therefore, the subcontractor wants to be the lowest cost bid, but not too much lower than its competitors.

Maintaining his or her reputation with the builder to ensure repeat business depends on the degree that the subcontractor delivered (or is believed to have delivered) what was promised. Therefore, subcontractors will only "game" a bid to the extent to which they can (or think they can) get away with it. Both profits and their relationship with the builder are harmed by "call backs."

Energy efficiency can increase costs.

HVAC subcontractors face the following market barrier in their decisions regarding the equipment to purchase and install:

- **Split incentives.** HVAC subcontractors do not install energy efficiency to obtain energy savings (i.e., actual energy efficiency is not their goal). They also do not install energy efficiency options to increase a home's marketability (the builder's incentive). Instead, they install the equipment that will get them the job, make the most profit, and protect their reputations. A lack of enforcement—by code officials or the builder—only serves to exacerbate this barrier.

We believe that the key market barrier for HVAC subcontractors with regard to this decision is split incentives.

HVAC Subcontractor Decisions Regarding the Installation of the HVAC System

Since it is hard to specify the sizing of the ductwork, the placement and size of registers, and how the system is balanced, these decisions are often left up to the HVAC subcontractor.

The HVAC subcontractor's motives in making decisions regarding HVAC system installation balance between minimizing costs and minimizing "call backs" and builder discontent. Costs are minimized by using less skilled labor, smaller sized ducts, shorter lengths, and doing the job quickly. "Call backs" and builder discontent are minimized by well-placed registers, and adequately sized and sealed and properly installed ductwork. Energy efficiency is enhanced by good air flow.

HVAC subcontractors face the following market barriers in deciding on the installation and sizing of ductwork:

- **Lack of coordination.** HVAC subcontractors often have to install ductwork in whatever space has been left by the builders. If a house has been poorly designed, the HVAC subcontractor may have no choice but to squeeze ductwork through too-small holes in the framing, or to install it around numerous corners. [This is a special type of practices market barrier that reflects the industry's practices rather than the specific practices of HVAC subcontractors.]
- **Practices.** HVAC subcontractors do not generally understand air flows. They install using standard patterns. For example, few know how to

correctly install a two-zone system, which qualifies as an efficient system under Title 24. (These usually involve a single HVAC unit with automatic dampers.)

- **Split incentives.** HVAC subcontractors install ductwork to minimize their costs (maximize their profit) while maintaining a good relationship with the builder. They do not see energy bill savings, and thus, energy efficiency itself is not their goal. They also do not experience the direct effects of a home's marketability (the builder's goal). A lack of enforcement—by code officials or the builder—only serves to exacerbate this barrier.

We believe the key market barriers for the HVAC subcontractor with regard to this decision are lack of coordination and practices.

INSULATION SUBCONTRACTOR

Insulation Subcontractor's Decisions Regarding Insulation Purchases

The insulation subcontractor determines the specific insulation to purchase from distributors to meet the specifications of the bid accepted by the builder.

The insulation subcontractor's motives in this decision are similar to the HVAC subcontractor's—i.e., balanced between getting the job, the size of the profit expected from the job, and his or her reputation and relationship with the builder for repeat business.

Getting the job requires being the lowest cost bid while meeting the builder's other requirements of timing and minimal hassle. Profits are enhanced by installing more expensive insulation because the contractor usually takes a percent mark-up on materials costs. Therefore, the subcontractor wants to be the lowest cost bid, but not too much lower than its competitors.

Maintaining his or her reputation with the builder to ensure repeat business depends on the criteria of getting the bid and on the degree that the subcontractor delivered (or is believed to have delivered) what was promised. Therefore, subcontractors will only "game" a bid to the extent to which they can (or think they can) get away with it.

Energy efficiency can increase costs and make it difficult to meet the timing of the builder's schedules.

Insulation subcontractors face the following market barriers in their decisions regarding the equipment to purchase and install:

- **Split incentives.** Insulation subcontractors do not install energy-efficient materials to obtain energy savings, they install the material that will get them the job, make the most profit, and protect their reputations. Since the energy efficiency rating of insulation installed is difficult to check after the walls and ceiling are completed, there is even less of an incentive to install to specifications here than for other subcontractors.
- **Practices.** Higher insulation levels often require a major change in construction practices. For example, fiberglass batt insulation beyond R-15 value typically requires a move from 2" × 4" to 2" × 6" framing.

We believe that the key market barrier for insulation subcontractors with regard to this decision is split incentives.

Insulation Subcontractor Decisions Regarding the Installation of Insulation

If the type of insulation to be installed is well specified, competition can cause insulation subcontractors to cut installation costs to make a profit.

The insulation subcontractor's motives regarding the installation of insulation balance between minimizing costs and minimizing builder discontent. Costs are minimized by using less skilled labor and doing the job quickly. Builder discontent is minimized by timely and proper installation. Energy efficiency is affected by poor insulation installation.

Insulation subcontractors face the following market barriers in making their decisions regarding the installation of insulation:

- **Lack of coordination.** Poor coordination of the building trades can compromise the insulation levels that can be achieved. For example, extra framing, plumbing, and electric work can reduce the wall cavity available for insulation or create leakage points that would require additional materials or labor to correct.
- **Split incentives.** Insulation subcontractors install insulation to minimize their costs (maximize their profit) while maintaining a good relationship with the builder. They do not see energy bill savings, and thus, energy

efficiency itself is not their goal, nor is a home's marketability their goal since they are not directly responsible. Since the actual energy efficiency of installed insulation is difficult to check after the walls and ceiling are completed, there is even less of an incentive here to install correctly than for other subcontractors.

- **Practices.** Pressure to lower costs to be competitive can result in poor installation practices, which can leave a wall with a much lower insulation level than is indicated in the product rating.

We believe that the key market barriers for insulation subcontractors with regard to this decision is lack of coordination.

WATER HEATER (PLUMBING) SUBCONTRACTOR

Water Heater (Plumbing) Subcontractors Decisions Regarding Water Heater Purchase and Installation

The water heater (plumbing) subcontractor determines the specific water heater to purchase from distributors to meet the specifications of the bid submitted to and accepted by the builder.

The water heater subcontractor's motives in this decision are similar to those of the HVAC and insulation subcontractors'—i.e., balanced between getting the job, the size of the profit expected from the job, and his or her reputation and relationship with the builder for repeat business.

Getting the job requires being the lowest cost bidder while meeting the builder's other requirements of timing and minimal hassle. Profits are enhanced by installing a more expensive water heater because the contractor usually takes a percent mark-up on equipment costs. Therefore, the subcontractor wants to have the lowest cost bid, but not too much lower than its competitors.

Maintaining his or her reputation with the builder to ensure repeat business depends on the criteria of getting the bid and on the degree that the subcontractor delivered (or is believed to have delivered) what was promised. Therefore, subcontractors will only "game" a bid to the extent to which they can and think that they can get away with it. Both profits and their relationship with the builder are harmed by "call backs" due to poor performance of the equipment.

Energy efficiency can increase costs.

Water heater subcontractors face the following market barriers in their decisions regarding the equipment to purchase and install:

- **Split incentives.** Water heater subcontractors do not install energy-efficient equipment to obtain energy savings, they install the equipment that will get them the job, make the most profit, and protect their reputations.

We believe that there are no key market barriers for water heater subcontractors. Even though they do not have the incentive to install energy efficiency for its energy cost reduction or marketability reasons, if asked to do so by the builder it is likely that they will do so. Water heater purchase and installation is straightforward and difficult to “game.”

LANDSCAPE SUBCONTRACTOR

Landscape Subcontractors Decisions Regarding the Purchase, Planting, and Actual Placement of Shade Trees

The landscaping subcontractor determines the specific shade trees to purchase from the nursery and their placement in order to meet the specifications of the bid submitted to and accepted by the builder.

The landscape subcontractor's motives in this decision are similar to those of the HVAC, insulation, and water heater subcontractors'—i.e., balanced between getting the job, the size of the profit expected from the job, and his or her reputation and relationship with the builder for repeat business.

Getting the job requires being the lowest cost bidder while meeting the builder's other requirements of timing and minimal hassle. Profits are enhanced by installing more expensive landscaping because the contractor usually takes a percent mark-up on materials costs. Therefore, the subcontractor wants to be the lowest cost bid, but not too much lower than its competitors.

Maintaining his or her reputation with the builder to ensure repeat business depends on the criteria of getting the bid and on the degree that the subcontractor delivered (or is believed to have delivered) what was promised. Therefore, subcontractors will only

“game” a bid to the extent to which they can (or think they can) get away with it. Both profits and their relationship with the builder are harmed by plants that die.

Installing energy-efficient landscaping (shade trees) can increase costs.

Landscape subcontractors face the following market barriers in their decisions regarding the landscaping to purchase and install:

- **Practices.** Builders do not typically landscape back yards. Shade trees are best placed on the south or west sides of a home to be of any use for energy efficiency. In a typical subdivision, only half the homes will benefit from shade trees in the front yard. Also, if the placement of the tree is off by several feet—the tree is too far from the house—the efficiency value of the tree can be dramatically reduced.
- **Split incentives.** Landscape subcontractors do not install shade trees to obtain energy savings, they install the trees that will get them the job, make the most profit, and protect their reputations. They also do not experience the direct effects of a home’s marketability (the builder’s goal). A lack of enforcement by code officials or the builder only serves to exacerbate this barrier.

We believe that the key market barrier for landscape subcontractors with regard to this decision is practices.

DISTRIBUTORS AND MANUFACTURERS

HVAC Distributor’s Decisions Regarding Efficiency Levels of HVAC Systems to Stock

HVAC distributors tend to stock those models that are in demand. Their incentives in stocking equipment involve minimizing inventory costs, maximizing profit by stocking those units that allow the highest mark-up and sell with the greatest volume, and keeping their customers satisfied.

We believe that there are no market barriers for HVAC distributors in this decision. High-efficiency air conditioning units are available to meet demand.

HVAC Manufacturer's Decisions Regarding Efficiency Levels of HVAC Systems to Manufacture

HVAC manufacturers tend to produce those models that are in demand. Their incentives in manufacturing decisions involve minimizing inventory costs, maximizing profit by manufacturing those types of units that allow the highest mark-up and sell the fastest, and keeping their customers satisfied.

We believe that there are no market barriers for HVAC manufacturers in this decision. High-efficiency air conditioning units are presently manufactured and available.

Ductwork and Insulation Distributor and Manufacturer Decisions Regarding the Efficiency Levels of Ductwork Insulation and Other Insulation to Manufacture and Stock

Since California tends to have milder weather than the rest of the United States, and since ductwork and insulation manufacturers tend to be national companies, the availability of high R-value insulation is not believed to be a problem in the residential new construction market in California—i.e., this market is assumed to be efficient.

Window Distributor/Manufacturer's Decisions Regarding Windows to Manufacturer and Stock

As discussed above, tract builders typically purchase windows directly from local manufacturers who can deliver on an "as needed" basis (within a week).

Window manufacturer's motives regarding which types of windows to manufacture are directly driven by their major clients' needs. Therefore, they do not tend to stock windows, but instead produce them on demand. They may, however, stock some of the materials needed for window manufacture.

Window manufacturers face the following market barrier in their decisions regarding the windows to manufacture:

- **Practices.** Increases in efficiency for windows require quantum changes in manufacturing processes and also may require a builder to change manufacturers—e.g., aluminum frames to aluminum with a barrier (a

changeover that requires retooling for a manufacturer) to vinyl frames (requiring an entirely new plant).

We believe that the key market barrier for window distributors and manufacturers is practices.

Gas Water Heater Distributor's Decisions Regarding Efficiency Levels of Water Heaters to Stock

Water heater distributors tend to stock those models that are in demand. Their incentives in stocking equipment involve minimizing inventory costs, maximizing profit by stocking those units that allow the highest mark-up and sell with the greatest volume, and keeping their customers satisfied.

We believe that there are no market barriers for water heater distributors in this decision. High-efficiency gas water heaters are available to meet demand.

Gas Water Heater Manufacturer's Decisions Regarding Efficiency Levels of Water Heaters to Manufacture

Gas water heater manufacturers tend to produce those models that are in demand. Their incentives in manufacturing decisions involve minimizing inventory costs, maximizing profit by manufacturing those types of units that allow the highest mark-up and sell the fastest, and keeping their customers satisfied.

We believe that there are no market barriers for water heater manufacturers in this decision. High-efficiency gas water heaters are presently manufactured and available.

Gas Range Distributor and Manufacturer's Decisions Regarding the Gas Ranges to Manufacture and Stock

Since the program specified a gas range or cooktop and since gas ranges have been available for years, the stocking practices and manufacture of gas ranges are assumed to be efficient.

Nursery Decisions Regarding the Types of Shade Trees to Stock

Since the shade trees recommended are of varieties commonly available and grown in California, the nursery market to landscape subcontractors is assumed to be efficient.

6. MARKET EFFECTS

In the previous section we identified the key market barriers for each market actor. As discussed in an earlier section, the effects of the market barriers of different market actors are interrelated and our categorization of key barriers is subjective. In this section, we identify the market effects that evidence the reduction or elimination of the key market barriers in the residential new construction market.

In a market structure, information regarding end-user demands flows upstream stimulating supply (or the desire to supply) and its corresponding derived demand to each higher level. Products and services flow back down this system. Market barriers can be seen as blockages or partial blockages in the system. Since the initial blocks encountered in the system, as information on demand flows upstream, will likely tend to have the largest impact on the market, we considered these to be the key market barriers for the market as a whole.

The *Welcome Home* and *Comfort Home* programs consisted of a number of different market interventions. 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, which allow larger homes to be purchased, 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)

Table 3 contains the market effects that would evidence the reduction or elimination of the key market barriers in the residential new construction market. The table also contains the program interventions directed at each barrier. Certain interventions can affect other barriers indirectly. For example, the interventions directed at realtor and lender barriers will also indirectly affect homeowner barriers. These interventions and those directed at the homeowner will also indirectly affect the builders' split incentives barrier.

As discussed in earlier sections, whether a market effect is lasting or not depends on the barrier and on the nature of the intervention. In general, an intervention must directly address and reduce a barrier rather than simply bypass it if the market effect is to last. If the information provided homeowners and realtors is learned and retained, the market effects for homeowners and realtors can be said to be reduced and may last. Similarly, if HVAC subcontractor and realtor training has been successful and that knowledge is retained, their barriers can be said to be reduced and may last. The indirect effect of any learning that may have happened due to other interventions may reduce builder barriers and produce lasting effects. However, the market effects solely caused by incentives to builders or homeowners are not likely to last.

Our Research Plan report, which is the next deliverable on this project, will propose our plan for estimating the size of key market effects.

Table 3
MARKET EFFECTS TO MEASURE FOR EACH KEY MARKET BARRIER

| Market Barrier | Interventions | Market Effect |
|--|--|--|
| Homeowner information-related barriers | <ul style="list-style-type: none"> • Advertising • Information packets • Incentives (coupons) | <ul style="list-style-type: none"> • Homeowner demand for energy efficiency, especially with respect to other desirable home characteristics |
| Realtor information-related barriers | <ul style="list-style-type: none"> • Information packets • Training | <ul style="list-style-type: none"> • Realtor knowledge with regard to energy efficiency and its benefits • Realtor promotion of energy efficiency |
| Lender practices barrier | <ul style="list-style-type: none"> • Promotion of energy-efficient mortgages • Discounts off closing costs | <ul style="list-style-type: none"> • 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 with regard to specifying energy efficiency in home design | <ul style="list-style-type: none"> • Incentives • Standards for ductwork installation | <ul style="list-style-type: none"> • Builder belief that energy efficiency increases a home's marketability enough to justify its additional costs; and the likely permanence of that belief • Builders designing homes more energy-efficient than Title 24 on own • Builders marketing homes as energy-efficient homes on 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 | <ul style="list-style-type: none"> • Incentives • Standards for ductwork installation | <ul style="list-style-type: none"> • 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 |
| Subcontractor lack of coordination barrier | <ul style="list-style-type: none"> • No direct intervention | <ul style="list-style-type: none"> • Changes in practices which allow for better subcontractor coordination |
| HVAC subcontractor practices barrier | <ul style="list-style-type: none"> • Standards for ductwork installation • Training • Testing | <ul style="list-style-type: none"> • Changes in ductwork installation practices |