Customer Energy Efficiency Program

Measurement and Evaluation Program

PACIFIC GAS & ELECTRIC COMPANY'S PY97 AGRICULTURAL ENERGY EFFICIENCY INCENTIVES: Pumping And Related Market Effects Study

STUDY ID #335A

March 30, 1999

Measurement and Evaluation

Customer Energy Efficiency Policy & Evaluation Section

Pacific Gas and Electric Company

San Francisco, California

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As part of its Customer Energy Efficiency Programs, Pacific Gas and Electric Company (PG&E) has engaged consultants to conduct a series of studies designed to increase the certainty of and confidence in the energy savings delivered by the programs. This report describes one of those studies. It represents the findings and views of the consultant employed to conduct the study and not of PG&E itself.

Furthermore, the results of the study may be applicable only to the unique geographic, meteorological, cultural, and social circumstances existing within PG&E's service area during the time frame of the study. PG&E and its employees expressly disclaim any responsibility or liability for any use of the report or any information, method, process, results or similar item contained in the report for any circumstances other than the unique circumstances existing in PG&E's service area and any other circumstances described within the parameters of the study.

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Energy Analysis

Project Management

Training

Final Report for

Pacific Gas & Electric's

PY97 Agricultural Energy Efficiency Programs

Pumping and Related Market Effects Study

Study ID # 335a

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March 30, 1999

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1 EXECUTIVE SUMMARY

1.1 Study Summary

This market effects study assessed the effect of Agricultural Energy Efficiency Incentive (AEEI) program on the primary set of market barriers in Pacific Gas and Electric's (PG&E's) Agricultural Pumping and related end-use market that are likely to be affected by AEEI program. As a part of the study, a set of four market barriers were identified as important in the agricultural pumping and related end use market and were hypothesized to be affected by PG&E's AEEI programs. Information on perceived existence of market barriers was collected via interviews of customers. This information was used in choice models, along with other attributes of the customer, to estimate the extent to which PG&E's program affected the hypothesized four market barriers. It assessed the contribution of the 1994-1997 AEEI programs to the existing market barrier levels, including estimates of the 90% confidence interval for the AEEI contribution. Interviews with supply-side market actors such as pump dealers and irrigation system designers were incorporated to provide a more complete picture of the market.

The study objectives were to (1) to characterize the agricultural pumping and related end use market, (2) identify market barriers affected by PG&E's AEEI programs, (3) conduct a telephone survey-based market effects study of four key market barriers for the AEEI pumping and pumping related end-use market segment, (4) test different modeling options, and (5) assess the effects of the AEEI programs on the hypothesized market barriers.

A detailed discussion of the methodology used in the study is presented in Sections 3, 4 and 5 of the report.

1.1.1 Market Barriers

A market characterization completed at the beginning of the study hypothesized the important barriers in the market. This understanding of the market was combined with program design and implementation information to hypothesize the subset of barriers that could possibly be affected by the program. These hypothesized market barriers were information and search costs, asymmetric information, performance uncertainty, and hidden costs.

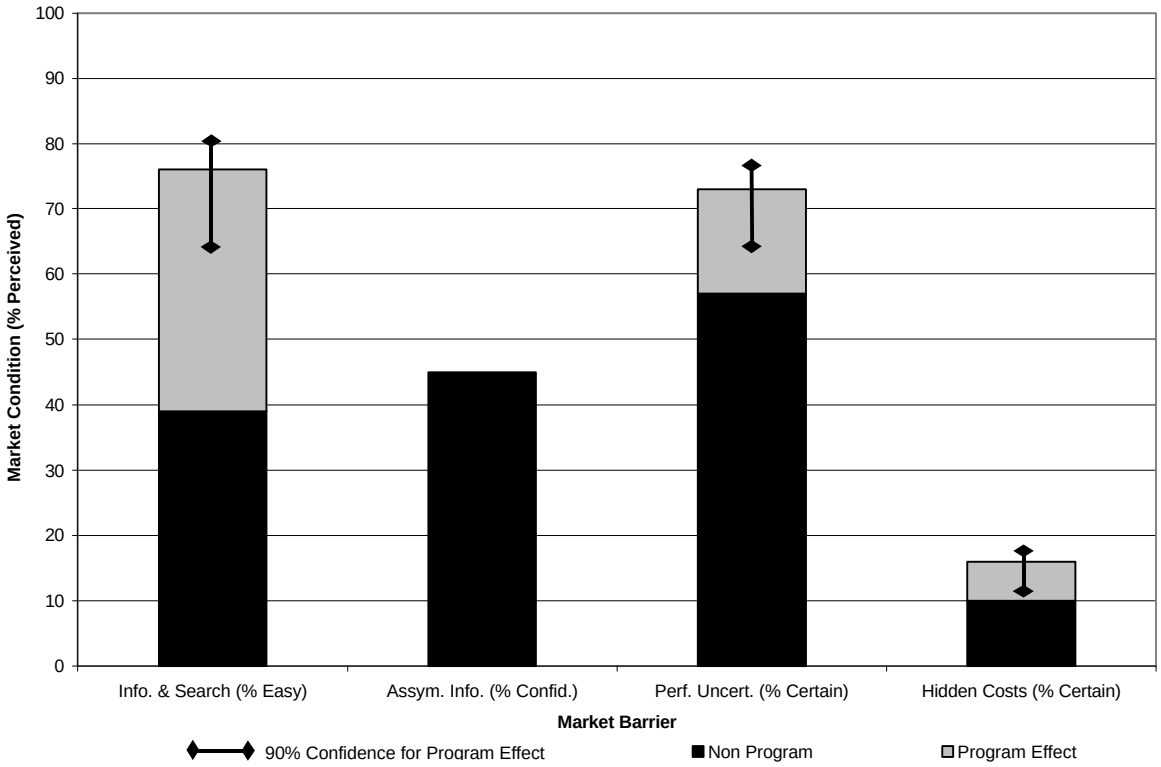
An additional market barrier, access to financing, was identified as a barrier present in the market, but PG&E's AEEI programs had no elements that would have addressed this barrier. For completeness, data was gathered during the study to assess the level of this barrier in the market. Details on this analysis are covered in the body of the report.

The four hypothesized barriers were based on a market characterization and an evaluation of the program design and implementation, prior to any data collection. The responses of customers, irrigation system designers, and pump dealers to telephone interviews confirmed that these are important barriers that affect the market and which are, in turn, affected by the AEEI program. During data collection, opportunities were afforded for market actors to identify additional barriers that affect the market for energy-efficient products and services.

That portion of the market that does not face the barrier is called the market condition, and is the inverse of the market barrier. The extent to which the existing market condition would have changed if the AEEI programs were not offered was estimated using choice models.

Exhibit 1.1 presents a graph of the market condition as perceived by PG&E customers. In addition to the overall market condition, it illustrates the portion of the market condition attributable to the AEEI programs along with the 90% confidence interval for the program contribution. The analysis was able to identify AEEI program contributions for three of the four hypothesized barriers. The following conclusions can be drawn concerning the four hypothesized market barriers:

Exhibit 1.1
Market Effects Attributable to the AEEI Program



Information and Search Costs – The information and search cost market barrier can be summarized as "the costs of identifying energy efficient products or services or of learning of energy efficient practices"[1]. The information and search cost barrier affects only about one quarter (24%) of the population. Of the customers surveyed, 76% said they do not face this barrier at present and do not think that they will face it in the future. However, of those 76%, 36% would have found it difficult to search for information were they not exposed to the AEEI program. The remaining 40% do not face the barrier because they would have gotten

[1] All definitions of market barriers used in this report are drawn from "A Scoping Study on Energy-Efficiency Market Transformation by California Utility DSM Programs", J. Eto, R. Prahl and J. Schlegel, July 1996.

the information anyway via vendors, magazines or other sources. Supply-side market actors think customers face this barrier to a greater extent than do the customers themselves.

Asymmetric Information – The asymmetric information market barrier can be summarized as "difficulties customers face in evaluating the veracity, reliability, and applicability of claims made by sales personnel for a particular energy efficiency product or service". The asymmetric information market barrier is encountered by over half of the customers in this market sector. Only 20% of customers responding had confidence in other agencies. Overall, 55% of the customers found it very difficult to trust any agencies other than PG&E when it came to projected benefits from energy-efficiency options. The models chosen for the study could not determine the extent to which PG&E's AEEI program generates confidence in other agencies.

Performance Uncertainty – The performance uncertainty market barrier can be summarized as "the difficulties consumers face in evaluating the claims about future benefits, which are made for many energy efficiency investments and activities". The performance uncertainty market barrier affects slightly more than one quarter (27%) of the population. The survey indicates that 73% of customers are perceived to be certain about the performance at the present and will continue to be certain in the future. Of the 73% of customers who are certain, approximately 16% would not have felt certain about the performance if they did not have implementation experience through the AEEI program. The remaining 57% of customers are certain about the performance due to others' implementation experience, or they would have implemented the technology outside the program. The supply-side market actors interviewed felt that performance uncertainty was less of a barrier than indicated by the customers.

Hidden Costs – The hidden costs market barrier can be summarized as "unexpected costs associate with reliance on or operation of energy efficient products or services". Hidden costs represent the largest barriers to energy-efficiency implementation in the pumping and related end-use market sector. Approximately 84% of respondents perceived it as a market barrier. Of the 16% of all customers who do not face this barrier, 6% is due to implementation as a result of the AEEI program. Supply-side market actors' perceptions of hidden costs as a barrier are very similar in that they see it as a major concern. However, supply-side market actors' responses suggest that the unexpected nature of the costs is the driving force behind the concern.

1.1.2 Sustainability of Market Effects

Sustainability of the effects were tested in two ways; first, by estimating the extent to which sustainable market effects are attributable to the program, and second, by observing the implementation actions taken by customers outside the programs since the programs ended December 31, 1997.

Through evaluation of sustainable market effects using the perceptions of market actors, this study demonstrates the program's capability to reduce the existence of market barriers in the future, as well as the present. Outside the programs, customers have demonstrated long-term effects via actions taken outside the program. In addition, dealers and designers also experience customer requests for energy-efficient products.

The number of actions outside the program, and customer perception that market barriers will continue at current levels in the future, indicate market effect sustainability.

1.2 Recommendations

1.2.1 Program Recommendations

If an AEEI type program is planned in the future it should:

- Target the supply-side market actors. There are fewer of them and virtually every customer with a pump goes to them for advice.
- Target education efforts to convince medium-sized customers of the benefits of energy-efficient technologies. Cost benefit analysis is very important to those customers with low electricity consumption that represents a large portion of their total costs. These customers are very sensitive to cost and performance uncertainties.
- Consider offering a financing program targeted to small users. Financing appears to be a significant barrier to small customers.

1.2.2 Evaluation Recommendations

The approach applied in this study should be considered for evaluating other programs. Properly applied, it can quantify the level of market barriers and program market effects.

2 INTRODUCTION

This report presents findings from a market effects analysis of Pacific Gas & Electric's (PG&E's) 1994-1997 Agricultural Energy Efficient Incentives (AEEI) Program, pumping and related end use. The California DSM Measurement Advisory Committee (CADMAC) approved a retroactive waiver for PG&E's 1997 AEEI program that allowed PG&E to conduct a market effects analysis of the pumping and related end use instead of conducting a net-to-gross analysis for the 1997 AEEI program.

The AEEI program provides information about energy-efficient technologies to agricultural customers at no cost to them and offers incentives for implemented measures. In this study, the perceptions of customers (participants and an intra-territory comparison group) are used to define the level of each of four hypothesized market barriers (whether or not the market barrier is perceived to exist), and to evaluate the extent to which the program affected the market. In order to evaluate the market effects of PG&E's 1994-1997 AEEI programs, market barriers that can be affected by the program are identified and analyzed. The extent to which the AEEI program affected each of these barriers is measured. An attempt is also made to study the agricultural market for energy-efficient technologies via interviews with three different market actors: i) customers, ii) pump dealers, and iii) irrigation system designers/consultants.

2.1 Study Objectives

The focus of this study is to develop a broad understanding of how the AEEI program affects the market for energy-efficient pumping equipment and services. It is important to note that the AEEI program was not explicitly designed to cause, or otherwise affect, market transformation. Therefore, it is more appropriate to view this study as both an assessment of the market for the pumping and related end use and the effects of the AEEI program in that market. Information about the market is used to identify barriers that discourage market actors from adopting efficient technologies/practices. The original program design and implementation information are used to identify those market barriers that may have been affected by PG&E's AEEI program. The extent to which the market for the pumping and related end use has been affected by the AEEI program is measured.

The specific study objectives are:

1. **Market Characterization.** One of the objectives is to characterize the agricultural pumping and related end use market. This involves understanding the roles of, and interrelationship between, important market actors using existing data sources. These data sources include PG&E's 1996 AEMS Market Effects study, Southern California Edison's (SCE) 1996 Agricultural Sector Market Effects Study, and the experience of the evaluation project team.
2. **Identification of market barriers affected by PG&E's AEEI program.** Since PG&E's AEEI program was not originally designed to transform the market, it is essential to study the program design and implementation and identify which bottlenecks in the market studied in Objective 1, the program is likely to affect.

3. **Conduct a telephone survey-based market effects study of four key market barriers existing in the market segment which the AEEI pumping and pumping related end-use programs can effect.** The retroactive waiver agreed to with CADMAC allowed PG&E to replace the mandated net-to-gross study with a telephone survey-based market effects study of the key market barriers (identified in Objective 2) for the AEEI pumping and pumping related end-use market segment.

   Since customers' perceptions represent the demand-side barriers and effects, it is important to study the market from the supply side and identify other barriers and AEEI program effects. Thus, PG&E also chose to study the market and market effects as perceived by the supply-side market actors of energy-efficient technologies via interviews with pump dealers and irrigation system designers.

   Similarly, while not mandated by the CADMAC retroactive waiver, PG&E chose to assess the level of a fifth market barrier which was identified as probably existing in the market, but which the PG&E AEEI programs were not designed to affect. This market barrier is access to financing.

4. **Comparison of different modeling options.** Since there is increasing interest in evaluating alternative modeling options to study market effects, the forth objective of this study is to test different modeling options.

5. **Summarize the program's effectiveness in terms of each of the market barriers identified in Objective 2 and tested in Objective 3.**

2.2 Scope of the Study

PG&E's AEEI program was originally designed as a marketing and customer assistance program and was later recognized as an incentive program to help promote energy-efficient technologies/practices. It was not designed to permanently transform markets for energy-efficient products and services. Nonetheless, there is interest in finding out whether the program has had market transformation effects. There is an even greater interest in assessing the program's suitability to serve as a vehicle for future market interventions that may be more directly targeted toward market transformation.

A comprehensive market effects study should examine the effects of all PG&E's energy efficiency programs. From 1994 through 1997 PG&E offered two different programs to agricultural sector customers: the AEEI program, and the Agricultural Energy Management Services (AEMS) program. As part of the AEMS program, PG&E offered information about energy-efficient technologies and pump test services at no cost to customers. As part of the AEEI program, PG&E offered information and incentives (in the form of rebates) for pump repair and installation of other energy-efficient technologies. These programs, at a minimum, have the potential to encourage customers to use energy-efficient technologies in the near term. Thus, primary effects of both programs can be observed as market actors.

The AEMS program has been offered since 1923, the AEEI program since the early 1970s. Since both programs have been offered for many years, market effects should really be observed over time. Long-running programs such as these have the potential to affect both the demand and supply side of the market. A comprehensive study of market effects should

include the behaviors of all relevant market actors – customers, dealers, irrigation system designers, distributors, and manufacturers – as related to energy-efficient equipment.

The information offered via the AEMS or AEEI programs is not limited to any specific energy-efficient technology. PG&E offers information and incentives for various types of energy-efficient technologies. Therefore a comprehensive study of market effects should also include the effects of all energy-efficient technologies.

However, it is beyond the scope of this study to observe all changes in the behaviors of all market actors for all energy-efficient technologies as a result of both energy-efficient programs for agricultural customers.

The following factors shaped this study:

1. First of all, though a combination of DSM programs affect the market, such an overall evaluation of market effects would assume that both programs offer the same services. In reality, each of the programs is unique in terms of its design and implementation. It is important to study the market effects of each individual program. The challenge faced in evaluating program-specific market effects is that the interactive effect of two or more programs is ignored. For example, incentive or informational programs alone may not have significant effects on different actors, but together the programs may succeed in changing the level of awareness, behavior, and attitude of market actors. Since the CADMAC Waiver dictates examining the effects of the AEEI program, this study focuses on the AEEI program.
2. Secondly, it is true that since the AEEI program has been offered for many years, it has the potential to affect all market actors. However, a program designed for customers may not affect other market actors to the same extent. For example, in the agricultural sector, it is extremely important to get site-specific advice on appropriate energy-efficient technologies. PG&E can encourage customers to implement energy-efficient technologies/practices by providing site-specific information and incentive via the AEEI program. Though the information may already be available to other market actors, incentives are not offered to all market actors. Thus, programs targeted to customers' needs may not affect other market actors to the same extent as they affect customers. However, in the long run, there is the possibility of secondary effects; i.e., increased demand by customers can lead to greater supply of energy-efficient technologies. Since the programs were originally designed as customer assistance programs, the focus of this study is to analyze the behavior of customers as market actors. Considering the long-term nature of these programs, an attempt was made to study long term secondary effects on other market actors like pump dealers and irrigation system designers.
3. Thirdly, since the program offers information on various energy-efficient technologies, it is important to evaluate overall effects on all energy-efficient technologies. For example, it is likely some customers were more aware of one equipment type (e.g., pump repair) than others (e.g., low-pressure sprinkler nozzles). They may have been convinced about the performance of a pump repair more than other equipment types, which may, in turn, result in a greater market effect for pump repairs than other equipment types. Thus, the market effect attributable to a single program can be different for various equipment types and they must be evaluated separately. Since energy-efficient technologies used in the

agricultural sector are diverse, it is beyond the scope of the study to evaluate the market effects for all energy-efficient technologies. In reality, it is difficult to find a sufficiently large sample of customers for each equipment type, and even if it was possible, fiscal limitations force the study to combine similar equipment types. The study focuses on the technologies in the pumping and related end use since that is the most important end use among agricultural customers.

4. From past PG&E and SCE market effect evaluations, it was evident that the programs have a lagged effect. For example, participation in one year may, after some time lag, affect customers' attitudes. Or, participation by customers in more than two subsequent years may change their attitudes and behavior. The possibility of such occurrences are greater when programs are offered for a long period of time. In such situations, it is difficult to identify and establish a causal relationship between the change in attitudes and behavior of customers to a specific year's program. Therefore, this study is focused on AEEI programs for the past four years (i.e., 1994, 1995, 1996, and 1997).
5. Ideally, it would be desirable to evaluate overall market effects of a "program" on the "market". However, the extent of perceived existence of a market barrier may differ from one barrier to another. For a given equipment type (e.g., pump repair), the perceived existence of one market barrier (e.g., unexpected costs) may be lower than the perceived existence of another market barrier (e.g., performance uncertainty). Thus, the market effects should be analyzed separately in terms of reduction in each of the identified market barriers, individually. The unavoidable downside of market barrier-specific analyses is that different market barriers may appear to be independent from one another when, in reality, they are not. This risk must be accepted.

Together, these factors restricted this study to (1) the market effects of the AEEI program, (2) the market for the pumping and related end use, (3) market barrier-specific effects of programs in the past four years, and (4) customers as market actors. In order to establish a causal relationship between market effects and the AEEI program during the past four years, an intra-territory comparison group was used due to fiscal/scope restrictions. The study also attempts to compare the perceptions of demand-side market actors with the perceptions of supply-side market actors and observe the secondary effect on the supply-side of the market.

2.3 Report Organization

This report is divided into the following sections:

Section 1 constitutes the executive summary.

Section 2 presents an overview of the study objectives, scope, and organization.

Section 3 documents data handling, sources of data, sample design, and sample sizes for additional data collection.

Section 4 explains the overall approach of the study, the theoretical framework, and how market barriers are identified.

Section 5 discusses the modeling system used to establish a causal relationship between market effects and the AEEI program.

Section 6 presents the results of the modeling analysis.

Section 7 summarizes the AEEI program's effectiveness in reducing each identified market barrier.

Section 8 presents recommendations for optimizing the AEEI program's future market effects and retrospectively assesses the method used.

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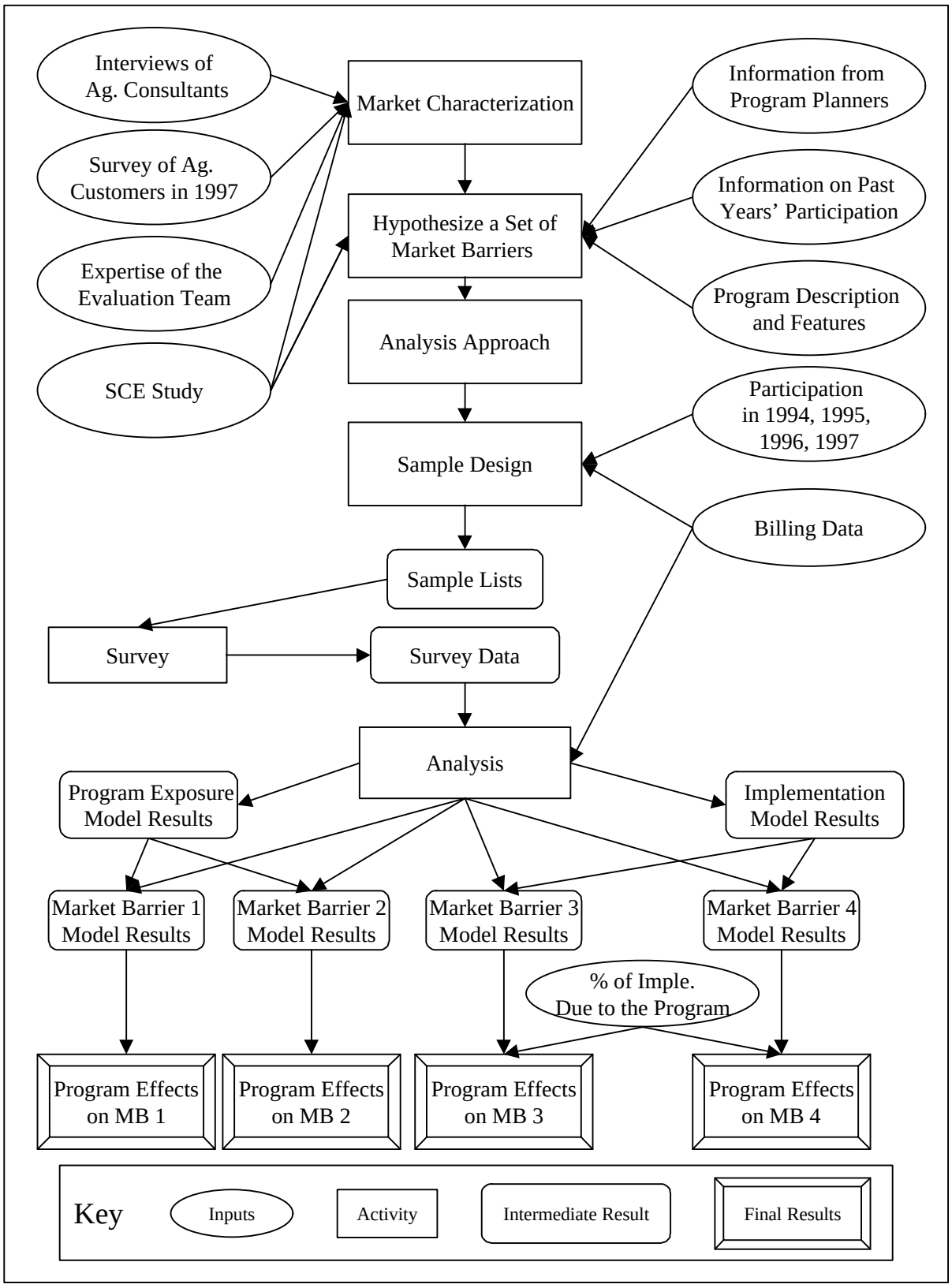
3 DATA SOURCES AND SAMPLE DESIGN

This section presents an overview of data used in the study, the data sources, and the sample design for additional data collection.

3.1 Study Overview

Exhibit 2.1 illustrates how different sources of information are used in the study. In order to broaden our understanding of the market, the evaluation team gathered a wide range of information. This information was distilled into a Market Characterization, which is presented in Appendix B. Only after completing this exercise in understanding the market and program features was a set of market barriers hypothesized that could have had program effects. An analysis approach was then developed to suit the program design and implementation. To complete the analysis, additional data were required from customers exposed to the program and from a comparison group. Therefore, the sample design was planned and sample lists were produced for telephone surveys. Information from the survey was combined with appropriate billing data to create the analysis dataset. Barrier-specific market effects attributable to the program were then estimated. Exhibit 3.1 presents an overview of the data used in the project analysis.

Exhibit 3.1
Overview of the Study



3.2 Data Sources

The key element to obtaining high accuracy in any evaluation is maximum use of all available data sources. The evaluation team assessed all applicable data available from PG&E and industry sources.

3.2.1 Existing Data

The primary existing data sources were:

- The participant data maintained in the PG&E Marketing Decision Support System (MDSS) database for 1994, 1995, 1996, 1997 – This database contains information on the programs for all sectors. The agricultural sector information was used for this study.
- The PG&E Pump Test Database for 1994, 1995, 1996, and 1997 – This database contains information on pump tests conducted as part of the AEMS pump test program.
- PG&E program description – The PG&E documents contain detailed descriptions of the participation criteria and program qualification procedures. This information, along with discussions with program designers and implementers, contributed to the analysis of potential program improvements.
- PG&E billing data for 1995, 1996 and 1997 – PG&E nonresidential billing data contain monthly energy consumption information for all agricultural customers in PG&E's service territory.
- PG&E's 1996 Agricultural Sector EMS Program Market Effects Study.
- Southern California Edison Hydraulic Services Program Market Effects Study, Study ID #3507, February, 1998.·

3.2.2 Collected Data

This study used additional data collected via telephone interviews of 215 exposed customers and 214 customers from a comparison group. Exposed customers are defined as customers who participated in PG&E's programs in the years 1994 through 1997[2]. The comparison group includes those customers within PG&E's service territory who did not participate in any of the PG&E agricultural programs in the years 1994 through 1997.

This study is also supported by 16 structured interviews with other agricultural market actors. Of a total of 16, 8 are pump dealers and 8 are irrigation system designers/consultants. Engineers experienced in the industry conducted these 16 interviews.

3.3 Sample Design

Data were collected via telephone interviews of a representative sample of exposed customers (i.e., program participants in 1994 through 1997) and a representative sample of customers from the comparison group. Data collected from these samples provided the information

[2] Participation is defined as paid during the calendar year(s) quoted.

needed for the market effects evaluation models. The sampling plan for this study, based on 1994-1997 program participation data and experiences in past evaluations, is presented in this section.

3.3.1 Population, Sample Frame, and Data Screening Criteria

The population includes all of the agricultural customers in PG&E's service territory. The samples of exposed customers or the comparison group were not drawn from the population of agricultural customers. Rather, they were drawn from sample frames. The sample frame for exposed customers included only those customers who participated in the AEMS or AEEI programs anytime during 1994 through 1997. The sample frame for the comparison group included only those PG&E customers who had not participated in PG&E's AEMS or AEEI programs between January 1, 1994 and December 31, 1997. Though it is desirable to select a comparison group from those agricultural customers who are not exposed to the program at all[3]; fiscal, time, and practical limitations did not allow us to do so. A unique premise (site) was considered an appropriate sample unit for developing the sample frames. The criteria for developing the sample frames for exposed customers and the comparison group are discussed below. It is important to note that, in both cases, the same exclusion criteria are applied. However, since they are applied sequentially, if accounts were already excluded for some reason, those accounts did not qualify to be tested for another criteria.

3.3.2 Sample Allocation, Sample Sizes and Sample Selection

Sample allocations designate the number of elements to select in each group (exposed and comparison group). Allocation is influenced by the project objectives, sampling error, and expected response rate.

In a stratified sampling, strata are mutually exclusive and collectively exhaustive cells from which the sample is drawn, allowing different sampling rates for different cells. The objective of stratification is to improve the overall reliability of the estimates by reducing sampling error, controlling non-response bias, and providing larger sample sizes for the sub-populations of most interest to the study. Stratification allows the sample to emphasize certain parts of the population over other parts. For the exposed customer sample, four strata were defined using pre-program (i.e., 1996) kWh usage of all customers included in the sample frame. Likewise, four strata were defined using pre-program kWh usage of customers in the comparison group. A sample was selected randomly from each stratum. The annual kWh usage categories were defined by classic stratification techniques.

3.3.2.1 Sample Frame for Exposed Customers

The population of exposed customers includes all participants of PG&E's AEMS and AEEI programs from the years 1994 through 1997. It consists of 15,269 unique control numbers. Of this total, 4,451 unique control numbers were included in the participant sample frame. The reasons for excluding the remaining 10,818 control numbers are:

[3] For example, customers from a reference area outside the PG&E service territory who were not exposed to any energy-efficiency programs.

- 1,070 control numbers were excluded because they did not have kWh usage billing information. Kilowatt-hour usage is very important for sample stratification and for further statistical analysis.

Since this study focuses on the pumping and related end use, it is important to include those customers that use pumping and related services. There were 934 control numbers that were unlikely to be pumping accounts and hence were not included in the participant sample frame. Using the address fields from the billing data, we checked whether or not a control number was likely to be a pumping account. This assessment was based on the first character of the address field. Most pumping account addresses are text descriptions of the location of the pump. Thus, if the first character was a number, the account was assumed to be an address or a "regular" account. If the first character was a letter, the address was assumed to be for a pump.

- Missing or bad values for key billing data variables made it impossible to construct a reliable billing history for a customer. There were 2,267 control numbers that were excluded because the service address and/or the contact phone number changed between 1995 and 1996.
- A further 752 control numbers were excluded because the annual usage in 1996 was zero or less than 50 kWh.
- An additional 916 control numbers were excluded because the SIC codes were missing or not in the range that indicates association with an agricultural account (i.e., SIC code greater than 100 does not represent an agricultural account).
- Since a unique site better represents a unique customer, it is important to select a representative control number from all control numbers at the site. In this process, 450 control numbers were not included in the participant sample frame since they represented the same site more than once.
- In order to avoid multiple contacts with the same customer, accounts with duplicate phone numbers were excluded. If sites with the same phone numbers were included in the sample frame, they have equal chances of being selected in the sample. Since multiple contacts with the same customer can be annoying, 4,429 control numbers were excluded because they had duplicate phone numbers.
- The remaining 4,451 unique control numbers at 4,451 unique sites with 4,451 unique phone numbers were included in the sample frame. After stratifying them into four groups based on kWh usage in 1996, a sample was randomly selected from each stratum.

3.3.2.2 Sample Frame for Comparison Group

The population of PG&E agricultural customers includes 94,010 unique control numbers representing 68,986 sites. Of this population, 21,086 control numbers were excluded since they represented sites that participated in either the AEEI or AEMS program in the years 1994, 1995, 1996, or 1997. Thus the population for the comparison group included 72,924 unique control numbers. Of a total of 72,924 unique control numbers, 20,348 were included in

the sample frame for the comparison group. The reasons for excluding the remaining 52,576 control numbers are:

- Since the purpose of creating the sample frame is to draw a sample for telephone interviews, telephone numbers are very important for contacting customers. Customers with missing phone numbers were excluded. Thus, 9,732 control numbers were excluded for this reason.
- Since the study is focused on the pumping and related end use, it is important to include those customers that use pumping and related services. There were 7,673 control numbers that were found unlikely to use pumping and related end use and hence were not included in the sample frame. Using the address fields from the billing data, we checked whether or not a control number was likely to be a pumping account. This assessment was based on the first character of the address field. Most pumping account addresses are text descriptions of the location of the pump. Thus, if the first character was a number, the account was assumed to be an address or a "regular" account. If the first character was a letter, the address was assumed to be for a pump.
- Missing or bad values for key billing data variables made it impossible to construct a reliable billing history for a customer. There were 11,811 control numbers excluded because the service address and/or the contact phone number changed between 1995 and 1996.
- After excluding customers with unreliable phone numbers or changes in phone numbers and/or addresses, an additional 5,872 control numbers were excluded because their electricity consumption in 1995 and 1996 was less than 50 kWh.
- An additional 5,237 control numbers were excluded because the SIC codes were missing or did not indicate control numbers associated with an agricultural account (i.e., less than 100).
- A further 141 control numbers were excluded because they represented control numbers or phone numbers of customers included in the pretest.
- After excluding control numbers for reasons mentioned above, there were 32,458 nonparticipating accounts that should have been included in the sample frame. The phone numbers of 32,458 unique control numbers were checked in order to avoid contacting the same customer more than once. An additional 12,110 accounts were excluded due to duplicate phone numbers.

The remaining 20,348 accounts representing unique sites were included in the sample frame for the comparison group.

3.3.3 Sample Sizes for Exposed and Comparison Customer Groups

The primary consideration in designing the sample size within each group was the budget. The budget allowed a telephone survey sample of 425 customers. The total number of surveys collected for the evaluation is shown in Exhibit 3.2. Since customers in each group are selected to represent the population of the respective groups, the strata boundaries were based on the kWh consumption of customers in each group. The exposed customer sample is

expected to reflect the population of customers who participated in the past four years in either the AEMS or AEEI programs. For both groups, customers were randomly selected from each stratum for the telephone survey.

Exhibit 3.2
Collected Data

Strata	Exposed Customers		Comparison Group	
	kWh Boundaries	**Sample Size**	**kWh Boundaries**	**Sample size**
Stratum 1	55<1996 annual kWh <=79,200	102	55<1996 annual kWh <=20,800	64
Stratum 2	79,200<1996 annual kWh <=182,600	64	20,800<1996 annual kWh <58,200	59
Stratum 3	182,600< 1996 annual kWh <=381,000	32	58,200<1996 annual kWh <=160,000	50
Stratum 4	381000< 1996 annual kWh	17	160,000<1996 annual kWh	41
Total	**-**	**215**	**-**	**214**

3.3.4 Relative Precision of Sample

The relative precision of a given sample design based on total annual energy use reflects the extent of uncertainty as to whether the allocated sample sizes are large enough to control for the population annual energy usage variance.

For the exposed customer group, a sample of 215 control numbers was surveyed that represented 4,451 participating accounts in the sample frame, whereas, 214 control numbers were surveyed to represent 20,348 comparison group accounts. The relative precision for both exposed customers and the comparison group is calculated using the equation shown in Exhibit 3.3.

Exhibit 3.3
Relative Precision Algorithm

$$\begin{pmatrix} \text{RP} \\ (\text{Relative Precision}) \end{pmatrix} = \left[\frac{1.64 * \sqrt{\text{Variance}}(sample)}{\text{Mean kWh}(population)} \right]$$

It is important to note that relative precision defined in this manner is in fact an index of imprecision. Since the variance is proportionately related to relative precision, it measures how imprecisely the sample reflects the population. Or, a lower value of relative precision reflects greater precision.

For a stratified sample, this definition can be further explained as in Exhibit 3.4.

Exhibit 3.4
Stratified Sample Relative Precision Algorithm

$$\begin{pmatrix} \text{RP} \\ \text{(Relative Precision)} \end{pmatrix} = \left\{ \frac{1.64 * \sqrt{\sum_{i=1}^{4} [W_i^2 * (\text{Std Err}_i^2 (_{sample}) / n_i) * (1 - s_i/n_i)]}}{\text{Mean kWh}(_{population})} \right\}$$

Where:

W_i = a ratio of number of accounts in strata$_i$/total population N that is weight n_i/N,

Std Err_i = the standard deviation of mean usage in strata$_i$,

$(1-s_i/n_i)$ = the correction factor for finite sample.

For the comparison customer group;

- The denominator = Mean kWh $_{(population)}$ = 27,922
- The numerator is (1.64*791) = 1297
- This gives us the relative precision of 4.6%.

For the exposed customer group;

- The denominator = Mean kWh $_{(population)}$ = 81,142
- The numerator is (1.64*3,381) = 5,545
- This gives us the relative precision of 6.8%.

Thus, the final achieved telephone survey samples for exposed and comparison customer groups yielded relative precision of less than 10% at the 90 % confidence level, in terms of annual energy usage.

4 ANALYSIS FRAMEWORK

4.1 Overall Approach

Overall, the study is based on the "market transformation model" presented by Eto, Prahl, and Schlegel (1996) in the "Scoping Study on Energy Efficiency Market Transformation by California Utility DSM Programs". They define market transformation as a "reduction in market barriers as evidenced by a set of market effects as a result of intervention that sustains even after the intervention is reduced, changed or withdrawn".

This definition indicates that estimation of market effects from an intervention would consist of three components. One, observing reduction in the market barrier. Second, causally relating reduction in market barriers to intervention. Third, determining the sustainability of reduction after intervention is changed, reduced or withdrawn. The definition implicitly assumes that the intervention has pre-defined objectives in terms of reduction in or elimination of pre-specified market barriers. However, the objectives of the AEEI program were not specified in terms of which market barriers to affect and to what extent. Since this program was designed some years ago to promote energy-efficient practices and technologies, the program objectives were not explicitly designed to transform the energy-efficiency market. Therefore, one of the first and very important steps is to hypothesize a set of market barriers that may have been affected by the program and to clearly define which of these market barriers are to be studied.

4.2 Identification of Market Barriers

There are three alternative ways that hypothesized market barriers can be derived.

1. Hypothesize an ideal set of market barriers that would have been faced by the market when the program was first designed and implemented.
2. Hypothesize a set of market barriers that the AEEI program is likely to have affected after understanding the current market structure and program design.
3. Find out which market barriers are important in the market today via telephone interviews with various market actors.

All three approaches have advantages and disadvantages. The main disadvantage of the first is that in the absence of predefined market barriers, it must rely on the memories of market actors to hypothesize the set of barriers that may have been faced many years ago. It is difficult to collect meaningful data regarding the distant past from market actors.

One of the disadvantages of the second approach is that the hypothesized set of market barriers does not reflect the current market and is not based on empirical data collection. The advantage is that existing knowledge of the program and program delivery, experience with the market, and understanding of the market structure all get utilized. For example, using the knowledge of the program via program literature, program implementation via interviews with program managers, and market structure via interviews with agricultural consultants in the market, a set of market barriers can be hypothesized that may have been affected by the program. It is important to note that a set of hypothesized market barriers would include all possible market barriers that could potentially be affected by the program. Therefore, the

study objective[4] (i.e., study the market effects of the program) can be fulfilled by establishing a causal relationship between the program as an intervention and changes in the market barriers.

Since the study objective can be fulfilled using existing resources with the second approach, that is the one we preferred to use. Since the evaluation team recognized the importance of knowing the most important market barriers in the current market, an attempt was made to collect information that may help PG&E (or the new program administrator) better understand the market and better focus any future intervention design.

One of the primary advantages of using the third approach is that the identified market barriers would be based on empirical data. Also, knowledge of the most important barriers prevailing in the market today can be very useful in targeting future interventions. However, it is important to note that the "most important" market barriers prevailing in today's market may or may not be the same as the "most important" market barriers in the market when the program was originally designed, or even four or five years ago. Based on analysis of past program participation data, overall spillover actions, and evidence from other studies, we think that the "most important" market barriers prevailing in the market today are less likely to be the same as the "most important" market barriers in the market four or five years ago.[5] In such a case, it is likely the program does not necessarily affect the most important market barriers prevailing in the market today. In this case, the question of testing (or developing) causality between program and effects does not arise at all.

After evaluating the three approaches, and comparing the effect on the analysis with the purpose of the study, it was decided to hypothesize market barriers that may have been affected by the program in order to evaluate the AEEI program effect. The market barriers were hypothesized after understanding the market and the program design and implementation.

4.2.1 Market Features

First of all, it is important to remember that in the agricultural sector, the demand for efficient technologies and practices is generally site specific. Each agricultural customer is unique with respect to weather, water requirements, water availability, crop pattern, and intensity of pumping water use and distribution system[6]. This means that energy efficiency can often be achieved in very unique ways. Although, in general, pump repair may be more cost effective than pump replacement, a small customer can benefit equally well by leaving the pump as it is

[4] Appendix E CADMAC Waiver "The study will attempt to assess the market for efficient technologies and practices and test or study the market effects of PG&E's 1994-1997 Energy Efficiency Incentives (EEI) Programs".

[5] Information on participation of PG&E's DSM programs indicates reduced participation. The program evaluation studies in the past four years indicate sizable spillover activities. "Edison has commissioned three different customer surveys since 1992. These data suggest (1) a trend toward an increase in the activity of independent pump test services in California. (2) A significantly greater frequency of pump testing among California-area nonparticipants as compared with water pump users in Arizona…" Southern California Edison Hydraulic Services Program Market Effects Study, Study ID #3507, February 1998. Pp. 1-II-1-III.

[6] From interviews with agricultural consultants in the field with over 25 years of experience. It is also confirmed by the SCE study,…"Interviewees who serve agricultural customers emphasized that each customer requires a solution to a unique set of problems and constraints…" (Feb 1998 pp.4-16).

and altering the distribution system instead. But in a different scenario, the distribution system may be less important and a pump repair or replacement may be the only solution for improving the system efficiency[7]. Thus, the demand for energy-efficient products and practices is generally site specific. The types of efficient technologies and practices possible in the agricultural market are not necessarily-energy efficient products; they can be services as well. For example, a pump repair is a service and no substitute service or product exists for it. Similarly, changing a water distribution system from low-pressure sprinkler nozzles to micro irrigation involves changing a whole system, not just one product[8].

Second, the demand for energy-efficient products and technologies in the agricultural sector is based on need/necessity. From telephone surveys of 400 customers performed for the market effects evaluation of PG&E's 1996 Energy Management Services program, it was observed that the demand for pump repair arises from pump breakdown or low pump performance. More often than not there are no close substitutes for the energy-efficient products and services required at the site.

Third, it is evident from the telephone surveys for the market effects study of PG&E's pump test program that the range of awareness among agricultural customers is very wide. For example, from the telephone surveys for the market effects study of the1996 pump test program, it was observed that approximately 57% of all customers interviewed were aware of the efficiency of their pumps. Of the 43% of customers who were unaware, 32% had either not thought about learning about their pump efficiency, did not consider it worthwhile, did not understand it, or were ignorant about how to get it done.[9]

Since the demand for energy-efficient services and products can be very specific to customers' needs, it is more important that customers are well informed about alternatives, and about any advantages and disadvantages of those alternatives. However, the survey performed in 1997 indicates that not all customers were aware of the alternatives. This suggests that a lack of information may be one of the barriers in the market[10].

Fourth, the dealers appear to be the primary source of information about efficient products and services. The agricultural customers normally have long-term relationships with pump dealers and pump dealers tend to be their primary source of information. Based on the Market Characterization in Appendix B, most customers are likely to depend on a pump dealer for information about pump tests, possible kWh savings from a pump repair, cost of a pump repair, suitability of an alternative water distribution system, and possible advantages or disadvantages of alternative water distribution systems. [11] If the pump dealer cannot handle the customers' needs directly, they will refer customers to a specialist in that particular field.

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[7] A real life example given from the audience at ACEEE summer study.

[8] From interviews with agricultural consultants in the field with over 25 years of experience.

[9] SCE study also found that "…for customers, the major market barriers to achieving cost-effective energy efficient pumping systems were found to be informational (imperfect information)…" pp1-II.

[10] Also supported by SCE study pp 4-35.

[11] This observation is supported by the SCE study "…many agricultural customers rely on local contractors to specify their needs, obtain appropriate equipment (from distributors) and install it." pp2-4.

Since the customers depend upon dealers as the primary source of information, it is possible that the dealers' advice may be influenced by the fact that dealers are involved in actually implementing the changes. Thus, one market barrier may be asymmetric information[12].

Fifth, the customers are very cost conscious. Interviews with agricultural consultants indicated that agricultural customers have to face the typical economic constraints of limited resources and multiple use of those limited resources. For example, since income/profit can fluctuate widely every year, resources are particularly limited. At the same time, there are many different aspects of farming that require improvement. Thus, the agricultural customer faces a priority clash, with limited resources. At such times, the customers tend to select short-term solutions at lower costs compared to long-term solutions at higher costs[13]. In their interviews, both agricultural consultants pointed out that customers are uncertain about the advantages of the efficient water distribution systems and that there are some customer costs associated with maintenance of the water distribution system. There are also differences in the way various distribution systems are maintained. For example, water flow from low-pressure sprinkler nozzles can be checked from a distance. Several nozzles can be checked at the same time by standing at one place in the field. Whereas, to check the water flow from micro irrigation, one has to check each emitter and that can be time consuming. In cases of problems in either system, the cost involved may not be known ahead of time. According to both agricultural consultants, the costs and hassles of maintaining the water distribution system can be unknown at the time of installation.

Thus, the cost-conscious customers can be discouraged from installing energy-efficient products and services due to their high initial costs. Unawareness of the hassle and costs involved in maintaining the efficient water distribution system adds to the initial high costs. Customers are not certain about the advantages of the energy-efficient water distribution systems. Overall, the performance uncertainty and unknown hassle and maintenance costs, along with the high initial costs, tend to discourage customers from installing energy-efficient water distribution systems.

4.2.2 Program Features

As per our understanding of the services offered by PG&E, agricultural customers with large energy bills are assigned to PG&E's agricultural representatives. These representatives keep in touch with the assigned customers on a regular basis[14]. They advise customers on several aspects of their energy use. Most often they deal with issues related to energy bills. They evaluate energy requirements at the site and make suggestions regarding how to use energy efficiently. If incentives are available, agricultural representative can help customers complete the forms necessary to apply for these incentives.

[12] Supported by SCE study pp. 5-14.

[13] This is also supported by SCE study. Of interviews with 10 manufacturers, 5 felt "…that it was the attitudes of customers who often were more concerned about savings on up-front costs…often due to realities…" pp 4-7.

[14] From an interview with the program manager at PG&E.

As a part of PG&E's 1997 Energy Efficiency Incentive Program for the pumping and related end use, incentives are offered (upon application) if the customer gets a pump repaired or if the water distribution system is converted to low-pressure sprinkler nozzles from high-pressure sprinkler nozzles or to micro drip irrigation from a sprinkler system. Earlier AEEI programs offered a broader array of irrigation measures. As a part of the AEEI program, information is offered along with the incentives. Therefore, PG&E's program affects the information set with which agricultural customers make decisions. In order to participate in the program, the customer has to install one or more-energy efficient products. Due to the incentives, the participant incurs a lower first-time cost on the energy-efficient products compared to a nonparticipant. If the AEEI program were not offered, then customers would have no choice but to pay the market cost involved with installing any/all of the energy-efficient technologies/practices. In 1997, PG&E took steps to improve the cost-effectiveness of the program by limiting the participation of 20-75 horsepower pumps by adding the condition that they must provide a pre-retrofit pump test indicating a "low" efficiency pump (i.e., OPE of less than 50%).

Thus, information dissemination via PG&E representatives and cost reduction via incentives are two ways in which the program affects the market of energy-efficient products.

4.2.3 Hypothesized Market Barriers Potentially Affected by PG&E's AEEI Program

A market barrier is defined by Eto et al. as any characteristic of the market for an energy related product, service, or practice that helps 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.

The approach taken in this study is to hypothesize the market barriers, based on available information, then to use the study to confirm/reject the hypothesis, as well as to measure possible program effects on the barriers. From our understanding of the current market and the program design, we identify the barriers mentioned by Eto et al that the agricultural market for efficient products and services for pumping and related end use faces. In addition, we then identify which of these market barriers the AEEI program can. *Thus, in order to studying the market effects of the AEEI program, this study focuses on those market barriers faced by the market which could have been affected by the AEEI program.*

Based on our understanding of the market for pumping and related energy-efficient practices and products, we believe the following represent the primary four barriers in the market that could have been affected by the AEEI program:

4.2.3.1 Information and Search Costs[15]

Advice and information regarding energy-efficient products via PG&E representatives is given at no cost to customers as a part of the AEEI program. In the market, an expert opinion on the suitability of energy-efficient products and services can be expensive. As a result, customers may remain unaware of the advantages of efficient services and products which, in

[15] Supported by SCE study pp 5-14.

turn, creates the gap between the desired and actual level of consumption of energy-efficient products and services. Since PG&E offers such information and advice which otherwise would be a cost to the customer, we think PG&E's AEEI program has the potential to reduce this barrier.

4.2.3.2 Asymmetric Information[16]

In the agricultural sector, vendors and pump dealers sell equipment the customers, including energy-efficient products and services. Since customers may consider information from these sources as tinged by a profit incentive, they may or may not believe the savings claims made by them. Customers may require reconfirmation of the benefit claims made by the vendors/dealers through an unbiased source. As explained earlier, the demand for energy-efficient products and services is based on customers' needs. Whenever customers have a problem or need advice, the primary source of advice is the pump dealer. As a part of PG&E's AEEI program, PG&E offers information on energy-efficient products and services. It can potentially make more customers aware of the advantages of the energy-efficient products and services. PG&E, by providing information, becomes another source of information for the customer in addition to the dealer or vendor. Customers have an opportunity to cross check the recommendation from one source with the other. PG&E is not involved in providing the services necessary to implement their own advice and therefore has no interest in advising customers in a way that could be less beneficial to the customer but more profitable to PG&E. Thus, PG&E's AEEI program, by providing an independent source of information, is expected to reduce this barrier.

4.2.3.3 Hidden Costs[17]

The costs of a pump repair or change in an irrigation system are high. In addition, if customers have not dealt with the operation of certain irrigation systems, then the cost and hassle of maintaining them is unknown. The unknown or apparently hidden costs increase the uncertainty of the total repair or conversion cost. This may be considered as an uncertainty related to the cost. The uncertainty regarding the maintenance cost can be a discouraging factor for customers. If customers have previously had experience with the equipment, the uncertainty is reduced, and customers tend to make decisions with a better awareness of all the costs involved.

The program encourages installation via reduction in initial costs. We think that after customers have had experience with the equipment, uncertainties regarding hidden costs may be reduced. Thus, the program has the potential to reduce this barrier indirectly, via installation of the equipment.

[16] Supported by SCE study pp 5-14.

[17] Supported by SCE study pp. 5-14.

4.2.3.4 Performance Uncertainty[18]

Since the communications network among agricultural customers is very strong, customers learn about efficient products and services quickly. However, the choice of the quantity and type of efficient products or services depends upon the specific needs at a given site. Since the choice itself depends upon the site, the benefits in terms of kWh savings also differ from one site to the other. Thus, though customers have known (or heard) about the advantages of efficient products and services in general, they may still be uncertain about the benefits of energy efficient products and services at their own site. Though they hear from friends in the same community, they need to reconfirm it with their own experiences. Unless they install the products and/or services, they may not be able to experience it at all.

It should be noted that in the agriculture sector, performance encompasses both energy savings performance and crop irrigation performance. The most important issue for many growers is whether the equipment will properly irrigate the crop.

The program encourages installation via reduction in initial costs. We think that after customers have experience with the equipment, uncertainties regarding performance may be reduced. Thus, the program has the potential to reduce this barrier indirectly, via installation of the equipment.

In addition to the four market barriers already discussed (existing in the market and potentially effected by the AEEI program) the evaluation team identified the following barrier which exists in the market but which the AEEI programs were not designed to affect.

4.2.3.5 Access to Financing

In the agricultural sector, yearly fluctuations in the availability of funds are experienced. Lack of financing can discourage customers in their decision to implement energy-efficient products with high capital costs. Even if the customer is aware of a low performing pump that requires repair, for reasons of cash flow, the customer may decide to wait. Access to financing can be considered a characteristic that generates the gap between the desired level of efficiency adoptions and the actual level of adoptions. If the costs are lowered via incentives, customers' cost benefit analysis indicates greater benefits (compared to the costs) earlier than otherwise would have occurred. The costs of energy-efficient products may be too high for some customers to even consider them as an option. With incentives, these customers may begin considering efficiency options in their choice set. Reducing the initial costs via the program is one way to ease financing when the customer is considering installation of energy-efficient measures. However, in the absence of the program, initial costs will continue to be a problem. Therefore, the program does not have the potential to affect this barrier in the long term.

Thus, there are four hypothetical barriers that may have been affected by the program. Of these four barriers, the program may directly affect two of them (information and search costs and asymmetric information) and may indirectly affect the other two (i.e., hidden costs and performance uncertainty). The fifth barrier, access to financing, is a hypothetical barrier which we do not think is affected by the program.

[18] Supported by SCE study PP 5-14.

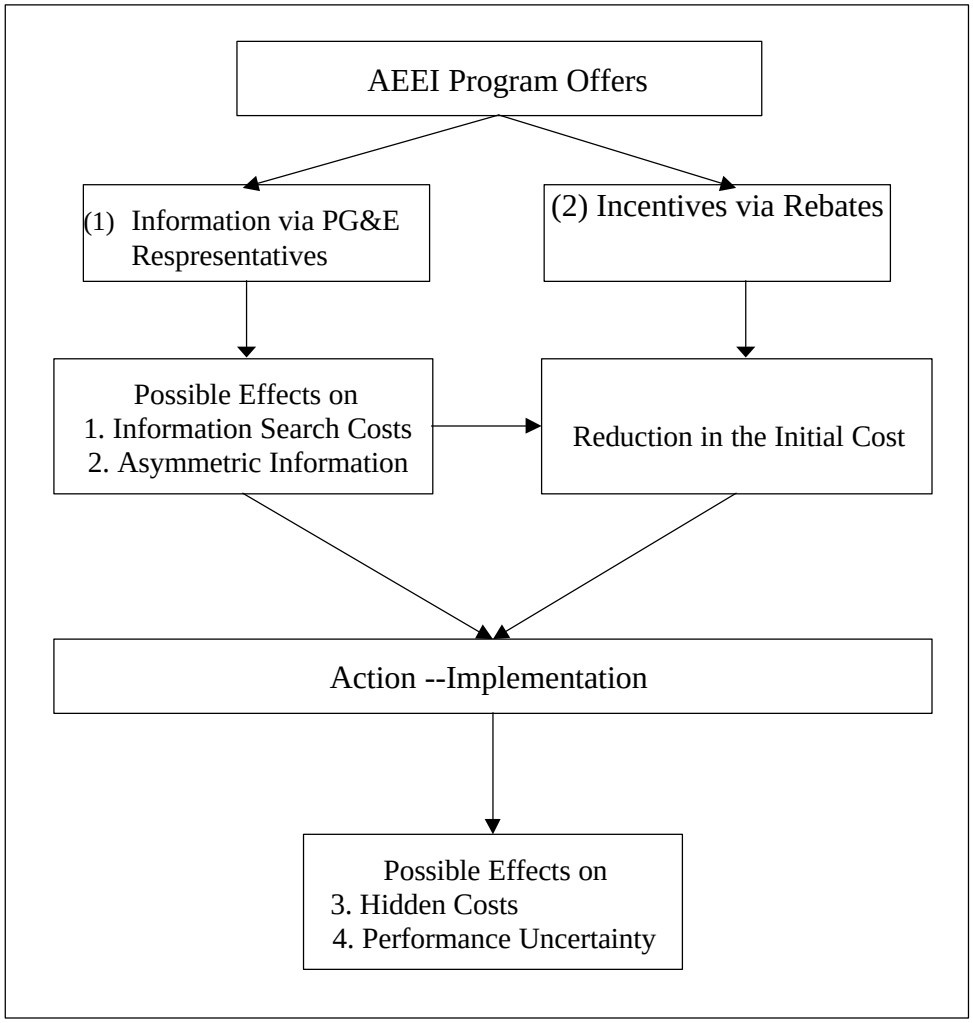
4.3 Theoretical Market Interactions

As mentioned above, we think that the information and search costs and asymmetric information barriers can be directly affected by AEEI program via either program participation or exposure to the program. However, we believe that the AEEI program does not affect the hidden cost or performance uncertainty barriers directly.

Exhibit 4.1 presents the overall flow of the market implementation and links the implementation to the market barriers affected.

Overall, lack of information and asymmetric information are likely to discourage the customers from installing/using energy-efficient products and services. Information and education may help customers better understand the options suitable to their specific requirements.

Exhibit 4.1
Market Barriers Affected by the Program



It is possible that in the initial stages, when the customer does not have experience with the product, the hidden costs and performance uncertainty raises the risk of implementing the

products or practices. High overall cost, along with high risk, may discourage customers from implementing the products/practices. PG&E's AEEI program reduces the high capital cost for implementers via incentives. Assuming that the overall risk of implementing the product remains the same for first time implementers, the incentives reduce the cost and encourage customers to implement the measure. The experience itself can reduce performance uncertainty and make the customer aware of the hidden costs. In the later implementation decisions, the hidden costs are known and performance uncertainty is reduced due to the experience. At this point, even if incentives are not offered, the reduction in performance uncertainty via first time implementation can compensate for the incentive.[19] Thus, the initial effect of the program can be encouraging customers to consider implementation of any of the three products via lowering the cost. However, the long-term effect can be encouraging customers to take actions by lowering performance uncertainty and increasing awareness of potential hidden costs.

The program participation requires implementation of any one or more energy-efficient products or services. This means that the program, via lowering the cost, encourages at least one experience with the energy-efficient product or service. The experience itself is likely to reduce the other two barriers (i.e., hidden costs and performance uncertainty). The program can motivate customers to take actions (encourage customers to consider the options) and reduce the time taken by customers to take actions initially by lowering costs and performance uncertainty in the long run.

4.4 Analysis Theoretical Framework

As mentioned in Section 1, PG&E has offered the AEMS and AEEI programs simultaneously for about the past 25 years. Both programs offer information and encourage implementation. Since information is offered and implementation is encouraged via both the programs, it becomes important to try to isolate the effects of the AEMS program and AEEI program.

As mentioned earlier, information can influence the market via reducing information and search costs and asymmetric information market barriers. It should not make any difference if the customer gets information from the AEMS program or the AEEI program, especially if information is offered in the same manner via both the programs. It is our understanding that customers can get information the same way (e.g., from the PG&E representative) via either of the two programs. The fact that information is offered at no cost from an independent source like PG&E can itself influence the market.

The other two barriers (hidden costs and performance uncertainty) are believed to be affected by the implementation of the energy-efficient products and services. Since implementation may be a result of either simple information from the AEMS program or information and the reduction in initial costs via AEEI incentives, it becomes more important to differentiate the effects of incentive programs from informational programs. In other words, it is important to find out whether customers can be motivated to implement the services with only information,

[19] The strong word-of-mouth network in the agricultural sector also plays a significant role in communicating both positive and negative experiences with new technologies.

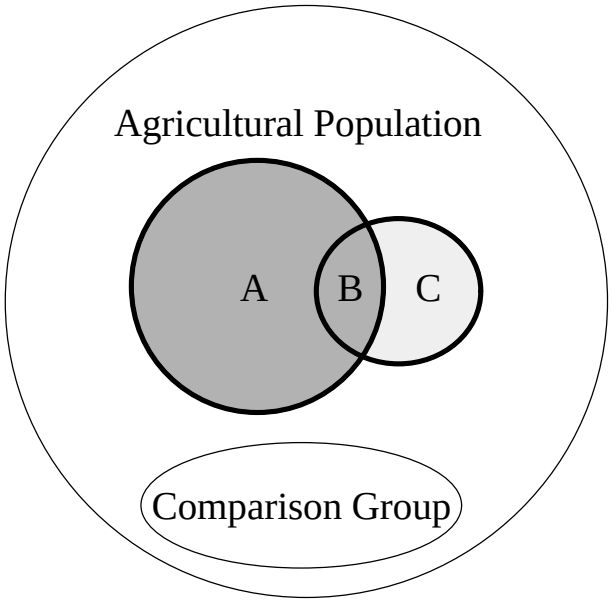
or if they need incentives in order to take action. The question becomes how to separate the effects of the incentive program (AEEI) from the informational program (AEMS).

After analyzing participation data for the years 1994, 1995, 1996 and 1997, it was found that the participants of the two programs are not independent of each other. There is an overlap[20]. It is therefore important to separate the effects of two programs.

- First, by comparing a sample of participants of either AEEI or AEMS or both programs with a comparison group, combined effects of AEMS and AEEI need to be estimated.
- Second, by comparing a sample of only AEMS participants with those who did not participate in the AEMS program in the past four years, effects of only the AEMS program need to be estimated.
- Third the difference between the overall (or combined) effect and the AEMS program effect should be calculated. The difference should indicate the AEEI program effect.

This solution is explained with the help of Exhibit 4.2. Overall, for PG&E, let us assume that area A represents the participation of the AEMS program, area C represents the participation in the AEEI program, and area B represents the participation of both the AEMS and AEEI programs.

Exhibit 4.2
Program Overlap (Conceptual)



To give some scale to relative program participation, the EMS program has over five times as many participants as the AEEI program and 5% of all participants participated in both

[20] 5% of all the participants participated in AEEI and a pump test program. This is equivalent to 30% of AEEI participants participating in both AEEI and AEMS program.

programs. The comparison group is a subset of the agricultural population and completely independent of either program group.

The overall maximum effects of both the programs in PG&E's service territory should be equal to Area A+ Area B + Area C. The overall effects can be estimated by comparing the participants of the programs with those who did not participate at all. The maximum effects of the information via PG&E representatives alone can be Area A + the portion of B that is attributable to the information portion of the AEEI program. The effects of information can be estimated by comparing participants who received information with those who did not. Both information and incentives affect the participants in B. The important task is to isolate the portion of B affected by information alone from the portion that needed the incentive along with the information. Let us assume that $B=B_1+B_2$, with B_1 being the portion that is affected by information and B_2 being the portion affected by the incentive. Then the separation of information and incentives can be determined as shown in Exhibit 4.3.

Exhibit 4.3
Separating Information and Incentive Effects

Effects of (A,B,C) – Effects of A +B_1 = Effects of B_2 + C

Where:

(A, B, C)	= the overall program effects
A + B_1	= the effects of informational programs
B_2 +C	= the effects of incentive program alone.

The circles in Exhibit 4.2 do not represent actual participation proportions. In reality, participation in incentive programs is small compared to participation in the informational programs.

Data collection in this study was aimed at analyzing AEEI effects in PG&E's service territory. If AEMS and AEEI programs were totally independent of each other without any overlap, or if AEEI participation was large enough to ignore the overlap, then we would have selected a sample of AEEI participants to represent the participant population and compared them with a comparison group to find what would have been the customers' perception of market barriers in the absence of the program. However, this is not the case. The AEEI participant sample is small. A sizable portion of AEEI participant population participated in the AEMS program as well. Thus, ignoring the overlap would bias the estimated market effect and, depending on the AEEI participant population, would make the size of the sample frame very small. Therefore, following the approach explained above, a sample of exposed customers was drawn to represent the population of participants of both programs. For any given market barrier, the overall combined effect of both programs was first estimated and then the effect of the AEMS program was estimated. The market effect of the AEEI program was then estimated as the difference between the overall combined effect and the AEMS program effect.

In order to estimate the overall combined effect of the program, first we have to establish a causal relationship between the existing market condition and the program. As explained in Section 2, a sample of 215 exposed customers is included in the survey, along with a sample

of 214 customers from a comparison group. The next section explains the approach used to establish a causal relationship between the market condition and the program.

5 ANALYSIS APPROACH

Once the market barriers have been hypothesized, the evaluation must determine how to observe the market to see if any change has occurred in the hypothesized barriers. In theory, the change in the market barrier can be observed by taking the difference between the market barrier before and after the intervention. In reality, it is difficult to measure such change for two reasons. First, there is no predefined appropriate indicator to measure the level of a market barrier that exists in the market at a given point in time. Secondly, even if an appropriate indicator is selected, it is not certain that information would be available to determine what that indicator would have been before the intervention, or what it would be after the intervention is removed or altered.

The perception of market actors regarding each market barrier is considered an appropriate indicator of measuring the extent to which the market barrier exists at any given point in time. Since customers are the largest group of market actors directly exposed to the program, customers' perception can be an appropriate indicator of the extent to which a market barrier exists in the market. The availability of this indicator before and after the intervention is not straightforward. Agricultural pumping and pumping related measures from the PG&E EEI program were withdrawn from the market as of December 31, 1197. However, the post-intervention period is not long enough to observe a change in perception. The best alternative is to ask the customers about their perceptions today and find out if that perception changes in the future. The present perceptions and their projections about perceptions in the future are then compared. In cases where the answers are not consistent, the conservative answers are given more weight. For example, if customers indicate they are certain about the performance today but that may change in the future, this was interpreted as a barrier for that customer.

The more important and difficult part is to find out the perceptions before the intervention. Since no such information is available, a deviation from the simple definition that takes the difference as the change is desirable. Therefore, for estimation purposes, market effects attributable to a DSM program can be defined as the difference between the extent to which the identified market barriers would have prevailed if the program had not been offered and the extent to which market barriers exist in the presence of the program. Since the extent to which the market barriers would have prevailed is not directly observed, it can be approximated by comparing the perceptions of the exposed customers with those who are not exposed to the intervention, in this case PG&E's efficiency programs for agricultural customers. One possibility is to select a comparison group from a region that does not have such programs at all. However, there are two practical problems with identifying this type of population. First, identification of a "similar" region without a program is difficult and imperfect. Second, once the area is identified, obtaining contact information on a properly stratified sample in today's deregulating environment is very difficult, if not impossible. Therefore, a comparison group was randomly selected from those PG&E agricultural customers who did not participate in either the AEEI or the AEMS programs in the past four years. A telephone survey of 215 exposed customers and 214 customers not exposed to PG&E's programs was used to analyze the extent to which the programs affected the market barriers.

5.1 Establish a Causal Relationship Between the Program and the Change in the Hypothesized Market Barriers.

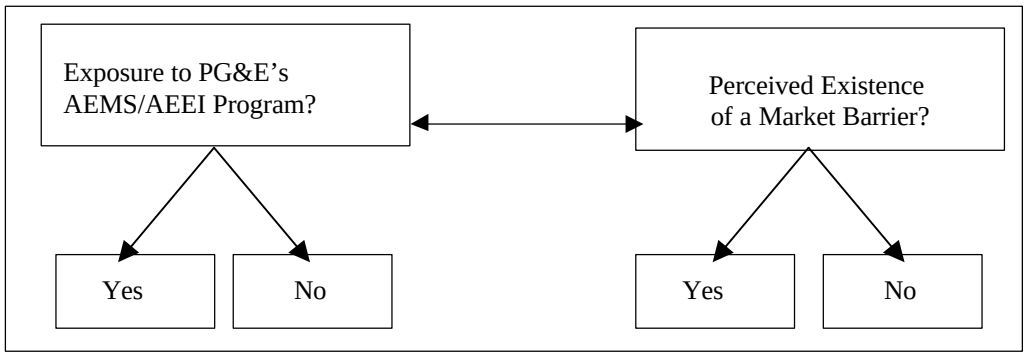
The reduction in a market barrier needs to be causally linked to the program in question. That is, the co-existence of the change or reduction in market barriers and the program in a particular service territory is not good enough to prove that the changes are attributable to the program. There are many other economic factors that can also affect customers' perceptions of market barriers. This is a typical case of confounding effects. Therefore, it is important to isolate the effect of the program from effects of other economic factors. We think that by comparing the perceptions of market barriers of those customers not exposed to the program with those who are exposed to the program, it is possible to estimate the effects (in terms of reduction in market barriers) attributable to the program. Inclusion of the comparison group is necessary for two reasons. First, the comparison group is needed to be able to develop causality between the program and the effects in the market. Second, since it is not possible to observe whether this perception is changed over a period of time or not, as pointed out earlier, perceptions of a comparison group acts as a baseline, or as a proxy, for what could have been the perceptions of customers before the program. However, it is important to recognize that including an intra-territory comparison group introduces the problem of self-selection bias. Though the comparison group includes only those customers who did not participate in agricultural DSM programs for the past four years, indirect effects of the program are unavoidable. It becomes necessary to attempt to isolate the effects of the programs from any other effects. In order to isolate the market effects of the program from the effects of other factors, we used a set of equations that are explained in the next section.

5.2 Modeling System for Two Barriers with Direct Effects

As mentioned in Section 3, PG&E's AEEI program has the potential to affect two of the hypothesized barriers directly. These two barriers are (1) information and search costs, and (2) asymmetric information. The first of these two barriers voices the belief that lack of information or the hassle of finding that information can discourage customers from implementing efficient technologies/practices. Similarly, the second barrier states that an unbiased source of information can increase the level of information reliability and encourage customers to implement efficient technologies/practices. The question is "to what extent" did the program reduce the costs to find information, or make it easy to get unbiased information about energy-efficient options. A percentage of the customers who do not perceive any difficulty in finding information regarding efficient technologies/ practices can be found from the telephone survey responses. Not all those who find it easy to get information on efficiency technologies/practices are exposed to the program. Not all those exposed to the programs perceive that finding information on efficient technologies is easy. Therefore the important question is – of those exposed customers – what proportion find it easy to get information because they were exposed to the program.

The relationship between customers' perceptions and the exposure of the program can be described using a diagram as in Exhibit 5.1.

Exhibit 5.1
Exposure to PG&E's Programs and Perception of Market Barrier Relationship



Two equations are used to determine whether a customer would find it easy to get information on efficient technologies because he was exposed to the program, or whether that customer would have found it easy anyway. Whether or not to be exposed to the program and how to perceive a market barrier are customers' choices. The models that explain these choices are called choice models. For the first two hypothesized barriers (information and search costs and asymmetric information), the perceived existence of market barriers and the choice of exposure to the program are described via two choice models. There are different kinds of choice models, such as Logit and Probit, that can be used to describe these two choices. For simplicity of explanation, the method is described using Logit models. However the applicability of different types of choice models is discussed in Section 5.5 of this report.

The customer's probability of exposure to the AEEI/AEMS programs is described by a logit function with the form shown in Exhibit 5.2.

Exhibit 5.2
Exposure Model

$$ME_i = \left(\frac{e^{bZi}}{\left(1 + e^{bZi}\right)} \right)$$

Where:

MEi (p=1) = the probability that the customer is exposed to either or both the programs,

Z = a vector of customer characteristics that relate to the customer's decision to be exposed,

β = a vector of parameters indicating how the characteristics Z relate to exposure.

This model can be estimated by standard logit routines (e.g., the Logistic Procedure in SAS). It is expected that customers' decisions to be exposed to either or both programs (i.e., AEMS, AEEI) are related to customers' perception of a market barrier.

The customer has an idea (perception) as to what extent a particular market barrier affects his/her decision to implement the efficient measure. The customer either does or does not

perceive any particular factor as a barrier. For example, customer A may find it easy to search for information on efficient technologies/practices while customer B may find it difficult. In these cases, it is not a barrier for customer A and is a barrier for customer B. This model takes the form shown in Exhibit 5.3.

Exhibit 5.3
Perception of Barrier Model

$$\text{Pbi} = \left(\frac{e^{(aXi+dDi)}}{\left(1+e^{(aXi+dDi)}\right)} \right)$$

Where:

Pb_i = the probability that the customer perceives the market barrier as not a barrier,

X = a list of characteristics of the customer and features of the measure that affect perception, and

D = a dummy variable that identifies whether the customer is exposed to either or both the programs.

The impact of exposure is captured by δ, the coefficient of this exposure dummy. This coefficient reflects the extent to which the exposure changed the customer's probability of perceiving the market barrier as <u>not</u> a barrier. Estimation of this model is complicated by the fact that the critical explanatory variable, the exposure dummy D, depends upon the customer's perception of the market barrier. Since the customer's perception of the market barrier affects the customer's decision to be exposed to the programs, causation in this case also runs from the dependent variable to the explanatory variable – exposure dummy. That is, those customers who are looking for information are more likely to get exposed to the programs. At the same time, those who are exposed to the program are likely to find it easy to get information on energy-efficient technologies/practices.

Such bi-directionality of causation is dealt with in a substitution procedure as used by Hartman (1988) and Train (1993). In this procedure, along with other explanatory variables, the probability of exposure is included as one of the explanatory variables instead of the exposure dummy. Technically, in a nonlinear model, replacing the exposure dummy with the probability of exposure does not provide consistent estimates of the coefficient, but the inconsistency is small.

The final logit model then takes the following form shown in Exhibit 5.4

Exhibit 5.4
Final Perception Model

$$\text{Pbi} = \left(\frac{e^{(aXi+dprob(Di))}}{\left(1+e^{(aXi+dprob(Di))}\right)} \right)$$

Where δ still captures the effect of the program and prob(Di) is the probability of exposure for the i^{th} customer.

Thus by including probability of exposure in the model for perceived nonexistence of market barrier, the causality between program exposure and the nonexistence of the market barrier is tested. Using the probability of being exposed and the probability of perceiving the market barrier not as a barrier, program effects are estimated. First, how customers perceive the market barrier for the program in place is estimated, then how they would have perceived it if there were no programs in place is estimated. The difference between the two indicates the effect of the AEEI and AEMS programs. This can be viewed as shown in Exhibit 5.5

Exhibit 5.5
PG&E Program Effects

$$\left\{\begin{array}{l}\text{Market Effects Attributable to the}\\ \text{Programs in Terms of First Set of}\\ \text{Barriers}\end{array}\right\} = \left\{\begin{array}{l}\text{Perceived Non - Existence}\\ \text{of Market Barrier that}\\ \text{Would Have Been}\\ \text{Perceived as a Market Barrier}\\ \text{if Not Exposed to the Program}\end{array}\right\}$$

$$= \left\{\begin{array}{l}\text{(Perceived Non - Existence}\\ \text{of Market Barrier When Exposed}\end{array}\right\} - \left\{\begin{array}{l}\text{Perceived Non - Existence}\\ \text{if Not Exposed}\end{array}\right\}$$

5.3 Modeling System for Other Two Barriers with Indirect Effects

According to our hypothesis, the other two market barriers are not directly affected by program participation or exposure. Information alone is less likely to reduce the fear of unexpected costs or the uncertainty regarding the performance. However, the experience with the product after implementation can possibly reduce the uncertainty around the hidden costs and make customers feel more confident about the performance. Since both programs encourage implementation of energy-efficient technologies/services, programs can potentially affect these two barriers indirectly by encouraging customers to gain implementation experience. Therefore, first it is important to test whether or not implementation actually reduces concern about unexpected costs and performance uncertainty. But this is not sufficient for estimating market effects attributable to the programs. Only those customers who:

1. implemented energy-efficient technologies/practices as a result of the program, and
2. do not perceive these factors (i.e., performance uncertainty or hidden costs) as barriers today and will not perceive them as barriers in the future,
3. but would have perceived them as barriers at present or in the future if they did not have implementation experience,

seem to have had effects attributable to the program.

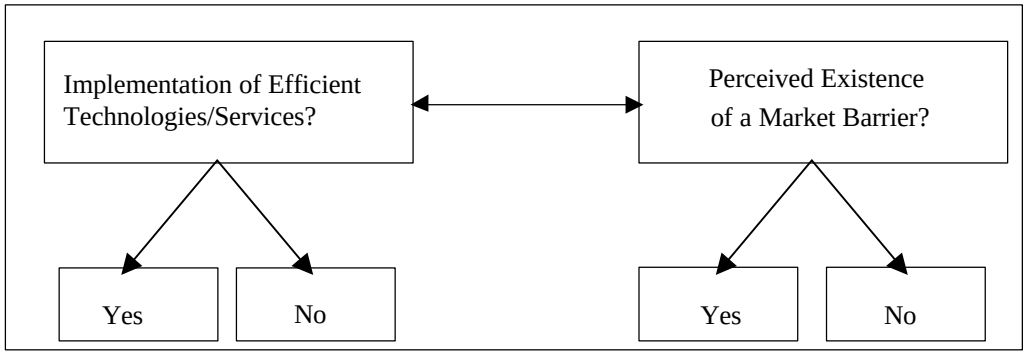
Thus, in order to establish a causal relationship between the program and the perceived existence of a market barrier, causality between implementation and the perceived existence of the market barrier needs to be first tested, and then applied to only those implementations that could not have occurred in the absence of the program. In other words, first find out whether

the perception of customers who do not perceive a market barrier as a barrier is due to an implementation experience with that efficient technology/service. (The implementation effect on the perception of a market barrier includes only those who would have perceived a market barrier as a barrier if they had not implemented the efficient technology/service.) Second, established causality between program participation and implementation. That is, whether or not customers implemented the efficient technology/service as a result of participation in the program or whether the customers would have implemented the efficient technology/practice even without participating in the program. The market effect attributable to the program includes only that portion of implementation that would not have taken place without program participation.

The overall indirect effect of the program in the market includes only those who would have perceived a market barrier as a barrier if (1) they did not have any experience with the efficient technology/service and (2) they would not have had the experience without participating in the program. Thus, both the causalities ((1) implementation and perceived existence of market barrier, and (2) participation and implementation) need to be established in order to estimate the indirect effect of the program on the market in terms of two market barriers.

The first relationship, i.e., between implementation and perceived existence of market barrier, is also presented in Exhibit 5.6.

Exhibit 5.6
Implementation and Perception of Market Barrier Relationship



As mentioned earlier, it is believed that experience can reduce uncertainty regarding unexpected costs and performance. In order to estimate to what extent such experiences can reduce uncertainty regarding unexpected costs and performance, two choice models were used. One choice model describes the customers' decisions to implement energy-efficient products or services. The other choice model describes the customers' perceptions regarding each specific barrier. In this case two barriers, hidden costs and performance uncertainty, were modeled. The customers' decisions concerning whether or not to implement the energy-efficient measure depend, at least partially, on the customers' perception of the market barrier. That is, if the customer perceives performance and cost uncertainties to be very high, then he/she may be reticent to adopt efficient equipment or practices. The customer may also have preconceived ideas about what stops him/her from adopting the measure. This perception of the market barrier is, in turn, affected by customers' implementation experience.

The customer's probability of implementing is described by a logit function with the form shown in Exhibit 5.7

Exhibit 5.7
Implementation Model

$$Mp_i = \left(\frac{e^{bZi}}{\left(1 + e^{bZi}\right)} \right)$$

Where:

Mpi (p=1) = the probability that the customer implements,

Z = a vector of customer characteristics that relate to the customer's decision to implement, and

β = a vector of parameters indicating how the characteristics Z relate to implementation.

It is expected that the decision to implement is related to the customer's perception of a market barrier. Customers' perceptions about market barriers affects the decision to implement the efficient measure and is affected, in turn, by the implementation experience. Thus perception regarding the market barrier can be explained as;

Exhibit 5.8
Perception of Market Barrier Model

$$Pm_i = \left(\frac{e^{(aXi + dGi)}}{\left(1 + e^{(aXi + dGi)}\right)} \right)$$

Where:

Pm_I = the probability that the customer perceives the market barrier as not a barrier,

X = a list of characteristics of the customer and features of the measure that affect perception, and

G = a dummy variable that identifies whether the customer implemented energy efficient product/practice.

The impact of implementation is captured by δ, the coefficient of this implementation dummy. This coefficient reflects the extent to which the implementation experience increased the customer's probability of perceiving the market barrier not as a barrier. Similar to the exposure and perception of a market barrier relationship, estimation of this model is complicated by the fact that the critical explanatory variable, the implementation dummy B, depends upon the customer's perception of the market barrier. Since a customer's perception of a market barrier affects his/her decision to implement, causation in this case also runs from the dependent variable to the implementation dummy.

As mentioned earlier, such bi-directionality of causation is dealt with a substitution procedure as used by Hartman (1988) and Train (1993). In this procedure, along with other explanatory variables, the probability of implementation instead of the implementation dummy is included as one of the explanatory variables. Technically, in a nonlinear model, replacing the implementation dummy with the probability of implementation does not provide a consistent estimate of the coefficient, but the inconsistency is small. The final logit model that explains the perception of market barrier takes the following form:

Exhibit 5.9
Final Perception Model

$$\mathrm{Pmi} = \left(\frac{e^{(aXi + dprob(\mathrm{G}i))}}{\left(1 + e^{(aXi + dprob(\mathrm{G}i))}\right)} \right)$$

Where δ still captures the effect of the program and prob(Gi) is the probability of implementation for the i^{th} customer. These two equations (Exhibit 5.7 and Exhibit 5.9) are used to estimate the probability to implement and probability of perceiving a market barrier not as a barrier. Using these probabilities, first the market effect of experience with and without the program is estimated. The market effect of implementation on the perceptions of two market barriers is determined by estimating the customers' perceived existence of the market barrier that would occur with and without the implementation experience, and then comparing the two.

It is important to note that not all implementations are a result of the program. Some of the actions of program participants may have been due to reasons other than incentives. In order to discount for this, the effect of implementation on the market barriers may need to be adjusted to reflect the portion of actions taken only due to the incentive program. Thus, with respect to the second relationship between program participation and implementation, an answer is required about the proportion of implementation due to the participation and the proportion of implementation that would have taken place even without participating in the program. This is the same as estimating net effects of the program in terms of Net-To-Gross ratios. In other words;

$$\left\{\begin{array}{l}\text{Market Effects}\\ \text{in Terms of}\\ \text{Second Set of}\\ \text{Barriers}\\ \text{Attributable to the}\\ \text{Programs}\end{array}\right\} = \left\{\begin{array}{l}\text{Perceived Non - Existence}\\ \text{of Market Barrier that}\\ \text{Would Have Been}\\ \text{Perceived as a Market Barrier}\\ \text{if Not Implement Due to Program}\end{array}\right\}$$

$$= \left\{\begin{array}{l}\text{(Perceived Non - Existence}\\ \text{of Market Barrier When}\\ \text{Implement Due to Program}\end{array}\right\} - \left\{\begin{array}{l}\text{Perceived Non - Existence}\\ \text{if Not Implement Due to Program}\end{array}\right\}$$

$$= \left\{\begin{array}{l}\text{Implementation}\\ \text{Attributable}\\ \text{to the Program}\end{array}\right\} * \left\{\left(\begin{array}{l}\text{Perceived Non - Existence}\\ \text{of Market Barrier}\\ \text{When Implement}\end{array}\right) - \left(\begin{array}{l}\text{Perceived Non - xistence}\\ \text{If Not Implement}\end{array}\right)\right\}$$

Responses from the telephone surveys regarding information on customers' perceptions of both market barriers and implementation status were used in estimating these two choice models. The model results were then used to assess the extent to which the implementation reduced the extent of a market barrier.

5.4 Model Diagnostics

As in estimation of any statistical models, a coefficient is estimated for each explanatory variable. A positive coefficient in the participation model indicates that the factor represented by the variable increases the probability that the customer is a participant. A negative coefficient for a variable in the participation model indicates that the factor represented by the variable decreases the probability that the customer is a participant. Similarly, the signs of the coefficients in the market barrier model indicate whether the barriers represented by the variable increase (if positive) or decrease (if negative) the probability that the customer considers the market barrier as not a barrier.

Wald Chi-square - As an indication of the explanatory power of each variable, a Wald-statistic is produced for each coefficient. Wald Chi-square is computed as the square of the value obtained by dividing the parameter estimate by its standard error. As a general rule, the larger the magnitude of the Wald-statistic (Chi-square distribution), the greater the explanatory power of the variable. In particular, if the Wald-statistic has a magnitude exceeding 1.32, then the hypothesis that the coefficient is zero can be rejected at the 75% percent significance level.

Percentage of Probabilities Correctly Predicted - To assess the quality of the logistic model SAS provides (as a part of logistic procedures) the percentage of probabilities correctly predicted (concordant). In a relative sense, a model with higher values for a concordant index has a better predictive ability than a model with lower values for the concordant.

Log Likelihood at zero and at convergence - Generally, it is expected that a binary choice model without any explanatory variables have less explanatory power than a model with an appropriate combination of explanatory variables reflecting customers' characteristics. Hence, it is expected, that for any model, Log Likelihood at convergence (that model with parameter estimates that maximize the likelihood function) will be higher than the Log Likelihood at zero (that model with all parameter estimates set to zero). As a result, we can judge how well a particular combination of explanatory variables describes customers' choices by comparing the Log Likelihood at convergence with Log Likelihood at zero. The difference between these values indicates the explanatory power of the model - a higher difference suggests higher explanatory power.

The model results presented in Section 6 were compared with the results of the many other alternative model specifications on the basis of the above-mentioned criteria. The possibility of serious collinearity among any explanatory variables in all the models was also explored by examining the correlation matrix of the explanatory variables. The sensitivity of the results was tested for any possible collinearity. Variables with high correlation affected the estimated coefficients and the resultant percentages. Of any two variables with high correlation, one of the two variables was selected primarily on the basis of the explanatory power of the variable as determined by the correlation with the dependent variable and contribution to the predictive power of the model as measured by the percentage correctly predicted. Of two highly correlated variables, the variable with higher explanatory power is preferred. If the contribution to the explanatory power is comparable, then the variable that contributes more to the predictive power as measured by the concordant is preferred.

5.5 Comparison of Different Model Types

The general term "choice models" designates a class of models. All models in this class calculate the probability that a decision-maker will choose a particular alternative from a set of alternatives, given data observed by the researcher. The two specific choice models considered in this study such as logit and probit are members of this class. They differ in the functional form that relates the observed data to the probability.

The decision-maker's choice of alternatives depends on the characteristics of each of the available alternatives. Different decision-makers, however, can make different choices when facing the same alternatives because the relative value they place on each characteristic is different. The differences in the valuation of each characteristic of the alternatives depend on the characteristics of the decision-maker, both those observed and not observed by the researcher. For example, when a person chooses whether or not to implement energy-efficient technologies/practices, he makes the choice based on the cost and benefits of the alternatives, as well as the size of their farms, the crop pattern, water requirements and so on.

Let us label the observed characteristics of decision-maker n as s_n and the observed characteristics of alternative i as faced by the decision-maker n as the vector $z_{in,}$ and the possible alternatives for customer n as J_i. The probability that decision-maker n chooses alternative i from set J_n (labeled P_{in}) depends on the observed characteristics of alternative i compared with all other alternatives (i.e., on z_{in} relative to all z_{jn} for j in J_n, *j not equal to I*) and on the observed characteristics of the decision maker (s_n). Choice models specify this probability as a parametric function of the general form shown in Exhibit 5.10.

Exhibit 5.10
Choice Model Functional Form

$$P_{in} = f(z_{in}, z_{jn} \text{ for all } j \text{ in } Jn \text{ and } j \neq i, s_n, b),$$

where *f* is the function that relates the observed data to the choice probabilities. Specific choice models, such as logit or probit are obtained by specifying *f*. Utility theory provides a context for motivating and deriving various specifications of *f*.

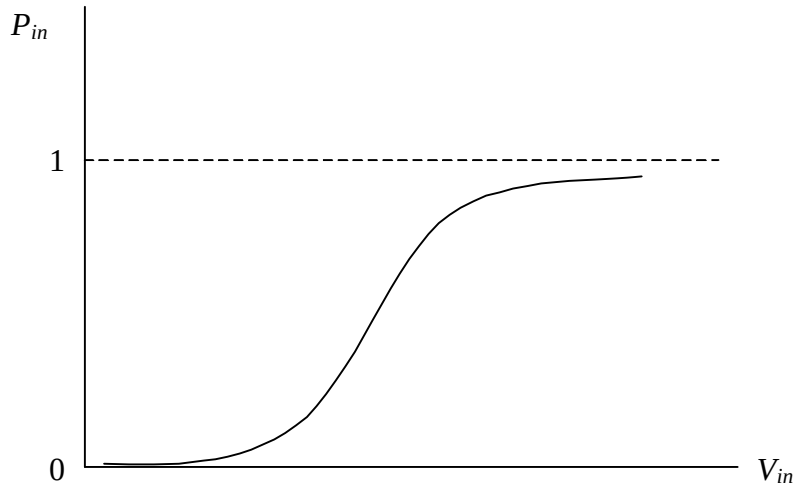
The decision-maker would obtain some relative happiness or "utility" from each alternative if he were to choose it. Let us designate the utility from alternative *i* in J_n as U_{in}, and similarly for each other alternative in J_n. This utility depends on various factors, including the characteristics of the alternative and the characteristics of the decision-maker. The decision-maker chooses the alternative from which he derives the greatest utility. If the researcher observed all the relevant factors and knew the decision-maker's utility function *U*, then the researcher could predict the decision-maker's choice using the underlying expectation that the customer chooses the option with the highest utility. However, the researcher does not observe all the characteristics of the alternatives or all the characteristics of the decision-maker and does not know the utility function exactly. In which case, the utility that customer *n* derives from option *i* depends upon those characteristics of the alternatives (z_{in}), and customer characteristics (s_n) known to the researcher and all factors and aspects of utility that are unknown by the researcher (e_{in}).

In the case of choice probabilities, the unobserved part of each decision-maker's utility is, by definition, not known by the researcher and will vary across decision-makers in the group. All choice models are obtained by specifying some distribution for the unknown component of utility and deriving functions for the choice probabilities. Different choice models are obtained by specifying different distributions for the *e*'s (i.e., unobserved component) giving rise to different functional forms for the choice probabilities.

5.5.1 Logit Model

The most widely used choice model is logit. It is popular because the formula for logit choice probabilities is readily interpretable compared to other choice models. Logit model assumes that the unobserved component (i.e., e_{in}, for all *i* in J_n) is distributed independently, identically in accordance with the extreme value distribution. Since the unobserved component of utility is assumed, through the extreme value distribution, to have zero mean, the observed part of utility (i.e., v_{in}) is called representative, expected, or average utility. Note that the expectation or average is over all possible values of factors unobserved by the researcher rather than by the decision-maker. There are three properties of the choice probabilities: First, each of the choice probabilities is necessarily between zero and one. Second, the choice probabilities necessarily sum to one. This follows from the fact that the choice set in a qualitative choice situation is exhaustive, so that the decision-maker must choose one of the alternatives, and the alternatives are mutually exclusive, so that the decision-maker cannot choose more than one alternative. Third, the relation of the choice probability for an alternative to the representative utility of that alternative, holding the representative utilities of the other alternatives fixed, is S-shaped. This is illustrated in Exhibit 5.11.

Exhibit 5.11
Graph of Logit Curve



If the representative utility of one alternative is very low, compared with other alternatives, a small increase in the utility of this alternative will have little affect on the probability of its being chosen; the other alternatives will still be generally preferred. Similarly, if one alternative is far superior to the others, so that its representative utility is very high, an additional increase in its utility will have little affect on the probability of its being chosen; it will usually be chosen, even without the extra utility. The point at which an increase in the representative utility of an alternative has the greatest effect on its probability of being chosen is when its representative utility is very similar to that of other alternatives.

Each one of these properties is reasonable. Logit probabilities also exhibit a property that is known as independence from irrelevant alternatives (IIA). In some cases, this property is an accurate reflection of reality and in other cases it is inappropriate. In the case of two alternatives; *i* and *k*, the ratio of the probabilities of these two alternatives does not depend on any alternatives other than *i* and *k*. Since the ratio is independent from alternatives other than *i* and *k*, it is said to be independent from "irrelevant" alternatives, that is alternatives other than those for which the ratio is calculated. We think that in our situation of exposure and implementation, IIA property reflects reality. The logistic procedure in SAS defines the logit function and corresponding distribution as;

$$g(p) = \log(p/(1-p))$$

This is the inverse of the cumulative logistic distribution function, which is;

$$F(X) = \frac{1}{(1+\exp^{(-X)})}$$

5.5.2 Probit Model

The logit model assumes that the unobserved components of utility are independently and identically distributed. The probit model relaxes the assumption about the unobserved components of utility. In particular, instead of assuming that the unobserved values are independent and identical extreme, the probit model assumes the unobserved components to be distributed jointly normal with a general variance-covariance matrix. The critical change here is not from the extreme value distribution to the normal, since these distributions for a single random variable are practically the same. The important distinction is that, with the joint normal distribution each e_{in}, for all i in J_n, can have a different variance and can be correlated with other e_{jn} for j in J_n, *j not equal to i*. The probit choice probabilities are derived from the assumption of jointly normal unobserved utility components. Proc Logistic within SAS uses the following probit function and the corresponding distribution;

$$g(p) = \Phi^{-1}(p)$$

This is the inverse of the cumulative standard normal distribution function.

$$F(X) = \Phi(X) = (2p)^{-\frac{1}{2}} \int_{-\infty}^{x} \exp(-z^2/2)dz$$

One of the primary disadvantages of the probit model is that it is a very complex form. In particular, estimation of probit models is very expensive because of the complexity of the choice probabilities. To evaluate a log likelihood function using these choice probabilities, numerous integrations are required for each sampled decision-maker. To find the value of the parameters that maximize the function, these numerous integrals must be evaluated numerous times. However, there are situations in which the probit model is very useful.

Note that independence or non-independence from irrelevant alternatives only becomes an issue in situations of three or more alternatives (since with only two alternatives there is no other alternative from which the ratio of the two probabilities can be independent or non-independent). Thus, in our case of exposure and implementation with only two alternatives, we think that IIA property of logit is appropriate and does not invite the complexities of probit. However, we estimated both, and a comparison of the results is included in Appendix I.

5.5.3 Ordered Logit and Ordered Probit Models

As explained earlier, all choice models describe the relationship between a categorical response variable and a set of observed explanatory variables. However, the scale of measurement of a categorical response variable is a key element in choosing an appropriate modeling technique. Ordered logit and probit are a special case of logit and probit models, respectively, and can be applied based on the type of categorical response.

Categorical responses can be dichotomous (two possible outcomes - usually yes or no), polytomous, (more than two outcomes), nominal, or ordinal. Not all the modeling types are suitable for any categorical data. For example, in this assessment it is required to study ”exposure” as an outcome and “perceived existence of market barrier” as a response. In the case of exposure, it can easily be a dichotomous variable with two possible outcomes: “yes”

or "no". However, in the second case, "perceived non-existence of market barrier", it can be a polytomous response such as most likely, likely, not likely and not at all likely. Such a polytomous response also has the added feature of inherent ordering. To take advantage of that inherent ordering, one can test the ordered logit or ordered probit models. We think that for "exposure" and "implementation" modeling a binary model is acceptable" however, for the "perceived nonexistence of market barrier" model it is worth testing inclusion of alternative specific constants to take advantage of the inherent ordering of the response variable. This is done by estimating the ordered logit function and testing it for the parallel lines assumption.

5.6 Observe the Program's Effectiveness in Achieving Substantial, Lasting Reduction, or Elimination of Specific Market Barriers

This portion of the market effects study is aimed at testing whether or not perceived non-existence of market barriers is likely to continue in the future. Only if the effects are long lasting can the market be considered transformed. If customers are likely to continue perceiving that market barriers will not exist in the future then the market can be considered to have transformed.

There are two ways in which this hypothesis is tested in this study. First of all, as far as possible, questions were included in the survey to find out whether or not customers' perceptions about market barriers are likely to change in the future. Before using the responses in the choice model, the conservative answer was given more weight. For example, if customers indicate they are certain about performance today but their certainty may change in the future, this was interpreted as a barrier for that customer. In other words, causality between the program and its effect on customers' perceptions in the future is developed in the study. Thus, the estimated market effects represent the effect that is sustainable into the future.

Another possibility was to test whether or not customers have taken any actions in the period after December 31, 1997 when the program was not offered. The actions taken by customers in this period (i.e., without the program) may prove that an increased level of demand continued even after incentives were no longer offered.

To summarize, the market effects study has hypothesized a set of market barriers based on a market characterization. The telephone survey was used to collect data on customer characteristics and their perceptions of the hypothesized market barriers. The approach presented in this section was used to estimate the extent to which the programs affected the market in terms of each market barrier. While testing the causality between the program and the perceptions of the market barrier, emphasis was on the sustainability of these changes.

The following sections present the results of the analysis using the approach explained in this section.

6 RESULTS

In this section, the results of the estimated choice models are discussed. As explained in Section 4, one "exposure" model and two individual market barrier models were estimated in order to observe the program effects on the two barriers that are hypothesized as directly affected by the programs. The probability of "exposure" was estimated so that it could be included in each of the two market barrier-specific models as an explanatory variable to estimate the effect of the programs.

To estimate the program effects on the market barriers that are assumed to be affected indirectly, one "implementation" model and two individual market barrier models were estimated. Note that the models were estimated to observe the combined effect of both the AEMS and AEEI energy-efficiency programs for agricultural customers. Using the results of the models, AEMS program effects were calculated. The difference between the combined effect and the AEMS program effect was considered as an AEEI program effect. This section discusses the model results only.

With respect to each of the market barrier models, the modeling approach required us to estimate the probability that a customer perceives the market barrier as not being a barrier (or in other words, the probability of perceived absence of a market barrier). *Therefore, the results are discussed for each market barrier as the probability of perceived absence of the market barrier, rather than probability of the perceived existence of the market barrier.*

As discussed in Section 4, along with binary logit models, probit models and ordered logit models were estimated for each of the market barriers. Since probit models are not particularly advantageous in explaining customers' binary choices, logit models are preferred. The results of logit and probit models are compared in Appendix I. Before selecting the model specification presented here, many alternative specifications were considered with fewer and with more variables. Variables were excluded from the model for one of the following reasons: (1) insignificant influence on the dependent variable, (2) elimination of multicollinearity, or (3) deterioration in the predictive power of the model as measured by a concordant ratio.

The "perceived absence of a market barrier" can be forced to be a binary variable such that the customer either perceives the barrier as a barrier or they do not. However, in reality, "perceived absence of a market barrier" can vary by degrees. Perceived absence may be "not present", "somewhat present" or "very much present". In order to give importance to such inherent ordering for each market barrier, ordered logit models were estimated for each of the market barriers. Depending upon the outcome of the comparison of diagnostic tests, one particular model for each market barrier was selected. This section presents the results of only the preferred models. The results presented in this section are used to estimate the program effects presented in Section 6.

6.1 "Exposure" Model

As explained earlier, the AEEI and AEMS programs could have affected two of the four hypothesized market barriers directly. In order to estimate the effect of the AEEI program in reducing the barriers, first the "exposure" model is estimated. Using the estimated probability

of exposure as an explanatory variable in the models for each of the two barriers, the AEEI program effect is estimated.

A logit model was estimated for the customers' decisions to expose themselves to PG&E's AEMS and/or AEEI programs. This model is estimated using the choices made by all surveyed customers. A pool of 429 total customers was surveyed. Of this total of 429 surveyed customers, 215 were participants of one or both of the programs (i.e., AEMS, AEEI) in any of the four years (i.e., 1994, 1995, 1996, or 1997), whereas the remaining 214 customers form a comparison who did not participate in either of the two programs during past four years.

In this market effects study, the effects are not assumed to be limited to effects on the participants only. In order to include the program effects outside formal program participation, effect of "exposure" is estimated. For the same reason, exposure is not defined solely on the basis of participation status. Telephone surveys included questions about whether or not customers were familiar with PG&E's programs. Responses to these survey questions (questions 23 and 24) have been used to create the "exposure" binary variable. Responses to these questions were used to define "exposure". Those customers who said they are very or somewhat familiar with either of the two programs were considered to be exposed customers. Estimated coefficients of the model with "exposure" as the dependent variable are presented in Exhibit 6.1. Of a total of 429 respondents in the model, 340 were exposed to the program and 89 were not.

Exhibit 6.1
Results of Exposure Model

Explanatory Variables	Parameter Estimates	Wald Chi-Square
Intercept	-1.21	1.9
Dummy=1 if the largest source of revenue of the business is from vegetable and field crops, packing plant, orchard.	0.75	8.4
The extent (not at all, not too, somewhat, very) to which customers are willing to spend time looking for information on ways to reduce energy use.	0.36	4.1
Importance of savings (not at all, not too, somewhat, very) when considering options for repair or replacement of old equipment.	0.37	2.7
Number of times PG&E representative contacted the customer.	0.56	18.2
Dummy=1 if annual electricity consumption is less than 31,820kWh	-0.39	2.2
Dummy=1 if location of the business is Sacramento Valley	0.64	3.9
Number of observations	429	
Number of exposed customers	340	
Number of non-exposed	89	
Percentage of probabilities correctly predicted (Concordant)	72.5%	
-2(LLR-LLU)	50.1	

All the coefficients are statistically different from zero at the 99% significance level.

Results of the exposure model indicate that the model predicts the probability of exposure correctly for 72% of the customers.

- If the customer's (or decision-maker's) business involves field crops, packing plants, or an orchard or water district, they were more likely to be exposed to the programs. The electricity usage for pumping and related end use is high for these businesses; hence, they are more interested in information on efficient equipment in the pumping and related end use. In the process, they get exposed to the programs. Similarly, if the customers are willing to spend the time to look for information on ways to reduce energy use, they are more likely to be exposed to PG&E's programs.

- Customers who have greater energy use realize the need to make an attempt to improve their energy use by adopting energy-efficient technologies; hence, they are willing to look for the information and are more likely to be exposed to PG&E's programs. This is confirmed by the electricity usage explanatory variable. Customers with 31,820 kWh or less are less likely to be exposed to the programs. Thus, proactive customers are more likely to be exposed to the program. If customers are not proactive, then PG&E's representative can help expose the customers to the programs. But it so happens that customers with higher electricity usage are usually proactive and, due to incentives' association with kWh savings, PG&E's representatives are also more likely to contact customers with higher electricity usage so they can maximize the potential kWh savings.

6.2 Market Barrier 1: Information and Search Cost

As discussed in Section 4.2.3, expert opinion on the suitability of energy-efficient products and services at a unique site is expensive. This fact may keep customers unaware of the advantages of efficient services and products which, in turn, can create a gap between the desired level of consumption and the actual level of consumption of energy-efficient products and services. Since PG&E offers such information and advice which otherwise would cost customers, PG&E's programs have the potential to reduce this barrier. By estimating a model that explains customers' perception of the information and search cost, (rather lack of information and search costs), the program effect on this barrier is estimated. In essence, the extent to which customers find it easy and would continue to find it easy to obtain information regarding efficient technologies/practices due to the program is estimated using the model results.

Customers were asked how easy they find getting information about alternative ways of reducing energy use in pumps or irrigation systems and how easy do they expect it to be in the future. The responses to these two questions (questions 17 and 20) were used to determine the extent to which customers do not face this market barrier. If the customer's response to either of the questions is "not at all easy" then the information search cost barrier for that customer does exist. This means that the customer faces the barrier to the greatest extent (index value 1). If the customer's response to either questions is other than "not at all easy" and if the response to either of the questions is "not too easy" then the customer faces the barrier to at least some extent (index value 2). If the customer's response to either questions is other than "not at all easy" or "not too easy" and if it is "somewhat easy" then the customer does not face the barrier most of the time (index value 3). However, if the response is "very easy" then they do not face the barrier at all (index value 4). Thus the index values are assigned on the basis of lack of information search cost or in a more positive manner, in accordance with the ease of getting the information. If the customer finds it very easy to get information about alternative ways of reducing energy use, then the value of the dependent variable is 4.

A logit model for the perceived ease of getting information was estimated. Since the extent to which the customers find it easy to get information may have any of four levels of ease, it is more appropriate to test whether or not the ordered logit model is appropriate. As discussed earlier in Section 5.5.3, if the response variable is a polytomous variable with inherent ordering; the ordered logit model is more appropriate. The score test for the proportional

odds assumption indicates a high *p* value, which says it is appropriate to assume that the slope coefficients for each response level is the same, but the constant is not. Hence, fitting response level minus one number of constants under the ordered logit model is required.

The probability of perceived non-existence of the market barrier or the perceived ease of getting information is likely to be affected by exposure to PG&E's programs. At the same time, a customer's exposure is affected by their perception of the market barrier. As explained in the Section 5, such bi-directionality of causation is dealt with through the substitution procedure as used by Hartman (1988) and Train (1993). In this procedure, along with other explanatory variables, the probability of exposure instead of an exposure dummy, is included as one of the explanatory variables. The results are presented in Exhibit 6.2

Exhibit 6.2
Results of Market Barrier 1: Ease of Information Model

Explanatory Variables	Parameter Estimates	Wald Chi-Square
Intercept_1: Intercept for response level 4	-3.48	26.8
Intercept_2: Intercept for response level 3 and 4	-1.10	2.8
Intercept_3: Intercept for response level 2, 3, 4	0.06	0.1
Dummy=1 if customers are aware of the effect of using efficient technologies, products, system design, and services on electricity bills.	1.19	6.4
Dummy=1 if customers learn about the energy efficiency options by approaching a vendor or contractor or PG&E.	0.26	1.5
Dummy=1 if customers consider the technical aspect of their equipment as a reason to believe the savings claim from pump repair/irrigation system.	-0.85	2.6
Dummy=1 if customers' confidence in the savings predicted by agencies other than PG&E depends upon other growers.	-0.65	6.8
Dummy=1 if annual electricity consumption in 1996 is less than or equal to 108,000 kWh and greater than 31,820 kWh.	-0.24	1.5
Dummy=1 if the largest source of revenue of the business is from live stock or dairy farm.	-0.35	1.8
Predicted probability of exposure.	1.7	6.4
Number of observations	429	
Percentage of probabilities correctly predicted (Concordant)	61.4%	
-2(LLR-LLU)	30.0	
Chi square with 14 Degrees of Freedom	16.8	
P Value	0.26	

All the coefficients are statistically different from zero at the 99% significance level.

Results of this ease of information model indicate that the model predicts the probability that the customer does not perceive information as a barrier at present and is not likely to perceive it as a barrier in the future correctly for 61% of the customers. The key points emanating from this model are:

- If customers are aware that energy-efficient technologies do help in reducing electricity bills, they are likely to perceive that information is not difficult to find. Overall, the share of electricity bills in the total costs of the business is not necessarily large enough for all agricultural customers to motivate them to search the information on ways to use energy efficiently. However, those who are interested in saving money on their electricity bills take the initiative to look for information. They contact a contractor, vendor, or PG&E to find out how to save money on electricity bills. If they come to know that energy-efficient technologies can help save money on electricity bills, that encourages them to continue learning about energy-efficient technologies/practices. As a result, in their perception, they would not find it difficult to look for information on efficient technologies/practices in the future.
- Customers with livestock or a dairy farm as their primary source of revenue, are less likely to perceive that it is easy to get information about efficient technologies/practices. The electricity usage in pumping and related end use is not high enough to motivate these customers to look for different ways to use energy more efficiently. Similarly if the customer's annual usage is not in the higher segment of the sample, they are less likely to find it easy to get information on efficient technologies/practices.
- Only those customers who do not have a long-term relationship with a dealer or with agencies other than PG&E, depend on other growers to make decisions. They would solicit the views of other growers before they decide whether they have confidence in the recommendations of any agencies other than PG&E. Usually, these customers are either small or they have not been in business very long. As a result, they are more likely to think it is difficult to get information on efficient technologies/practices.
- Very sophisticated customers who do understand the uniqueness of the technical aspects of the pumping and related end use at any particular site, are more likely to think it is very difficult to obtain information. Though information is available, it is more important to check the suitability of any replacement or changes in pumping and related equipment at a specific site. Depending upon the conditions and requirements of each site, the savings may differ and information regarding any given site seems to be perceived as difficult to find.

Thus, small customers with short business histories and very large sophisticated customers are both likely to perceive that information is not easy to obtain. However, the majority of customers in between these two customer segments perceive that information is not very hard to find. The coefficient of the most important variable, "probability of exposure", is positive, indicating that customers with a high probability of exposure are more likely to perceive that search for information on energy efficiency is easy.

6.3 Market Barrier 2: Asymmetric Information

Another related factor that may discourage customers from taking action to improve energy efficiency is the source of the information. It is possible that customers have more confidence in one agency for their prediction of savings than in others. In this case, PG&E may have provided a technically reliable and professionally unbiased estimate of pump repair benefits projected via a pump test. However, only if PG&E has successfully created a situation where customers feel as confident about other agencies as they do about PG&E, can the program be considered to have reduced the asymmetric information market barrier. In order to find out whether or not PG&E has affected this market barrier, it is important to know whether customers have any confidence in the benefits projected by agencies any other than PG&E.

In the telephone survey, customers were asked to rate their confidence in the benefits of energy-efficient technology if the benefits are calculated by PG&E (question 46) or by an agency other than PG&E (question 49). A question regarding customers' level of confidence in the future regarding the benefits calculated by an agency other than PG&E (question 52), was also included. First, responses to questions 49 and 52 (i.e., about present and future confidence in the benefits calculated by the agency other than PG&E) were compared. The conservative answer was selected to observe the level of confidence in agencies other than PG&E. For example, if the customer responded "not at all" confident to either of the two questions, then the customer is considered to be not confident, or to put it positively, the confidence level in agencies other than PG&E is considered to be the lowest. Then, the confidence in other agencies was compared with their confidence in PG&E. If customers were at least as confident about other agencies as they are about PG&E, then they were considered to be confident. Customers' confidence can be used as a binary variable or it could have four different levels such as "not too", "not very", "somewhat", and "very".

Ordered logit models require that in each of these levels there are sufficient responses. If not, then two levels are combined to create a total of three levels and so on. For this market barrier, the distribution of customers into these four levels was not appropriate for use of the ordered logit model; hence, a binary logit model was estimated.

Of a total of 429 customer surveys, only 362 responded to this question. This resulted in a final analysis dataset of 362 observations for this market barrier. In order to observe the effect of the program, probability of exposure is used as one of the independent variables. The results are presented in Exhibit 6.3.

Exhibit 6.3
Results of Market Barrier 2: Confidence Model

Explanatory Variables	Parameter Estimates	Wald Chi-Square
Intercept	1.13	2.1
Dummy=1 if customer has experience with agencies other than PG&E or/and have long term relationship with them.	1.13	21.5
Dummy=1 if perceive agencies other than PG&E are unbiased.	1.24	7.3
Dummy=1 if customers use complex financial methods to evaluate energy-efficiency improvements.	0.60	4.6
Dummy=1 if perceive PG&E is unbiased.	-0.88	5.3
Willingness to pay (not at all, not too, somewhat, very)for information regarding alternative ways of reducing energy use at the pump.	-0.25	4.4
Importance of general health of the economy (not at all, not too, somewhat, very) when considering options for repair or replacement of old equipment	-0.22	3.8
Predicted probability of exposure.	-0.8	0.8
Number of observations	362	
Percentage of probabilities correctly predicted (Concordant)	69.5%	
-2(LLR-LLU)	42.0	

All the coefficients are statistically different from zero at the 99% significance level.

Results of the confidence model indicate it predicts the probability of being confident about projected savings correctly for 70% of the customers. The key points emanating from this model are:

- If customers have a long-term relationship with agencies other than PG&E, then they are likely to be confident about the benefits/savings projected by agencies other than PG&E. Similarly, based on their own experience with agencies other than PG&E, customers may think these agencies are unbiased in their savings projections of energy-efficient

technologies. These customers are more likely to be confident about savings predicted by agencies other than PG&E.

- Customers who use complex financial methods to evaluate their investment in replacing their old equipment with energy-efficient alternatives, are more likely to trust agencies other than PG&E. However, if customers think PG&E is unbiased, they are less likely to be confident about savings projected by agencies other than PG&E. Similarly, if customers are willing to pay for information, they are less likely to be confident in the projections by agencies other than PG&E. Customers who are willing to pay for information do realize the importance and need for such information. Since the information is perceived to be useful, customers are willing to pay for it. The information is also important for investment decisions. This dependency on information to make well-calculated investment decisions makes customers think such information should be unbiased from any profit incentives. These customers consider PG&E an unbiased source and are less likely to be confident about other sources.

- The coefficient of the most important variable 'probability of exposure' is negative, indicating that, overall, customers with a low probability of exposure are more likely to be confident about projected benefits by non-PG&E agencies. This suggests that programs were not effective in reducing this barrier. This is quite understandable with programs like AEEI and AEMS. These programs have been offered for a long time. Instead of trying to educate customers about how to evaluate or check projected savings, they just inform customers about which energy-efficient technologies/practices would be beneficial and to what extent. By providing a very reliable source of such information at no cost to customers for a long period of time, PG&E has become part of the market. In the absence of PG&E as a market player, the market itself would be different. However, the Wald Chi Square of this coefficient suggests that the coefficient is not proved to be significantly different from zero. This does not allow us to determine the program effects. Rather, it would mean that program effects are not significantly different from zero.

Thus, the analysis suggests that asymmetric information is a barrier for at least the smaller growers who do not have an established relationship with a dealer or vendor. However, the effect of the programs as currently structured is not significantly different from zero.

6.4 Implementation Model

As explained earlier, programs could have affected other barriers by encouraging implementation. In order to estimate the programs effect in reducing these barriers, first the relationship between "implementation" and the market barrier is established by estimating an implementation model and then using the probabilities of implementation in the models for each of the two market barriers. Next, the program effect on implementation is applied to the implementation effect on the barriers. In the remainder of this section, results of the implementation model and the models for each of the two market barriers are presented.

A logit model was estimated for the customers' decisions to implement energy-efficient technologies/practices. This model was estimated using choices made by all 429 surveyed customers. Questions 58 and 62 were asked about customers' actions during the program in the years 1994, 1995, 1996 and 1997. If customers took any action, then the implementation

flag is set to one. If customers did not take any action, then the implementation flag is set to zero. Thus, a binary implementation variable is created. Estimated coefficients of the model with "implementation" as the dependent variable are presented in Exhibit 6.4. Of a total of 429 respondents in the model, 285 implemented at least one energy-efficient technology/practice and 144 did not implement any.

Exhibit 6.4
Results of Implementation Model

Explanatory Variables	Parameter Estimates	Wald Chi-Square
Intercept	1.26	1.0
Dummy=1 if the reason for pump repair/micro irrigation system is broken equipment or poor performance.	1.4	3.9
Number of times (often, sometimes, not too often, never) customer did not make changes in the irrigation systems due to lack of financing	-0.22	3.2
Importance of (not at all, not too, somewhat, very) potential energy savings when considering options to increase the efficiency of electricity use by installing new equipment or repairing old equipment.	-0.59	6.6
The extent (not at all, not too, somewhat, very) to which customers are willing to spend time looking for information on ways to reduce energy use.	0.30	3.3
Number of times PG&E service representative contacted the customer in past four years.	0.31	8.8
Dummy=1 if customer consider his business operated by a company.	1.61	8.0
Dummy=1 if customer categorizes his business as medium compared to other similar businesses.	0.57	5.7
Dummy=1 if customer first learned about energy-efficiency options by approaching a vendor, contractor or PG&E.	0.62	5.1
Dummy=1 if property is owned by the customer.	-0.67	4.0
Dummy=1 if annual electricity consumption in 1996 is less than or equal to 31,820 kWh.	-0.39	2.7
Number of observations	429	
Number of customers who implemented an efficient technology.	285	
Number of non-exposed	144	
Percentage of probabilities correctly predicted (Concordant)	74%	
-2(LLR-LLU)	70.1	

All the coefficients are statistically different from zero at the 99% significance level.

Results of the implementation model indicate the model predicts the probability of participating correctly for 74% of the customers.

- The severity of the customer's need dictates his or her implementation decision. Those customers who consider potential energy savings as an important factor when assessing options to increase the efficiency of electricity use by installing new equipment or repairing old equipment, are less likely to implement the efficient technology. Even those customers who do not think finance is a problem are less likely to implement efficient technology. This is primarily because even customers with strong finances who consider savings to be important, are not likely to implement the efficient technology unless they need to replace the existing system due to poor performance or equipment failure. This is probably because of the perception that savings are small compared to the high capital cost of the repair or replacement, compounded by the fact that the pump is supplying sufficient water and other, more important issues require attention.
- More frequent PG&E representative contact does encourage customers to implement the efficient technology. Similarly, those customers willing to spend time on getting information about alternatives, initiate the search for information, and learn about the efficient technology are more likely to implement efficient measures. If the business is run like a company and is not extremely large or very small, then it is more likely to implement the efficient technology.
- However, if the business is very small in terms of electricity consumption or/and if the owner makes decisions regarding energy-efficiency improvements, then they are less likely to implement efficient technologies/practices. This implementation decision result is consistent over the past two years.

In summary, the probability of implementation is highest for medium-sized businesses that perceive themselves as operating as a business. However, even in these cases, energy-efficient measures are only likely to be installed when the equipment fails and requires repair or replacement. More frequent contact with the PG&E representative increases the likelihood of an energy-efficient installation when replacement does occur.

Using the estimated coefficients of the implementation model, the probability of implementation is calculated for each customer. The estimated probability of implementation is then used as an explanatory variable in the indirect effect market barrier models.

6.5 Market Barrier 3: Performance Uncertainty

As mentioned earlier, the choice of the quantity and type of any efficient products or services depend upon the specific needs at a given site. Since the choice itself depends upon site-specific characteristics, the benefits in terms of kWh savings also differ from site to site. Thus, though customers know (or have heard) about the advantages of efficient products and services, they may still be uncertain about the benefits of energy-efficient products and services at their own site. Though they hear of benefits from friends in the same community, they need to reconfirm it with their own experiences. Unless they install the products and/or services, they may not be able to experience it at all. Since PG&E's programs encourage installation either via information or reduction in the initial costs, the program has the

potential to reduce this barrier indirectly via installation of the equipment. To evaluate the extent to which implementation could build confidence among customers regarding predicted energy savings, a performance certainty model was estimated.

Questions were asked in the survey regarding the extent to which customers believe benefits of a pump repair (questions34 and 40) and micro irrigation systems (questions 36 and 42) at present and in the future. Since the extent to which customers are certain about the benefits can be more than just a binary response, four levels (not at all, not too, somewhat, very) of response were modeled using ordered logit. Only if customers stated they are certain at present and will be certain in the future, the highest level (i.e., very certain) is assigned. If customers are not at all certain either at present or in terms of future prospects, then they are assigned the lowest certainty level. Of 429 respondents, 395 customers responded to either micro irrigation systems or pump repairs; therefore, the model was estimated using the responses of 395 customers. The results are presented in Exhibit 6.5.

Exhibit 6.5
Results of Market Barrier 3: Performance Certainty Model

Explanatory Variables	Parameter Estimates	Wald Chi-Square
Intercept 1	-3.57	14.1
Intercept 2	-1.59	2.9
Intercept 3	-0.35	0.1
Dummy=1 if customers understand the technical aspect of their equipment and consider it as a reason to believe the savings claim from pump repair/irrigation system.	-1.38	7.1
Importance of (not at all, not too, somewhat, very) reliability of the equipment when considering options to increase the efficiency of electricity use by installing new equipment or repairing old equipment.	0.31	2.1
Importance of (not at all, not too, somewhat, very) general health of the economy when considering options to increase the efficiency of electricity use by installing new equipment or repairing old equipment.	0.30	10.1
Dummy=1 if annual electricity consumption in 1996 is less than or equal to 108,000 kWh and greater than 31,820 kWh.	-0.49	5.73
Dummy=1 if the largest source of revenue in the business is from ornamental nursery, indoor crops, or vineyard/winery.	0.24	1.6
Predicted probability of implementation.	1.04	4.47
Number of observations	395	
Percentage of probabilities correctly predicted (Concordant)	62%	
-2(LLR-LLU)	27.7	
Chi square with 14 Degrees of Freedom	10.5	
P Value	0.57	

All the coefficients are statistically different from zero at the 99% significance level.

Results of the performance certainty model indicate the model predicts the probability of being certain of pump repair/micro irrigation savings correctly for 62% of the customers. One of the most important variables that explained the reasons for performance certainty was previous experience regarding predicted savings. If customers obtained the predicted benefits in the past, then they are more likely to be certain about predicted savings. But this variable was highly correlated with another important variable - the predicted probability of implementation. To avoid the biased results due to multicollinearity, it was necessary to exclude the previous experience from the model. However, it is important to note that past experiences do help in reducing the barrier. The key points emanating from this model are:

- An important variable is the level of technical understanding and whether or not customer's perception of certainty about the performance depends upon their technical knowledge. The customers who understand that the performance of efficient technologies/practices depends on the technical aspects are not likely to be certain about the performance. In other words, if they know that performance depends upon technical aspects, they are less likely to be certain about performance.
- When assessing options to increase energy efficiency by installing new equipment or repairing old equipment, customers who consider reliability of the equipment and general health of the economy as important factors are more likely to be certain about performance. Similarly, if the largest source of revenue in the business is from an ornamental nursery, indoor crops, or a vineyard/winery (less water intensive activities), customers are more likely to be certain about performance. This may be because small deviations in performance compared to what customers expected do not significantly affect their business nor render their investment decision questionable.
- Again, the positive coefficient of the most important variable, "probability of implementation", indicates that, overall, customers with a high probability of implementation are more likely to be certain about the performance of energy-efficient technologies/practices.

Overall, the results of this model indicate that customers with previous experience are more likely to be certain of performance. These also tend to be customers with highest pumping-related bills.

6.6 Market Barrier 4: Hidden/Unexpected Costs

As explained earlier, the costs of a pump repair or other changes in an irrigation system are high. In addition, if customers have not dealt with the operation of certain irrigation systems, then the cost and hassle of maintaining them is unknown. The unknown, or apparently hidden, costs increase the uncertainty of total costs. This may be considered as an uncertainty related to costs. Uncertainty regarding maintenance cost is a discouraging factor for customers. If customers have previous experience with unanticipated costs, then uncertainty is reduced, and customers tend to make decisions with a better awareness of all costs involved.

The program encourages installation via reduction in initial costs. We think that after customers have experience with the equipment, uncertainties regarding hidden costs may be reduced. Thus, the program has the potential to reduce this barrier indirectly via installation of

equipment. Using the predicted probabilities of implementation as an explanatory variable, the relationship between implementation and perceived non-existence of this barrier is checked.

In the telephone survey, questions were asked about how concerned the customer would be about possible unexpected costs of the irrigation system (question 54) and how concerned they would be in the future (question 56). As in other market barriers, the responses to these two questions were analyzed to create an analysis variable. Again, the conservative answer dominated the analysis variable. That is, if the customer is very concerned, either at present or would be concerned in the future, then he or she is considered as facing the market barrier.

Since the analysis variable has an inherent order, ordered logit was estimated. However, the test of whether the parallel line assumption can be accepted or not failed, which meant that fitting the number of responses minus one constant is not appropriate. This suggested that either inherent ordering of the response variable should be ignored and the generalized logit model may be tested, or that the response variable be converted into a binary response variable. The generalized logit model was also tried; however, a very skewed distribution across different values of the response variable made the results biased. Therefore, it was thought that binary logit gave the least bias and most reliable results.

Of a total of 429 survey respondents, 381 customers responded to this question. Of these, 59 did not consider hidden cost as a problem and 322 were either very or somewhat concerned about hidden costs. Cost certainty, or lack of concern about hidden cost, was estimated using the responses of 381 customers. The results are presented in Exhibit 6.6.

Exhibit 6.6
Results of Market Barrier 4: Costs Certainty Model

Explanatory Variables	Parameter Estimates	Wald Chi-Square
Intercept	1.84	1.6
Dummy=1 if customer's opinion about unexpected costs is based on experience of other growers.	-1.77	7.7
Dummy=1 if customers first learn about energy-efficiency options when PG&E, contractor, or vendor contacts them or by word of mouth.	0.62	3.4
Importance of (not at all, not too, somewhat, very) reliability of the equipment when considering options to increase the efficiency of electricity use by installing new equipment or repairing old equipment.	-0.91	8.1
Importance of (not at all, not too, somewhat, very) the general health of the economy when considering options to increase the efficiency of electricity use by installing new equipment or repairing old equipment.	-0.36	5.0
Dummy=1 if customer grows annual crops.	-0.90	4.8
Dummy=1 if the largest source of revenue of the business is from live stock or dairy farm.	-0.95	2.5
Dummy=1 if annual electricity consumption in 1996 is less than or equal to 108,000 kWh and greater than 31,820 kWh.	0.95	7.4
Probability of participation.	1.4	2.4
Number of observations	381	
Percentage of probabilities correctly predicted (Concordant)	76%	
-2(LLR-LLU)	39.7	

All the coefficients are statistically different from zero at the 99% significance level.

Results of the cost certainty model indicate that the model predicts the probability of lack of concern about hidden cost correctly for 76% of the customers. The key points emanating from this model are:

- Only those customers who first learned about the energy-efficient technologies and practices by approaching vendors, contractors, or PG&E are not concerned about hidden costs. All other customers are more likely to be concerned about hidden costs. For example, customers with lower annual kWh usage, or those who grow annual crops, are concerned about hidden costs. Customers whose opinion on hidden costs is based upon the experiences of other growers are also likely to be concerned about hidden costs. This suggests that other growers' experience is not sufficient to convince customers about cost certainties. Customers may have to depend upon their own experience to realize cost certainty. In such a case, implementation would make a lot of difference.
- Despite a fairly high rate of implementation (as seen in the implementation model), the majority of customers are concerned about unexpected costs. This would happen only in two cases. One, since the overall cost of the energy is not too high, most implementers take the benefits for granted and do not watch costs too closely unless they become obvious. That is, in theory, they appear to be concerned about hidden costs since it is rational to be concerned about them. Two, all implementers observed costs very closely and feel the need to be concerned about them. If the second scenario were true, then customers would not implement these efficient technologies on their own. This year's survey and surveys from previous studies indicate that customers continue to take action even outside the programs. Therefore, we think chances are higher that those customers who initiate the search for information regarding energy-efficient technologies are more cautious, carefully operate new equipment the way they were supposed to, and, as a result, do not find a reason to be concerned about hidden costs.
- The coefficient of the most important variable, probability of implementation, indicates that implementation does affect concern about hidden costs. The positive sign of the coefficient indicates that customers who implement are more likely to be certain about costs. Implementers' experience help in reducing concerns about hidden/unexpected costs.

In summary, the results indicate that, indeed, AEEI program participation does decrease the hidden cost market barrier. The results also indicate that the more sophisticated users, who have close relationships with credible suppliers and who watch their costs, tend to be least worried about hidden costs in energy-efficiency projects.

Using these model results and estimated coefficients, market effects attributable to the AEEI program were estimated. An assessment of the market effects attributable to the program is presented in Section 7.

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7 MARKET EFFECTS ATTRIBUTABLE TO THE AEEI PROGRAM

The purpose of this section is to discuss market effects attributable to the AEEI program in terms of each of the four market hypothesized barriers analyzed. In addition, results are discussed for a fifth market barrier not addressed by the programs. This section also presents the possibility of long-term sustainable market effects in terms of action taken by the customers.

7.1 Estimating Market Effects and Confidence Intervals

The results of each respective model discussed in Section 6 are used in the calculating the final net effects of the AEEI program in reducing the market barrier. Using an example of one market barrier directly affected by the program and one indirectly affected by the program, the following steps describe the way in which effects of the AEEI program in reducing the market barriers are calculated after estimating the models.

1. Using the estimated coefficients of exposure, a probability of exposure model is estimated for each customer. Using the estimated coefficients of the information ease model, the probability that a customer finds information search easy is estimated for each customer.
2. Next, the product of these two probabilities in the scenario that PG&E's programs are in place is calculated. This is called "overall effect of both the programs". Then, the product of these two probabilities, including only the participants of AEMS program participants, is calculated. This is called "overall effect of AEMS programs". The difference between the two results is called "overall effect of AEEI programs".
3. To get the net effects, the product of these two probabilities in the scenario that none of PG&E's programs are offered is simulated. This is called "overall effect in absence of the programs". The difference between the "overall effect of both the programs" and the "overall effect in absence of the programs" is called the "net effect of both the programs". The "net effect of AEMS program" and the "net effect of AEEI program" are calculated similarly.
4. Since these effects are calculated in terms of probabilities, it is difficult to interpret the effects, and a comparison across market barriers is not possible. Therefore, a ratio of net effect and overall effect is calculated for each barrier and for each program. For example, for the first barrier, this ratio would indicate the percentage of customers in the market who would not have found it easy to search for information if they were not exposed to the AEEI program.
5. For the two other barriers that are indirectly affected by the programs, the calculation differs in two respects. One, instead of probability of exposure, the probability of implementation is used in step one. With this change in step 1, and following steps 2 through 4, the effect of implementation on the market barriers is estimated. Two, calculation of effects attributable to the AEEI program requires one additional step after step 4. It is important to find the rate of implementation attributable to the program, or,

the net effect of the program. To do this, the net-to-gross ratio for the 1997 (75%) is applied to the ratio of the net implementation effect on market barrier calculated in step 4.

In order to make use of the market effects attributable to the AEEI program in an informed manner, one must also have at least an approximate knowledge of the uncertainty associated with the estimated ratios. Estimation of uncertainty is complicated by the fact that the functional relationship between the market effects and the model coefficients is nonlinear. For this study, a confidence interval around the effect is estimated using one of the explanatory variables. The method involves using the standard error of the estimated coefficient of the most important variable in all four market barrier models to calculate the maximum and minimum market effects at the 90% significance level. In this approach, the choice of the one explanatory variable is critical. The estimated coefficient and the standard error of the probability of exposure (for the first two barriers) and probability of implementation (for the other two barriers) is used because the probability of exposure/implementation is a function of all the variables in the exposure/implementation model. As such, its parameter is estimated in the market barrier model. The results indicated a confidence interval around the effects attributable to the program. These results are discussed below.

The main purpose of this study is to estimate the market effects attributable to the AEEI program. The effects in terms of each barrier indicate the extent to which that market barrier would have prevailed if PG&E did not offer the AEEI program in the years 1994 through 1997. The estimated effects using the model results are presented in Exhibit 7.1.

Exhibit 7.1
Market Effects Attributable to the AEEI Program

Market Barrier – Responses by Customers	**Current Market Condition**	**Market Effects Attributable to the Program***	**90% Confidence Interval**
1: *Information and Search Cost* – Somewhat or very easy to find information about energy efficient technology	76%	36.7%	26%--42%
2: *Asymmetric Information* – Somewhat or very confident about projected savings/benefits if recommended by agencies other than PG&E.	45%	Unable to Determine	
3: *Performance Uncertainty* – Somewhat or very certain about the performance.	73%	15.8%	7%--21%
4: *Hidden cost* – Somewhat or very certain about hidden costs.	16%	5.6%	1%--7%

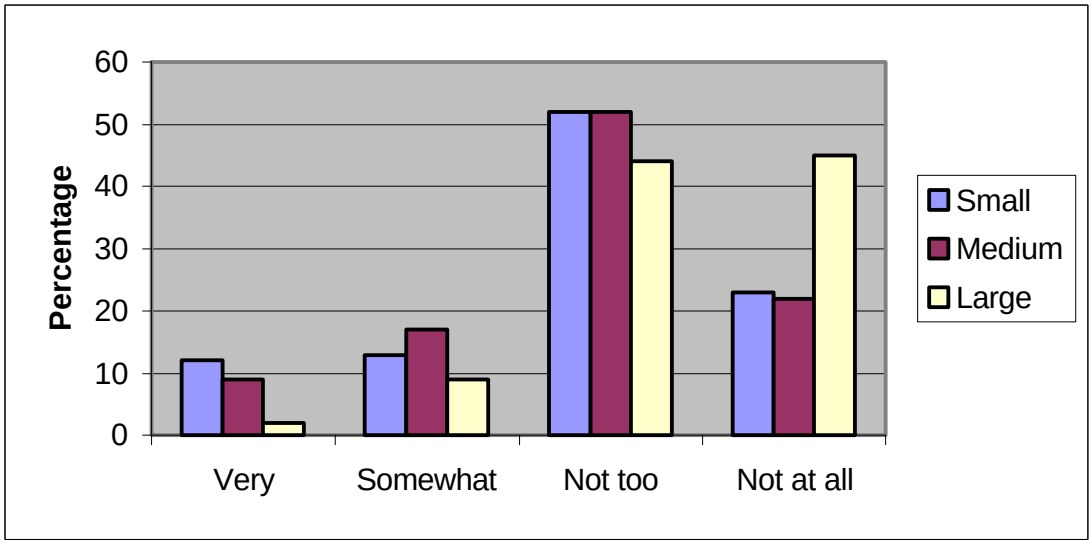
7.1.1 Information and Search Costs – Ease of Getting Information

As mentioned earlier, advice and information regarding energy-efficient products via PG&E representatives is given at no cost to customers as a part of the AEEI program. In the market, the expert opinion on the suitability of the energy-efficient products and services for a specific site can be expensive. As a result, customers may remain unaware of the advantages of efficient services and products which, in turn, creates a gap between the desired and actual levels of consumption of energy-efficient products and services.

In theory, any agricultural customer whose energy costs, as a proportion of the total costs, are large enough should be interested in information about appropriate energy-efficiency options suitable for the customer's site and operations, its costs and its benefits, so that the customer can make rational choices. Thus, in order to make a rational choice, a customer would need different types of information representing different levels of detail. For example, first, awareness or ease of getting information regarding possible options in the market, second, the characteristics of these options to check the suitability, its costs and benefits if applied to the customer's business.

In the telephone survey, it was not possible, for reasons of time, to ask how easy it was for customers to get information on each one of these aspects. The question was asked at a very general level as to how easy is it to get information on energy-efficiency options. Of a total of 414 customers who responded, 108 felt that it is very easy, 206 thought it was somewhat easy, 60 considered it not too easy, and 40 thought it not at all easy to get information. For planning purposes, it is very important to know which types of customers found it very difficult (not at all easy) to get the information. Comparison of the perceived existence of this barrier with the size of the customer, either in terms of annual kWh usage or size as stated by the customer, reveals that:

Exhibit 7.2
Information Search Cost Barrier



- Very few (2%) of large customers found it very difficult to get information.

- Small and medium-sized customers are not very different from each other in experiencing difficulties in searching for information.
- In the market represented by these customers, 76% of them do not find it too difficult or not at all difficult to obtain necessary information.

The survey responses indicate that 76% of the sample do not face this barrier at present and are not likely to face it in the future. Model results indicate that of this 76% of the sample, 36% would have found it difficult to search for information in the present and in the future if they were not exposed to the AEEI program. As a result of their exposure to the program, these customers will continue to find it easy to search for information in the future (i.e., the effect is sustained).

Assuming that 100 customers represent the market, our survey indicates that 76 customers find it easy to search for information at present and will continue to find it easy in the future. Our model results indicate that 36 of these 76 customers who do not face this barrier in the present or in the future would have faced the barrier (either in the present or in the future) had PG&E not offered the AEEI program. The remaining 40 of 76 customers do not face the barrier not because they are exposed to the program, but probably because they would have gotten the information anyway via vendors, magazines or other sources. The confidence interval indicates that of 76 customers who find it easy to search for information in the present and in the future, 26 to 42 customers would not have found it easy in the present or in the future if they were not exposed to the program.

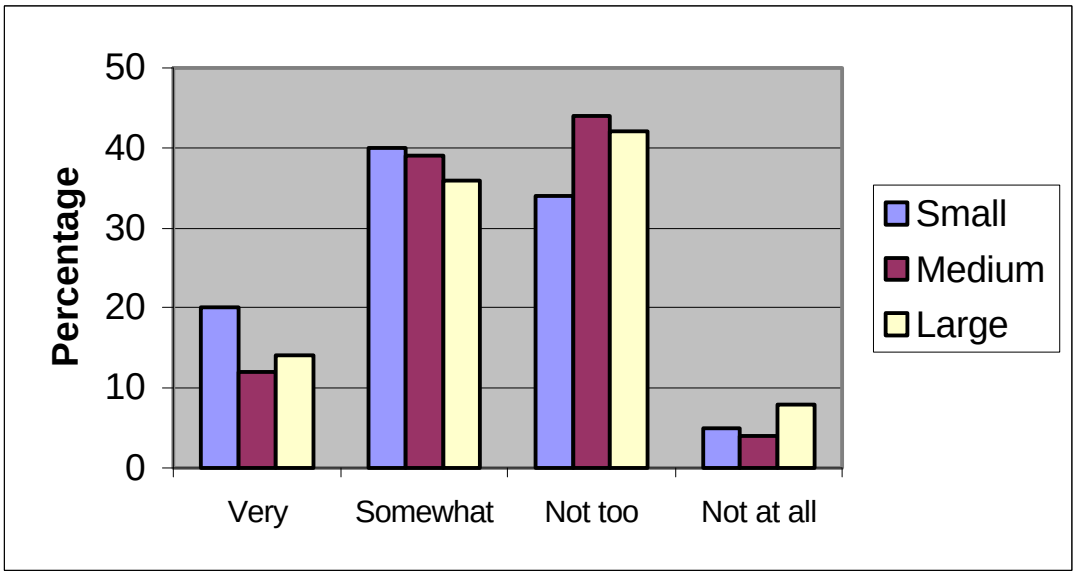
The program effect would decrease if the future program does not focus on those who do find it difficult to get information about the suitability of energy-efficiency options for their sites.

7.1.2 Asymmetric Information - Level of Confidence in Projected Benefits If Not Done by PG&E

In the agricultural sector, vendors contact customers to sell them equipment, including energy-efficient products and services. Since customers may consider such contacts as tinged by a profit incentive, they may or may not believe the savings claims by the vendors. Customers may require reconfirmation of the benefit claims made by the vendors through an unbiased source. As a part of PG&E's AEEI program, PG&E offers information regarding energy-efficient services and products. PG&E, by providing information, becomes another source of information for the customer in addition to the dealer or vendor. Thus, PG&E's AEEI program, by providing an independent source of information, has the potential to reduce this barrier.

Of a total of 393 customers who responded to questions about whether or not they are comfortable with sources of information other than PG&E in the present context or in the future, only 20% had confidence (no problems at all in trusting other agencies) in other agencies in the present and in the future. Overall, 55% of customers found it very difficult to trust any agencies other than PG&E when it came to projected benefits from energy-efficiency options. Analyzing the types of customers who faced this barrier, it was found that customers of all sizes face this barrier. The extent to which small and large customers face this barrier is not very different, as can be seen from Exhibit 7.3.

Exhibit 7.3
Difficulty in Believing Projected Savings If Not Done by PG&E



As can be observed from Exhibit 6.3, small customers seem to find it more difficult to trust other agencies. The inherent problem in testing the hypothesis is that PG&E is the only neutral party where customers can cross check the information on projected benefits. PG&E has become part of the market by providing such services. In the absence of PG&E's services, customers have no alternative but to believe projections of agencies other than PG&E. In such a situation, customers are rather uncertain and, therefore, a majority of them find it somewhat difficult or not too difficult to trust the projected benefits by agencies other than PG&E.

Choice models could not determine the extent to which PG&E's AEEI program induces any confidence in other agencies.

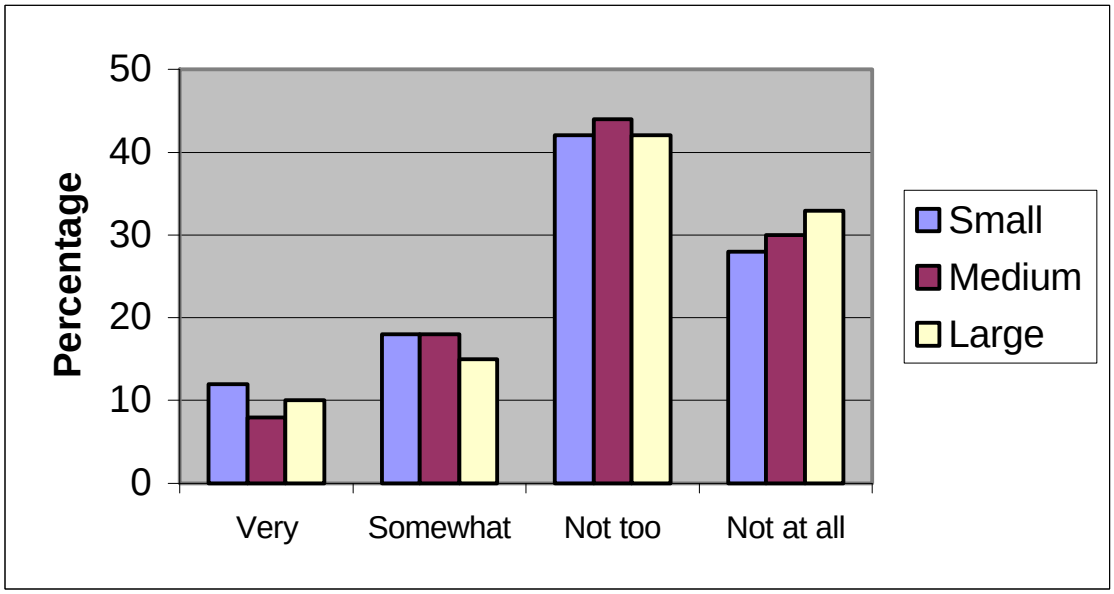
7.1.3 Performance Uncertainty - Certainty About Performance

As mentioned earlier, in the agricultural sector, the choice of the quantity and type of any efficient products or services depends upon the specific needs at a given site. Since the choice itself depends upon the site, the benefits in terms of kWh savings also differ from one site to the other. Thus, though customers know (or have heard) about the advantages of efficient products and services in general, they may still be uncertain about the benefits of energy-efficient products and services at their own site. Though they hear about benefits from friends in the same community, they need to reconfirm it with their own experiences. Unless they install the products and/or services, they may not be able to experience it at all. Since the program encourages implementation, it has the potential to reduce this barrier via encouraging implementation experience.

The survey responses indicate that of 395 customers who responded to questions regarding uncertainties, only 39 were not at all certain and 67 were not too certain about the projected benefits. Overall 73% of customers were somewhat or very certain about the projected benefits and will continue to be certain about performance in the future. Of the 26% of

customers who were somewhat or very uncertain about projected benefits, 63% were somewhat uncertain. It takes little extra effort to move somewhat uncertain customers into the category of somewhat certain. Future programs, if effectively geared towards customers in this category, can be successful. As can be seen from Exhibit 7.4, these 26% are from all groups; however, a lower proportion of large customers face this barrier.

Exhibit 7.4
Performance Uncertainty Barrier



The relevant question is how much of the perceived certainty about performance in the present and in the future is attributable to the program. The survey indicates that 73% of customers are perceived to be certain about performance in the present context and will continue to be certain in the future. Of the 73% of customers who are certain, approximately 16% would not have felt certain about performance if they did not have an implementation experience through the AEEI program. These 16% will continue to be certain about performance in the future (i.e., the effect is sustained).

Again, assuming that the market is 100 customers, the responses indicate that 73 customers are certain about performance today and will continue to be certain. The analysis indicates that of these 73 customers, 16 customers would not have been certain about performance today and in the future, if they did not have implementation experience via the AEEI program. The remaining 57 customers are certain about performance today or in the future due to others' implementation experience, or they would have implemented the technology outside the program. The confidence interval indicates that, of 73 customers who are certain about performance, the number who are certain about the performance as a result of the program ranges from 7 to 21.

The survey responses indicate that perceived certainty regarding performance is quite high, and will continue to remain high, indicating that the performance uncertainty market barrier is

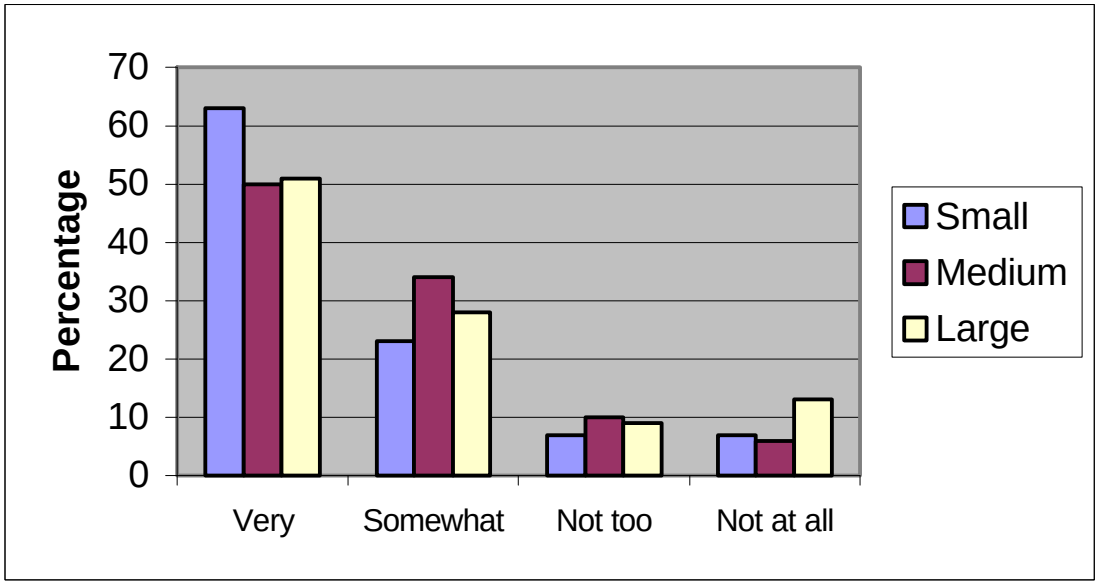
low. The analysis using choice models indicates that the program contribution to the performance certainty is low.

7.1.4 Hidden Costs/Unexpected Costs

The costs of a pump repair or change in an irrigation system are high. In addition, if the customers have not dealt with the operation of certain irrigation systems, then the cost and hassle of maintaining them is unknown. The unknown or unexpected or apparently hidden costs increase the uncertainty of total costs. Uncertainty regarding maintenance cost is a discouraging factor for customers. If customers have previously had experience with unanticipated costs, then uncertainty is reduced, and customers tend to make decisions with a better awareness of all the costs involved. The program encourages installation via reduction in initial costs. The hypothesis that implementation experience can reduce uncertainties regarding costs was tested. Since the AEEI program encouraged an implementation decision, the program has the potential to reduce this barrier indirectly via installation of equipment.

Of a total of 381 customers who responded to questions regarding their concerns about unexpected costs, 213 customers responded they are very concerned about hidden costs today and will continue to be concerned about hidden costs in the future. Only 27 customers were not at all concerned about hidden costs, 32 were not too concerned about hidden costs and 109 were somewhat concerned about hidden costs. Overall, 84% of all customers were very or somewhat concerned about hidden costs. Though implementation was experienced by more than 16% of the surveyed customers, the barrier is perceived not to exist by only 16% of customers now and in the future. This, in itself, indicates that implementation would have had a small influence in reducing the barrier. Interviews with dealers and irrigation system designers confirm the finding that a majority of customers perceive this barrier to exist. Part of the reason is that customers are not informed about the costs of maintaining the equipment. Since costs are unknown to the customer, when the customer experiences these costs after implementing the technology, he or she is more likely to be disappointed in the experience. As can be observed from Exhibit 7.5, a greater proportion of large customers, who also are more sophisticated in terms of knowing the latest technology and finding out more information about efficient technologies, do not face this barrier.

Exhibit 7.5
Concerns About Hidden Costs.



From the analysis of choice models, it is estimated that of 16% of all customers who do not face this barrier and do not think that they will face barrier in the future, 6% is due to the implementation as a result of the AEEI program. Alternatively, 6% out of the 16% of customers would have perceived this barrier as a barrier if they had not experienced implementation via AEEI program. The market effects of 6% are sustained due to the program, and the remaining 10% are sustained due to other factors.

Again using the concept of a market composed of 100 customers, the survey responses indicate only 16 out of 100 customers are not concerned about hidden costs and will continue to be not concerned about them. The analysis using choice models indicates that of 16 customers who are not concerned about hidden costs in the present and in the future, 6 are not concerned as a result of the AEEI program. This is actually a significant effect. About a third of customers would have perceived the barrier to exist and would have continued to face the barrier in the future if they did not experience implementation via PG&E's program. It could be that some of the implementations that were encouraged via the AEEI program also educated customers about hidden costs in particular. Since these customers were anticipating such costs, their experience did not cause them to be concerned about them the next time. Overall, awareness, along with the implementation experience, can make a difference in the way customers perceive unexpected costs.

The survey responses indicate that perceived certainty about hidden costs is quite low, and will continue to remain low, indicating that the hidden costs market barrier is very high (84% very or somewhat concerned). The analysis using choice models indicates that the program contribution to the portion of the population who are not concerned about hidden cost is significant.

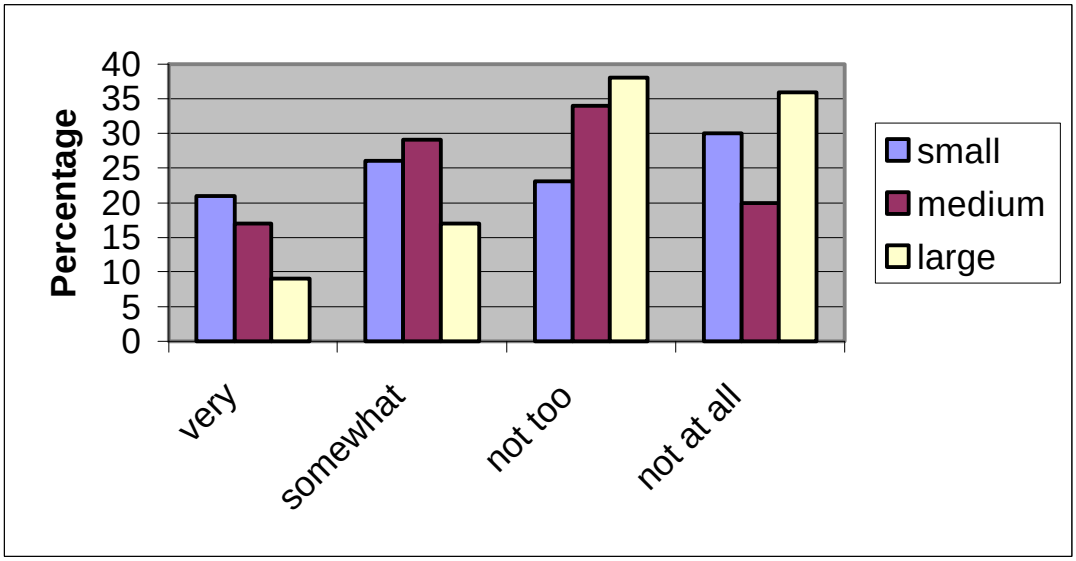
7.1.5 Access to Financing

As mentioned in the Section 4.2.3, the agricultural sector experiences yearly fluctuations in the availability of funds. Lack of finance can discourage customers in their decision to implement energy-efficient products with high costs. Even if the customer is aware of a low performing pump that requires repair, the customer may decide to wait for cash flow to improve. Thus, access to financing can be considered as a characteristic that generates a gap between the desired and actual level of efficiency adoptions.

Since it was recognized from the start that the program does not have the potential to affect this barrier, a causal relationship between the program and the perceived existence of this barrier was not established. However, perceived existence of this barrier was observed via the telephone survey of customers. Thus the barrier was included in the data collection and analysis for completeness.

Of a total of 429 customers interviewed, 422 customers responded to either or both of the questions regarding difficulty in getting financing. One question was regarding how easy would it be for them to finance irrigation equipment changes or upgrades that cost 800-1,000 dollars per acre (question 28), and the second was regarding how often they could not make necessary changes in irrigation systems due to lack of funds (question 29). If they responded to both the questions, then after reversing the index for question 28, the conservative answer was selected to indicate the extent to which customers face the barrier. From the responses, it appears that 45 % of customers face the barrier at least to some extent (i.e., “very” and “somewhat” categories combined). It appears that customers who consider themselves large compared to similar businesses do not face this barrier as much as those who consider themselves small or medium-sized. These results are illustrated in Exhibit 7.6.

Exhibit 7.6
Access to Finance Barrier by Size



Those customers who find it somewhat difficult to obtain financing may be more likely to hold off on their adoption of energy-efficient technologies due to difficulties with financing. Thus,

difficulties in financing create a gap between the level of implementation that could be possible with assistance compared to what would have been possible otherwise. It appears that assisting with financing, at least to those customers who find it somewhat difficult to get the financing, (i.e., 26% of 422) would encourage adoption of energy-efficient technologies and practices. This is important for future program planning.

7.2 Perception of the Suppliers

As a part of this study, engineers experienced in the field interviewed eight pump dealers and eight irrigation system designers. The responses of the dealers and irrigation system designers give us an idea about perceptions of each of the four market barriers above from supply-side market actors.

First of all, with respect to the four market barriers discussed above, pump dealers' responses pertained mainly to efficient motors rather than pump repair. Pump dealers think of pump repairs as a service without any alternatives rather than a product with substitutes. Therefore, they responded to all questions about pump repairs as if efficient motors were the only contributing products. This makes it difficult to compare the responses of market actors on the demand side with responses of market actors from the supply side. However, general observations can be made.

7.2.1 Information and Search Costs

Of eight pump dealers and eight irrigation designers, five dealers and five irrigation designers think the information delivery channel is somewhat satisfactory and two of the pump dealers and three of the designers think it is very satisfactory. A total of 15 of 16 (94%) market actors on the supply side are somewhat or very satisfied with the information delivery channel. Thus, only 6% of supply-side market actors are not happy with the information delivery channel.

Five of eight pump dealers and six of eight designers do not find it difficult to find information on energy-efficient technology. A total of 11 of 16 (69%) find it easy to get information and do not face information and search cost barrier. Thus, 31% of supply-side market actors face this barrier.

With respect to their perceptions about how difficult it is for customers to get information, 10 (i.e., five pump dealers and five designers) of 16 market actors think customers are generally satisfied with available information. Nine out of sixteen (56%) market actors think customers do not find it difficult to obtain information about energy-efficient technologies. However, for micro irrigation systems, designers think customers may have to spend some time and effort to get it. Thus, 44% of supply-side market actors think customers face information and search cost barriers. This is higher than what customers think they face. Thus, supply-side market actors think customers face this barrier to a greater extent then the customers themselves.

7.2.2 Asymmetric Information

Since the dealers and designers themselves are one of the sources of information other than PG&E, it is not considered appropriate to ask market actors on the supply-side if they had any

incentive in recommending efficient equipment. However, questions were asked about their role in customers' decision processes and the extent to which they influence customers.

Five out of eight designers (63%) think they influence the customers' decisions. Two of them think that they do designs according to requirements, but then customers decide on their own. In case of pump dealers, of eight dealers only one of them (13%) responded that customers are not aware of what they want; hence, customers rely on them. Four of the remaining seven responded that if customers ask about efficiency they do help, and half the time they may influence the customer. Otherwise, pump dealers felt that customers already have the specifications and dealers do the design according to the specifications. This indicates that for micro irrigation systems, designers play an influential role and customers do depend upon designers, while in the case of pump repairs and motors, dependency on dealers is much lower.

This may be due either to the fact that the two services are different or the market for the technologies is at a different stage. Pump repairs have been popular among customers for a much longer time then micro irrigation systems. In a mature market, customers are more aware of what they need and sources of information cannot afford to be biased. The pump repair service itself requires no design per se and, therefore, there has less chance for differences of opinion.

Generally, designers influence customers with respect to micro irrigation system designs more than the pump dealers' opinions about equipment designs.

7.2.3 Performance Uncertainties

From the responses of dealers and designers, it is evident they expect each market barrier to vary by technology. This is because of differences in the nature of the technology and differences in the maturity of each market.

As for the irrigation system designers, none of the eight designers were reluctant to recommend efficient technologies. They do not appear to be worried about performance. Among the pump dealers, three are hesitant to recommend efficient technologies, but only one of them is hesitant because of the reliability of the motor. Thus, though, overall, designers and dealers seem quite confident about performance, dealers show some concerns about the reliability of the motor.

Pump dealers feel their customers have some concern about performance and cost. According to designers and dealers, they themselves find it very difficult to justify the higher cost of efficient equipment to customers. Their concern about justification of higher costs may, in some part, be due to performance uncertainty. However, in open discussion with them, it appears the concern is primarily centered on the length of time required to recoup the high initial costs.

7.2.4 Hidden Costs

Two of five dealers have had customers shy away from efficient technologies (low-pressure sprinkler nozzle/micro irrigation in particular) due to their experiences with the unexpected operating costs. However, they believe that the problems were not with the equipment per se,

but rather with the system design. Five of eight designers think technologies like low-pressure sprinkler nozzles and micro irrigation systems are not trouble-free and require more maintenance. They felt that customers who did not anticipate these increased maintenance needs are affected. Some of them think it is still a good service and the crop benefits override the difficulty. The tone of the responses about their experience indicates that the unexpected nature, or no lack of anticipation of the issue, is what can discourage customers more than the actual dollar cost. They believe that the crop results can easily offset the dollar cost of manual maintenance or the extra operating costs. If customers are informed and prepared for the increased maintenance, then discouragement can be reduced. Thus, about 63% of the designers think unexpected cost is a barrier.

Customers' responses indicated that 322 of 381 respondents (85%) appeared concerned about hidden costs. Likewise, a majority of designers think customers are concerned about hidden costs. This suggests that, overall, the perceptions of both customers and supply-side market actors of hidden costs as a barrier are very similar and that most of them do find a reason to be concern about it. However, from the responses of supply-side market actors, it appeared that the unexpectedness of the costs is the problem.

7.2.5 Access to Financing

Of eight pump dealers, four were not even aware of how customers finance their investment in irrigation equipment changes. The remaining four think it is not too difficult or not at all difficult to finance. The only source of finance for customers, according to them, is the bank.

Almost all irrigation system designers think it is not too difficult or not at all difficult to finance investment in irrigation equipment changes. They think that crop loans, banks, cash flow, and lease purchases are some of the ways customers finance such investments.

A majority of irrigation system designers and pump dealers consider initial high cost as one of the primary reasons for customers to shy away from energy-efficiency improvements. Overall, all market actors on the supply side do feel it is difficult for them to justify the high initial costs.

Compared to customers' opinions from the telephone survey, it appears there is a discrepancy between the perception of supply-side market actors and customers. At least 45% of customers find it difficult to fund these investments, and supply-side market actors think it is easy for customers to fund such investment or get financing.

7.3 Sustainability of Program Effects

So far, the discussion has focussed on the market actors' perceptions about four market barriers. In this section, the discussion of market effects is focussed on the actions.

Overall, market effects attributable to the program in terms of the four market barriers were estimated using the customers' projections about how would they perceive these barriers in the future. In fact, if customers think they would not perceive it as a barrier in the future, but do think it is a barrier at present, then the barrier is perceived to exist, in order to be conservative. Only when customers could not give their opinions about future barriers, are the perceptions of the present used. This was necessary in order to keep the sample size for

estimation as large as possible. In this respect, sustainability is already incorporated in the estimated effects. The market effects presented in Exhibit 7.1 indicate sustainable program effects in terms of each of the four market barriers. The choice models were used to measure the extent to which the barrier would have existed in the long run if the program were not offered. Thus, instead of estimating market effects attributable to the program, sustainable market effects attributable to the program are estimated.

However, the actions customers take outside the programs and the actions customers took in the period after January 1, 1998 do indicate whether or not sustainable demand for efficient equipment has been created. Market actors on the supply side were interviewed as a part of this project and their responses also indicate the effect on the demand for efficient equipment. Our analysis of information from these two sources is presented in this section.

7.3.1 Demand Side

In the telephone survey, questions about actions by customers since 1994 (questions 58 and 62), actions outside the program (questions 59 and 63), actions in 1998 (questions 60 and 63), and the motivations/reasons for these actions were queried. Since the questions were asked for two main technologies, the results are presented for each one of the two technologies. Exhibit 7.7 presents the number of customers who took actions since 1994.

Exhibit 7.7
Number of Customers Implementing Efficient Technologies

	Number of Customers Who Got Pumps Repaired at Their Site	Number of Customers Who Installed Micro Irrigation Systems	Number of Customers Who Installed Any One or More Energy Efficient Technology.
Actions since 1994	250	99	282
Actions Without Rebate Since 1994	178	60	205
Actions in 1998	88	59	127

It is important to note that implementation is not the only criteria that can be used to evaluate short-term or long-term market effects. Implementation is only one of the ways the market may show signs of change. Customers' perceptions in the future are more important since that guides the market. The implementation activity depends, not only on customers' perceptions of market barriers in the long run, but also on the need for repair or replacement. Respondents may not have realized such a need until they were asked these questions. From the information

presented in Exhibit 7.7, and information on customer characteristics collected via the survey, the following points deserve attention:

- Of a total of 429 respondents, 282 customers implemented one or more of the energy-efficient technologies since 1994. Of these customers, 73% customers took action without a rebate. Since the sample includes participants of the AEMS program as well, it is not appropriate to label these actions as spillover of the AEEI program alone. Overall, unless customers are convinced of the advantages, a large percentage (73%) of them would not have implemented these technologies without a rebate.
- Of all the customers who took action, 250 customers repaired their pumps and 99 installed micro irrigation systems. Since 67 customers repaired their pumps and installed micro irrigation systems, there are only 282 unique customers who took at least one of the actions. Likewise, 33 customers repaired a pump and installed a micro irrigation system without a rebate; hence, there are only 205 unique customers who took at least one of the actions since 1994. Similarly, 20 customers implemented both the technologies in 1998. Overall, the proportion of customers who implemented both technologies without a rebate is smaller than the proportion of customers who implemented both technologies with the program.
- More important is the fact that of a total of 429 respondents, 127 customers took action in the year 1998. In absolute terms, it appears that the number of customers taking action is reduced. However, it is important to note that the 282 actions since 1994 include actions over four years (1994 through 1997), assuming that customers remembered their activities for up to four years, while the actions in 1998 represent actions only in the first nine months of 1998 (i.e., until the survey date). Since the AEEI program was not offered in 1998, these actions represent what customers are likely to do when the program is withdrawn. Of a total of 429 respondents, 127 respondents took action in 1998. That represents approximately 30% of the respondents who took action, indicating the long-term effect is greater than zero. It should also be noted that the 1998 micro irrigation systems actions are an even larger proportion of all actions since 1994 than for pump repair.
- Comparing the size of the customers, 17% of customers who considered their business as small implemented energy-efficient technologies in 1998. Compared to this, 44% of those who considered their business large implemented energy-efficient technologies in 1998. This indicates that market effects are more obvious in the large customer group compared to the small customers.
- With respect to reasons for implementing energy-efficient technologies, questions were asked and analyzed by each of the two technologies. It appears that motivation for pump repairs come from necessity. Out of a total of 250 implementers of pump repair, 218 customers stated that the reason for pump repair was to fix the broken pump or to improve performance of the pump, while 7 of a total of 99 customers who implemented micro irrigation systems did so because their old system was broken. The most frequent reason stated for installing micro irrigation systems is the dealer's/consultant's recommendation and previous experience.

The differences in motivation is another reason why implementation rate alone should not be used as an index of change in the market or the market effect. In the case of pump repairs, the market cannot be changed to increase the demand since it really depends upon necessity, while the demand for micro irrigation is more elastic in the sense that customers' experience and designers' recommendations can change the market. Even if implementation rates are used, these results show positive market effects. Without any baseline or target, it is difficult to say whether or not it is large enough to indicate this is a sustainable market effect.

7.3.2 Supply Side Perceptions

As mentioned earlier, engineers experienced in the field interviewed eight pump dealers and eight irrigation system designers. The responses of the dealers and the irrigation system designers provide their perceptions about demand for energy-efficient services and the reasons/motivations for the demand.

From the designers' responses, it appears that for three of six designers, less than 10% of their customers ask for energy-efficient equipment, and for four of seven designers more than 50% of their customers ask for efficient equipment. Overall, except for two, all six designers come across customers who request energy-efficient equipment. The primary reason for customers requesting efficient equipment is the overall cost-benefit analysis. If the efficient equipment is cost-effective, then customers are likely to request it. Most of the dealers and designers think the motivation for agricultural customers to think about low-pressure sprinkler nozzles and micro drip irrigation is efficiency, including efficient use of water. This is similar to what was observed from the customers' responses.

The dealers, water districts, water utility, large farms or new businesses request energy-efficient equipment. Besides these, not many customers request efficient equipment. The primary reasons for lack of interest are that customers do not care about operating costs, customers are not large enough to bear replacement costs, or they are not sophisticated enough to realize the advantages. With respect to the motivation for getting the pumps repaired, six of eight pump dealers think customers get their pumps repaired out of necessity. This is also very similar to what was observed from the customers' telephone survey.

With respect to the supply of energy-efficiency services, four of eight designers responded that they recommend energy-efficient equipment alternatives very often. Two out of eight recommend efficient alternative somewhat often. Thus, overall, 75% of designers do recommend efficient equipment. Of the eight pump dealers, only one of them recommends it always, and three others recommend it somewhat often, leading to a total of 50% recommending the efficient alternative. This indicates that designers are more influential, and more likely to recommend energy-efficient alternatives than the pump dealers.

A comparison of customers' perceptions of market barriers and designers'/dealers' perception of market barriers indicate they are very similar.

- Suppliers and customers both perceive that information about energy-efficient technology is not very difficult to get. Customers who initiate the search usually get the information they are looking for. Similarly, both groups think that unexpected or hidden costs are of concern to a majority of customers. Regarding performance uncertainties, designers and dealers tend to think more in terms of costs/benefit and feel that long-term benefits are

hard to sell because of the accompanying high initial costs. Implementation experience has proved to be helpful in reducing these two barriers. At the same time, some designers and dealers think the benefits of experience may help to overcome hesitance on the part of customers.

- With respect to sustainability, in terms of the shift in demand, customers have demonstrated long-term effects via actions. Some dealers and designers also experience requests from customers. Though both groups show a decrease in the number of actions after the program, it is important to note that terminating programs of any kind is bound to result in decreased numbers of actions. Customers, dealers, and designers perceive the reasons for actions very similarly. The telephone survey analysis and designers' and dealers' interviews indicated that large customers are likely to be sophisticated in their technical understanding, have the money to invest, are likely to initiate the search for information, and are likely to continue to adopt efficient technologies more than small ones. This is a very important finding for future program planning.

7.4 Other Potential Market Barriers: Demand and Supply Side

The telephone survey of customers and interviews of dealers and designers helped us to understand the market better and identified other bottlenecks in the efficient technologies and practices market. This section discusses other market barriers from the point of view of customers and demand-side market actors.

7.4.1 Sources of Information

7.4.1.1 Demand Side

In the survey, all customers were asked "If an irrigation system requires an improvement at your site and you had only two options, one has low initial costs with less benefits and the other option has high initial cost with more benefits, which would you choose?"(question 30). Only 324 of a total of 429 surveyed customers responded to this question. This, in itself, indicated that the choice is not easy to make. Customers have to evaluate each situation as unique and the cost benefit analysis in each unique situation is not likely to be based on the same principles since the urgency and opportunity costs can be very different. However, within the limited time of a telephone survey, this gives an idea about why customers do not give importance to long-term benefits – a typical characteristic of energy-efficient technology. The customers responses also give us the reasons for their choice, producing a sense about what may generally discourage customers from placing importance on long-term benefits.

Of a total of 324 respondents, 103 selected the low-cost with short-term benefit option. In a hypothetical situation where all 324 respondents could have chosen energy-efficient technologies/services, 103 would not have selected energy-efficient technologies/services. Thus, there is a gap of about 32% between what could have been implemented and what customers would select to do. The more important point is to find out why these 32% would not have selected the high-cost with long-term benefit option.

7.4.1.2 Supply Side

In the telephone interviews with pump dealers and irrigation system designers, specific questions about general practices and uncertainties and finance problems were asked. These questions offered an open-ended opportunity to discuss bottlenecks in the market for energy-efficient equipment or services, to share the problems they think exist and persist in the market, and to depart from the list of market barriers the interviewers or survey instrument developers had in mind.

The sample of irrigation designers and the pump dealers that was surveyed for this evaluation, appears to be diverse in terms of size, length of time in business, and the kinds of services offered. Exhibit 7.8 presents the profile of the pump dealers.

Exhibit 7.8
Profile of Pump Dealers

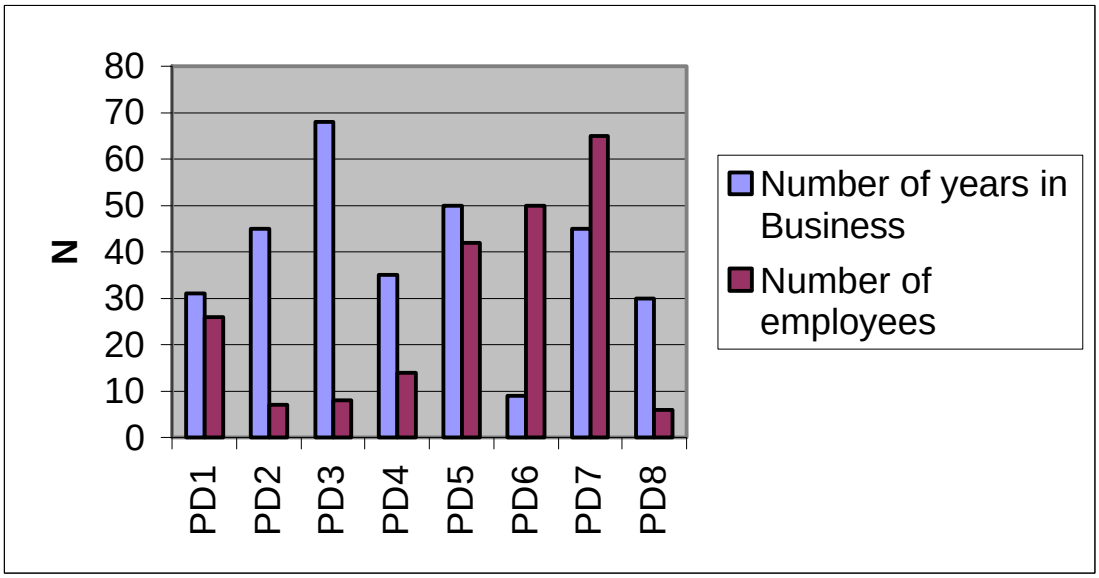
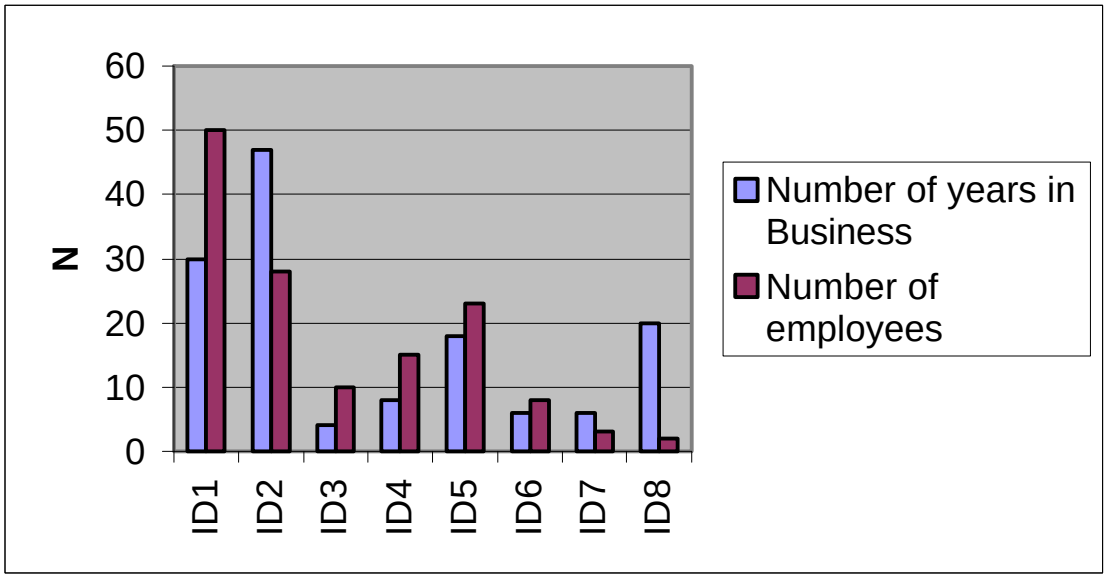


Exhibit 7.9
Profile of Irrigation System Designers.



Interviews of such a diverse sample, should cover the market fairly well. Opinions of such a diverse sample should also give us a more realistic idea about the bottlenecks that exist in the market for energy-efficient technologies and services.

In many different questions, irrigation system designers and pump dealers had an open opportunity to talk about their opinions of the bottlenecks in the market. A list that includes all the bottlenecks can be summarized as:

- Do not understand savings over time, or are not educated about costs.
- Do not believe in benefits, or have a fear of not getting what is advertised.
- Uncertainties about performance.
- Fear of facing unexpected costs.
- Have fear of change.
- Long-term payback.
- High initial costs.
- Unavailability of [high-efficiency] motors.
- No competition among suppliers.
- Percentage of electricity cost in total cost is too low to do anything about energy efficiency.

From this exhaustive list, the first four refer to the four barriers that are hypothesized in this study and analyzed. For example, the first relates to information and search cost and so on. Similar to what the analysis concluded, the irrigation system designers and pump dealers also think the programs have been effective in educating customers. However, other barriers have been experienced for a long time and the situation has remained the same or slowly changed for better.

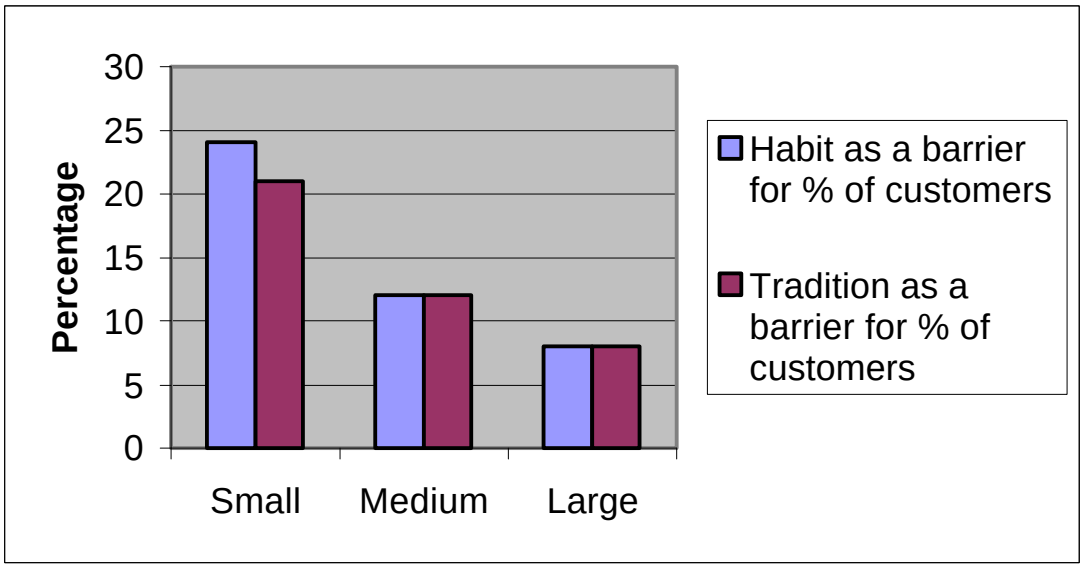
The remaining bottlenecks do not relate to any of the barriers that were analyzed. Irrigation system designers confirm our hypothesis that though these may be the barriers on which to focus future program attention, in the long run, PG&E's AEEI program could not have affected these barriers directly or indirectly. Regardless, we do recognize the need to study them; therefore, they are discussed in the following sections.

7.4.2 Bounded Rationality

It is possible that even if customers have completely overcome all other barriers, they would not willingly take the steps necessary to take actions to improve the efficiency of their operations. The behavior of an individual during the decision-making process that may seem inconsistent with the individual's goals is described as bounded rationality by Eto et al.

Customers were asked to give reasons for not selecting the higher-cost with longer-term benefits option. Two of the reasons given for not selecting this option were (1) habit of selecting a low initial cost option and (2) that is how all investment decisions are made in the organization. The number of customers with a low-cost option that selected one of these as the reason for their choice indicates whether or not it is the habit or tradition that keeps them from selecting energy-efficient options. Of a total of 103 respondents selecting the low-cost option, 56 customers said that they have a habit of selecting low initial cost option. Targeting these customers would be more effective in reducing the market barriers. Of 324 respondents, though habit affects only 17% of the customers, it affects more than 54% of those who face the barrier. Exhibit 7.10 compares the size of the customers and perceived existence of the market barrier.

Exhibit 7.10
Habit by Size



As can be seen from the graph, customers who consider themselves small compared to similar businesses, do not select a high-cost option with long-term benefits due to their habits or tradition in the organization.

Two of seven irrigation designers who responded, think that customers tend to rely on neighbors' opinions. The rest (a majority) of them think that customers base their decisions on the cost/benefit analysis. In some cases, banks encourage customers to do financial analysis. The four pump dealers who responded feel that customers base their decisions on the water application uniformity, efficiency and cost/benefit analysis, or comfort with the supplier. One of them did mention that some customers are more technically oriented than others. Overall, designers' and dealers' opinions are quite different from the customers'. This is possibly because designers and dealers talked only about their clients, or those customers who approach the dealers/designers. It was evident from the customers' telephone survey that not all customers go to dealers or designers for advice. In fact, as mentioned in the market characterization, those who are more aware, technically sophisticated, and larger in size go to experts for advice. Therefore, the designers and dealers tend to observe only that segment of customers, while the sample of customers reflects the population of agricultural customers.

With respect to specific technology, for example pump repairs, dealers confirm our finding that customers get their pumps repaired when they have to. The decision to get pumps repaired is generally based on need. Similarly, they confirm that the decision to install the micro irrigation system is based on the need for efficiency.

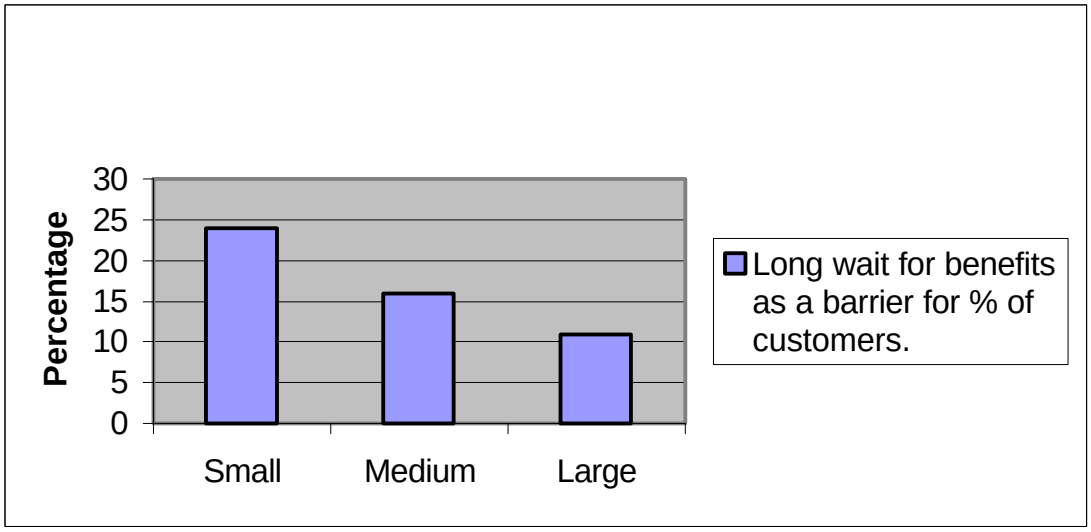
7.4.3 Long Payback

One of the reasons for not selecting the higher cost with more benefits option could also be that customers are not willing to wait for a long time to realize the benefits. The greater up-front investments with uncertain future return generally are more difficult to justify than smaller investments with shorter term returns. One of the reasons to select low-cost options

with less long-term benefits was that customers have to wait too long for the benefits. In their responses, 61 of 103 customers agreed that they tend to select low initial cost options because they have to wait too long for the benefits. This represents 59% of the customers who are not likely to select the high-cost option.

As in the barriers discussed earlier, knowing which types of customers face this barrier is an important step in understanding how to deal with it. As can be observed from Exhibit 7.11, more of small customers are likely to face this barrier. The long wait for the benefits is not the technical characteristic of the efficient technology per se. However, it does generally take a long time to recover the high initial cost with constant flow of benefits. As discussed earlier, small customers typically have problems funding investments with high initial costs. Therefore, they are the ones who are looking for quick recovery of costs in terms of benefits.

Exhibit 7.11
Long Payback for Benefits as a Barrier by Size



In actuality, this barrier is a combination of the "access to financing" and "performance uncertainty" market barriers. It is possible that by helping to finance the high initial cost for energy-efficient options, this barrier can also be reduced. Overall, designers and dealers agree that return on investment takes a long time. For them, this becomes a barrier because they find it difficult to convince the customer that the investment is justifiable.

7.4.4 Supply-Side Constraints

Only the pump dealers mentioned the problem of "product or service unavailability". It is important to note that pump dealers mainly focussed their attention on motors rather than any other energy-efficient services. They think that motor suppliers do not face any competition and, hence, the customers experience delays. This affects whether or not dealers encourage using efficient motors. Since customers wait until the pumps break down to get them repaired, they are always on a short repair timeline. Thus, any delay in availability of motors results in a standard-efficiency motor being installed.

The next section summarizes the conclusions and recommendations of this study.

8 CONCLUSION AND RECOMMENDATIONS

8.1 Conclusions

This market effects study assessed the level of market barriers in PG&E's agricultural pumping and related end-use market. It employed telephone data collection of customer perceptions, along with statistical modeling to estimate the state of four market barriers hypothesized to exist in the market and to be affected by the programs. A fifth market barrier hypothesized to exist in the market but not affected by the programs was also studied. It assessed the contribution of the 1994 –1997 AEEI programs to the existing market barrier levels, including estimates of the 90% confidence interval for the AEEI contribution. Interviews with supply-side market actors were incorporated to provide a more complete picture of the market.

8.1.1 Market Barriers

At the beginning of the study a market characterization was completed and used as a basis for hypothesizing the market barriers exist in the market and to be affected by the programs. These hypothesized market barriers are:

- Information and Search Costs
- Asymmetric Information
- Performance Uncertainty
- Hidden Costs

These barriers were hypothesized on the basis of the market characterization part of the study but before any additional data collection. Responses to customer surveys, irrigation system designer and pump dealer the telephone interviews confirmed that these are important barriers affect the market and are affected by the AEEI program.

In addition, one market barrier (access to financing) that was hypothesized to be present in the market, but which the AEEI program was not intended to affect, was assessed.

Opportunities were afforded during data collection for the market actors to identify additional barriers that affected the market for energy-efficient products and services.

The portion of the market that does not face the barrier is called the market condition—which is the inverse of the market barrier. The extent to which the existing market condition would have changed if the AEEI programs were not offered was estimated using logit models.

Exhibit 8.1 presents a graph of the market condition as perceived by PG&E customers. The following conclusions can be drawn concerning the four hypothesized market barriers:

Information and Search Costs – The information and search cost barrier only affects about one quarter (24%) of the population. Seventy-six percent of the customers surveyed responded that they do not face this barrier at present and do not think they will face it in the future. However, of the 76% who do not encounter the barrier, 36% would have

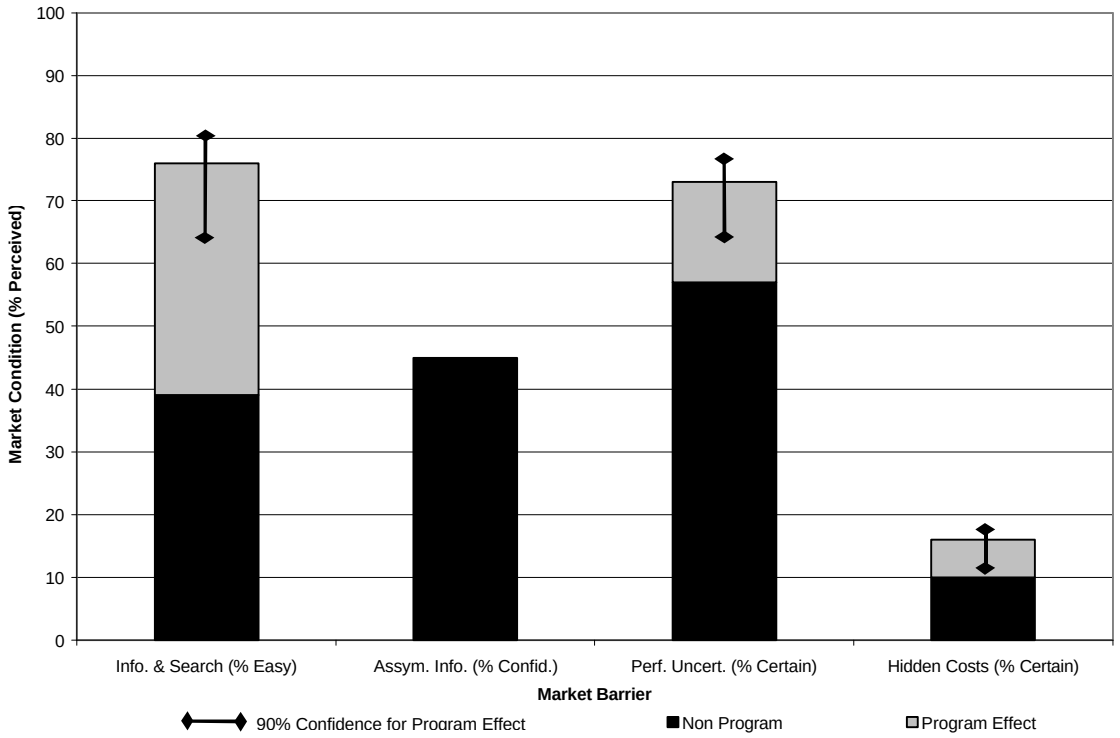
found it difficult to search for information at present or in the future if they were not exposed to the AEEI program. The remaining 40% do not face the barrier, not because they are exposed to the program but probably because they would have gotten the information anyway via vendors, magazines or other sources.

Thus, while information and search costs are a barrier in the market, only about a quarter of the customers encounter it. Were it not for the PG&E program, about 60% of the customers would view it as a barrier.

The supply-side market actors think customers face this barrier to a greater extent than the customers themselves.

Asymmetric Information – The asymmetric information market barrier is encountered by over half the customers in this market sector. Only 20% of customers responding had confidence in other agencies. Overall, 55% of customers found it very difficult to trust any agencies other than PG&E when it came to projected benefits from energy-efficiency options. All sizes of customers face this barrier. The choice models used in the study could not determine the extent to which PG&E's AEEI program induces any confidence in other agencies.

Exhibit 8.1
Market Effects Attributable to the AEEI Program



Performance Uncertainty – The performance uncertainty market barrier affects slightly over one quarter (27%) of the population. The survey indicates that 73% of customers are perceived to be certain about performance at present and will continue to be certain in the future. Of the 73% of customers who are certain, approximately 16% would not have felt

certain about performance if they did not have implementation experience through the AEEI program. The remaining 57% of customers are certain about performance due to others' implementation experience, or they would have implemented the technology outside the program.

Thus, while performance uncertainty is a barrier in the market, only about a quarter of customers encounter it. Were it not for the PG&E program, slightly over 40% of customers would view it as a barrier.

The supply-side market actors, pump dealers and irrigation system designers interviewed felt that performance uncertainty was less of a barrier than indicated by customers. This could be due to the fact that their clients also happen to be more knowledgeable technically.

Hidden Costs – Hidden costs represent the largest barriers to energy-efficiency implementation in the pumping and related end use market sector. Approximately 84% of the respondents perceived it as a market barrier. Of 16% of all customers who do not face this barrier, 6% is due to implementation as a result of the AEEI program.

Supply-side market actors' perceptions of hidden costs as a barrier are very similar in that they see it as a major concern. However, supply-side market actors' responses suggest that the unexpectedness of the costs is the driving force behind the concern.

Access to Financing – Access to financing was identified as a market barrier in the market, but was not a market barrier that the AEEI programs were intended to affect. Thus the analysis was based on response frequencies rather than on logit models. From the responses, it appears that 45 % of customers face the barrier to some extent. It appears that larger customers do not face this barrier as much as small or medium-sized customers. Assistance with financing could encourage adoption of energy-efficient technologies and practices for an estimated 26% of the population. This is important for future program planning.

Interestingly, the supply-side market actors interviewed did not perceive access to financing as a barrier. They seemed generally uninformed about the sources of financing their customers used.

Since access to financing was not one of the barriers for the AEEI program, it did not receive the same level of analysis as the other four barriers.

8.1.2 Sustainability of Market Effects

It is important to note that there are two ways in which sustainability of the effects was tested in this study. First, by estimating the extent to which sustainable market effects are attributable to the program. And second, by observing the implementation of actions that customers took outside the program and in the period after January 1, 1998, when the program stopped.

We think that implementation should not be used as the only criteria to evaluate long-term market effects. Customers' perceptions of the future are equally as important since that guides the market. The implementation activity depends not only on the customers'

perceptions of market barriers in the long run, but also on the need for equipment repair or replacement. The lack of need could be one of the reasons for changes in implementation activities and, hence, implementation activities alone are not sufficient to evaluate sustainability of effects.

Through the evaluation of sustainable market effects using the perceptions of market actors, this study demonstrates the program's capability to reduce the existence of market barriers in the future as well as the present.

The actions customers take outside the programs and the actions customers took in the period after January 1,1998 (when the program ended) were used as another indicator of sustainability. Customers have demonstrated long-term effects via actions taken outside the program, and some dealers and designers also experience requests from customers for energy-efficient products. While both demand- and supply-side market actors indicate a decrease in the number of actions since January 1, 1998, it is important to note that terminating any program of this type is bound to result in decreased numbers of actions. Thus, a sizable number of actions and the effect of the perceived existence of market barriers in the future indicate that the program did have sustainable effects. However, the current program design and implementation practices may not continue to change the market at the same rate.

8.2 Recommendations

The following recommendations evolved from this market effects analysis:

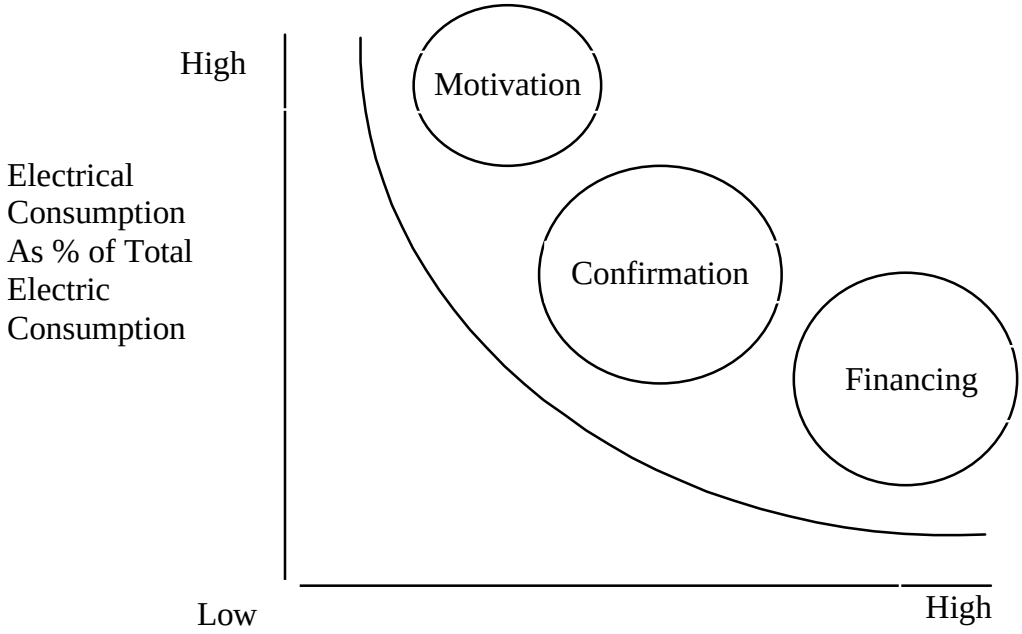
8.2.1 Program Recommendations

Historically, the AEEI program has focused on large electrical consumers to achieve the maximum savings per marketing encounter. However, if the focus of the effort is market transformation, this is not necessarily the optimum marketing strategy. If an AEEI type program is planned in the future, observations from this study can be used as a guide to program design. The data suggest that the intensity of market barriers faced by various groups of customers is different. Future programs can be designed after understanding the characteristics of different groups and the type and intensity of the market barriers they face. Exhibit 8.2 illustrates that the factors that create the gap between the desired level of adoptions and the actual level of adoptions can be very different for customers of different sizes.

- **Target the supply-side market actors.** One of the important observations is that the large customers (i.e., whose electricity consumption in proportion to total agricultural sector electricity consumption is relatively high) are usually run like a business and have the expertise to technically evaluate energy-efficiency options at their business. Sometimes these large customers' electricity costs are a very small portion of the total costs of the operation, in which case the customer may have the expertise but not the motivation to invest in energy-efficient options. However, they are likely to be in touch with pump dealers and irrigation system designers for many other operational purposes. Influencing these customers via the supply-side market actors would probably be the most effective way. Since the number of supply-side market actors is

much lower than the demand-side market actors, it takes less effort and resources to educate and convince the supply-side market actors about the advantages of energy-efficient alternatives. These market actors, in turn, can help the utility to motivate large customers.

Exhibit 8.2
Target Strategy for Future Programs



- **Target education efforts to convince medium-sized customers of the benefits of energy-efficient technologies.** The second observation is that cost benefit analysis is very important to those customers who are not very large in terms of their electricity consumption, and whose electricity costs are a large portion of their total costs. These customers are very sensitive to cost and performance uncertainties, since that can directly affect the flow of benefits. It is beneficial for the utility to invest in educational efforts for this customer segment so they feel more certain about costs and performance and feel confident about overall long-term benefits. This group may benefit from supply-side market actors, as well as direct intervention from well-designed educational efforts.
- **Consider offering a financing program targeted to small users.** The third group of customers is small in terms of electricity consumption. Since their individual ability to save significant amounts of electricity is low due to their low overall kWh consumption, they are ignored by the utility. However, if their electricity costs are a large part of their total expenditures, they may be motivated but don't have the resources to take action. This group needs help in financing their investment. Educational intervention, along with help in financing via supply-side market actors, may be a way of assisting them.

Thus, targeting the pump dealers and irrigation designers can be effective in order to reach out to all customer segments. Every customer who repairs or replaces a pump, or installs irrigation systems, goes to one of these firms. If the program can convince them that the measures are in the long-term interest of the customer, they will try to convince every customer who approaches them of the benefits. In addition, this is an access route to the many small customers the program does not easily reach, and who are most affected by the barriers identified in this market effects study.

8.2.2 Evaluation Recommendations

The evaluation team recognizes that market transformation is the complex result of many related factors. It is difficult to imagine a straightforward evaluation approach capable of assessing all such complexities. The approach used in this study is capable of dealing with many but not all of the complexities inherent in a market transformation assessment. There were two main difficulties in this evaluation. One is that, from inception, the main goal of the program was not market transformation; hence, there were not well-specified goals to be evaluated. Second, the expectation for this evaluation was quantification of the market effects. There are many factors that affect the market that are not quantifiable. The indirect relationships and interactions between the factors that affect the market make it more difficult to estimate the part that is attributable to the program.

The approach adopted in this study does not capture the overall market effects, it does not compare the attitudes, behavior and actions within PG&E's service territory with those of other service territories without any such programs. This could possibly be rectified in a larger budget program with a longer timeline, if a truly comparable comparison group could be identified.

However, it does have many other attributes that make it a unique and valuable approach. One such attribute is that choice models are powerful instruments to understand the underlying effects of customer and market characteristics on customers' attitudes, behavior and actions. The variety of different types of choice models allows us to select the right kind of choice model depending upon the data, the research question, and underlying assumptions. In the case of this evaluation, it has been demonstrated that the results of the logit and probit models do not differ so much. However, in other applications the results may differ, and the disadvantages of the probit model may have to be accepted. Another attribute of the approach is the capacity to quantify the effects. Though the quantified effects can not be used for earnings claims, if the purpose of the study is to quantify the effects, then this is by far the only broad approach that can accommodate customer responses and relate them with least harmful assumptions.

Therefore, the evaluation team believes that the approach applied in this study has applications in many other arenas.

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Appendix A – CADMAC Waiver

Appendix B - Market Characterization

Appendix C - Market Effects Telephone Survey of Customers

Appendix D - Survey Methodology and Disposition

Appendix E - Telephone Survey with Frequencies

Appendix F - Supply Side Market Actor Survey Instruments

Appendix G - Supply Side Market Actor Survey Responses

Appendix H – Data Sources and Uses Chart

Appendix I – Comparison of Modeling Results