SOUTHERN CALIFORNIA EDISON

HYDRAULIC SERVICES PROGRAM

MARKET EFFECTS STUDY

FINAL REPORT

Study ID # 3507

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Executive Summary

This study investigated the market effects associated with Southern California Edison's Hydraulic Services Program. The program provides energy efficiency information and 4,000 - 5,000 free pump tests per year to over 650 agricultural and municipal water pump end users. Over the four years from 1993 –1996, the program reached 19% of all premises in the sector, but 52% of all energy consumed. The study began with a market characterization, and proceeded to develop and test a set of hypotheses on how the program may have affected a wide-range of market barriers to the adoption of cost-effective energy efficient water pumping equipment and services. Surveys of almost 200 relevant market actors — customers, dealers, contractors, distributors and manufacturers, as well as consultants, lenders, regulators, utility personnel and academics — were completed. Customer samples were drawn using stratified random sampling techniques, which enabled weighting to correct for any differences in respondent scale. Other market player samples targeted all major players active in either market. Responses of market players from Edison's service area were compared to those of a comparison area (Arizona) where no such water pump assistance program is offered. The dealer and consultant surveys collected a limited amount of proximate sales data to estimate the market shares of energy efficient equipment in the two areas. A program tracking system assessment developed participation counts and program penetration estimates, and documented motor and overall pump efficiency trends over the past seven years. The study also included an extensive review of secondary sources including former Edison market research, and past market and field pump testing studies done by others. Past Edison impact evaluation surveys (1992 and 1996) of agricultural and water supply customers provided additional data on non-participant and third-party pump testing trends. Edison's approach was designed to leverage these existing secondary sources rather than perform extensive new customer surveys.

This study sought to obtain both qualitative and quantitative information on changes and differences occurring: (1) over time, (2) over space (between Edison's service area and Arizona), and (3) at different levels of the supply and demand chains.

For each of the various types of market players and levels of market activity, the study examined:

- The existence of *"market changes,"* in terms of knowledge, attitudes and behavior regarding energy efficiency in the Edison service area (compared to elsewhere);
- The role of Edison's program in causing *"market effects,"* i.e., its apparent role in causing some of those observed changes in its service area; and
- Persistence of these market effects in the marketplace (as evidence of *"market transformation*" through lasting reduction in pre-existing "*market barriers"* to energy efficiency in the water pumping market).

The research design for this study reflects the fact that the Hydraulic Services Program was not explicitly designed to cause or otherwise affect *"market transformation."* If the program had been designed to achieve market transformation, then the analysis could have focused on assessing the extent to which the program succeeded in reducing or eliminating certain pre-existing structural market barriers. However, since that was not the intent of the program design, there are no specific market barriers to which it was explicitly addressed. Instead, the analysis presented in this report is aimed more broadly at examining the extent to which there are market differences and barriers occurring at various levels of the supply and

demand chains, and program effects on them. This analysis allows us to assess how well the program might serve as a vehicle for future market transformation initiatives.

MAJOR FINDINGS

- For program participants over the past seven years, **overall plant efficiency** has increased at a greater rate than motor efficiency. Motor improvements alone were found to be responsible for less than half of the increase in overall system efficiencies. This contradicts popular assumptions held by dealers and others that high efficiency motors are the primary drivers of increasing efficiency in the water pumping end use. For both rebate and pump-test only sites, the majority of the improvement in overall pumping plant efficiency occurs in the residual category of all other efficiency improvements to the pumping system. In particular, sites receiving an Edison rebate owe only a small share of their overall plant improvements to higher efficiency motors. Sites receiving pump tests alone can credit a greater share of their overall plant improvements to higher efficiency motors, but still less than half.

- **Agricultural** and **water supply** end users exhibit significantly different characteristics. Water supply customers typically operate high flow capacity pumps, maintain on-staff design engineering and maintenance expertise, hire professional consultants to design new facilities, and have highly organized and functionally specific financial, administrative, and technical decision-making procedures. Agricultural customers on the other hand typically operate a wide range of smaller volume pumps, rely on contractors for hydraulic engineering expertise and may experience managerial and financial constraints which inhibit their abilities to formally consider and invest in energy efficiency improvements. More than their water agency counterparts, some agricultural customers tend to be 'least first cost' oriented. These differences result in the operation of two distinct albeit overlapping market channels supplying the pumping equipment needs of these two general types of customers.

- For **customers**, the major market barriers to achieving cost-effective energy efficient pumping systems were found to be informational (imperfect information) and behavioral (uneconomic decision-making). The program substantially addresses both of these types of barriers. Program recipients stated that its primary benefit was the reduced time and cost of collecting information. Other benefits were reducing uncertainty when making new purchases, reducing the hassle of performing tests and helping customers to deal more effectively with contractors and dealers. Of the participating water supply customers, 62% "always or usually" practice predictive maintenance (efficiency record-keeping) and 49% practice volume validation (for adjudication filings), as compared with corresponding rates of only 15% and 7% for their counterparts in Arizona. In the agricultural submarket, 28% of Edison program participants have adopted each of the practices, compared to none of their counterparts in Arizona.

- 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 providers in California, and (2) a significantly greater frequency of pump testing among California-area non-participants as compared with water pump users in Arizona. Most of this growth in private pump testing in Edison's area

appears to have occurred in the last five years as Edison has taken steps to increase the cost-effectiveness of its program. In the early 1990's, Edison was by far the primary provider of pump testing services in its service territory, commanding a market share of 95% or more. Private vendors were responsible for only a minor proportion (17 %) of the few tests provided by others. Considering only the small sample of 16 pump test program non-participants surveyed in 1992, only three (1% weighted) reported having a pump test in the previous four years. By 1996, an estimated 60% of customers who had not received an Edison test in at least four years reported they had their pumps tested by a non-Edison source. Even if this estimate is high (as explained below), the pattern of non-Edison pump testing appears to have changed. Of these Edison-area "non-participants" who received testing, 70% reported using an outside vendor or contractor for this service. By comparison, the present study found only 17% of Arizona-area "non-participants" reported having their pumps tested (31% of water supply customers; 7% of agricultural customers). Only 9% of program participants report receiving pump tests from an alternate service provider (19% of water supply customers; 2% of agricultural customers). The mean number of annual tests provided by these other test services was 13.7 among participating Edison customers and only 2.6 among Arizona customers. Dealers agreed that Edison's pump test program has led to more informed customers who are better able to continue to monitor their pump system operations, detect performance problems and act to address them through repair and/or replacement. The comparison with Arizona dealers confirmed that the testing and preventative maintenance which are now common in Southern California rarely take place when there is no comparable service offered by the utilities there. These findings are consistent with the argument that the program has in fact substantially increased the information available to Edison area customers, as well as increased their demand for test information, without substantially supplanting other privately-available services.

- Among **dealer/contractors** and **consulting engineers**, informational barriers were found to occur when dealers make pump specifying and installation decisions based on imperfect information, which testing would alleviate. Behavioral barriers occur where dealers do not test pumps even though it would periodically lead to replacement sales (in this case a habit of not testing pumps would constitute uneconomic behavior on the part of the dealer). The program was found to have an effect on both of these types of barriers. Most of the dealers who concentrate on the water supply and agricultural markets in California described recommending pump tests or using the data themselves as part of their regular business practices. Un-weighted dealer estimates suggest that "super high" efficiency market shares are higher in California than in Arizona, as shown in Exhibit 1.[1] Without a means to estimate aggregate market volume in the two areas and market share by dealers in each, properly adjusted weights are not possible. Therefore these proximate sales data are presented with the caveat that they are based on small samples and should not be interpreted outside the context of this study. Nevertheless they do support the qualitative comments made by dealers and customers. These data also suggest that manufacturer comments that high efficiency market shares between the two areas do not significantly differ may be short-sighted.

[1] In the delivery of the question, "Super High" efficiency was defined to dealers as "State-of-the-art, optimized in all components". "High efficiency was defined as "High efficiency motors only").

Exhibit 1: Dealer Estimates of High Efficiency Market Share — Combined Market

All Markets (All Pumps) — Dealer Estimates of Efficiency										
		% Super High Efficiency			% High Efficiency			% Standard Efficiency		
State	n	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
CA	13	0%	100%	38%	0%	60%	25%	0%	100%	37%
AZ	4	0%	40%	8%	3%	50%	62%	10%	97%	30%

- In addition the possibility of **structural market barriers** was investigated at the level of dealers and consultants. No significant barriers to new market entrants or competition between these actors was found. In fact the level of competition within the industry was often described as intense. Product unavailability was also not considered a significant market barrier by market actors at this level. There were some minor references to limited stocking of higher efficiency pump equipment, but these comments were isolated and not broadly confirmed by all dealers. To the extent to which this barrier is occurring it appears to affect only lower HP pumps, smaller agricultural end-users and emergency replacements. Given the proximity of Edison-area end-users to major manufacturing or regional warehousing facilities, and the long lead times associated with most pumping plant purchases, no significant product availability market barriers were found to exist.

- However, dealers also confirmed that pump purchase decisions are still largely driven by considerations of purchase price, as most farmers and water agencies are under pressures (both perceived and real) to minimize **short-term costs**. The contractors serving the agricultural submarket and consultants serving the water supply submarket generally reported that they necessarily respond to their clients' preferences, even if the client is under-informed. This sometimes precludes them from attempting to justify the cost-effective expenditure of more money for higher efficiency equipment. Many contractors and consultants have adopted standard practices that do not specify the option of higher cost equipment unless they hear a client request it. Again, these findings suggests that the program's effect has been strongest in terms of customer information and maintenance practices affecting the nature of customer-dealer relations. Product sales pattern effects or dealer practices effects follow secondarily from the informational and behavioral effects the program has on customers.

- At the levels of **manufacturers** and **distributors**, no major market barriers to achieving cost-effective energy efficient pumping systems were identified. The behavioral, structural, and product feature-related barriers hypothesized to be occurring at these levels were not substantiated by the data collected for this study. Nevertheless the program did have some indirect influences on these kinds of actors. This was primarily through the indirect route of changing the information available to customers and their operations and maintenance behavior.

- **Lenders** were hypothesized to possibly be creating a barrier to energy efficient pumping systems by refusing to make loans that if pump test data were available, they otherwise would make. Such a market effect was not documented by this study. Instead the way in which lenders use pump test data appears to have little if any impact on the pricing-related or behavioral barriers presented by lenders. Pump efficiency is a moot issue for real estate lenders because pumps can be dismantled and moved. Instead, loan officers focus on stationary fixtures such as wells. The primary criteria for agricultural lenders in making a loan is a farmer's operating credit worthiness. Indirectly, energy use as well as water costs are components of a borrower's credit, in that they contribute to the ability to

repay an obligation. However none of the lenders interviewed reported considering specific equipment payback issues in making what are often bundled farm improvement loans.

- The survey of **regulatory agencies** in California and Arizona revealed that the California agencies do indirectly benefit from Edison's pump test program, as they utilize pump test data as part of the broader databases used for validating water allotments (in adjudicated basins) and for hydrological modeling done to assess aquifer properties. The market effect identified here is that the program has created a demand for pump test data that would likely persist even if the program were to end.

- Because the program was aimed at directly affecting the attitudes and behavior of customers rather than actors higher up in the distribution chain (manufacturers, distributors and dealers), it is difficult to confirm whether or not the effects would **persist** without the program. The nature of the changes in customer attitudes toward testing or preventive maintenance practices makes it likely that many of the existing customers have been lastingly influenced by the program. This is especially true in their elevated demand for pump testing *vis-à-vis* Arizona, an effect which appears to be largely program-driven. However were the program no longer available, new customers moving into the area would not find their informational and behavioral barriers substantially reduced. Over time, as with any informational program, the continued entry of new customers could thus diminish the program effect. This process is less of an issue where customer organizations have institutionalized these practices. Where this has occurred, it increases the likelihood that these effects will persist through time, even as the specific individuals effected by the program may no longer occupy their positions.

- As a result, only a portion of these program effects can be considered to constitute **market transformation**. The data available indicates:

  – 60% of Edison-area non-participants report pump testing through non-Edison sources,
  – 51% of existing pump test participants report they would continue testing without Edison support,
  – Dealers estimate that approximately 50% of customers would continue testing if Edison support were discontinued, resulting in roughly a 50% drop in the overall number of tests performed, and
  – 17% of Arizona customers (weighted to be of comparable scale to Edison's high consumption program participants) report pump testing without any utility assistance.

  This range of estimates suggests that the "naturally-occurring" or "market-sustainable" level of pump testing in Edison's area may be as low as the 17% of customers determined in Arizona, or as high as 58% of all premises (if the Edison-area non-participant estimate is to be believed). Assuming that the average energy intensity (MWh/premise) of the tested pumps was to remain the same (a conservative assumption) this high estimate of persistent pump testing would equal 55% of the total 2,660 GWh consumed in the segment.

  However this 60% estimate should be considered high since it is based on a very small sample. This rate of private pump testing cannot be supported by the qualitative data collected from dealers and others on the size of the private pump testing market. Instead, if we assume half the rate of Edison area non-participant testing (i.e.30% instead of 60%) a more moderate estimate of persistent testing would result: 34% of premises and 40% of energy.

This suggests that roughly a third of pumping premises would continue to be tested in the absence of the program, accounting for approximately 40% of the energy consumed by the segment. Even so, this estimate is probably still optimistic in the long run. Dealers hastened to point out that even among those convinced of the benefits of pump testing, the persistence of their efforts would not be 100%. Without some periodic reminders of the benefits of pump testing and predictive maintenance, attention to these rational and cost-effective practices will still continue to diminish over time.

RECOMMENDATIONS:

Edison and others interested in pursuing future broad-based public policy goals to improve energy efficiency in the pumping end use should explore opportunities for combining efforts to exploit the program's inherent strengths as a vehicle for best practices and new technology transfer to customers and dealers. Other potential program partners include governmental entities (California Board for Energy Efficiency, California Energy Commission, Department of Water Resources, etc.), end user and professional trade associations (Association of California Water Agencies, Hydraulics Institute, etc.), other utilities (PG&E, SDG&E, Southern California Gas, etc.) and/or non-profit advocacy organizations. Planning for any such joint or publicly supported efforts should consider the following specific recommendations:

- Expand the program to coordinate with other existing pump testing programs to enable consistent statewide implementation and record keeping and to maximize administrative efficiencies.
- Support current primary stage national efforts (e.g., US DOE Motor Challenge Program, Consortium for Energy Efficiency, etc.). These include: 1) establishing standards for labeling pumping components "high efficiency", 2) developing design assistance tools to facilitate the side-by-side comparison of the energy-related costs and benefits of competing pump models, and 3) to collect data from manufacturers and distributors on the regional market penetration of high efficiency equipment.
- Design new intervention approaches specifically intended to mitigate the remaining market barriers identified in this study. Key among these are 'access to credit' barriers in agriculture and the competitive bidding practice barriers which occur in municipal water supply.
- Develop a market effects measurement and evaluation plan specifying in advance which market barriers will be targeted. Such a plan would also identify how to measure both the "ultimate" indicators of barrier changes as well as the "proximate" (or "leading") indicators of program influences, needed to attribute causality to the program. A subsequent study should include a sufficiently large sample of program non-participants to establish pump testing among this group and other attitudinal and behavioral practices data at the statistical confidence level of 90% (+/- 10%).

1. INTRODUCTION

DSM professionals have begun to focus on the challenges of evaluating the market effects of energy efficiency programs, distinct from narrowly defined participant impacts. As part of this ongoing research effort, Southern California Edison's (Edison) has performed this study of the "market effects" associated with Edison's Hydraulic Services Program. Edison believes that this long-established service provided to its agricultural and water supply customers has produced and maintained lasting changes in the attitudes, behavior and knowledge of various market actors in the water pumping sector.

This report documents the findings of the study. The program provides free information and pump testing services regarding agricultural and municipal water pumps. The introduction which follows summarizes the study objectives, program features and analysis approach. This, together with the summary of findings in Chapter 2, provides a concise presentation of the study. The remainder of the report provides more detailed descriptions of the approach, analysis and findings.

1.1 OBJECTIVES

1.1.1 Study Overview

The focus of this study was on developing a broad understanding of the effects of the program on "markets" for energy efficient water pumping equipment and services. We define "markets" in terms of various levels of "product supply and demand chains" – i.e., the processes of ordering, manufacturing, stocking, purchasing and replacement of water pumping equipment and services. This includes the behaviors of all relevant "market players" – customers, dealers, contractors, distributors and manufacturers, as well as consultants, lenders and regulators — as related to energy efficient equipment. In order to accurately assess the program's effects, the study utilized surveys and interviews covering all of these various types of market players operating at all of the various levels of supply and demand chains. Responses of market players from the Southern California area were compared to those of a comparison area where no such water pump assistance program is offered.

This study sought to obtain both qualitative and quantitative information on changes and differences occurring: (1) over time, (2) over space (between Edison's service area and other areas that lack such a program), and (3) at different levels of the supply and demand chains.

For each of the various types of market players and levels of market activity, the study examined:

- The existence of *"market changes,"* in terms of knowledge, attitudes and behavior regarding energy efficiency in the Edison service area (compared to elsewhere);

- The role of Edison's program in causing *"market effects,"* i.e., its apparent role in causing some of those observed changes in its service area; and

- Persistence of these market effects in the marketplace (as evidence of "*market transformation*" through lasting reduction in pre-existing "*market barriers*" to energy efficiency in the water pumping market).

Exhibit 1-1 provides more detailed definitions of these italicized and other related terms.

Exhibit 1-1. Definitions of Key Terms

Market Condition – a *characteristic of the market* for an energy related product, service or practice, including its availability, features, prices, marketing, sales channels, financing and knowledge and attitudes towards it.

Market Change – *a change* in any of the characteristics of the market for an energy related product, service or practice, including any change in terms of knowledge, attitude or behavior.

Market Barrier – a characteristic of the market for an energy related product, service or practice that *helps to explain the gap between the actual level of investment in (or practice of) energy efficiency and an increased level that would appear to be cost beneficial.* A barrier can be a factor affecting information and knowledge, pricing, organizational behavioral, structural production / distribution processes, and/or consumer behavior.

Market Intervention -- a *deliberate effort by an entity (e.g., government, utilities, etc.) to reduce market barriers* and thereby change the level of investment in (or practice of) energy efficiency.

Market Effect – a *change in the structure of a market or the behavior of participants* in a market that is reflective of an change in the adoption of some energy efficient products, services or practices and is causally related to market intervention(s).

Market Transformation – a *lasting reduction in market barriers* resulting from a market intervention, as evidenced by a set of market effects that persists after the intervention has been withdrawn, reduced or changed.

Note: For further explanations of these terms, see Eto, Prahl and Schlegel: "A Scoping Study on Energy-Efficiency Market Transformation by California Utility DSM Programs," July 1996.

It is important to note that the Hydraulic Services Program was originally designed as a marketing and customer assistance program, and later also recognized as an information program to help promote energy efficiency for the water pump market. It was not designed to permanently "transform" markets for energy efficient products. Nonetheless, there is some interest in finding out whether it has had market transformation impacts. There is also an equal or greater interest in assessing the program's suitability to serve as a "vehicle" for future market interventions, more directly oriented toward the goal of market transformation.

Accordingly, this study and its report are organized to address interest in two different questions:

(a) In the general sense…What value has the program had in affecting the actions of market players operating at various levels of the supply and demand chains?

(b) In the specific sense…What impact has the program had towards achievement of lasting *market transformation*?

1.1.2 Specific Objectives

The specific project objectives follow directly from the research paradigm detailed in the CADMAC (California DSM Advisory Committee) Market Transformation Scoping Study. The list of primary objectives for the project were to:

1. Develop a set of hypotheses concerning the range of market effects which may have resulted from the Hydraulic Services Program (including but not limited to those effects most likely to be "lasting" or "transformative" effects).

2. Test these hypotheses using conventional empirical methods employed in the social sciences (supporting results with statistical precision or defensible qualitative arguments in support of the veracity of the results).

3. Summarize the program's effectiveness towards achieving sustained effects on pump market organizations and processes and/or lasting changes in the attitudes and behaviors of specific pump market actors, related to the identified market barriers.

4. Summarize the program's effectiveness toward achieving substantial, lasting reduction or elimination of specific market barriers.

5. Develop recommendations toward the optimizing the Hydraulic Services Program's future market impacts.

The approach used for this study reflects the fact that the Hydraulic Services Program was not explicitly designed to cause or otherwise affect "*market transformation.*" If the program had been designed to achieve market transformation, then the analysis could have focused on assessing the extent to which the program succeeded in reducing or eliminating certain pre-existing structural market barriers. However, since that was not the intent of the program design, there are no specific market barriers to which it was explicitly addressed. Instead, the analysis presented in this report is aimed more broadly at examining the extent to which there are market differences and barriers occurring at various levels of the supply and demand chains, and program effects on them. This analysis allows us to assess how well the program might serve as a vehicle for future market transformation initiatives.

It is also important to note that Southern California Edison has had its Hydraulic Services Program in operation for over 80 years. Any market effects the program has caused have occurred over this long-

term. Accordingly, changes in sales and stocking patterns in recent years cannot be attributed to the advent of the program. Instead, emphasis has to be given to identifying differences compared to a Control Area (in another state) where no such program has been offered.

1.2 PROGRAM FEATURES

1.2.1 Program Overview

Southern California Edison's Hydraulic Services (Pump Test) Program has been in existence since 1911, making it one of the nation's oldest energy efficiency programs. The program provides municipalities, agricultural, and other water pumping customers with a pump efficiency test that determines overall system efficiency, electrical motor performance, pump hydraulics and water well characteristics. The pump test compares the relationship between energy consumed (in terms of kWh) and water flow (in terms of gallons per minute) at a given pumping head (in terms of feet). The result is a computerized report containing the estimate of overall efficiency of the pumping plant, which includes the motor, pump assembly and applicable distribution system. If a replacement or upgrading of equipment is warranted, then the customer is issued a cost analysis letter, which includes estimates of capital and operating cost impacts for a new system. Issues which may affect tested efficiency are addressed, including motor efficiency, variable speed drives, piping system friction loss, excess pumping pressure, reservoir storage and energy management. If after assessing overall plant efficiency, no change in equipment is warranted, then the customer gets a "congratulatory" letter.

The program is delivered on demand – i.e., customers request a pump test from Edison. There is no effort to recruit participants for pump testing. In order to more accurately identify potential sources of inefficient operation, enhanced diagnostic services are also provided to the customer when warranted. These include meg-Ohm testing, vibration detection, and infrared panel inspections. Collectively these tests provide an indication as to what specifically is contributing to plant inefficiency, and when shared with a pumping contractor, can help determine an appropriate course of action. In this sense the program functions as an information program, delivering information to customers to promote the implementation of energy efficiency. Unlike a traditional audit program, the hydraulic services program is built around ongoing customer requests for site specific information. The unique and ongoing relationship between Edison's pump testers and their customers helps to position the program as an ideal vehicle for future market interventions to this significant community of energy users.

In recent years, Edison has taken steps to improve the cost-effectiveness of the program by limiting the testing of smaller (<25 HP pumps) and recommending tests for some plants on a two-year cycle (as opposed to annually). The enhanced diagnostic services were made available in 1997. These changes are believed to have led to higher satisfaction among program participants and greater program cost-effectiveness. This report also suggests there may be some evidence that these changes are indirectly encouraging the development of an independent market for pump test services.

1.2.2 Target Population

Under the Hydraulic Services Program, Southern California Edison's Pump Test Specialists perform 4,000 - 5,000 free tests per year. The program has national stature, and Edison joins Pacific Gas and Electric Co. as a world leader in annual volume of tests.

The tests are focused on two broad categories of customers:

(1) Agricultural (irrigation) customers – primarily growers, poultry, stock or dairy operators, plus a few golf courses; irrigation districts also serve some groups of agricultural customers.

(2) Water Supply customers – including municipal agencies and private water companies.

In 1996, the program tested pumps belonging to some 294 Agricultural customers and 296 water supply customers. Most of the agricultural customers participating in the program are concentrated in northern parts of the service area, while water supply customers are concentrated in the southern "metro" area. Golf Courses and other types of customers – including wastewater, industrial, and commercial customer types –have also participated in the program, but do so in comparably insignificant numbers. Due to the limited manpower available to meet a high level of demand for testing, the program has in recent years focused predominantly on larger customers (who tend to have more pumps and larger horsepower pumps).

A detailed analysis of program participation is contained at the end of this section.

1.2.3 Target Pump Types

The program focuses on the most commonly used types of water pumps used for agricultural crop irrigation and municipal water service. These are:

- The ***horizontal centrifugal pump*** -- a single-stage impeller unit mounted on a horizontal axis. It is used in applications requiring large water flow at low pressure, such as irrigation.

- The ***deep well turbine*** -- a vertical centrifugal pump mounted at the bottom of a well, provides higher pressure flow from deep wells. A line shaft separates the (top) motor from the (bottom) bowl assembly, which contains one or more impellers and bowls.

- The ***submersible pump*** -- less common; used instead of deep well turbine where above ground space is at a premium or straight line access to the water source is not possible. Like the deep well turbine, it provides higher pressure flow.

In general, the water supply customers operate a wide range of pumps including very large, high flow capacity pumps. Agricultural customers typically operate smaller volume pumps. Exceptions to these basic types occur. For both types of customers, many of the pumps can be powered by an electric motor or by a diesel or natural gas-driven engine. The choice of fuels is determined largely by local site availability as well as air quality regulations. Southern California Edison's program provides services only for electric motor driven pumps.

1.2.4 Linkage to Other Programs and Services

Complementing the Hydraulic Services Program, Edison now offers additional pump inspection services designed to further help customers reduce energy costs, extend equipment life, and improve system operation. This package of Enhanced Services includes ***Motor and Pump Vibration Detection***, ***Meg-Ohm Testing*** of motor windings and ***Infrared Panel Inspections and Cleaning***. These service are offered to customers on a fee-for-service basis.

Edison also currently operates the Agricultural Technology Application Center in Tulare. ***AgTAC*** offers workshops, seminars, displays and demonstrations designed specifically to help agricultural customers use electricity more efficiently. Edison's ***CTAC*** facility in Irwindale offers similar services to a wider range of customers, including those with pumping end uses. Edison also operates the ***Clean Power Program*** offering incentives to customers to install or reactivate electric motors.

1.2.5 Program Participation Assessment

A detailed participation assessment was performed in order to develop a more comprehensive understanding the types of customers and equipment the pump test program serves. A more comprehensive report of the findings of this assessment is presented in Appendix D. This analysis was based on an extract of the pump test tracking system, delivered to RLW Analytics in May of 1997. This file contained over 28,000 records of individual pump tests performed between January 10, 1990 and April 9, 1997. Exhibit 1-2 provides a summary of the number of pump tests performed and customers served for each of these years.[2] Exhibit 1-3 allocates the tests according to the SIC code describing the customer's site. Exhibit 1-4 shows the trends of tests and customers served for years for which complete data is available.

Exhibit 1-2: Tests Performed and Customers Served, 1990-1997

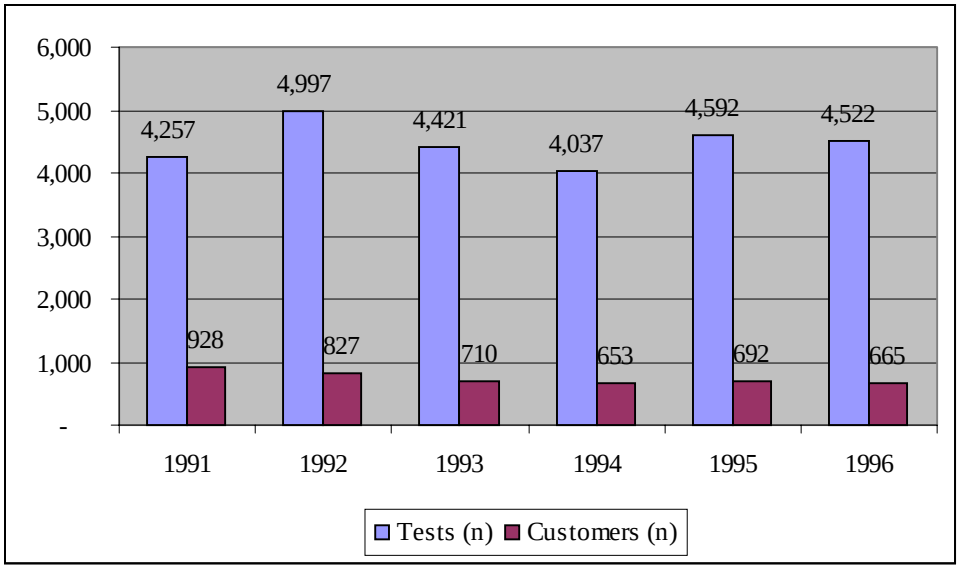
	1990	1991	1992	1993	1994	1995	1996	1997	Total
Tests (n)	470	4,257	4,997	4,421	4,037	4,592	4,522	845	28,141
Customers (n)	118	928	827	710	653	692	665	169	—
Tests/Customer	NA	6.0	6.2	6.2	6.2	6.6	6.8	NA	—

[2] The counts of customers served are based upon the database variable "Top" customer number. This variable identifies the "corporate" or "parent" customer, i.e. an aggregation of all subsidiaries and multiple site facilities.

Exhibit 1-3: Tests Performed by Customer Type, 1990-1997

Edison Test Population: Number Tests/Year, by Customer Type						
Test Year	Agricultural	Golf	Other	Sewage	Water	Total
1990	179	14	63	5	209	470
1991	1,911	82	603	47	1,614	4,257
1992	2,129	96	643	66	2,063	4,997
1993	1,865	107	551	59	1,839	4,421
1994	1,570	108	514	47	1,798	4,037
1995	1,774	94	612	49	2,063	4,592
1996	1,652	116	582	63	2,109	4,522
1997	272	26	107	18	422	845
Total	11,352	643	3,675	354	12,117	28,141

Exhibit 1-4: Test and Customer Trends 1991-1996



Exhibits 1-5 and 1-6 below demonstrate motor and overall plant efficiency trends by customer types. Trend lines have been added to each graph to summarize the trend for each variable. Of particular interest is the observation that overall plant efficiencies are increasing at a greater rate than motor efficiency.

Exhibit 1-5: Motor Efficiency Trends, by Customer Type

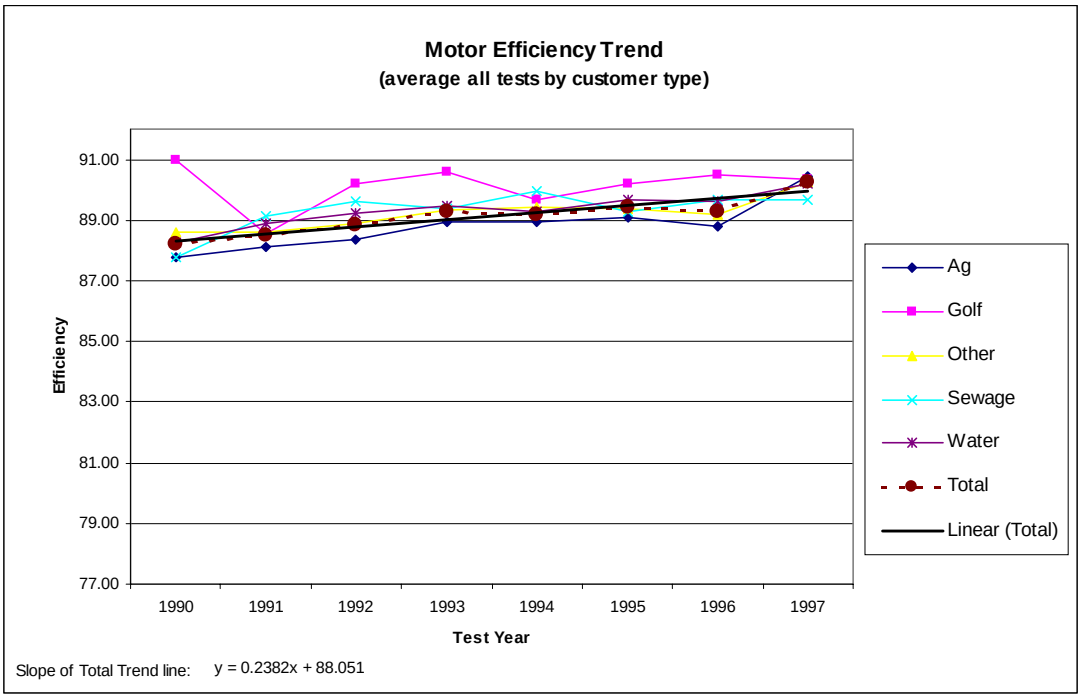
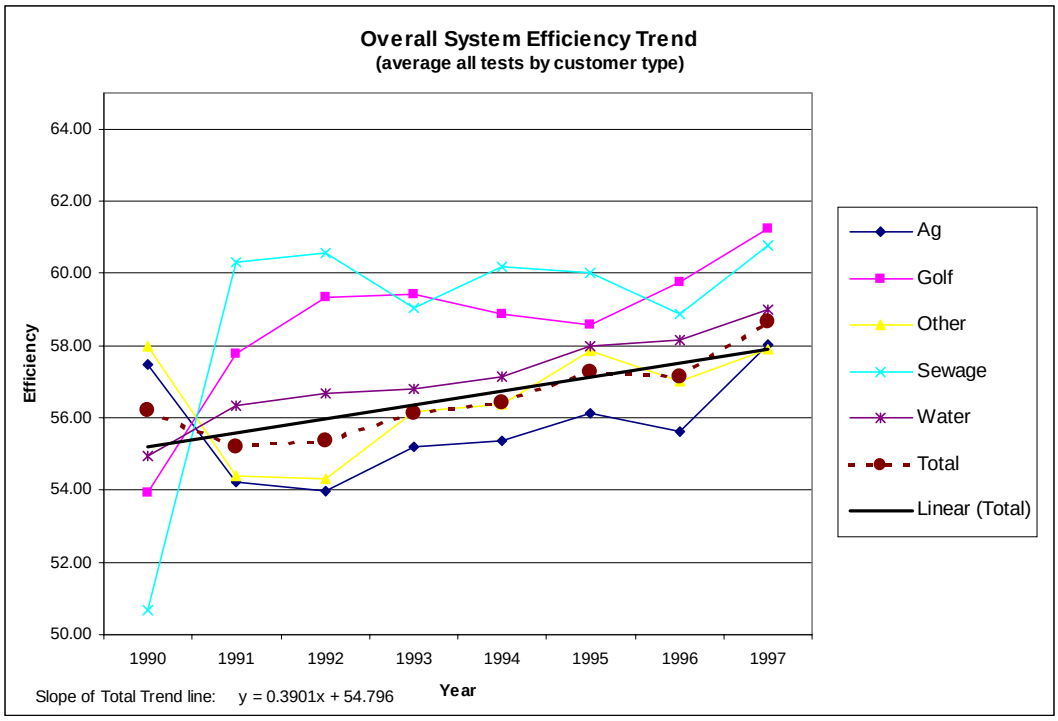


Exhibit 1-6: Overall Plant Efficiency Trends, by Customer Type



Simple regression equations were developed to further describe the motor efficiency and overall plant efficiency (OPE) trends for each of the customer types. This analysis included some additional data cleaning,[3] that resulted in some minor changes to the 1990 average overall plant efficiencies reported above. These results are reported in Exhibits 1-7 and 1-8. Given the variance of the small samples of golf and sewer tests, the OPE trends identified for both groups and the motor efficiency trend for sewage pumps are not considered statistically significant. Regression outputs are provided in Appendix H.

Exhibit 1-7: Motor Efficiency Trends, All Sites Tested

Motor Efficiency Yearly Increase Trend — All Sites Tested							
	Obsv.	1990	%/Yr. Coeff.	Std.Er	Lower 90%	Upper 90%	Intercept
Ag	11,055	88.0%	0.200	0.021	0.165	0.235	-310.209
Golf	634	89.5%	0.162	0.082	0.027	0.296	-232.165
Other	3,591	88.6%	0.151	0.038	0.088	0.214	-211.562
Sewage	344	89.2%	0.077	0.110	-0.105	0.259	-64.749
Water	11,924	88.8%	0.158	0.020	0.125	0.191	-225.119
All	27,548	88.5%	0.183	0.013	0.161	0.205	-275.044

[3] Removal of all observations with efficiency values < 1.0%, or > 100%, or in "1999"; missing values were excluded from this and prior analyses as well.

Exhibit 1-8: Overall Plant Efficiency Trends, All Sites Tested

Overall Plant Efficiency Yearly Increase Trend — All Sites Tested							
	Obsv.	1990	%/Yr. Coeff.	Std.Er	Lower 90%	Upper 90%	Intercept
Ag	10,422	53.6%	0.436	0.071	0.319	0.554	-814.440
Golf	602	57.7%	0.355	0.279	-0.104	0.814	-647.913
Other	3,399	53.8%	0.630	0.124	0.427	0.834	-1200.859
Sewage	317	59.9%	-0.047	0.372	-0.660	0.566	153.052
Water	11,315	55.8%	0.415	0.066	0.306	0.524	-769.981
All	26,055	54.6%	0.476	0.044	0.403	0.549	-893.167

In order to understand how these trends have been affected by Edison's rebate programs, the pump test data was split into two sets:

- Test program participants who also received a rebate during 1993, 1994, or 1996[4] (11.5%)
- Test program participants who did not receive a rebate in those years (88.5%).

Exhibits 1-9 through 1-12 report the results of additional analyses run separately for each of these customer groups. Motor efficiency trends are reported first, followed by the overall plant efficiency trends. Comparisons are drawn in Exhibits 1-13 – 1-17.

Exhibit 1-9: Motor Efficiency Trends, Pump-Test Only Sites

Motor Efficiency Yearly Increase Trend — Pump Test Only Sites							
	Obsv.	1990	%/Yr. Coeff.	Std.Er	Lower 90%	Upper 90%	Intercept
Ag	9,872	87.9%	0.182	0.023	0.145	0.220	-274.540
Golf	547	89.1%	0.230	0.091	0.080	0.380	-368.852
Other	3,264	88.5%	0.144	0.041	0.077	0.211	-197.956
Sewage	311	89.1%	0.078	0.121	-0.121	0.277	-66.083
Water	10,373	88.6%	0.152	0.022	0.116	0.188	-213.843
All	24,367	88.3%	0.175	0.014	0.151	0.199	-259.748

Exhibit 1-10: Motor Efficiency Trends, Rebate Sites

Motor Efficiency Yearly Increase Trend — Rebate Sites							
	Obsv.	1990	%/Yr. Coeff.	Std.Er	Lower 90%	Upper 90%	Intercept
Ag	1,183	89.0%	0.330	0.056	0.238	0.422	-567.890
Golf	87	91.2%	-0.161	0.164	-0.433	0.111	411.297
Other	326	89.5%	0.275	0.093	0.122	0.428	-458.468
Sewage	33	90.0%	0.108	0.121	-0.097	0.314	-125.125
Water	1,550	89.7%	0.246	0.044	0.174	0.318	-400.053
All	3,179	89.5%	0.262	0.032	0.210	0.314	-431.711

[4] No rebates were offered in 1995.

Exhibit 1-11: Overall Plant Efficiency Trends, Pump-Test Only Sites

Overall Plant Efficiency Yearly Increase Trend — Pump Test Only Sites							
	Obsv.	1990	%/Yr. Coeff.	Std.Er	Lower 90%	Upper 90%	Intercept
Ag	9,281	53.7%	0.345	0.075	0.221	0.469	-632.935
Golf	516	59.1%	0.047	0.302	-0.450	0.545	-34.815
Other	3,076	54.3%	0.527	0.130	0.313	0.740	-994.320
Sewage	284	59.7%	-0.176	0.390	-0.819	0.468	409.342
Water	9,802	56.0%	0.321	0.071	0.203	0.439	-582.653
All	22,959	54.9%	0.384	0.047	0.306	0.462	-708.965

Exhibit 1-12: Overall Plant Efficiency Trends, Rebate Sites

Overall Plant Efficiency Yearly Increase Trend — Rebate Sites							
	Obsv.	1990	%/Yr. Coeff.	Std.Er	Lower 90%	Upper 90%	Intercept
Ag	1,141	52.3%	1.275	0.225	0.904	1.646	-2485.835
Golf	86	51.3%	1.863	0.719	0.667	3.059	-3656.545
Other	323	49.1%	1.676	0.405	1.008	2.344	-3286.180
Sewage	33	61.0%	1.424	1.027	-0.317	3.165	-2771.939
Water	1,513	53.9%	1.094	0.178	0.802	1.387	-2123.831
All	3,096	52.8%	1.262	0.129	1.049	1.475	-2459.359

Exhibits 1-13 and 1-14 summarize the yearly % efficiency increase results provided in the preceeding tables. Agricultural sites show slightly greater increases in motor efficiency, while Other sites show the greatest increases in overall plant efficiency. Regardless of customer type, both motor and overall plant efficiencies are increasing at a greater rate at rebate sites. Rebate sites show a much stronger rate of increase in overall plant performance (1.26% per year), as compared with their increases in motor efficiency alone (0.26% per year). By comparison, the rates of increase are more moderate at pump test only sites (0.38% per year in OPE and 0.17% per year in motor efficiency).

The relationships between the motor, other and overall plant efficiency increase trends are summarized in Exhibits 1-15 through 1-18. These comparisons show that for all sites, motor improvements alone are responsible for less than half of the increase in overall system efficiencies. This contradicts popular assumptions held by dealers and others that high efficiency motors are the primary drivers of increasing efficiency in water pumping. For both rebate and pump-test only sites, the majority of the improvement in overall pumping plant efficiency occurs in the residual category of all other efficiency improvements. In particular, rebate sites owe only a small share of their overall plant improvements to higher efficiency motors. Sites receiving pump tests alone can credit a greater share of their overall plant improvements to higher efficiency motors, but still less than half.

Exhibit 1-13: Comparison of Motor Efficiency Yearly Increases

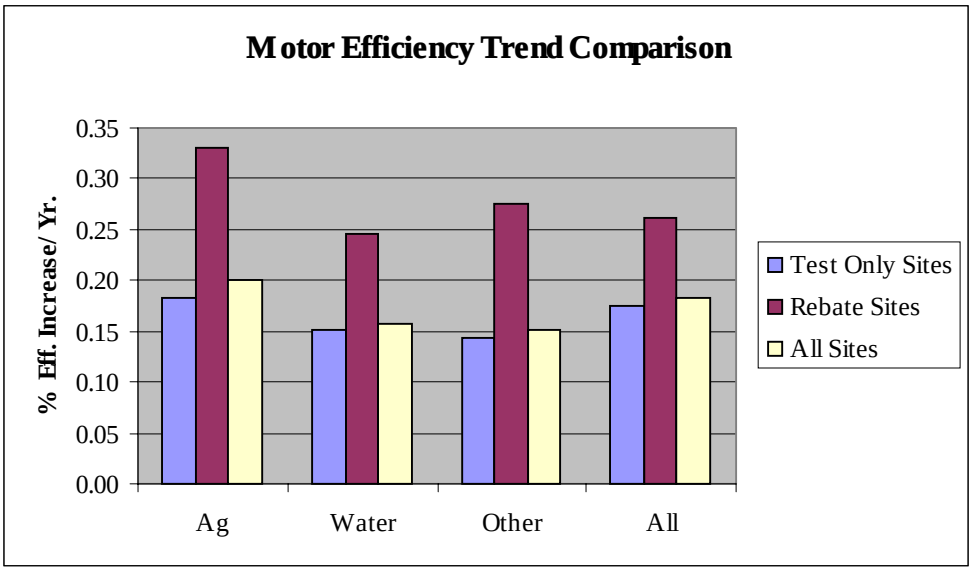


Exhibit 1-14: Comparison of Overall Plant Efficiency Yearly Increases

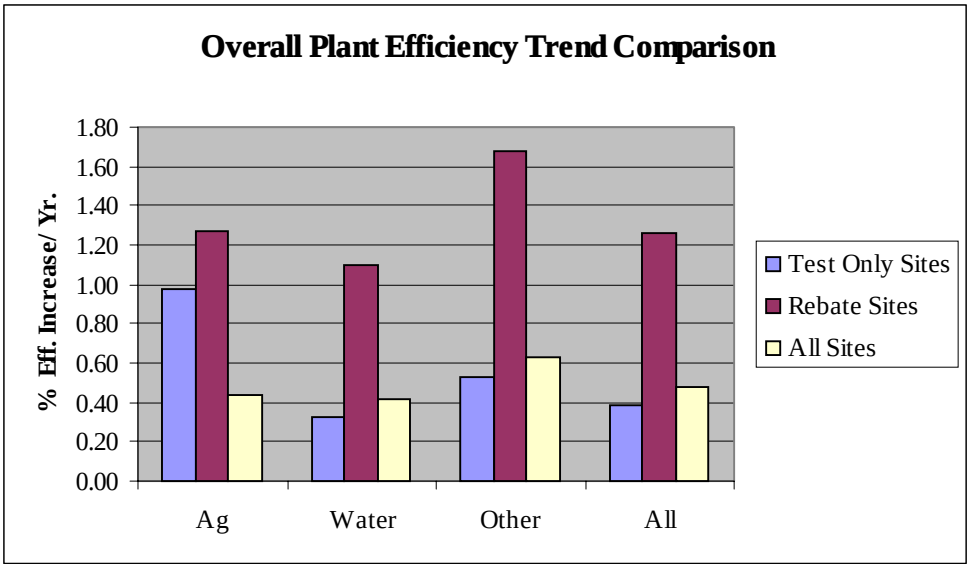


Exhibit 1-15: Comparison of Efficiency Trends- Agricultural Pumps

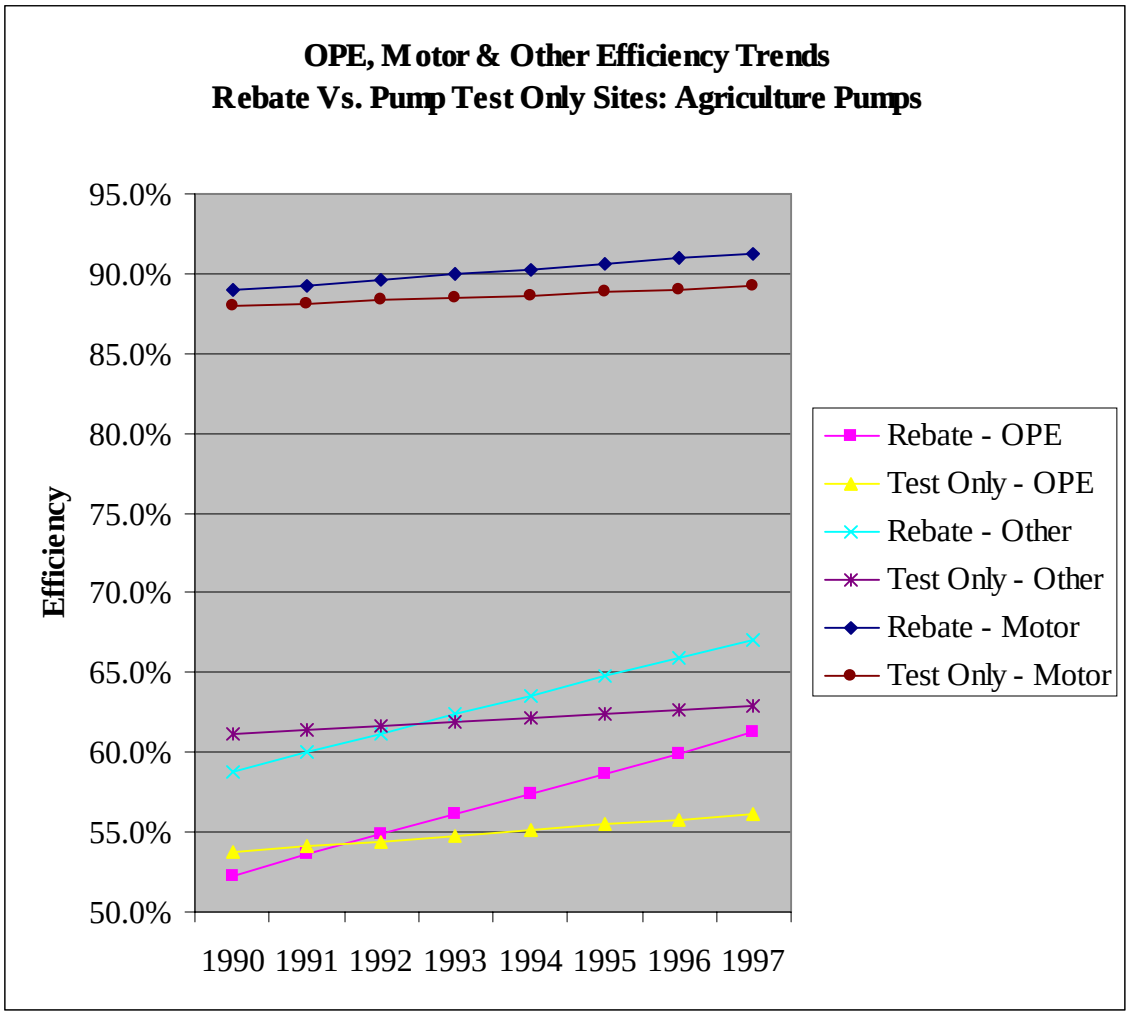


Exhibit 1-16: Comparison of Efficiency Trends – Water Supply Pumps

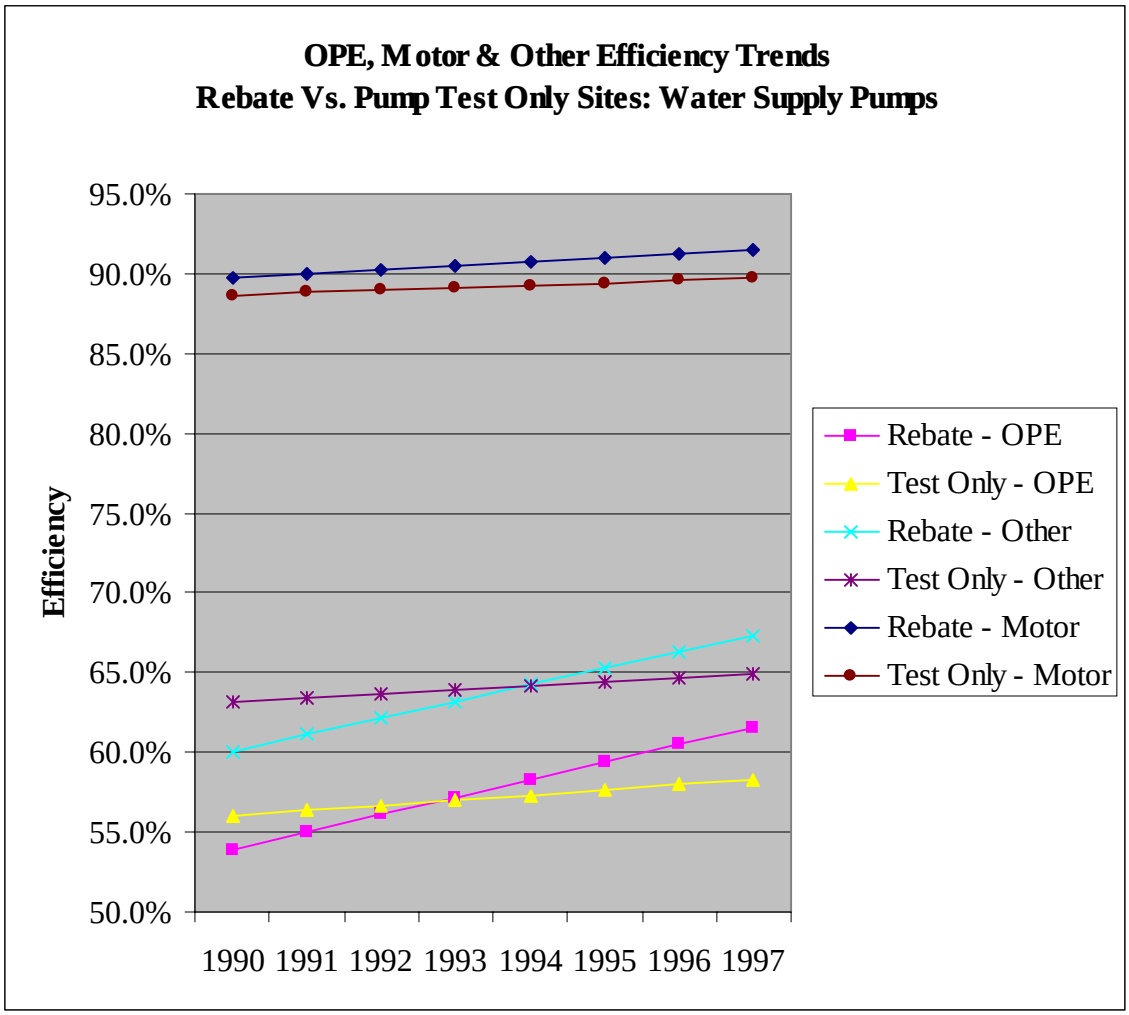


Exhibit 1-17: Comparison of Efficiency Trends – Other Pumps

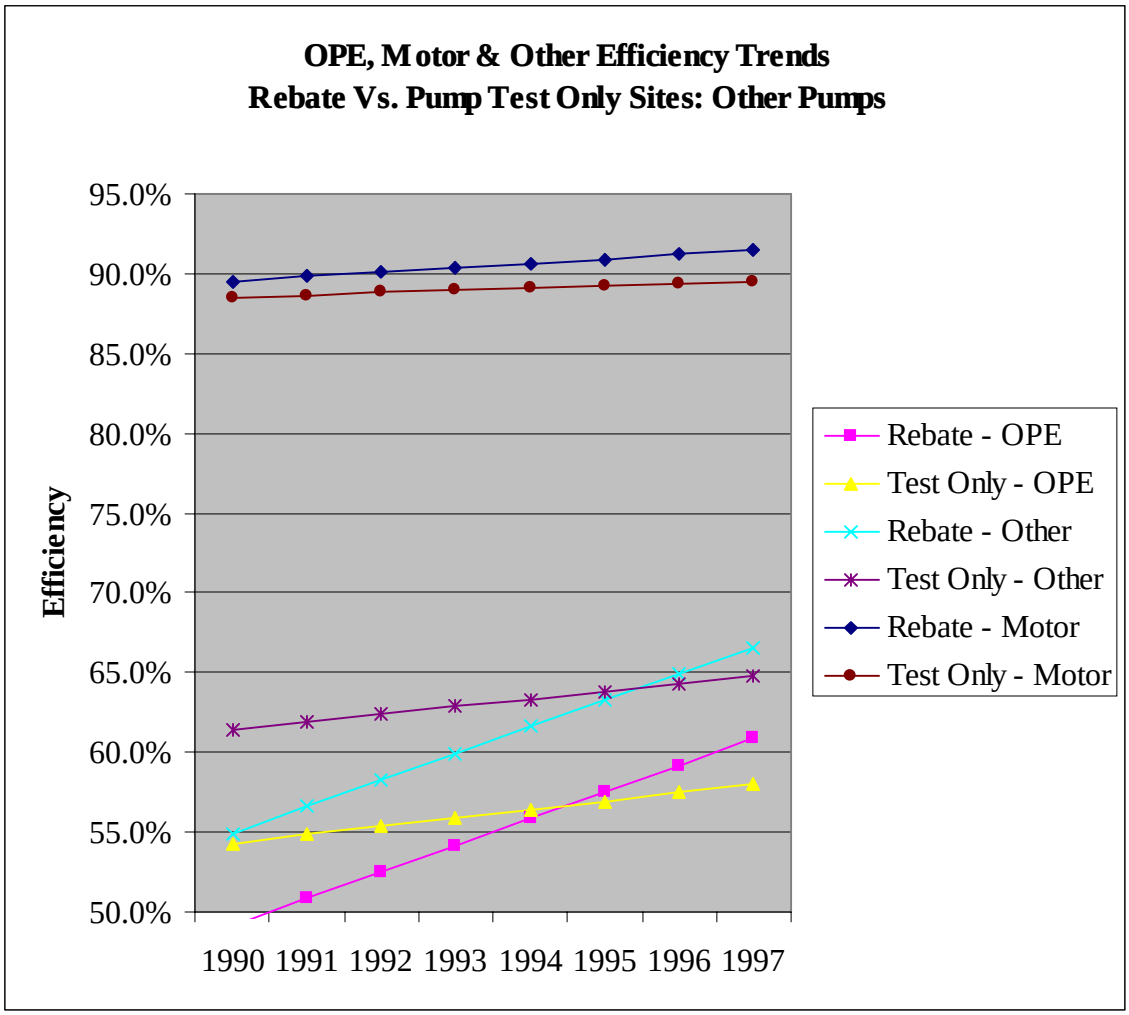
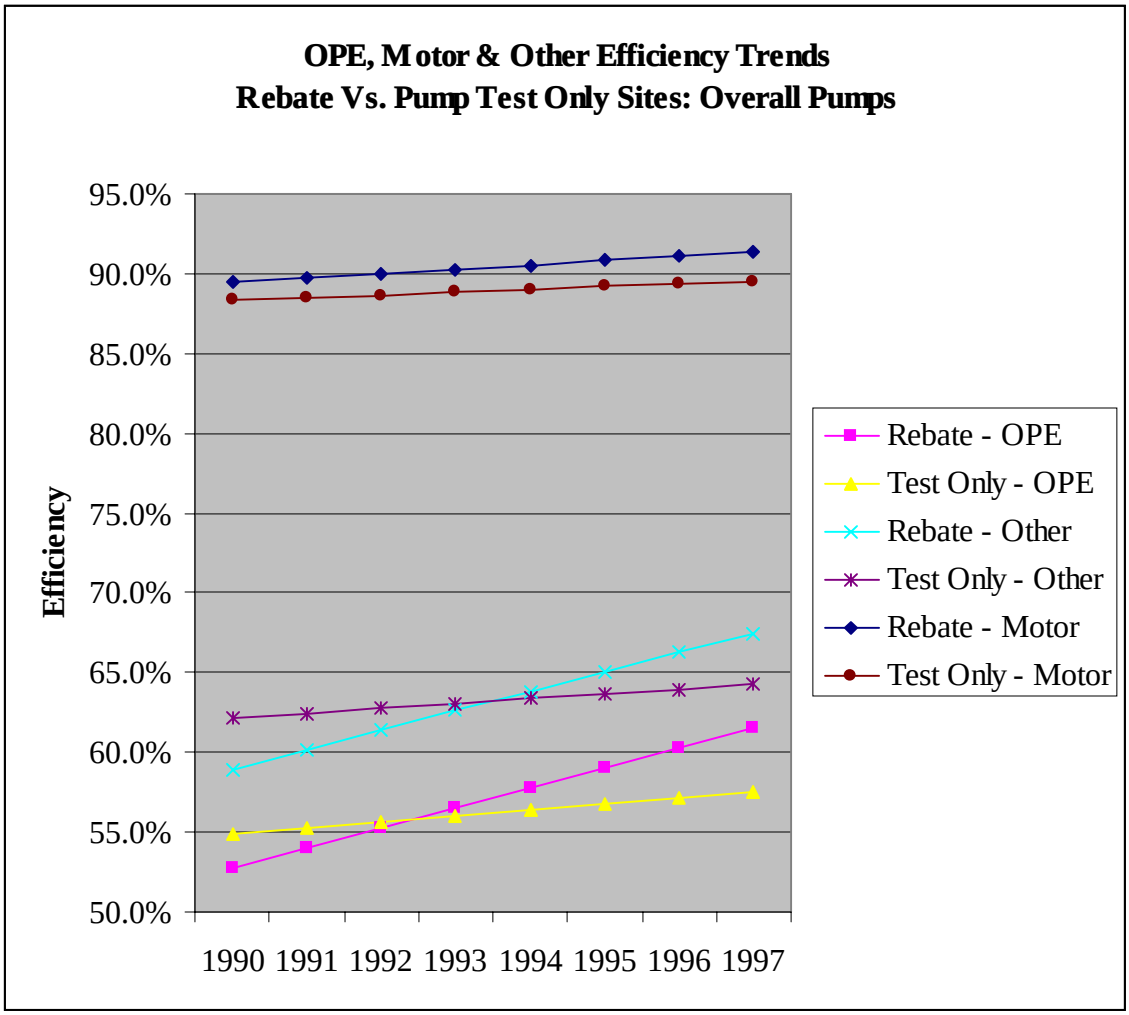


Exhibit 1-18: Comparison of Efficiency Trends – All Pumps Tested



1.2.6 Market Share

Edison account records were analyzed to identify the total size of the agriculture and water supply segment and to estimate the pump testing program's penetration in the segment. Exhibit 1-19 reports program market penetration at the premises level[5] and at the corporate customer level (as defined by the variable "Top Number"). This assessment is based on a February 1997 Edison agriculture and water supply population extract crossed with the populations of pump tests performed and rebates paid during the four year period, 1993-1996 (inclusive).[6] The program reached 19% of all premises, but 52% of all energy consumed at the premises level. At the corporate customer level, the program reached only 13% of customers, but these were responsible for two-thirds of the energy consumed in the segment. The average annual consumption of a pump tested premises was 202.2 MWh, as compared to 44.8 MWh for non-participants. The difference is even more marked at the corporate identifier level, where the average consumption of a pump tested customer was 658.3 MWh, as compared to 53.2 MWh for non-participants.

Exhibit 1-19: Pump Test Program Market Penetration

Agri. & Water Supply	**Premises**				**Corporate Customers**			
	N	%	GWh	%	N	%	GWh	%
SCE Pump Tested	6,861	19%	1,387.20	52%	2,655	13%	1,747.72	66%
Non-Participants	28,392	81%	1,272.81	48%	17,155	87%	912.29	34%
Total	35,253	100%	2,660.01	100%	19,810	100%	2,660.01	100%

A total of 6,861 unique premises were tested during this four year period. Some premises received more than one test during this time. Exhibits 1-20 and 1-21 show the extent of overlap which occurred between the pump testing program and Edison's rebate programs. Only 9% of the premises tested received a rebate during the same period.

Exhibit 1-20: Pump Test Program Overlap with Rebate Program

Rebate/Pump Test Program Interplay (1993-96)		
Rebate	614	9%
No Rebate	6,247	91%
Total Unique Premises	6,861	100%

[5] "Premises" level results are nearly identical to "Location" level results.

[6] The population includes both pump tariff and non-pump tariff customers. Rebate years are 1993, 1994, and 1996. Edison did not provide rebates in 1995.

Exhibit 1-21: Overlap with Rebate Program

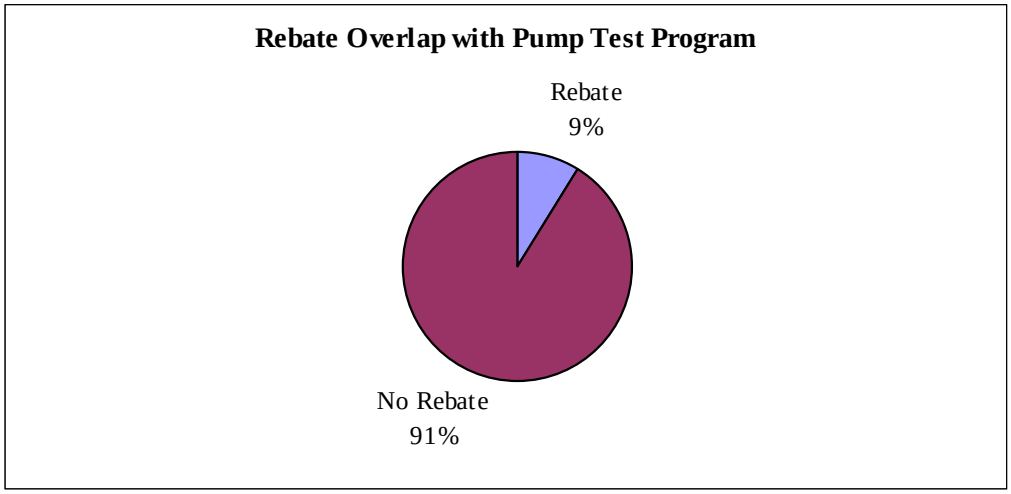


Exhibit 1-22 presents the results of the pump tests administered between 1993 and 1996. The majority (74%) received a cost analysis letter recommending some efficiency improvement. Customer responses to these costs letters are described in Section 3.5.

Exhibit 1-22: Results of Pump Tests

Results of Pump Tests (1993-96)		
Pump Ok	1,771	26%
Cost Analysis Sent	5,090	74%
Total Unique Premises	6,861	100%

1.2.7 Market Players

The Hydraulic Services Program is an information and assistance service provided to pumping customers of Southern California Edison. But the program also directly or indirectly affects a variety of "market players:"

- ***Dealer and Contractors*** can use the pump test results to provide the necessary equipment and installation services. They can also recommend to customers that they have their pumps tested, to help address problems, make replacement recommendations and provide specifications for new purchases.
- ***Manufacturers and Distributors*** potentially can see effects of pump testing on customer demand for certain equipment, and may need to adjust marketing, stocking and/or product availability accordingly.
- ***Lenders*** can use pump test results for property and/or equipment loan applications.

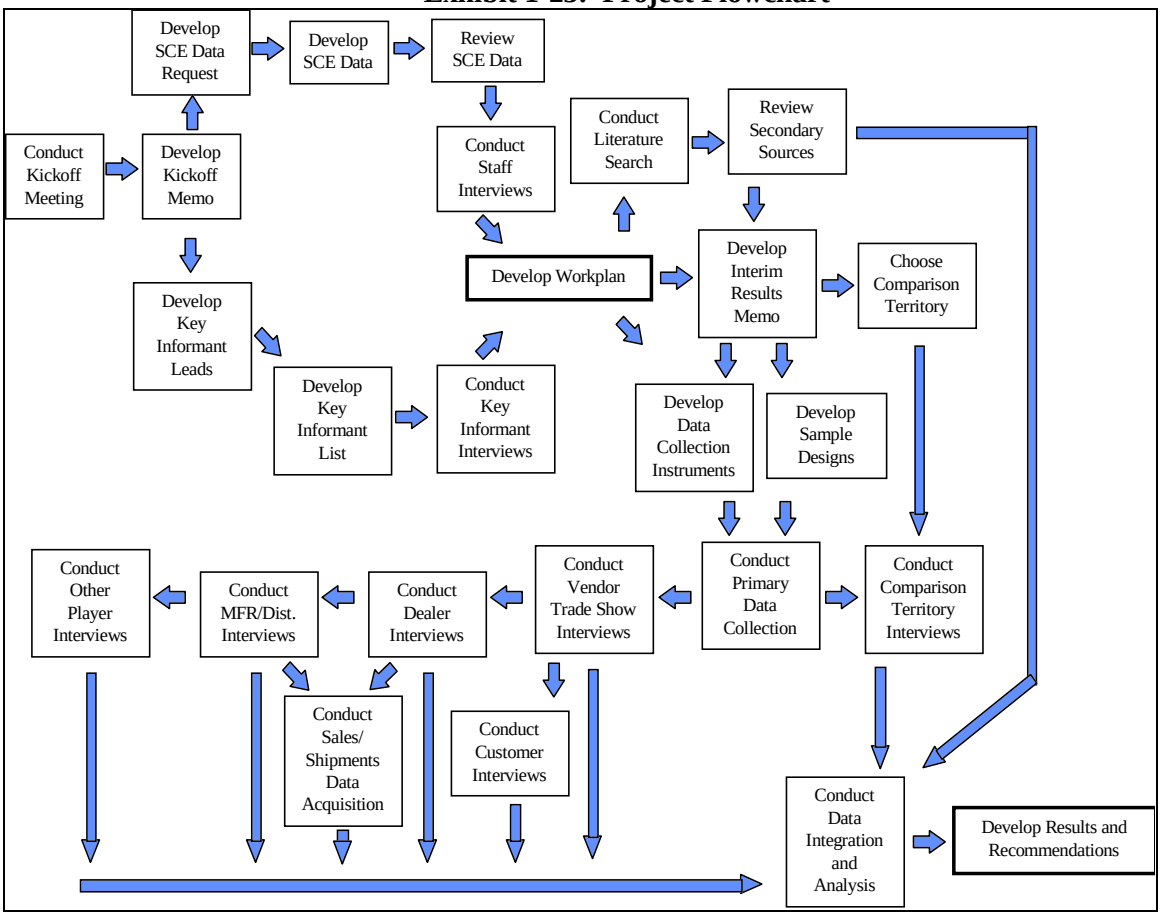
- ***Consulting Engineers*** (working for municipal water customers) can recommend pump tests and can utilize test results to verify their specifications for new or replacement equipment.
- ***Regulators*** can use pump test results to aid in their monitoring of water supply conditions.

The analysis process, summarized below, sought to examine the extent to which the program actually did in fact have any effects on these various types of market players.

1.3 ANALYSIS SOURCES AND METHODS

The analysis process consisted of data collection and evaluation of program impacts on energy efficient water pumping equipment demand and supply, at the various levels of "product supply and demand chains" – i.e., the processes of ordering, manufacturing, stocking, purchasing and replacement of water pumping equipment and services. The flowchart shown in Exhibit 1-23 provides an overview of the project's scope and methods.

Exhibit 1-23: Project Flowchart



The sources of data and analysis methods are described in the sections below. The data collection included both existing ("secondary") data and new ("primary") data on the knowledge, attitudes, behaviors, processes and practices of all relevant "market players" – customers, dealers, contractors, distributors and manufacturers, as well as consultants, contractors, lenders and regulators. Comparable information was collected in Arizona where no such water pump assistance program is offered.

1.3.1 Secondary (Existing) Data Sources

Existing data sources included customer data, market data and field pump testing data. These sources provided information on characteristics of water pump users, pump sizes and efficiencies. They covered Edison program participants, other Edison customers (nonparticipants) and other water pump end users in other states. They provided a basis for customer survey sample design and the selection of a comparison area, as summarized in the final section of this chapter and described more fully in Appendix B. Key sources included the following:

Customer Level Data:

- ***Edison pump test database*** - information on program customers over the period of 1990 - 1997, covering 28,156 tests and 664 "Top" customers.
- ***Edison market research*** - including a 1992 equipment saturation survey and a 1996 impact study of the rebate and audit programs (including a piggy-backed study of the behavior and preferences of tested and untested customers).

Market Summary Data:

- ***US Industrial Electric Motor System Market Assessment*** - Xenergy (May 1997)
- ***Electric Motors - Markets, Trends, and Applications*** - EPRI (June 1992)
- ***Energy Efficient Motor Systems*** - ACEEE (1992)

Field Pump Testing Studies:

- ***Texas Irrigation Pumping Plant Efficiency Testing Program*** - Texas Agricultural Extension (1995)
- ***Cost of Pumping Irrigation Water in Central Arizona*** - Arizona Agricultural Experiment Station Technical Bulletin 182.
- ***Field Determination of Agricultural Pumping Plant Electric Motor Efficiencies*** - Center for Irrigation Technology (1994)
- ***Pump Plant Efficiency Tests*** - Irrigation Journal, v.45, n.5, 1995.

A complete bibliography of published sources reviewed for this study is included in Appendix E.

1.3.2 Primary (New) Data Sources

New sources included interview and survey data covering utility staff, customers and market players. Those sources provided primary information on knowledge, attitudes, behavior, and processes at all levels of the demand and supply chains.
Key sources were:

Staff and Key Informant Interviews:

- ***Utility Program Staff*** - 7 interviews of current Edison program staff, plus telephone discussions with 8 Texas and Arizona utilities concerning the nature of their assistance programs for water pump customers
- ***Key Informants*** – 9 telephone interviews of researchers, consultants and other recognized pumping industry experts to identify potential data sources and characterize the water pump industry[7]

[7] A list of the organizations contacted to complete this report are included in Appendix F.

Market Actor Interviews:

Inland County Water Association trade show intercept interviews:

- ***Water Agency Customers*** **-** in-person interviews with 7 water supply agency customers
- ***Vendors*** **-** 7 dealers, contractors, or vendors attending the "Vendors Fair"
- ***Private Pump Test Service Providers*** **–** 2 owners of such firms were interviewed

Telephone surveys:

- ***Manufacturers*** - 10 largest national water pump manufacturers
- ***Distributors*** - 10 major regional distributors, who represent specific manufacturers
- ***Lenders*** - 10 banks or credit institutions providing agricultural equipment and/or commercial property loans
- ***Regulators*** **–** 10 water agency regulatory personnel
- ***Dealer/Contractors*** - 19 major dealers who sell (and in most cases install pumps) were surveyed, in addition to 7 who were interviewed at the ICWA trade show.
- ***Consulting Engineers*** - 9 major firms providing consultation for pump bid specifications by municipal water agencies
- ***Customers*** - 102 customers (95 via telephone and 7 in person at the ICWA trade show), selected based on a stratified sampling plan to cover a range of sizes amongst agricultural customers and municipal water agency customers.

The interviews and surveys of market actors were split between those serving the Southern California Edison service area and those serving the comparison area of Arizona. The allocation of these samples is summarized in Exhibit 1-24, after which the content of the surveys is discussed.

Exhibit 1-24: Market Actor Interview and Survey Sample Sizes

Primary Data Collection Actual Sample			
	Territory		
	Edison	*Comparison*	Total
Manufacturers	10	--	10
Distributors	5	5	10
Dealer/Contractors	21	5	26
Consulting Engineers	5	4	9
Water Agency Customers	25	25	50
Agricultural Customers	26	26	52
Lenders	5	5	10
Regulatory Agency Staff	5	5	10
Other Pump Testers	2	--	2
Total	104	75	179

The interviews and surveys covered the following topics:

- ***Profile of Interviewees*** – Size, Type, Pump Characteristics, Role in Demand/Supply Chain, Knowledge of Edison's Program – awareness
- ***Customer Behavior*** - maintenance, testing, purchasing behaviors
- ***Roles and Behavior of Market Players*** -Products, Services, Marketing Methods, Changes over time in Sales and Stocking Patterns, Differences between Southern California and Arizona (in terms of attitudes, knowledge, products and services, efficiency levels)
- ***Perceptions of Market Barriers*** – demand side (customer knowledge and resources / capabilities) and supply side (product availability and stocking)
- ***Program Effects*** - perceived short-term market effects, perceived lasting market effects, perceived program cross-influences, identification of supporting evidence, hypothetical expectation of effects of eliminating program
- ***Contact Referrals*** - identification of other key primary market players, contacts and secondary sources
- ***Availability of Data*** - sales and stocking data for purposes of assessing market changes over time and between areas

1.3.3 Research Approach

Since the Hydraulic Services Program was designed to provide customers with information, it follows that an important part of any study of program effects would be to assess how it has helped to change awareness, attitudes, decision-making and ultimately – behaviors. In order to assess the extent of changes in market structures and intermediate behaviors, the analysis process was designed to follow a 5-step process. The steps were as follows:

1. Develop a set of hypothetical program effects spanning multiple levels of market players
2. Establish a baseline for comparison
3. Measure market changes against the baseline
4. Build a case for attributing credit to the Edison program for causing these changes
5. Assess the permanence of the documented changes

The first step was the identification of multiple levels of market players. The primary groups were identified as: (1) Customers, (2) Dealer/Contractors, (3) Manufacturers, (4) Distributors, (5) Consultants, (6) Private pump testers, (7) Lenders and (8) Regulators.

The second step was the identification of hypothetical program effects at the various levels. They included the following general categories:

Customer Level Effects -

Impacts or Outcomes: changes in the average system efficiency, mix of equipment or fuel types and frequency of repair/replacement
Behavioral Practices: increased adoption of predictive maintenance, prioritization, testing habits, and knowledge and attitudes

Dealer and Contractor Level Effects -
Impacts or Outcomes: changes in the mix of equipment sold or specified, stocking patterns and marketing practices
Behavioral Practices: enhanced specifying criteria, design practice changes, testing habits, knowledge and attitudes

Manufacturer and Distributor Level Effects -
Marketing or distribution practice changes
Design practice changes

Other Market Player Effects -
Private Pump Testers: Stimulated demand for testing, improved pump test practices, spawns new testing firms
Lenders: Increased request and use of test data, offer better terms if tests validate payback
Regulators: Availability of test data leads to government mandate requiring testing.

This led to the more detailed development of 29 hypothesized program effects, as listed in Exhibit 1-25 on page 1-27. The 29 market effects were considered to be potential results of the program's interventions in the marketplace. These hypothetical effects were investigated individually and where feasible, estimates of their impacts were measured or qualitatively assessed.

The third step applied comparisons to establish the extent of changes and differences which could potentially represent program effects. All of the comparisons used to investigate those effects were cross-territorial, i.e., comparing the various market indicators (pumping plant efficiency, stocking practices, etc.) in Edison's territory against the same type of data in the comparison area. Time-series comparisons were also used to a limited degree, but were not of much value since the program has operated in much the same way during the period for which data was made available.

The fourth step was the investigation of causality, i.e., the case for attributing credit to Edison for causing the market changes. This involved the use of multiple sources of survey data. The hypotheses were tested through surveys applied to the appropriate groups of market actors. For example, customers were asked "Do you ever use "predictive maintenance" (periodic pump testing, etc.) to help anticipate major repairs?" The responses of Edison customers were compared to those of their counterparts in the comparison area. The outcome measures, which are by definition more quantifiable, included estimates of pump test efficiency measurements and rates of pump sales and replacements. In practice, however, it was found that a lack of standards in pump designs, ratings and performance made it difficult to quantify differences in sales patterns across areas. Nevertheless in some cases market players were willing to qualitatively assess any perceived differences.

The qualitative interview and survey data were then used to help build the case for linkages between the program's market interventions and the effects on actor attitudes and practices. It was assumed that if the

program linkages to attitudes and practices were significant, then they should have led to demonstrable differences in outcome measures (e.g., sales patterns) between the two areas. Such comparisons were derived to help determine the extent to which market barriers have been mitigated in Southern California as a result of Edison pump testing.

The fifth and final step involves an assessment of likely permanence in market effects. That, in effect, requires some forecast of the future in order to assess what *would* happen if the program was no longer available to customers. This was accomplished by analyzing market actor self-reports from current and previous surveys of how their behavior and the associated outcome measures would likely change if this were to occur.

Exhibit 1-25: Market Change Measurement Matrix

Market Effect Hypotheses (Causal Factors)	Evidence of Market Effects
Enhanced minimum efficiency or fuel type criteria "Predictive maintenance" procedures "Prioritization" procedures Pre-installation inspection procedures Post-installation validation procedures Troubleshooting procedures Volume validation procedures Improved cost/benefit analysis procedures Increased knowledge of alternative dealers Increased knowledge of available technologies Any other indirect benefits of participation Spillover to non-participants	→ Increase in overall pumping plant efficiency → Increased Saturation of high efficiency equipment → Increased Frequency of equipment replacement
Enhanced minimum efficiency, design, or fuel choice criteria Other design practice changes involving new technologies Self-administered pre-installation testing procedure Self-administered post-installation testing procedure Self-administered test-driven troubleshooting procedure Recommending third party post-installation validation testing Procedure to maintain or extend staff expertise Improved cost/benefit analysis procedures	→ Increased sales of high efficiency equipment → Increased stocking of high efficiency equipment → Increased Marketing of high efficiency equipment
Changes in marketing or distribution practices Changes in system or component design practices	→ Increased Shipments of high efficiency equipment → More efficient equipment designs
Request historical pump test data Commission testing of wells and pumps Offer better terms based on pump test data Mandate requirements for pump test data	→ Increased use of pump test data by others
Stimulated customer demand for pump testing services Improved pump testing methods and practices Trained personnel who formed new pump testing firms	→ Increased frequency of non-Edison testing (in SCE territory) → Increased frequency of non-Edison testing (outside SCE territory)

1.4 COMPARISON AREA

One of the important aspects of studying program market effects is the assessment of how they have changed the nature of products and services offered and sold in the marketplace. Thus, one of the key aspects of the analysis is the collection of information comparing market conditions (i.e., pump and testing service offerings, sales and prices) in the Edison service area with those in some other "comparison area" where no such pump test program is offered.

In choosing the comparison case, primary consideration was given to meeting the following two basic criteria:

(1) similar types of pumps being bought and installed for roughly similar purposes; and

(2) the lack of any significant free or subsidized pump test program.

In order to select an appropriate comparison area, information was collected on candidate areas. The findings from that process are summarized below; details are provided in an Appendix to this report.

Similarity in Pumping Needs and Types. The first criterion – similar types of pumps being used for similar purposes – basically calls for similarities between the Edison service area and the comparison area in terms of factors such as: (a) use of irrigation pumps, (b) climatological conditions – particularly precipitation, (c) types of crops grown, (d) pump power sources, (e) types of irrigation and (f) energy pricing and consumption patterns. Findings were as follows:

(a) Use of Irrigation Pumps. While pumps are widely used around the country for municipal water supplies, only a few states make substantial use of pumps for agricultural irrigation. Accordingly, the assessment of potential comparison areas focused on seven western states –California, Arizona, Texas, Nevada, New Mexico, Nebraska, and Oregon—in which significant agricultural irrigation takes place. Other parts of California outside of the Edison service area were eliminated as candidates for comparison because they either had their own forms of pump test programs (PG&E areas) or because their dealer and distributor markets overlapped with that of the Edison service area.

(b) Climatological Conditions. The natural level of precipitation affects the pattern of use of irrigation pumps. It was found that Arizona, Nevada and New Mexico are equally or more arid than Southern California, while rainfall is much more plentiful in Texas, Nebraska, and Oregon.

(c) Types of Crops Grown. Crops affect irrigation requirements. Arizona shares with California a reliance on dairy, lettuce and cotton crops, while the other states generally had a greater reliance on cattle production as a top agricultural product.

(d) Pump Power Sources. Only electric pumps are relevant for this study. As in California, electric motors are clearly also dominant (i.e., used in over ¾ of all pumps) in Arizona, Nebraska and Oregon. In the other states, electric motors account for a smaller share of pumps; the other sources used there are propane, natural gas and diesel fuels to power the motors.

(e) Types of Irrigation. The split between gravity and sprinkler irrigation affects pumping requirements. As in California, gravity systems are also dominant in Arizona, Texas, Nevada and New Mexico. In the other states (Nebraska and Oregon), sprinkler systems are dominant.

(f) Energy Pricing and Consumption Patterns. Southern California has relatively high energy prices, which increase the importance and energy savings stakes associated with pump testing. Arizona and New Mexico have average rates that are within 10% of Edison's rate, while rates in the other states are all at least 20% lower. The average annual cost per irrigated acre in each state is also highest in California and Arizona, and significantly lower in the other states.

Based on the preceding analysis, it was decided that Arizona and Texas were the most comparable settings. Nebraska was eliminated as a potential comparison case because its produces different agricultural commodities than southern California and because of the large disparity in electricity prices between the two areas. Oregon was eliminated because average rainfall there is around 2.5 times higher than in southern California. Major differences in crops caused New Mexico and Nevada to be eliminated.

Investigation of Existing Pump Test Programs in Arizona and Texas. Telephone interviews were then conducted with 24 persons representing state and federal agencies, universities, electric utilities, national and regional organizations. These interviews focused on the availability of free or subsidized pump testing or other forms of assistance or incentive programs that could affect reliance on pump testing, as well as the availability of information on efficiency levels of pumps being sold. Key findings were as follows:

(a) Pump Testing in Texas. In the early 1990s, some of the major electric utilities in Texas and the Agricultural Engineering Department at Texas A&M provided free pump testing to selected customers as part of a study to assess the efficiency of agricultural energy consumption. Since then, free pump testing for farmers has continued to be offered as a service by several major utilities, upon customer request. Those utilities that have a significant base of agricultural customers (e.g., Central Power & Light and Southwest Public Services) have special service representatives to serve that market segment, and they provide some incentives for those users to consume electricity rather than natural gas or diesel. Since practically its inception, CPL has reportedly provided free information services to agricultural customers, as well as pump testing. Additional free programs are provided by some environmental and agricultural organizations in Texas. For example, the High Plains Water Conservation District in Lubbock performs free pump tests for farmers in their area and the director of the program estimates that they have tested several thousand pumps since program inception.

(b) Pump Testing in Arizona. Free pump testing is available from some utilities in Arizona, but only on a very small scale. Several utilities do perform free pump tests for cases when large customers (i.e., those with large pumping capacity) make a special request; however, these services are not marketed and are offered on only a very small scale. The largest identified utility pump testing program formally offered in Arizona tests only 50 pumps/year and charges customers for those tests. Other pump testing that has been performed in Arizona over the past 20 years were tests performed by the Arizona Department of Water Resources and the US Geological Survey for an annual report on groundwater quality in the state.

Based on this information, it was clear that no state can provide a perfect comparison case against which to measure the effects of Edison's program. However, Arizona emerged as the most appropriate choice in terms of both of our major criteria. Similarities in characteristics of the climate, crops, electricity costs and reliance on electric-powered pumps, all argued for Arizona. In addition, the chance of identifying

distributors with experience in both California and the comparison area was believed to be much greater with the choice of Arizona rather than Texas. Finally, the low level of formally-offered free pump testing in Arizona made that state the best available location for comparisons of pump market conditions.

1.5 REPORT ORGANIZATION

Chapters 1 and 2 together provide a concise presentation of the study. Whereas Chapter 1 introduces the program and the study objectives and methods, Chapter 2 summarizes the analysis results and findings. The subsequent chapters then provide more details on the analysis processes and findings. Chapter 3 describes the customer survey findings, and Chapter 4 describes the findings of interviews with market players. Chapter 5 then evaluates program effects relative to market transformation criteria, as delineated in a document of the California DSM Advisory Committee (CADMAC). Appendices provide the survey and interview instruments, details of the comparison group selection process, program data base documentation and tracking system analysis.

2. FINDINGS - PROGRAM EFFECTS

This chapter presents a summary of the findings of the study concerning the nature of the market in which the Hydraulic Services Program operates, and effects of the program on that market. This chapter is organized by a discussion of the value of the program to the various levels of market players. Together with Chapter 1, this chapter provides an overview of the entire study process and its findings on market effects.

The sources of information and analytic basis for these findings are discussed in further detail in Chapters 3 and 4, which explain the data collection processes and their results. The findings presented here and their implications for the assessment of "market transformation" are then discussed in Chapter 5, in a presentation organized around how the program addressed various "market barriers." Readers interested in a detailed consideration of the program's market effects are directed to Chapter 5.

This chapter is organized into six parts:

2.1 Characterization of the customer sub-markets
2.2 Identification of the key types of market actors and how their roles differ by submarket
2.3 Findings on program effects on those market actors
2.4 Findings on additional value of the program
2.5 Implications for the findings for lasting market transformation.

2.1 CUSTOMER SUBMARKETS

Of recent Hydraulic Services program participants (i.e., pump test recipients), approximately 50% are agricultural operations and 39% are water supply agencies. The remainder is split between sewer, golf and miscellaneous other irrigation-related activities. The program specifically excluded residential property irrigation as well as industrial and commercial pump users. For purposes of this study, we therefore focus on the two primary submarkets – agricultural and water supply.

- **Agricultural Submarket.** The agricultural participants range in size from less than 100 acres with only one or two pumps to over 4,000 acres with as many as 200 separate pumping facilities. Some are single person run operations, while several others have several hundred employees. As typical of Southern California agriculture, the diversity of crops is remarkable, including tree, row and field crops, livestock, nursery stock and other agricultural products.

- **Water Supply Submarket.** Water suppliers include municipal water agencies and irrigation districts providing bulk water service for primarily agricultural end uses. They range in size from large municipal agencies serving populations in excess of 120,000 to small mutual and privately-owned water companies serving rural populations of less than 100. A notable aspect of the water supply submarket in Southern California is the large number of limited territory utilities. Since the area includes some densely populated and suburban areas, this leads to

sometimes large, but relatively localized, water utilities. Wells are often used as a water source, in addition to Southern California's extensive canal distribution network. [8]

2.2 MARKET ACTORS AND ROLES

2.2.1 Distribution Channels

Agricultural and water supply customers exhibit significantly different characteristics. Water supply customers typically operate high flow capacity pumps, maintain on-staff design engineering and maintenance expertise, and have highly organized and functionally specific financial, administrative, and technical decision-making procedures. Agricultural customers on the other hand typically operate a wide range of smaller volume pumps, rely on others for hydraulic engineering expertise and may experience managerial and financial constraints which inhibit their abilities to formally consider and invest in energy efficiency improvements. More than their water agency counterparts, some agricultural customers (e.g., growers) tend to be 'least first cost' oriented. These differences result in the operation of two distinct albeit overlapping market channels supplying the pumping needs of these two general types of customers.

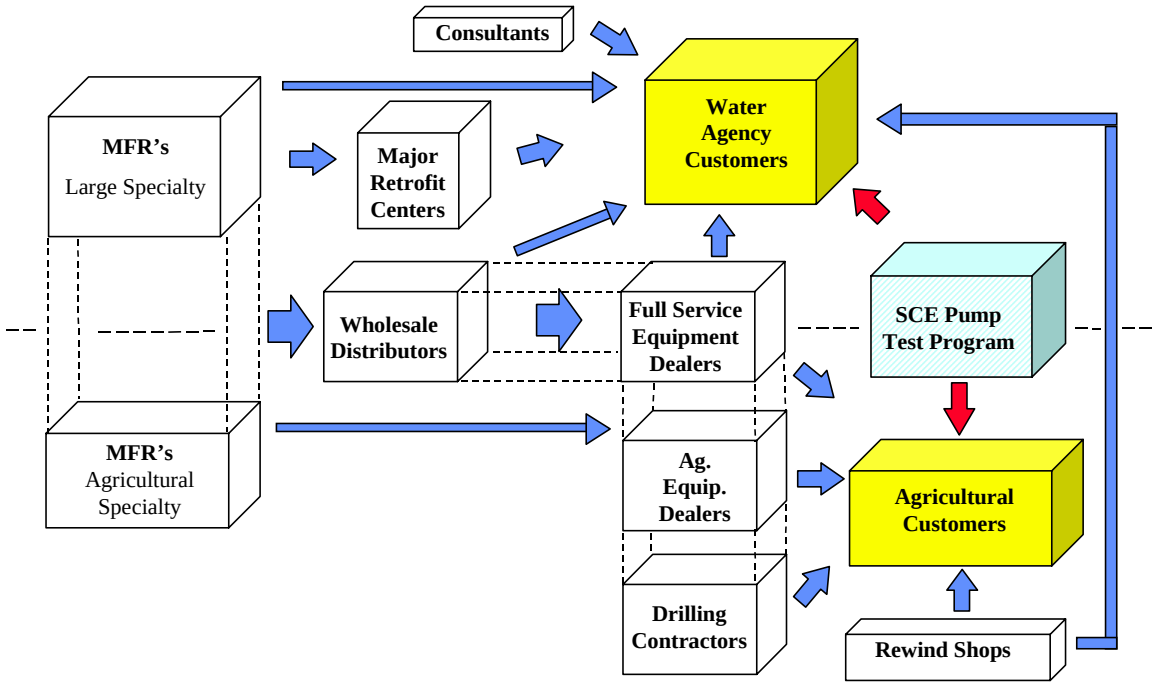
Irrigation district customers exhibit some characteristics in common with either of the two other groups. As water wholesalers they tend to use high flow pumps, more similar to the scale of water supply equipment. However these customers tend to use the same suppliers as do the agricultural customers. For this reason a simple two segment typology is most descriptive.

For each of these market segments, we can thus identify a range of different market actors, playing different roles depending on the submarket. Exhibit 2-1 illustrates the findings on the dominant distribution channels for the water supply submarket (shown in the upper half) and the agricultural submarket (shown in the lower half). Findings on the roles of these various market players are then summarized below.

[8] Two-digit SIC code definitions for the Agricultural submarket were 00-07. SIC code definitions for the Water Supply submarket used the four-digit codes: 4941 and 4971. The category "Others" included Sewage (4952), Golf (79), missing, and all other codes.

Exhibit 2-1: Key Actors in the Water Supply and Agricultural Pumping Markets

Water Supply Customer Market Channel



Agricultural Customer Market Channel

Manufacturers

Manufacturers include firms which make equipment for a wide range of pumping applications as well as niche manufacturers who provide a specific type of pump or pumping component to a specific type of customer. The diagram separates manufacturers into the subgroups "Large Specialty" and "Agricultural Specialty." In reality most manufacturers span both markets but operate divisions and maintain brands which are oriented to one customer group or another.

Some manufacturers (or divisions) do specialize in high volume equipment for the water supply submarket. The water supply submarket is characterized by equipment that is often custom assembled at the factory in response to special orders coming directly to the manufacturer (or its representative) from the municipal water agency.

Other manufacturers (and divisions) focus on supplying the agricultural submarket. Equipment sold in that submarket is frequently characterized by lighter weight materials and which is usually stocked by regional distributors.

Wholesale Distributors

A variety of firms and other intermediaries distribute equipment from manufacturers to dealers (or sometimes, directly to customers).

For the water supply market, the distribution function is completed by:

- Wholesale distributors providing traditional stocking and sales services for manufacturers; they are sometimes a branch of the manufacturer but more frequently an independent operation with a contract to handle product distribution for one or more specific manufacturers
- Sales representatives and marketing staffs working directly for manufacturers
- Major retrofit service centers owned and administered by major manufacturers.

In the water agency submarket, manufacturers often sell their custom-order products directly to the engineering and purchasing departments of their largest scale customers. Otherwise, most equipment sales move through distributors before reaching end users. Wholesale firms typically are either national firms with regional offices, or else regional operations.

In the agricultural market, the distribution function is performed primarily by:

- Full service, often vertically integrated "wholesaler / distributors" who sell directly to contractors and other customers. They offer wholesale pricing for certain manufacturers' equipment and often also provide additional services such as design/specification, installation, maintenance, service, repair and parts.

The distinction between "Wholesaler Distributors" and "Dealers" as shown in Exhibit 2-1 thus applies insofar as many agricultural customers rely on local contractors to specify their needs, obtain appropriate equipment (from distributors) and install it.

Equipment Dealers and Contractors

Contractors are the major players in the delivery of pumping equipment and services to customers in the agricultural submarket, where they provide one stop service for all of a customer's pumping-related needs. Major dealers serving the agricultural submarket offer most, if not all, of the following:

- pricing for multiple manufacturers' equipment
- system design and component specification
- installation
- maintenance, service and repair
- trucking
- spare parts stocking
- well cleaning and well drilling

The term "contractor" is also used as a synonym for "dealer." For our purposes we use it to refer to those dealers whose focus is primarily on installations, especially on-farm well drilling.

For the water supply submarket, the direct contact tends to be between the manufacturer (or its regional representative) and the water agency's own staff engineers and private consultants. However, that submarket is also served by a few ***major retrofit centers,*** which are operated by major manufacturers to perform customized equipment assembly and repair functions at a centralized site (as opposed to in the customer's facility). Typically they are contracted to perform a comprehensive rebuild of a pumping

plant. The customer usually hires a different dealer to remove and reinstall the plant at the customer's site, and provide skidding and trucking to and from the service center.

It should also be noted that pump motors from either customer segment which require major service may be sent out for repair to specialty "motor shops." These service providers typically operate independently from the dealers who otherwise sell and service pumping systems, concentrating on the motor component. Some repair shops may also rebuild other components of the pumping system in addition to motors. These providers are more active in the agricultural market, especially with smaller horsepower pumps.

Other Market Players

Consultants. In the water supply submarket, consultants are frequently called on to augment the skills of water supply agency staff engineers during a major purchase or retrofit decision. Consultants tend to be skilled engineers, well known in their field and highly specialized in their areas of expertise. These areas include equipment specification, capacity planning, water quality, pumping optimization and pump testing. Consultants often work on behalf of water supply agencies to specify and distribute the pump bid requests for new pump equipment, and then continue to participate in the judging and selection of bids from manufacturers.

2.3 PROGRAM EFFECTS ON CUSTOMERS AND MARKET ACTORS

This section considers the primary benefits of the pump testing program, in terms of the program's value to the various market actors considered in this study. The discussion is structured by the levels of market actors, beginning with customers and proceeding "up" the distribution chain. Each subpart includes a brief discussion of the types of market barriers hypothesized and found to be experienced by each group of market actors. The degree to which these barriers have been effected by the program is also considered.

2.3.1 Effects on Customers

Summary of Value to Customers

+ Increases Awareness of Energy Cost Factors
+ Reduced Cost of Information Access on Efficiency Options
+ Broader Access to Pump Testing Services
+ Better Problem Diagnosis – through more testing than would otherwise occur
+ Reduced Cost of excess electricity use through earlier replacement of defective pumps
+ Reduced Cost of testing (for those inclined to have testing done anyway)
+ Increased Callbacks to repair installations found to be under-performing

At the level of customers, the major market barriers to achieving cost-effective energy efficient pumping systems were found to be informational (imperfect information) and behavioral (uneconomic decision-making). The program substantially addresses both of these types of barriers.

The availability of free pump testing provided through Edison's Hydraulic Services Program is very widely known among market players active in both market segments. Participating customers contacted were uniformly aware of the program. In particular, many larger agricultural users and municipal water agencies alike reported heavy reliance on the testing program. In a 1996 survey of Edison area non-participants, over 74% indicated they were aware of the pump testing program while almost 24% reported having had an Edison test in the past.

This study's survey of program recipients showed that the primary program benefit was its effect on reducing the time and cost of collecting information. The other widely reported benefits were reducing uncertainty when making new purchases, reducing the hassle of performing tests and helping customers to deal more effectively with contractors and dealers.

A comparison of program participants with a comparison group in Arizona showed that the most significant difference between the areas was in terms of predictive maintenance and volume validation practices, where the Edison program has led to notably higher adoption of these practices. This was particularly true in the water supply submarket. Overall, 62% of the participating water supply customers "always or usually" practice predictive maintenance and 49% practice volume validation, as compared with corresponding rates of only 15% and 7% for their counterparts in Arizona. In the agricultural submarket, adoption of these practices was significantly lower among Edison program participants (28% for each of the practices), but totally non-existent for their counterparts in Arizona.

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 providers in California, and (2) a significantly

greater frequency of pump testing among California-area non-participants as compared with water pump users in Arizona. Most of this growth in private pump testing in Edison's area appears to have occurred in the last five years as Edison has taken steps to increase the cost-effectiveness of its program. In the early 1990's, Edison was by far the primary provider of pump testing services in its service territory, commanding a market share of 95% or more. Private vendors were responsible for only a minor proportion (17%) of the few tests provided by others. Considering only the small sample of 16 pump test program non-participants surveyed in 1992, only three (19% unweighted; 1% weighted) reported having a pump test in the previous four years. By 1996, 60% of customers who had not received an Edison test in at least four years reported they had their pumps tested by a non-Edison source. Of these Edison-area "non-participants", 70% reported using an outside vendor or contractor for this service. By comparison, the present study found only 17% of Arizona-area "non-participants" reported having their pumps tested (31% of water supply customers; 7% of agricultural customers). Only 9% of program participants report receiving pump tests from an alternate service provider (19% of water supply customers; 2% of agricultural customers). The mean number of annual tests provided by these other test services was 13.7 among participating Edison customers and only 2.6 among Arizona customers.

The 60% estimate of Edison-area non-participant testing should be considered high since it is based on a very small sample (n=20) and implies that private pump tests outnumber Edison tests over 2 to 1. This rate of private pump testing cannot be supported by the qualitative data collected from dealers and others on the size of the private pump testing market. A more conservative estimate would be half that rate, or 30% of all non-participants.

The interviews of dealers confirmed a broad agreement that Edison's pump test program has led to more informed customers who are better able to continue to monitor their pump system operations, detect performance problems and act to address them through repair and/or replacement. The comparison with Arizona confirmed that the testing and preventative maintenance which are now common in Southern California rarely take place when there is no comparable service offered by the utilities there. Most of the dealers who concentrate on the water supply and agricultural markets in California described recommending pump tests or using the data themselves as part of their regular business practices. Several Edison area consultants too were aware of the program, and reported using pump test data or recommending Edison pump tests to their clients.

These findings are consistent with the argument that the program has in fact substantially increased the information available to Edison area customers, as well as increased their demand for test information, without substantially supplanting other privately-available services.

2.3.2 Effects on Dealers and Consultants

Summary of Value to Contractors / Dealers

+ Increased Knowledge of testing and efficiency issues
+ Increased Reliance on testing for diagnosis of problems
+ More Frequent Replacement pump sales (minor effect)
+ Verification of their own tests and assessments of need

Among dealer/contractors and consulting engineers, the major market barriers to achieving cost-effective energy efficient pumping systems were hypothesized to be informational and behavioral. The

informational barriers were believed to occur when dealers made pump specifying and installation decisions based on imperfect information, which testing would alleviate. The behavioral barriers were expected to occur where dealers were not testing pumps even though it would periodically lead to replacement sales; in this case a habit of not testing pumps would constitute uneconomic behavior on the part of the dealer. The program was found to have an effect on both of these types of barriers. In addition the possibility of structural market barriers was investigated at the level of dealers and consultants. No significant barriers to new market entrants or competition between these actors was found. In fact the level of competition within the industry was often described as intense.

Product unavailability was also not considered a significant market barrier by market actors at this level. There were some minor references to limited stocking of the higher efficiency pump equipment, but these comments were isolated and not broadly confirmed by all dealers. To the extent to which this barrier is occurring it appears to affect only lower HP pumps, smaller agricultural end-users and emergency replacements. Given the proximity of Edison-area end-users to major manufacturing or regional warehousing facilities, and the long lead times associated with most pumping plant purchases, no significant product availability market barriers were found to exist.

However, dealers also confirmed that pump purchase decisions are still largely driven by considerations of purchase price, as most farmers and water agencies are under pressures (both perceived and real) to minimize short-term costs. The contractors serving the agricultural submarket and consultants serving the water supply submarket generally reported that they necessarily respond to their clients' preferences, even if the client is under-informed. This sometimes precludes them from attempting to justify the expenditure of more money for higher efficiency equipment. Many contractors and consultants have adopted standard practices that do not specify the option of higher cost equipment unless they hear a client request it.

Again, these findings suggests that the program's effect has been strongest in terms of customer information and maintenance practices affecting the nature of customer-dealer relations. Product sales pattern effects or dealer practices effects follow secondarily from the informational and behavioral effects the program has on customers.

2.3.3 Effects on Manufacturers and Wholesale Distributors

Summary of Value to Manufacturers and Distributors

+ Highlights efficiency - promotes sales for manufacturers of those products (minor)
+ More Replacement Sales (minor)
- Increased Complaints on New Equipment (minor)

At the levels of manufacturers and distributors, no major market barriers to achieving cost-effective energy efficient pumping systems were identified. The behavioral, structural, and feature-related barriers hypothesized to be occurring at these levels were not substantiated by the data collected for this study. Nevertheless the program did have some indirect influences on these kinds of actors. This was primarily through the indirect route of changing the information available to customers and their operations and maintenance behavior.

Interviews found that program awareness was high at the regional level (i.e., the regional offices of the manufacturers and among the regional distributors), but low at the headquarters of the manufacturers (even when they were located in California). The interviews of both manufacturers and distributors indicated widespread agreement that California customers are more aware of energy efficiency and energy cost issues than their counterparts in other states, although the difference was often also ascribed to factors such as the more irrigation-intensive nature of California farms and water agencies and the higher cost of electricity in the state, as well as to the existence of utility information and testing services.

Manufacturers and distributors widely reported that the primary effect of the higher interest in energy efficiency issues in California was in terms of a higher rate of requests for further information from California customers. Several manufacturers also confirmed that the pump testing in California has led to a greater level of complaints that new pumps are not performing as expected, which was often judged to be a minor nuisance to the manufacturers as they blamed such problems on the installations.

However effects on manufacturer sales were generally minor. Only one specialty manufacturer, who specializes in lighter-weight pumps with high efficiency ratings, perceived that the testing program had helped them promote sales of their pumps in Southern California. However, all of the pump manufacturers reported that controlling for size differences the average efficiency ratings of the pumps they sell in California and in other states are generally the same. Most of them confirmed, however, that broad differences in sizes, designs and motor-pump combinations made it effectively impossible for them to scientifically compare the efficiencies of comparable pumps between states.

Responses of wholesale distributors indicated widespread agreement that the testing program was useful to educate customers, promote earlier replacement of poorly-performing pumps and validate the performance of newly-installed pumps. However, their reports on sales patterns appeared to indicate rising efficiency levels occurring both in California and elsewhere, with ambiguous results concerning whether or not the testing program had in fact raised efficiency levels any higher in Southern California than elsewhere (after controlling for differences in pump sizes and application types).

2.4 OTHER ASPECTS OF PROGRAM VALUE

In addition to the program's effects on the market players active in the distribution chain, other influences were considered. The program effects on lenders, regulatory agencies and the environment in general are considered in this section.

2.4.1 Lenders

Summary of Value to Lenders
\+ Contributing Information for Property Appraisals by Banks (Lenders)

Lenders were hypothesized to possibly be creating a barrier to energy efficient pumping systems by refusing to make loans that if pump test data were available, they otherwise would make. Such a market effect was not documented by this study. Instead the way in which lenders use pump test data appears to have little if any impact on the pricing-related or behavioral barriers presented by lenders.

The interviews with lenders indicated that the availability of water and an operating pump were important factors in property appraisal. They showed that some banks do indirectly benefit from the pump test program, as they use pump test data (when available) as inductive proof that there is a functioning pump effectively providing necessary water flow. The actual efficiency of the pump, however, has no further effect on loan decisions or lending rates for property as well as equipment loans. Instead lenders are concerned primarily with the overall credit-worthiness of a prospective borrower. The financial payback associated with any particular credit line-item their client may seek is not usually a major criteria in their lending decisions.

2.4.2 Regulators

Summary of Value to Regulatory Agencies
+ Regulatory Use by Watermasters (adjudicated basins)
+ Hydrological Modeling by Dept. of Water Resources

Water agency regulators were not believed to constitute a market barrier to water pumping system energy efficiency. But their use of pump test data was investigated to explore whether they might continue to mandate the filing of that data in the absence of Edison's program.

The survey of regulatory agencies in California and Arizona revealed that the California agencies do indirectly benefit from Edison's pump test program, as they utilize pump test data as part of the broader databases used for validating water allotments (in adjudicated basins) and for hydrological modeling done to assess aquifer properties. The market effect identified here is that the program has created a demand for pump test data that would likely persist even if the program were to end.

2.4.3 Environment

Value to Environment
+ Increased Awareness of energy efficiency issues
+ Earlier and More Frequent Repair or Replacement of inefficient pumps

As a final value worth noting, the program effects documented above also have beneficial consequences for the environment. Again this is primarily the result of the program's effects on customer purchase decisions and operating practices. Customers' increased awareness of the benefits of energy efficiency has led to increases in customer monitoring of pump performance and correction (repair or replacement) of poorly-functioning pumps. These effects help to reduce energy consumption, with attendant effects on carbon emissions and other negative effects of energy production. At present, policies are not in place that enable full accounting for these effects. Nevertheless these are program benefits which do accrue to the environment in Southern California.

2.5 IMPLICATIONS FOR LASTING MARKET TRANSFORMATION

In general, *market transformation* occurs when a program has effects on overcoming *barriers* to acquisition of energy efficient equipment, and those effects last beyond the duration of the program. The extent to which the program actually provided such effects is analyzed in detail in Chapter 5. Key findings from that analysis are summarized here.

Since we cannot ever know for sure what would last "beyond the duration of the program" without discontinuing the program, it is necessary to estimate the extent of lasting effect by noting the extent to which there are "structural" changes in the market. Different types of changes have different likelihood's of being lasting, structural changes:

- Shifts in *regulations* are generally lasting structural changes.

Shifts in *product offerings and stocking practices* (by actors in the product distribution chain - manufacturers, distributors and dealers) often are lasting, although they can sometimes be reversed and changed.

- Changes in *standard customer attitudes or practices* (affecting the product demand chain) can be lasting, but may not be if they depend on continuation of some subsidy or free service.

The extent of these kinds of changes are discussed below.

2.5.1 Persistence of Effects on Customer-Level Barriers

The findings from this study indicate that the program did clearly have a direct and positive value in reducing the market barrier of limited information availability on the cost-effectiveness of improving equipment efficiency. The testing itself also clearly reduced the barrier of uncertainty regarding existing pump performance or for validating the performance of new installations. This effect can be thought of as mitigating the otherwise prohibitive cost of obtaining this information. The program furthermore clearly helped to overcome some of the behavioral barriers of customer practices which ignored consideration of preventative maintenance, an otherwise cost-effective business practice.

Thus the program's direct effects on customer informational and behavioral barriers were key benefits. However, because the program was aimed at directly affecting the attitudes and behavior of customers rather than actors in the distribution chain (manufacturers, distributors and dealers), it is difficult to confirm whether or not the effects would continue without the program. The nature of the changes in customer attitudes toward testing or preventive maintenance practices makes it likely that many of the existing customers have been lastingly influenced by the program. This is especially true in their elevated demand for pump testing *vis-à-vis* Arizona, an effect which appears to be largely program driven. However were the program no longer available, new customers moving into the area would not find their informational and behavioral barriers substantially reduced. Over time, the continued entry of new customers could thus diminish the program effect. This process is less of an issue where customer organizations have institutionalized these practices. Where this has occurred, it increases the likelihood that these effects will persist through time, even as the specific individuals effected by the program may no longer occupy their positions.[9]

As for the viability of the emerging private pump test market, the demand outlook is good. The 1996 survey asking all pump test program participants (including those who received rebates and other audits) found that 51% agreed with the statement, "If the Edison pump test program did not exist, your company would pay for the same testing services from non-Edison sources." In terms of the number of customers

[9] This discussion of the potential effects of new customers entering the market is intended to introduce a theoretical barrier to market effects persistence which should be anticipated in designing programs intended to achieve customer-level effects. To measure the rate at which this hypothetical problem might be occurring was deemed to be out of scope for this study.

engaging in testing, these findings suggest that if the program were ended, demand for testing would continue at roughly half the level it is at present. This estimate of a 50% drop in customers tested is corroborated by the comments of dealers discussed in Section 4.4.3. However 60% agreed, "If your company used non-Edison testing services, the cost would keep your company from using these services as regularly as you have." On its face, these findings suggest that the number of tests could drop by even more than 50% were the program to end. But there is insufficient data to predict the relationship between the number of customers who would continue testing and what total number of tests (or what % of total pump energy) would result from their decisions to keep testing. What data we do have suggest that the relationship would probably *not* be linear. Some 19% of customers disagreed with the statement above, in effect stating that paying a reasonable cost would not reduce their quantity of testing at all. Since both studies have shown that the customers with the largest loads and who receive the most tests are usually the most satisfied with the program, it would appear that these 19% of "committed" pump test customers represent a greater share of the total number of tests than they do of the sum of all customers tested. Therefore it seems reasonable to predict that in the short term following the discontinuation of the program, the number of customers tested and the number of tests performed would likely continue at roughly half the rate currently occurring through the Edison program.

As a result, only a portion of these program effects can be considered to constitute market transformation. The data available indicates:

- 60% of Edison-area non-participants report pump testing through non-Edison sources,
- 51% of existing pump test participants report they would continue testing without Edison support,
- Dealers estimate that approximately 50% of participant customers would continue testing if Edison support were discontinued, resulting in roughly a 50% drop in the overall number of tests performed, and
- 17% of Arizona customers (weighted to be of comparable scale to Edison's high consumption program participants) report pump testing without any utility assistance.

This range of estimates suggests that the "naturally-occurring" or "market-sustainable" level of pump testing in Edison's area may be as low as the 17% of customers determined in Arizona. On the other hand it may be as high as the approximately 50% of existing participants who are expected to continue testing if Edison were to end the program, plus the 60% of Edison-area customers estimated to already test without Edison assistance. If we consider the total population of 35,253 premises in the agricultural and water supply segment, this high estimate of persistent pump testing equals 3,431 (50% of the 6,861 premises currently tested) plus 17,035 (60% of the remaining 28,392 non-participants). This equals a total of 20,466 persistent pump test premises, or 58% of all premises in the segment. Assuming that the average energy intensity (MWh/premise) of the tested pumps was to remain the same (a conservative assumption) this high estimate of persistent pump testing would equal 55% of the total 2,660 GWh consumed in the segment.

However this 60% estimate of non-participant testing should be considered high since it is based on a very small sample. This rate of private pump testing cannot be supported by the qualitative data collected from dealers and others on the size of the private pump testing market. Instead, if we assume half the rate of Edison area non-participant testing (i.e.30% instead of 60%) a more moderate estimate of persistent testing would result: 34% of premises and 40% of energy.

This suggests that roughly a third of pumping premises would continue to be tested in the absence of the program, accounting for approximately 40% of the energy consumed by the segment. Even so, this estimate is probably still optimistic in the long run. Dealers hastened to point out that even among those convinced of the benefits of pump testing, the persistence of their efforts would not be 100%. Without some periodic reminders of the benefits of pump testing and predictive maintenance, attention to these rational and cost-effective practices will still continue to diminish over time.

2.5.2 Persistence of Effects on Dealer-Level Barriers

In terms of indirect effects, the testing program did appear to change the behavior of dealers and contractors, who adopted practices of encouraging customers to have their pumps tested, and of working with pump test results to help make appropriate purchase, replacement and maintenance decisions. However, there was no clear evidence of overall changes in the volume or mix of products being manufactured, stocked and offered to customers, or in the practices of lenders. Marginal effects on sales could not be measured, due to the very long period of time during which the program has already existed, and a lack of standardization of pump products for comparison across areas. Limited reports from dealer/contractors and consulting engineers suggest that some differences between the two areas in the mix of products may exist, and that to a small extent this may be due to the effect of the program. However, manufacturers and distributors generally reported that the program had not substantially affected their overall sales patterns, although it had affected pump maintenance and replacement practices.

The duration of these effects is considered no more persistent than those associated with customers. Dealers respond to customer demand for pump testing and actually have a vested interest in their diminished information options. It is therefore expected that dealer practices of recommending pump tests and using pump test data would likely continue at a rate in proportion to that for customers commissioning the tests. Clearly some dealers would take advantage of the fact that Edison was no longer offering the service. These dealers would likely position themselves as high quality value-added service providers, and continue to market the benefits of pump testing. Others however would move to specialize on those customers who are most concerned with first costs, and those who's attention to operating efficiency may wane in the absence of Edison's free service.

2.5.3 Persistence of Other Market Effects

One significant effect quite likely to continue regardless of Edison support for pump testing is the requirement of Watermasters in adjudicated basins to require pump tests to validate water meter readings. This presumably lasting effect of the program effectively constitutes a public benefit subsidy, the cost of which is passed on to all Edison customers through rates. In the event the program was discontinued, a sizable number of the 29% of all program participants (49% of water supply customers) who reported using pump tests for this purpose would likely be required to continue providing the data to their Watermasters. This is considered a market effect with a high likelihood of persisting in the absence of the program. Of course political opposition to paying the cost of such tests could lead to policy decisions which could have an unforeseen effect on the persistence of this market effect.

The Hydraulic Services Program was designed and operated as a customer information and assistance service, rather than as a market transformation program. While the program did in fact help to address some barriers to energy efficiency, it was not intended to (and did not) address others. If there is a goal of effecting permanent change in the structure of market demand and market supply for highest efficiency water pumps, then those additional issues may need to be addressed. They include issues concerned with:

- Availability of access to financing for energy efficiency equipment,
- Organizational practices for municipal bidding which penalize energy efficiency,
- Lack of standards for defining and distinguishing high efficiency pumping equipment, and

- Lack of incentive for contractors and consultants to promote acquisition of energy efficient products over less-costly standard products.

Edison's Hydraulic Services program has established a long tenure in the market and won a well-regarded reputation as a reliable and unbiased third-party. Past investments in underwriting the program are responsible for the building of these perceptions. The pump test program should be considered to be among the most substantial factors driving water pumping customers' favorable perceptions of the Edison brand. From this position of established brand equity, the program provides an excellent vehicle for the delivery of future market transformation initiatives and/or other product service and service offerings to customers and other pumping market actors alike.

The following chapters provide a detailed discussion of the study methods and findings. Chapter 3 describes the customer survey findings, and Chapter 4 describes the findings of interviews with market players. Chapter 5 then evaluates the program effects in the context of the market transformation paradigm and lexicon.

3. CUSTOMER SURVEY RESULTS

This section describes the methods and principle findings of the customer surveys completed for this project. For a detailed discussion of the market effect hypotheses and overall research plan for demonstrating market transformation, refer to Chapter 5.

3.1 COMPARISON METHODOLOGY

3.1.1 Research Design

The study approach has been to use existing customer survey data as a secondary data source for assessing certain customer level effects in order to have resources available for investigations at other levels of the distribution chain. The research design for the customer level investigations was structured to focus the primary data collection only on *participating* customers in Edison's Southern California territory and *non-participating* customers in Arizona. The two area comparison was also chosen because of the program's long history in California, coincident with PG&E and SDG&E's pump testing activities, and because customers and dealers alike were expected to have a high level of awareness of the benefits of pump testing. These conditions render any time-series comparison of little value. An out-of-state comparison group was used instead.

For an important third group, non-participating customers in Edison's service territory, the data collected in two earlier surveys that included program non-participants (1996 and 1992), and the survey of Southern California dealers were considered useful sources of information on issues regarding intra-market effects on non-participants. Edison's approach was designed to leverage these existing secondary sources rather than perform extensive new customer surveys of non-participants. Conclusions about overall customer level effects were based, where possible, on comparisons between the three customer groups. However, in some cases, the out-of-state control group was heavily relied on for comparisons over a local non-participant sample because in theory, market differences between the two areas should be a minimum condition before considering the possibility of any program spillover effects.

The obvious difficulty in structuring a cross-territorial comparison of this type is that other factors which may differ in the two areas (e.g., energy prices, business scale, etc.) may be as important, if not more so, than utility-sponsored pump testing. To minimize this inherent limitation, a detailed assessment of a number of alternative states was made prior to selecting the comparison area (Cf. Appendix B). Again, the interviews with supply chain market players having experience in both areas were considered to be an appropriate means of controlling for this research constraint.

Arizona was chosen because it matched Edison's territory more closely than any of the other states considered. Nevertheless a number of important differences exist between the two areas. First, electricity prices in Southern California are higher than almost anywhere else in the nation. While Arizona prices were closer than all other areas considered, the remaining difference in prices does affect energy investment payback decisions, and can be expected to contribute to customers' attitudes and behaviors involving energy use. Other factors, such as the higher level of environmental regulation in Southern California (emissions, water quality assessment, water volume assessment) and environmental awareness may also contribute to some of the differences observed in the two areas. Also in the outlying Phoenix area, since the development of the Central Arizona Project (CAP), the majority of water used in agriculture no longer comes from underground sources. Significant deep well pumping is still prevalent in many other parts of the state (e.g. Tucson, Yuma, and smaller towns). This increased diversity of sources actually improves the comparison to California's end users. However, CAP growers who once

paid to pump water from deep in the ground but now only need to move it around may have seen a decrease in their energy costs and perceive little need to focus on energy costs.

These differences should be kept in mind when reviewing the survey results. However customer and dealer responses in favor of the value of pump testing do suggest that the Edison testing program is responsible for some of the differences documented through the surveys.

3.1.2 Sample Design

The sample design for the customer surveys was structured to match the Arizona group to the Edison's territory program participant group. The participating customer (Edison territory) sample was drawn from the Pump Test Tracking system[10]. The non-participating customer (Arizona) sample was drawn from two sources. Agricultural customers were selected from Dun and Bradstreet; Water supply customers were selected from a database of all registered water purveyors in Arizona provided by the Arizona Department of Health Services. Since no variable common to all three sets (CA pump test participants, AZ farmers, AZ water purveyors) was available at the outset, the surveys collected data which enabled a scaled comparison. Major steps in developing the customer sample design are described below.

1. Identify major customer groups served according to the SIC codes associated with the tests
    - Water Supply
    - Agricultural
    - Waste Water
    - Golf/Country clubs
2. Collapse the dataset of 28,156 tests conducted between mid-1990 and March 16, 1997 into a dataset of the 664 customers who received them in 1996, using the Top_Customer variable. (Top_Customer is a "corporate" or "parent" company identifier, therefore all tests performed for multiple site customers were aggregated together under their corporate parent.
3. Assign each customer to one of the above groups based on the two digit facility SIC code associated with the majority of the tests they had performed (many customers had various facility SIC codes associated with their tests)
4. Select only the Agricultural and Water Supply groups for further study.
5. Stratify, using model-based statistical methods, the two customer populations according to the total amount of HP each had tested in 1996. (best scale variable available)
6. Randomize the population within each HP-defined strata.
7. Eliminate any customers who either had recently been the subject of Edison market research or whose representatives requested they not be contacted. [11]
8. Perform the participating customer survey, collecting a self-report of key data necessary for the Arizona comparison: For Water Supply customer's the variables were Total Population Served or Number of Service Connections. For Agricultural customer's the variables were Total Sales in 1996 and/or Number of Employees in 1996.

[10] File "HARVRLW"; cf. Appendix D for a more detailed description.

[11] Step 7 had the effect of eliminating more of the very largest customers from the sample. Although unavoidable, this may have introduced bias into the survey. The expansion weighting attempts to control for such bias. It's unknown if any such effect may have occurred.

9. Expand the sample of participating Edison customers attained back to the original Pump Test Program population to develop case weights
10. Design a model-based sampling plan for the Arizona Water Supply customers, using the weighted Edison territory participant sample as the population, and stratifying on the variable Total Population Served.
11. Design a model-based sampling plan for the Arizona Agricultural customers, using the weighted participant sample as the population, and stratifying on the variable Number of Employees in 1996.
12. Randomize the population within each strata.
13. Perform the Arizona customer surveys.
14. Expand the sample of Arizona customers attained back to the sample of participating (Edison) customers to develop analysis case weights (using a balanced post-stratification weighting method).
15. Apply the weights to the survey results.

The Arizona sample was weighted so as to be representative of the Edison territory pump test tracking system population. This weighting method was used to correct for cases where differences in scale occurred. As described above, the variables used to develop the weights were population served (water supply) and number of employees (agriculture). All quantitative survey results are weighted to enable comparison between the two groups. Results are representative of the pump test program population, not all Edison or Arizona pumping customers.

A simple lookup table for estimating the statistical precision of the survey results is provided below. [12]

Exhibit 3-1: Estimated Statistical Precision of the Customer Survey

Estimated Statistical Precision of the Customer Survey				
Survey Estimate	**Standard Error**	**Error Bound**	**Low Estimate**	**High Estimate**
0%	0	0.0%	0.0%	0.0%
10%	0.041	6.7%	3.3%	16.7%
20%	0.054	8.9%	11.1%	28.9%
30%	0.062	10.2%	19.8%	40.2%
40%	0.066	10.9%	29.1%	50.9%
50%	0.068	11.1%	38.9%	61.1%
60%	0.066	10.9%	49.1%	70.9%
70%	0.062	10.2%	59.8%	80.2%
80%	0.054	8.9%	71.1%	88.9%
90%	0.041	6.7%	83.3%	96.7%
100%	0	0.0%	100.0%	100.0%

3.1.3 Pump Test Tracking System SIC Code Verification

As described in the previous section, an initial analysis of the SIC codes associated with tests in the pump test tracking system was performed during the process of developing the sample frame for the customer surveys. This analysis suggested that of a total of 664 "Top" or corporate customers who received at least one pump test in 1996, 45% belonged to the category water suppliers, while 44% were agricultural end users. The survey collected customer reports of main business activity, leading to the

[12] Estimated precision is based upon the equation: SQRT(1-(n/N))*SQRT((p*(1-p))/n).

recategorization of several customers. The weighted survey results suggest that the pump test tracking system may contain more agricultural customers and fewer water supply customers than is indicated by the frequency of the facility SIC codes associated with individual tests. The table below presents the results of these analyses, both before and after recategorizing customers based on their self-reports of main business activity. No estimates are reported for the other three categories of customers as the survey did not target these customer groups.

Exhibit 3-2: Comparison of Tracking System and Customer Reports of Business Activity

	Agriculture	Water Supply	Sewer	Golf	Other	Total
Tracking System (N)	294	296	5	13	56	664
Tracking System (%)	44%	45%	1%	2%	8%	100%
Sample Design (n)	23	27	--	--	--	50
Actual Survey (n)	19	31	--	--	--	50
Weighted Survey (N)	333	257	--	--	--	590
Weighted Survey (%)	50%[13]	39%	--	--	--	89%

3.2 CUSTOMER PROFILES

3.2.1 Profile of Participating (Edison Territory) Customers

A total of 50 surveys of customers participating in the pump test program were conducted in Edison's territory. According to their designation in the pump test tracking system, 23 were agricultural users and 27 water suppliers. The survey collected customer reports of main business activity, leading to the recategorization of several customers. The final distribution of customers was 19 Agricultural and 31 Water Supply customers. Included within the 19 agricultural users, five golf course/country clubs were identified.

Water suppliers ranged in size from large municipal agencies serving populations in excess of 120,000 to small mutual and privately owned agencies serving rural populations of less than 100. Contacts at the larger suppliers were typically Superintendents, Operations Managers or General Managers, while at the smaller agencies, it was usually a part-time Secretary/Treasurer, the President, or if privately owned, the owner. One customer reported no longer operating their well pumps as a result of perchlorate contamination in their aquifer. Instead they now draw water from a large neighboring municipal utility.

Agricultural users ranged in size from less than 100 acres with only one or two pumps to over 4,000 acres with as many as 200 separate pumping facilities. Some were single person run operations, while several had in excess of several hundred employees. Contacts were typically the owner, ranch foreman or a partner. There were no livestock operations included in the Edison territory survey. The golf course customers described using mainly reclaimed water for the greens, using their wells primarily for backup and for potable water uses.

3.2.2 Profile of Arizona Customers

[13] This estimate of 50% "agricultural" includes several customers who identified themselves as operating golf courses or country clubs.

A total of 52 surveys were conducted in Arizona, 26 with water suppliers and 26 with agricultural users. No recategorization of user types was necessary. Water use in Arizona differs from that in Southern California in several ways. The most notable difference is the more extensive territories of utility districts, with several utility districts or large private water companies managing multiple service areas throughout the entire state. In Edison's territory, the more densely populated and suburban municipal organization of the area leads to sometimes large, but relatively localized, water utilities with less extensive service areas. Some larger agricultural users in Arizona reported being serviced by several utility companies or districts, each with varying levels of service and programs. Where available, Arizona water suppliers and agricultural users rely heavily on Colorado River water from canals and less on well water. A number of Arizona surveys reported rarely using their wells anymore since the river water is cheaper to draw and plentiful.

There were no golf courses included in the Arizona surveys, but the Arizona sample included a number of livestock and nursery operations, neither of which were in the Edison territory survey. Agricultural users were generally responsible for larger farms than in California, with some locations covering in excess of 20,000 acres. Most of the Agricultural users in Arizona raised ground crops (barley, soy beans, cotton, etc), while California users were more likely to grow tree crops (citrus, avocados, etc). Titles of those surveyed for both Arizona suppliers and agricultural users were similar to their California counterparts.

Of all of the calls placed in Edison's territory, only two refused the survey, while calls to Arizona resulted in six refusals. Californians knew of the program and were generally more willing to talk. Arizona contacts were much less willing to talk, only gradually understood why they were being called, and in many cases needed to be convinced that they were not being sold something. As a result, the Arizona surveys on average took about 30% longer than those in Edison territory.

3.3 CUSTOMER SURVEY RESULTS

3.3.1 Program Awareness and Use of Other Testing Services in Southern California

All 50 contacts in Edison's territory (100%) were aware of the pump testing program. Many larger agricultural users and municipal water agencies alike reported heavy reliance on the testing. Many also cited other advice Edison offers on rate structures, energy saving technologies, seminars and other educational and informational services. Smaller suppliers and agricultural users reported familiarity with the program, but several stated they haven't had a pump tested or even seen Edison people in years. Several of these reported feeling that Edison had cut back on the program and because of their size, they probably would not be included any longer in the free testing. Several of these smaller operations reported simply "waiting until something breaks".

A minority of program participants also rely on private testing services. Overall, 9% of program participants report having received a pump test from another service.[14] Taken separately, 18.7% of water supply customers and only 1.5% of agricultural customers state they would use another testing service. The main reasons given for the use of other test services are:

[14] All quantitative survey results reported in this section are weighted to enable comparison between the two groups. Results are representative of the pump test program population, not all Edison or Arizona customers.

- Customer requires testing of gas-driven pumps
- Customer requires testing on a short time frame and the wait for an Edison test is too long
- Customer requires testing of a facility outside Edison's area.

Of those who reported having another service provider test their pumps, the mean number of tests done per year was 13.7. The highest number of non-Edison tests reported was 20 per year. The minimum number was 2.

3.3.2 Arizona Pump Testing Practices

Only 13.6% of Arizona customers report receiving any informational assistance from their utility. Taken by customer type, 29.2% of Water Supply customers and only 1.5% of Agricultural customers report receiving utility assistance. Only 17.3% of the Arizona customers surveyed have ever had a pump test (31.1% Water Supply; 6.6% Agricultural). For those customers who reported having a pump test, the mean number performed per year was 2.6 (3.1 tests/year Water Supply; 0.8 tests/year Agricultural). The highest number of tests reported by an Arizona Water Supply customer was 30 per year. The highest number for an Arizona Agricultural customer was only one test per year. The vast majority of these tests are performed by private testing services or contractors, with the remainder being conducted by in-house staff.

3.3.3 Attitudes About Pump Testing in Edison's Territory

In general, participating customers are very satisfied with the pump testing program. The following table reports the % of agricultural, water supply, and customers overall who agreed that Edison's pump testing program has helped in the following ways.

Exhibit 3-3: Customer Reports of Ways the Edison Pump Testing Program Helps Them

Perceived Benefits: All Participating Customers	Ag.	W.S.	Overall
Reduced time or cost of collecting information	17.4 %	33.5 %	24.4 %
Reduced doubt and uncertainty when making new purchases	15.6 %	27.7 %	20.9 %
Reduced information disadvantage with dealers and suppliers	0.6 %	26.8 %	12.0 %
Reduced the hassle of performing testing yourself	14.4 %	35.2 %	23.4 %
Improved access to financing	2.7 %	9.3 %	5.6 %
Changed their attitudes about technologies or business practices	3.6 %	19.8 %	10.7 %
Changed the way they are organized or do business	2.7 %	23.0 %	11.5 %
Increased the availability of products or services of benefit	12.3 %	21.4 %	16.3 %

These results may seem low at first. This is because the perception of program benefits is strongly correlated with the size of the customer (as measured by "total horsepower tested in 1996"). Smaller customers are far less likely to agree that the program helps them in any of these specific ways. Looking just at the three largest strata of customers, 57% of agricultural customers and 97% of water supply customers agreed that the program "reduced the time or cost of collecting information". Clearly it is the larger customers who perceive more benefits of receiving Edison's assistance. The % of the largest customers who perceive specific program benefits are shown below.

Exhibit 3-5: Largest Customer Reports of Ways the Pump Testing Program Helps Them

Perceived Benefits: Participating Customers (Highest Strata)	Ag.	W.S.
Reduced time or cost of collecting information	100 %	100 %
Reduced doubt and uncertainty when making new purchases	100 %	63 %
Reduced information disadvantage with dealers and suppliers	100 %	100 %
Reduced the hassle of performing testing yourself	100 %	82 %
Improved access to financing	50 %	0 %
Changed their attitudes about technologies or business practices	100 %	36 %
Changed the way they are organized or do business	100 %	18 %
Increased the availability of products or services of benefit	100 %	18 %

Only one participating water supplier reported negatively about the pump testing program. He felt that Edison had cut back so much in the program that they are not keeping up on technology and he is considering having a private testing service do all of his testing in the future even though it will cost his agency.

Program participants were intentionally not asked to speculate on how their behavior might change were the program to be discontinued. However one large water supply customer did volunteer his opinion that if the program ended, it would open up a gap in the marketplace, one that some service provider would be sure to fill. "Maybe it would be me", he joked. "Sure, some folks would give it up [and stop testing], but not me."

None of the Arizona surveys of either water suppliers or agricultural end users reported pump testing being offered by their utility. In fact many were surprised to hear it existed in California. When asked to consider pump testing, most larger water suppliers are only familiar with factory testing of pumps, which they only receive prior to a new piece of equipment being installed.

3.3.4 Edison/AZ Comparison of Procedures and Practices

For the purposes of the market transformation assessment, the most telling comparison comes from juxtaposing customer operations and maintenance practices in the two areas. The survey asked both Edison and Arizona customers to describe how often they followed a number of procedures encouraged by the pump testing program. The procedures were phrased as follows:

1. "Predictive maintenance" (periodic pump testing, diagnostic record-keeping, etc. to help anticipate major repairs
2. "Priority pumping" (operating most efficient equipment first) to help reduce energy costs
3. "Pre-installation inspection" pump testing to determine well conditions prior to having a new pump sized or installed
4. "Post-installation validation" pump testing to verify that newly installed pumping equipment has been properly sized and installed
5. "Troubleshooting" pump testing to help determine the causes of malfunctioning equipment
6. "Volume validation" pump testing to determine the water table levels or certify water flow rates in adjudicated basins
7. Some form of "cost/benefit analysis" (e.g., simple payback, lifecycle costing, ROI) that uses pump test data to make new pump equipment investment decisions.

The following table reports the % of customers in Arizona and Edison's territory who stated that they always or usually do these things.

Exhibit 3-6: Percentages of Customers Who "Always" or "Usually" Practice Certain Procedures

	Edison Territory			Arizona		
	W.S.	**Ag.**	**All**	**W.S.**	**Ag.**	**All**
Predictive Maintenance	61.5 %	28.2 %	42.7 %	15.2 %	0 %	5.3 %
Priority Pumping	24.5 %	11.3 %	17.1 %	27.2 %	1.5 %	12.7 %
Pre-Testing	54.7 %	18.0 %	34.0 %	37.0 %	10.2 %	21.9 %
Post-Testing	30.3 %	28.1 %	29.1 %	62.0 %	25.2 %	41.3 %
Trouble-Testing	19.9 %	8.4 %	13.4 %	10.1 %	0 %	4.4 %
Volume Validation	49.4 %	13.8 %	29.3 %	7.0 %	0 %	3.0 %
Cost Benefit Analysis	27.6 %	12.9 %	19.3 %	52.0 %	19.5 %	33.6 %

The most significant differences between the two areas have to do with predictive maintenance and volume validation practices. Of pump test program participants, 62% of Water Supply customers "always or usually" practice predictive maintenance, as compared with only 15% in Arizona. No Arizona agricultural customers reported "always or usually" engaging in predictive maintenance. The low level of adoption of this energy-saving practice in Arizona is believed to be the result of the relative paucity of pump testing options. Many Arizona respondents had a hard time understanding the difference between "predictive" and "preventative" maintenance. Most Arizona locations apparently leave pumping equipment alone unless something very obvious is observed, such as escalating energy consumption, or decreased water flow.

The frequency of volume validation pump testing is also significantly different between the two areas. Among Edison territory participants, 49% of Water Supply customers "always or usually" practice volume validation pump testing, as compared with only 7% in Arizona. Again no Arizona agricultural customers reported "always or usually" engaging in this practice. Only one Arizona supplier reported functioning under adjudication, but said he had never approached the allocated limit. Most suppliers in Arizona who discussed the matter stated they have to report usage to the state but they never hear back and are not required to verify the accuracy of their flow meters. In contrast, many Edison territory suppliers do operate within adjudicated basins and must conform to strict reporting requirements. The adjudication process in California, coupled with increasing populations, decreasing water supplies and a more developed regulatory system than in Arizona apparently leads to more routine meter validation pump testing.

Several other practices hypothesized to have been more prevalent in California as a result of pump testing do not appear to be significantly less common in Arizona. In general, priority pumping, and the use of pump testing before installing a pump and to troubleshoot a problem are more common in Edison's territory, but not by a margin that would suggest these practices should be considered to be major program effects. Indeed considering just Water Suppliers, priority pumping is estimated to be slightly more common in Arizona. Finally the use of cost/benefit analysis, and post-installation pump testing are actually both more common in Arizona despite the absence of utility pump testing. The latter most likely refers to simple tests of flow performed by the installation contractor to verify that the pump is putting out the volume of flow it was designed to provide.

Participating pump test customers were asked to rate the importance of Edison's program in their decision to adopt these practices. The percentages of those who rated the program's influence "very important" ("4" or "5" on a scale of 1-5) are shown in Exhibit 3-7. Again these results show that taken together, most customers only rate Edison a moderate influence on their decision-making. Arizona customers were similarly asked to rate the importance of "informational assistance from your utility" in their decisions to adopt these practices. Not one gave their utility a rating of "4" or "5".

Exhibit 3-7: Customer Ratings of Utility Influence

	California Edison's Pump Test Program			Arizona Utility Informational Help		
	W.S.	**Ag.**	**All**	**W.S.**	**Ag.**	**All**
Predictive Maintenance	17 %	4 %	10 %	0 %	0 %	0 %
Priority Pumping	10 %	1 %	5 %	0 %	0 %	0 %
Pre-Testing	2 %	1 %	1 %	0 %	0 %	0 %
Post-Testing	7 %	1 %	3 %	0 %	0 %	0 %
Trouble-Testing	6 %	1 %	3 %	0 %	0 %	0 %
Volume Validation	6 %	1 %	3 %	0 %	0 %	0 %
Cost Benefit Analysis	10 %	1 %	5 %	0 %	0 %	0 %

3.4 1997 SURVEY CONCLUSIONS

The major findings of the Arizona customer surveys are:

1. No utility pump testing assistance exists in Arizona
2. Only 13.6% of Arizona customers have received information assistance from their utility
3. Pump testing is much less common in Arizona (only 17.3% have had a pump test)
4. These tests are typically provided by contractors or private testing services
5. Arizona customers perform cost/benefit analysis and post-installation pump testing more often than do their Edison territory counterparts
6. Arizona Water Supply customers practice priority pumping more often than do program participants

The major findings of the pump test program participating customer surveys are:

1. All participating customers surveyed were aware of Edison's program
2. Participating customers, particularly those who have the most HP tested, feel the tests help them, especially to reduce the cost of collecting information
3. Only 9% have had a test from another service provider
4. Pump test customers say they "always" or "usually" practice predictive maintenance far more often than their Arizona counterparts (62% vs. 15%)
5. Pump test customers also practice volume validation pump testing much more often (49% vs 7%)
6. Other practices hypothesized as possible program effects are not significantly more common for pump test program participants
7. Edison customers rate the program a moderate influence on their decisions to adopt specific practices
8. Some 10% (17% of Water Supply customers) rate the program "very important" in their decision to adopt predictive maintenance

These findings suggest that the program does provide substantial value to customers, primarily by reducing the informational market barriers they experience. Customer effects and support for the program are most noticeable for the participants who have the most horsepower tested. Customers report that the program helps them by reducing their information search costs, their uncertainty in making new equipment purchases, and the asymmetrical information advantage that dealers have over them. These findings are corroborated by the results of the 1996 survey which showed that 84% of all pump test-only participants agreed with the statement, "The Edison pump test program has helped your company maintain the efficiency of your pumping plant."

The behavioral barriers the program addresses are primarily related to encouraging the practices of predictive maintenance and volume validation. The former appears to have significant value to customers who have adopted predictive maintenance as a routine practice, and would likely continue to pay for it themselves were program funding to end. Clearly the program is not the only influence customers cite when adopting new practices. Nevertheless some do consider the program "very important", particularly when it comes to adopting the habit of predictive maintenance.

3.5 1996 SURVEY ANALYSIS

This report's estimate that 9% of program participants are using alternate testing services differs somewhat from the findings of the follow-up study to the 1996 Agricultural Rebate and Audit Program Impact Evaluation (Agricultural Pumping: Analysis of January 1996 Survey Data, Athens Research, April 1996). In this earlier study, participating customers who agreed that "If the Edison pump testing program did not exist, [they] would pay for the same testing services from non-Edison sources" were asked whether their firm was currently obtaining testing services elsewhere. The weighted estimate of non-Edison test use among customers who would pay was 33.9%. From that study, "the implication is that approximately 20% of customers with some recent testing experience have one or more accounts involved in non-Edison testing." The present study asked all respondents to answer the question, resulting in the estimate of 9%.

The 1996 survey included customers belonging to three groups that could have had experience participating in the pump test program, and a fourth group of non-participants:

- Customers who received a rebate in 1996 (n=109)
- Customers who received an audit in 1996 (n=37)
- Customers who received a pump-test only in 1996 (n=171)
- Customers (non-participants) who did not receive a pump test or rebate from Edison (n=133).

The 133 "non-participants" included 113 valid responses from Edison water pumping customers who had not received a pump test from Edison as recently as 1991. This survey confirmed that awareness of the pump testing program is high, even among such "non-participants". Over 74% indicated they were aware of the pump testing program (78% unweighted) while almost 24% (30% unweighted) reported having had an Edison test in the past on a pump corresponding to the sampled account.[15] In addition 60% (18% unweighted) of all non-participants indicated that they engage in pump testing, using a non-Edison source. The difference between the weighted and unweighted results point out that this third-party pump

[15] The question was phrased, "Have you ever participated in this testing program run by Southern California Edison?" If the answer was "Yes", customers were asked to confirm that the test they recalled had in fact been performed on the pump at the sampled location and meter.

testing of non-participants occurs primarily on the lower consumption accounts. The implication here is that Edison's program serves the high consumption accounts while the private testers are serving the smaller accounts.[16] Taken together, 70% of these indicated that a vendor of some type was the source of these non-Edison tests. The unweighted frequencies of these sources of non-Edison pump tests are shown in Exhibit 3-8.

Exhibit 3-8: Non-Edison Sources Used by Edison Area Non-Participants (Jan. '96 Survey - Edison)

Source of Pump Test	Frequency	%
The Company Itself	3	15%
Private Vendor	9	45%
Vendor – Seller	3	15%
Vendor – Installer	2	10%
Other	2	10%
Don't Know	1	5%
Total	20	100%

Edison's 1996 survey also explored customer reports of actions taken in response to receiving a pump test cost analysis letter. Customers who received a cost analysis letter were asked whether they recalled the pump test and whether they recalled the cost analysis letter. All (100%) recalled the test and 75% recalled the cost analysis letter. Those who recalled receiving a cost analysis letter were asked, "Did you make any changes to this pump or pumping system in response to the letter?" Rebate-receiving customers reported making a change 52% of the time, as compared to 30% of audit-receiving customers and 25% of pump-test only customers. Though not receiving pump tests from Edison, 21% of all non-participants surveyed reported that they had made an addition or replacement of some type in 1994 or 1995 that would enhance pumping efficiency.

Customers' reports of which individual measures they added or replaced showed that rebate customers consistently took actions more often than either audited, pump-test only, or non-participant sites. At the individual measure level, pump-test only customers reported addition and replacement rates roughly the same as those reported by non-participants. Not surprisingly, these data confirm that pump test program participants generally took advantage of Edison rebates when making efficiency improvements. Even so, the program did at that time appear to encourage the adoption of specific control technologies at a rate higher than that observed for non-participants. The table below compares adoption rates for some general categories and for some selected control equipment. When these individual measure reports were summarized, 33% of pump test-only participants reported some change to their facilities, as compared with 21% of the non-participants.

[16] For water supply customers, the minimum annual consumption required for an account to be assigned to the highest stratum was 25.77 MWh for pump test participants. For non-participants it was less than one third this level at 7.88 MWh. For agricultural customers, the ratio was even greater (8.58 vs. 2.33 MWh).

Exhibit 3-9: Pump Test and Non-Participant Measure Taking in 1994-95 (Jan. '96 Survey - Edison)

	Non-Participants		Participants	
	% Added	% Replaced	% Added	% Replaced
General				
Motor	0.59%	11.35%	1.81%	9.89%
Other Electrical	0.23%	0.00%	1.50%	2.39%
Pump/pump tube	0.00%	13.39%	1.77%	15.40%
Other	10.79%	18.16%	15.60%	17.38%
Selected Controls				
VSD	0.02%	0.00%	0.85%	1.19%
Capacitor	0.00%	0.00%	1.07%	2.39%
Time Clock	2.02%	0.23%	6.84%	2.20%
Other Control	0.00%	0.59%	2.76%	3.09%
EMS	0.00%	0.00%	0.60%	1.19%
Any Changes	21.2%		32.8%	

The finding that no dramatic differences exist between pump test participants and non-participants was previously interpreted to mean that the pump testing program "induces little customer activity that would not have occurred *naturally*." However the earlier finding that 60% of these non-participating customers are in fact getting some kind of pump test may explain some of this naturally occurring conservation.

3.6 1992 SURVEY ANALYSIS

The original report documenting Edison's 1992 agriculture and water supply energy usage survey does not provide information directly pertinent to the pump testing program. Instead this mail survey of 674 locations was designed to collect general equipment saturation data on the agriculture and water supply segment. However reanalysis of the 1992 data suggests some interesting trends in development of an independent market for pump test services. All respondents were asked, "Within the last four years (1989, 1990, 1991, 1992) has an **energy survey** been performed at the location referred to on the front page of this survey?" Therefore this category of customers recalling an "energy survey" includes both pump tests and other more general building energy audits. But if we consider only the 66 locations surveyed which described themselves as Pump-Only Locations, the so-called "energy survey" can be assumed to constitute a pump test.

Though the number of pump-only locations is small (66) compared to the full sample (674), these sites represent 75% of the water supply locations and 72% of the irrigation locations. The higher a location's kWh consumption, the more likely respondents were to report a pump-only site. Sixty% of the sites in the highest consumption bin (+960 kWh/year) were pump-only sites. If we look only at these 66 sampled pump-only sites, 53 of them (80%, unweighted) reported receiving an "energy survey" (i.e., pump test). Interestingly when weighted, the result is that only 37% of the full population of pump-only sites are estimated to have received a pump test. This confirms what we already know, namely that

testing of pump-only locations is markedly skewed toward the largest energy consumers. All 53 "surveyed" pump sites reported who performed their survey, and four sources were cited: 89% named Edison alone, 4% Southern California Gas, 2% "private consultants" and 6% were completed by the facility's own employees. If we look only at the six pump-only respondents who mentioned another test provider, three (50%) cited their own employees, two So. Cal. Gas (33%) and only one (17%) a private source. Taken individually, the one respondent who reported using a private consultant and two of the three who reported using their own employees also said they had received a test from Edison.

When weighted, these data suggest that in 1992 Edison held at least 95% of the market share of energy surveys (pump tests) performed at electrical pump only locations in its service territory. In fact this estimate is conservative. Of the remaining share of locations that had tests by employees (2%), private consultants (2%) and So. Cal Gas (1%), Edison also provided testing services 61% of the time. Only two% of all locations reporting a pump test indicated they had not received a test from Edison in the last four years.

A total of 16 of these 66 pump-only location customers either reported no energy survey (13) or only a non-Edison survey in the previous four years (3). Therefore, these locations constitute a sample of pump test program non-participants from the 1992 survey. Considering this small sample, only three (19% unweighted) reported a test. When weighted, the rate of such non-participant testing in 1992 drops to just 1%.

Respondents were asked "Within the last four years (1989, 1990, 1991, 1992) has your business received a rebate for energy-efficient equipment at the location referred to on the front page of this survey?" Of those who identified Edison as their pump test provider, 13% (weighted) reported receiving a rebate in the last 4 years. All of these cited Edison as the source of their rebate. This suggests the overlap between the pump test and rebate programs was relatively minor at that time.

3.7 CONCLUSIONS FROM THE COMPARISON OF THREE CUSTOMER SURVEYS

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 providers in California, and (2) a significantly greater frequency of pump testing among California-area non-participants as compared with water pump users in Arizona. In the early 1990's, Edison was by far the primary provider of pump testing services in its service territory, commanding a market share of 95% or more. Private vendors were responsible for only a minor proportion (17%) of the few tests provided by others. By 1996, 60% of customers who had not received an Edison test in at least four years reported they had their pumps tested by a non-Edison source. Of these Edison-area "non-participants", 70% reported using an outside vendor or contractor for this service. By comparison, in 1997, only 17% of Arizona-area "non-participants" reported having their pumps tested. The 60% estimate of Edison-area non-participant testing should be considered high since it is based on a very small sample. This rate of private pump testing cannot be supported by the qualitative data collected from dealers and others on the size of the private pump testing market. A more conservative estimate would be half that rate, or 30% of all non-participants.

The comparison of the California and Arizona non-participants is somewhat obscured by the fact that in California the pump test program is targeted to the highest consumption pumps, resulting in a self-selected "non-participant" population running what are on average, smaller pumps. Our analysis of the Arizona survey data was specifically designed to address this issue. Instead results were weighted to match the Arizona "non-participants" to California participants using scale criteria. However this

difference in methods only amplifies the significance of the findings: a large percentage (60%) of California's smaller consumption non-participants employ pump testing, compared to only a small percentage (17%) of Arizona customers comparable to the program participants. Given these findings and the high levels of program awareness (74%) and past participation (24%) among Edison area non-participants in 1996, it would appear that the pump test program has already substantially contributed to the development of an independent market for pump testing in Southern California. Against the baseline of the 1992 survey, it would appear that most of this growth in independent pump testing has occurred since then, as Edison has taken steps to improve the cost-effectiveness of its program.

4. MARKET PLAYER INTERVIEW RESULTS

4.1 COMPARISON METHODOLOGY

This section presents analysis findings from the telephone surveys and interviews with the different groups of market players in Southern California and Arizona. For each type of market player, the Edison territory surveys were completed first. Interviews were completed between May and September of 1997. Similar survey instruments were used for all market player interviews. Each group of market player interviews covered the following categories of questions:

- Business focus and scale, area of specialization, personal experience in pump business
- Drivers of efficiency: What determines whether efficient equipment is installed?
- Business practices (stocking, specifying, and marketing of high efficiency equipment)
- Sales trends
- Comparisons between Southern California and elsewhere, particularly Arizona
- Program effects on market conditions and behavior
- Rating utility efforts and other factors influencing trend toward more efficient pump systems.
- Perceived market barriers (and "bottlenecks") to energy efficiency

The market player surveys discussed cross territory comparisons with respondents who had direct experience in both the Edison and Arizona markets. Comparison area interviews skipped the module containing questions about Edison's program, (other than awareness of the program and whether alternative pump test services existed in their area). In addition the dealer/contractor and consultant surveys also explored:

- % of sales/service work (by pump types and efficiencies level)
- Self-performed pump testing and recommendations for pump testing.

In general, discussions with each group of market players were focused primarily on their perceptions of program effects at their own level of the market. However some market players, especially dealers contractors and consultants, have insights into the decision-making processes and market barriers of *customers* that may be different or even superior to even those of the customers themselves. For these reasons customer level issues were also explored in the surveys of other market players.

In developing the market characterization, we found that in the agricultural and water supply markets, there are a number of different types of equipment vendors, installation and service contractors and consulting engineers who place orders for pumping equipment. This made the collection of data from these groups more problematic than would have been the case in a simpler, single channel market. Niche markets and differences in dealer scale can be significant sources of distortion in this type of survey. These issues were dealt with through two means:

- Careful development of the sample frames for these groups as informed by key informants, the literature search and staff interviews, and
- Screening and business focus questions which asked to the respondent to characterize their main business activities, the type of customers they served, their geographic concentration, and their years of experience in the market.

California area market players familiar with the program were able to provide their perspectives on the market effects and barriers they perceived to be most effected by the Edison program.

Regional distributors were a fruitful source of information on product sales trends. The surveys of distributors were particularly effective for the agricultural market, since the majority of products sold to this end user group tend to flow through them. Distributors were found to be less important in the water supply market, where direct manufacturer representatives, consultants, and full service dealers perform the majority of the distribution function. They were asked to discuss whether they saw any program effects at their level of the market. Distributors too were asked to provide their perspective on customer decision-making processes and the market barriers they perceive to be most effected by the Edison program.

Manufacturers were expected to be a good source of information on overall shifts in regional and national product characteristics, but they normally lack the level of geographic detail necessary to establish utility-specific sales trends. They were approached as a source of important broad-level information supplementing that available from distributors. In addition manufacturers were asked to discuss the occurrence of program effects at their level of the market.

The hypothesis that the program has affected the banking and credit institutions was investigated through interviews with these market actors in both Southern California and Arizona. Program effects on the water supply regulatory agencies were explored through a survey of water agency personnel in both states.

Prior to the telephone surveys, a vendor fair sponsored by the Inland County Water Association was held on May 8, 1997 in Rialto, CA. This event provided an exceptional opportunity to speak with a wide range of marketplace actors and to see them all in action. It also allowed for a pretest of the market player survey instrument. Two RLW interviewers were present for participant observation, semi-structured in-person interviewing, and administration of a written questionnaire. This event involved primarily water supply agency customers, and a wide range of "vendors" (distributors, dealers, and contractors) active in both the water supply and agricultural markets. The event drew approximately 300 attendees, 65 of which were vendors. An Edison employee sits on the board on the ICWA and several Edison staff members were also in attendance. This allowed the direct observation of typical customer interactions between customers and Edison Hydraulic Services staff. It was clear from observing the ICWA show that Edison maintains a high profile within the municipal water pumping community.

4.2 SURVEY OF MANUFACTURERS

4.2.1 Profile of Manufacturers Interviewed

Interviews were completed with the following ten manufacturers: ITT/A-C Pumps, Grundfos, Ingersoll-Dresser, General Signal (Verti-Line), Weir/Floway, Sterling Peerless, Floserve Corp (formerly BW/IP; Byron-Jackson pumps), Goulds, Sim-flow; Paco/Johnston. The sample of manufacturers was derived from lists of major brands generated by Edison staff, confirmed with key informants, and further researched via the World Wide Web. This latter step was valuable in identifying parent/subsidiary and brand name overlaps for these complex and often international businesses. Information about interviewees is presented in Exhibit 4-1.

Exhibit 4-1: Manufacturers Surveyed

Respondent	Division - Position	Customers	Customer Location	Specialty/Other	Sales Data
MF-1	Marketing- Product Line Mgr	Mostly Municipal; some Agriculture	Worldwide	vertical centrifugal pumps	Recently completed market study, but not willing to release it; says no regional differences
MF-2	Product Line Manager (Design)	Agriculture; Municipal; Other	Worldwide	large. Centrifugal pumps	Nothing to show since no effects
MF-3	Sales Manager	Agriculture; Municipal; Other	National	vertical + split case centrifugal	Nothing to show since no effects
MF-4	Director of Municipal Group	Agriculture; Municipal; Other	National	centrifugal pumps	Nothing to show since no effects
MF-5	Product Design Mgr	Agriculture; Municipal; Other	National	centrifugal pumps	Has data, may be willing to share, but doubts value to us
MF-6	Sales Mgr	Mostly Agriculture; some Municipal	Worldwide	centrifugal pumps	Nothing to show since no effects
MF-7	Mgr, Regional Sales	Mostly Agriculture; some Munic+Other	National	centrifugal pumps	Nothing to show since no effects
MF-8	Corporate HQ Sales	Agriculture; Municipal	National	centrifugal pumps	Nothing to show since no effects
MF-9	National Sales Office	Mostly Municipal, some Agriculture	National	centrifugal pumps	Willing to share, but no organized data on efficiency differences
MF-10	Sales, western region	Mostly Municipal	National	centrifugal pumps	Sales data – not willing to release it

As indicated in the Exhibit, interviewees included both marketing vice presidents and product managers at the headquarters offices, as well as some regional representatives. In many cases, different individuals were contacted regarding the larger-pump municipal sector and the smaller-pump agricultural sector. All firms interviewed manufacture pumps for use in agricultural and/or municipal water applications.

Types of Manufacturers

All of the manufacturers sold to national markets and many also sold internationally. In fact, three of them were subsidiaries or divisions of European companies. All served the agricultural and irrigation markets, although some specialized in larger pumps oriented more towards the municipal water market, while others specialized in smaller pumps oriented more towards the irrigation market. The interviews appear to encompass most of the major players, since many of them cited the others in noting differences in pump styles and market orientation. Calls were also made to a variety of other pump manufacturers who were disqualified from these interviews because they made either : (1) smaller pumps for largely residential water supply and residential yard irrigation, or (2) high pressure pumps oriented more towards the needs of Midwestern grain farms rather than California specialty crop farms, or (3) specialized pumps for industrial and commercial applications.

Types of Distribution Networks

The meaning of the term "distributor" can be ambiguous, depending on the type end user. For the municipal water market, the distributor is usually a sales agent for the manufacturer rather than a true wholesaler. For this market, the pumps are very expensive and most of the orders come in the form of requests for proposals (RFP's) for custom quotes, generated by engineering consultants (working for the municipal water agencies). Those orders are often submitted to the manufacturer's regional "distributor", who may be either a local branch office of the manufacturer or else an exclusive representative of the manufacturer for that region. The regional representative then passes the RFP on to the corporate HQ as part of the bid preparation process. For some companies, RFP's are handled directly at the headquarters. For the agricultural pump market, on the other hand, the distributor is likely to be a wholesale dealer who stocks off-the-shelf pumps. The orders for those pumps typically come most often from pump contractors, and less often directly from the farmer. These same patterns were confirmed in both states.

4.2.2 Awareness and Perception of Edison's Pump-Testing Program

Familiarity with the Edison Pump Test Program

One-half (5/10) of the interviewees were aware of the Edison pump test program. Those aware of the program were generally those associated with the regional sales office. The others, who were not aware of the program, were generally involved in national-level sales and were familiar with product sales patterns among states but not with specific programs in California.

Exhibit 4-2: Program Awareness by Manufacturers

Location	Aware	Not Aware
California	3	2
Other (AZ, NM, TX, NY)	2	3

Perceived Effects of the Edison Pump Tests

Of the 5 manufacturers who were aware of the program, all felt that it was a useful service and did make a difference in terms of helping customers identify problems, although most (4 of the 5) reported that it did not affect their own product mix or sales volume in any way.

The one who did perceive an effect was a smaller manufacturer who had specialized in lighter-weight agricultural pumps, and had moved up to serve the municipal market as well. The representative of this firm noted that while they do not do business any differently as a result of the program, they think that Edison's program may lead to more frequent pump replacements. The representative from that same firm also noted that high interest in pump efficiency ratings in California has helped them make inroads there, and improved their market penetration. However, that same manufacturer was the one mentioned by two others as being a maker of the cheap, lighter weight pumps which look good on paper but do not last as long. The other four manufacturers noted that the lighter weight pumps do not last as long or maintain their output efficiency as long as heavier weight pumps. Two of them complained that customers and their consultants often did not appreciate that difference, and they noted that Edison's program appeared to emphasize short-term efficiency ratings without equal emphasis on long-term durability and efficiency. (One cited an Arizona Public Service study showing how pump bowls wear out in 4 - 12 years, depending on the manufacturer.)

Four of the five manufacturers aware of the program also reported that the Edison program lead to some additional inquiries from California customers, who send them pump tests reporting that their pumps are not performing up to factory specifications. They all said that this was a minor nuisance, since the problem was nearly always related to the installation and field conditions, rather than the pump itself. One also noted that pump testing may lead to more motor repairs than replacements.

Exhibit 4-3: Manufacturer Ratings of Program Effects

Summary of Findings (of 5 mfrs)	Perceived Effect of Edison Program		
	None	Some	Don't Know
Customer pump testing frequency	0	5	0
Efficiency of pumps made and sold	5	0	0
Reliability of pumps made and sold	5	0	0
Prices of pumps made and sold	5	0	0
Volume of pumps made and sold	4	1	0

4.2.3 Comparison of California and Arizona

Attitudes

There was a consensus that most customers (both municipal and agricultural) still cared more about price than efficiency or durability. All ten manufacturers noted that the interest in efficiency was mostly coming from the municipal water market, where the RFP bid requirements are set by consulting engineers who have the ability to set efficiency specifications. It was generally agreed that most farmers are more interested in current price than efficiency and its long-term payback.

Six of the ten manufacturers noted differences in customer buying patterns between California and other states. Two noted that CA and AZ have larger farms than states such as TX. Higher efficiency pumps are sold more often to the larger farmers in these states than the small ones. The third one noted that CA municipalities tend to have more stringent requirements on efficiency. The fourth one noted that among municipal water pump users, those in California were buying pumps with more monitoring electronics. The fifth one noted that CA municipal customers needed more documentation and "witness testing" than customers elsewhere in the western US. The sixth one rated customer interest in efficiency as high in CA, medium in AZ and low in TX.

The other four manufacturers reported no perceivable difference among customers in the various western states. They generally agreed that there was very limited interest in efficiency among farmers, and a higher interest among municipal customers. Two of them cautioned that perceived differences among states were often due to differences in the composition of the company customer base in various states, rather than any fundamental difference in attitudes among similar customers. For instance, they noted that large municipal water customers tend to have higher efficiency requirements, and those are predominantly located in California. They also noted that the largest farms, which are more likely to have big pumps and better financial conditions, were also predominantly located in California. Two noted that they distribute their pumps differently in CA and AZ, with a company-owned office in CA (due to the larger market there) and an independent distributor in AZ.

Efficiency Trends

Half (5/10) of the manufacturers reported that pump efficiencies were clearly increasing nationally, including changes in bowl/impeller assemblies, motors and monitoring equipment. Three reported a slow increase in sales of variable speed drives. One noted a small but growing market for pumps with monitoring electronics (measuring watts/flow). The remaining five felt that pump design changes were very minor and mostly (or solely) due to improvements in motor efficiencies rather than pump technology. Two noted that design and installation factors can affect operating efficiency (and cost) more than equipment efficiencies.

In addition, four manufacturers noted that a significant share of the pumps sold in the agricultural sector are natural gas or diesel pumps (rather than electric pumps), and two of them reported increasing sales of the non-electric pumps for those markets. Those pumps were most applicable for in-line pumping. (At least two of the others only made electric pumps.) There was general agreement that current electric prices, especially in CA, made it more economical for the truly cost-conscious farmer to switch fuels rather than pay more for a premium efficiency pump.

All ten manufacturers reported that there is no overall difference between CA and other western states in terms of: (1) the types of products they manufacture and offer, (2) the efficiency levels of the pumps they sell to the various customer types. Thus while some of them felt that CA customers were somewhat different in their demands for information, they generally felt that customer size and type were the major driving factors behind differences in types of pumps sold. Most agreed that there are so many different types and sizes of pumps sold for so many different kind of applications, as well as many different combinations of driving motors and controls, that it is difficult to get statistics to actually compare across states. But in general, the manufacturers agreed that they are not aware of any dramatic differences in what they sell in CA versus elsewhere, except that CA has more larger customers.

However, three manufacturers reported that numbers of pump sales in CA have recently been growing faster than pump sales elsewhere around the country. Two of them noted that since the Edison program has been in place for a long time, they cannot attribute the trend to that program. The third one felt that a greater concern about efficiency issues in CA was indeed helping their line of products sell there, although that firm still noted that the efficiencies of the pumps they sell in CA are still the same as elsewhere. Another one noted that interest in pump performance, particularly in CA, has lead their firm to introduce a new line of pumps which have built-in electronic equipment to monitor the ratio of watts/flow, and indicate when the ratio goes too high, implying a need for servicing.

Other Factors

Three of the manufacturers noted that a factor minimizing differences in pump efficiencies between Arizona and California was that while Arizona utilities did not offer free pump tests, they did actively offer advice on pump purchase specifications for their customers. That form of customer education was felt to be most important in helping customers request the best pumps for themselves.

4.2.4 Market Barriers

There was consensus among all ten manufacturers that there were no real market bottlenecks or other barriers in the availability or stocking of manufactured pump products to impede the sales of higher efficiency pumps. The only market barrier, they agreed, was customer demand. The only point of any disagreement was on who needed to be better informed. Half (5/10) of the manufacturers felt that more could be done to sensitize contractors (for agricultural installations) and consulting engineers (for municipal water installations) about the need to trade off higher up-front price for longer-term efficiency and cost-savings. The others felt that it was the attitudes of the ultimate customers (farmers and municipal water districts), who often were more concerned about saving on up-front costs, which was the real underlying factor affecting contractor buying and consulting engineer bid specs. Most agreed that the customer focus on up-front costs was most severe for farmers, and that was often due to economic realities rather than knowledge of efficiency options.

4.2.5 Availability of Data

Some data comparing pump equipment sales trends between California and Arizona may be obtainable from manufacturers. However, the data cannot be meaningfully sorted by efficiency level, since there is no standard for differentiating higher-efficiency pumps from lower-efficiency pumps. The problem is that efficiency levels vary mostly by pump size. Thus we are left only with relative sales volumes for different sizes of pumps.

The case for connecting changes in the size of pumps in Southern California to an effect of the Edison pump test program would be tenuous at best. In any case, such data would fail to quantitatively substantiate the hypothesis that the program has changed the frequency of replacement or mix of high efficiency equipment. For these reasons no further efforts were made to collect shipment data from manufacturers.

4.3 SURVEY OF WHOLESALE DISTRIBUTORS

4.3.1 Profile of Distributors Interviewed

Summary information about the distributors interviewed is presented in Exhibit 4-4 and Exhibit 4-5 on the following pages. As the information suggests, interviewees were drawn from a wide range of occupations and a number of positions in the supply chain. All firms interviewed sell products to customers, either in a retail or wholesale capacity, and all have agricultural and/or municipal customers.

Exhibit 4-4: Profiles of California Pump Distributors

Respondent	Position	Market Segment	Customers	Customer Location	Specialty/Other	Sales Data	Comments
CA-1	Sales	Retail sales	Agriculture	San Joaquin	Residential/domestic pumps	Yes, not computerized but has all job order cards, sales, and Edison test results.	President of the company may be able to provide more information.
CA-2	President	Manufacturing; distribution	Agriculture; municipal; some industrial		No		
CA-3	Head of sales	Retail; installation; pump testing; manufacturing	Agriculture (85%); municipal; industrial	CA: south of Madera and north of Frazier	No		
CA-4	Head of operations	Retail sales dealer; contractor; pump testing	Municipal	All of CA—two offices, Fresno and Bakersfield	Wells—majority of sales in this	Yes, but not in computer files.	
CA-5	Service	Distributor	Agriculture; municipal	L.A. and Orange County	complete turnkey repairs; electric and variable speed motors	Yes, but not in central location	Separate municipal section may be able to provide more information

Exhibit 4-5: Profiles of Arizona Pump Distributors

Respondent	Position	Market Segment	Customers	Customer Location	Specialty/Other	Sales Data	Comments
AZ-1	Sales	Wholesale	Mostly industrial; utilities; some municipal	AZ	Mostly pumps for cooling		
AZ-2	Sales	Retail—pumping equipment; installation of pipelines	Agriculture (30-35%); municipal and industrial (65-70%)	AZ	Design and sell vertical turbine pumps; pipeline systems		
AZ-3	Sales	Service and sales (retail)	Agriculture; municipal water districts	AZ	Also do water districts		
AZ-4	Owner	Distribution and retail; mfr rep. Dorr-Oliver	Mostly industrial; some municipal	National			
AZ-5	Owner	Distributor	Municipal	AZ	Waste-water treatment equipment		
AZ-6	Sales manager	Wholesale; retail; manufacturers rep.	Municipal and industrial	AZ			

4.3.2 Awareness and Perception of Edison's Pump-Testing Program

Every California interviewee was aware of the Edison pump-testing program and all but one said that they or their customers use the service frequently. Two of the respondents, CA-1 and CA-2, said that Edison pump-test results are the primary source of information on pump efficiencies for themselves and their customers. CA-1 said that their company keeps all customer Edison test results on file. CA-2 said that upon meeting with a customer who hopes to buy or retrofit a pump, he first asks for recent Edison test results. CA-3 and CA-4 said that both their companies do pump testing but one of the respondents (CA-3) admitted that despite this, the majority of his customers' tests are performed by Edison. CA-4 said that they use the Edison program infrequently and only as a third-party verification of test results. This response may be explained by the fact that most of his customers are not farmers. CA-4 said his municipal customers will occasionally have Edison test their pumps but that many of the municipalities have their own pump-testing capabilities.

Respondents generally agreed that the pump testing program is an important factor in rising pump efficiencies, second only behind "rising energy costs" as a driver of increasing pump efficiency. Exhibit 4-6 presents distributors ratings of the importance of the testing program as compared to the ratings given to nine other factors. As the information in the table shows, all rate the pump testing program as more important than the average of the other factors but in three of the four cases for which there is information, the difference is slight. Rebate programs are also highly rated, relative to other factors.

Exhibit 4-6: Perceived Effect of Various Factors on Water Pump Efficiencies

	CA-1	CA-2	CA-3	CA-4	CA-5	Average
Rising Energy Costs	5	5	5	5	5	**5.0**
Free Pump Testing	**5**	**N/A**	**3**	**3**	**5**	**4.0**
Rebate Programs	5	1	5	3	5	**3.8**
Technology Improvements	3	N/A	1	3	5	**3.0**
Education	1	N/A	3	N/A	5	**3.0**
Marketing by Mfrs.	1	5	1	2	5	**2.8**
Pump Prices	1	N/A	1	N/A	5	**2.3**
Marketing by Distributors	1	N/A	1	2	5	**2.3**
Changes in Regulations	1	N/A	5	1	1	**2.0**
Average	**2.6**	**3.7**	**2.8**	**2.7**	**4.6**	**3.1**

(1 = no effect; 5 = large effect)

All five California interviewees mentioned the role of Edison testing as useful for third-party validation of private testing. Four respondents mentioned the tests as very important to their customers and their businesses. In some cases, this testing was seen as necessary because companies do not have the capability to do full testing and so their recommendations need to be backed up with actual test results. One respondent said that he does not have the equipment he needs to test pumps and so, without Edison results, his recommendations are basically just educated guesses. In other cases, Edison tests serve to give farmers a second unbiased opinion. As one interviewee said, the Edison test results allow customers to distinguish between sound recommendations and "some guy just looking for a day's work." Given the emphasis that respondents placed on the difficulty of getting farmers "to buy into" the idea that premium equipment will save them money, the ability of Edison to provide unbiased estimates of energy savings may be very important.

The importance of Edison's program as a source of free and unbiased information is confirmed by respondents' beliefs about changes that would occur if the program were ended. Three of the four interviewees responding[17] believe that if free pump-testing were not available to farmers, the demand for pump testing would fall and turnover of equipment might slow. Two respondents linked this directly to water pump efficiencies. In addition, one of the respondents from a small company in San Joaquin expressed concern that it would be difficult for farmers in her area to get their pumps tested. This company does not have the capability to do proper testing of pumps so that pump testing would have to be contracted out. Only one respondent suggested that in the absence of the Edison program, demand for pump testing would stay constant and the private sector would perform necessary testing. This, though, seems an optimistic view--his company currently performs testing for $50/pump (versus an average cost of $45,000 for each pump system sold) yet Edison performs a majority of the testing for his customers.

4.3.3 Comparison of California and Arizona

When comparing Arizona and California two caveats must be kept in mind. Sample sizes for the two areas are small, and predominantly agricultural suppliers replied in California while predominantly municipal suppliers responded in Arizona. The California interviews focused on specific ways in which the Edison pumping program has affected equipment choices and efficiency. The Arizona interviews focused on whether there were noticeable differences between pump markets in the two states; and how, in the absence of a free testing program, the private sector would respond.

One important qualitative difference between the states is the existence of distributors and retailers in Arizona, including those who serve agricultural and municipal markets, who are not familiar with pump testing or are not sure whether their customers pumps are even tested. One respondent (AZ-6) told us that his customers do not have their pumps tested before replacing them or after they are installed. Another (AZ-4) told us that he was not aware of any pump testing in his area. A third respondent (AZ-5) told us that there is no pump testing available locally and that when testing needs to be performed, pumps are removed from the ground and shipped to a center in southeast Arizona. Half of the AZ respondents reported that either pump testing is not available locally or that they are not aware of any testing done locally. The other half of the respondents work for companies who perform private tests themselves.

Only one of the Arizona respondents (AZ-5) reported that his company performs free pump tests for regular customers. In addition, the company provides cheap pump-testing for others ($50/pump). A second company (AZ-1) performs pump tests but these are relatively expensive ($100 to $1000) as third-party or validation testing. A third interviewee (AZ-2) reports that his company provides pump testing but that these tests include only water flow data and do not include any data on the energy efficiency of pumps. Overall, then, it appears that pump-testing availability and quality are much lower in Arizona than in California and information about pump-testing is more scarce.

California respondents also reported higher sales of energy-efficiency equipment in the pump sector. It is important to note that the numbers provided by respondents on relative sales of premium and standard equipment are educated guesses. Still, California respondents consistently reported higher sales of premium equipment than interviewees from Arizona. There is one important *similarity* in the results, though: interviewees from both California and Arizona reported that municipalities generally use premium equipment. Only one respondent (AZ-5) suggested that municipalities still frequently buy

[17] The fifth interviewee refused to hazard a guess--he said it was "impossible to say" what might happen if the Edison pump testing program were not offered.

standard equipment--her company sells only to municipalities and she estimates that less than half of all equipment sold is of the highest efficiency.

Four of the five CA respondents serve agricultural customers, whereas only two of the six Arizona interviewees do. All of the CA respondents report that they sell at least some premium equipment (high efficiency) to farmers and one respondent reports that virtually all the motors he sells to farmers are premium. Another reports that about half of his agricultural customers are very concerned with efficiency and so he must stock premium motors. Of the two Arizona respondents, on the other hand, one reports that standard motors outsell premium ones by about 10:1 and the other respondent reports that he does not even stock premium equipment.

A summary of findings on differences between California and Arizona is presented in on the following pages.

Exhibit 4-7: Pump Testing Comparison – California Distributors

Respondent	Perform Pump Testing?	If Yes, Fee For Testing	If No, Who Does Testing?	Noticed Efficiency Trend In Past 5 Years?	Comment	Sales Of Premium: Standard Equipment
CA-1	No	NA	Edison			
CA-2	No	NA	Edison/PGE			50:1
CA-3	Yes	$50/pump	NA	Yes		50% of agricultural customers concerned with efficiency; stocks premium motors
CA-4	Yes	?	NA	Yes	Seeing increased use of VSD	Overall: 70% Municipal: 100% Farmers: still sell some standard
CA-5	No	NA	Contractors; Edison	Yes	Seeing trend towards more efficient pumps; doesn't sell motors	40% of all pumps; 100% of pumps to municipalities; "fewer" premium pump sales to farmers

Exhibit 4-8: Pump Testing Comparison – Arizona Distributors

Respondent	Perform Pump Testing?	If Yes, Fee For Testing	If No, Who Does Testing?	Noticed Efficiency Trend In Past 5 Years?	Comment	Sales Of Premium: Standard Equipment
AZ-1	Yes	$100-$1000; will not do 3rd-party validation tests	NA	Yes	VSD and premium motors	N/A
AZ-2	Yes	$100--doesn't include energy analysis	NA	Yes	Only in municipal; not in agriculture	Farmers: no premium sales Municipal: all premium sales
AZ-3	Yes	Free to regular customers; $50/pump to others	NA	Some	In municipal	Agriculture: 1:10 (motors)
AZ-4	No	NA	Doesn't know--not aware of any testing	Yes	VSD used more in industrial than municipal	General: no estimate; Municipal: all premium Do not sell vertical-type pumps
AZ-5	No	NA	Pumps sent to place in SE Arizona	No "recent" trend	VSD seem to be catching on	<50% premium
AZ-6	No	NA	Customers do not get their pumps tested	Yes		20% of sales are premium

4.3.4 Market Barriers

It is possible that a clearly defined and generalizable water pump "market" does not exist in either the agricultural or the municipal sectors. Interviewees who serve agricultural customers emphasized that each customer requires a solution to a unique set of problems and constraints. The range of customer needs has also been given as a reason for the rather small effect of advertising on consumer decisions. Only one respondent believed that advertising had a measurable effect on sales of high-efficiency pumping equipment. A number of respondents dismissed advertising as a waste of money, emphasizing that farmers hear about products and suppliers from word-of-mouth and that equipment decisions are usually made only after consulting with pump sellers and suppliers.

Rather than advertising being the driving factor, regulations and equipment requirements seem to define the parameters of the "market" for pump equipment for municipalities. A number of respondents noted that RFP's for pump jobs for municipalities often specify whether standard or premium equipment is to be used. One Arizona respondent noted that municipalities use premium equipment unless out-dated regulations force them to use equipment that is not up to the latest standard. Only one respondent, CA-5, mentioned a true market barrier in the municipal market. She commented that sometimes municipalities want premium equipment but because of delays in filling these orders (i.e., the equipment is not pre-stocked), they will settle for lower-efficiency equipment.

Similarly, it is not clear that growth of high-efficiency equipment in agricultural markets is being hampered by market barriers. The most common "barriers" discussed by respondents seems to be the unwillingness of farmers to invest in high-efficiency equipment because of skepticism over the reality of estimated payback time and the general seasonal and climatic uncertainty that governs agricultural production. One other possible market "barrier" is the low resale value of high-efficiency equipment when a farm is sold. If farmers are planning to retire or uncertain about how much longer they will farm, they will be reluctant to purchase high-efficiency equipment.

Survey of Dealers, Contractors, and Consultants

4.3.5 Profile of Dealers, Contractors, and Consultants Interviewed

Interviews were completed with 38 representatives of firms dealing directly with pump end users. These included the following types of industry professionals:

- **Dealer/Contractors** – Firms selling, installing, servicing or replacing pumps
- **Specialty Dealers** – Firms providing a specialty product or service to end users (control valves, submersible wastewater pumps, flow meters, hot tapping, and epoxy coatings)
- **Consulting Engineers** – Firms writing system specifications and RFP's for water agencies
- **Private Pump Test Contractors** – Firms offering pump testing on a fee for service basis

The numbers of surveys conducted in each area are shown in Exhibit 4-9 below.

Exhibit 4-9: Dealer/Contractor Surveys by Business Type and Area

	CA	AZ	Total
Dealer/Contractors	16	6	22
Specialty Dealers	5	—	5
Consulting Engineers	5	4	9
Private Pump Test Contractors	2	—	2
Total	28	10	38

This sample of firms was developed from a combination of sources. Dealer/contractors were drawn primarily from the Dun and Bradstreet commercial database (organized by 8-digit SIC code) and augmented through a review of telephone directory advertisements. Consultants were identified through recommendations from several dealers active in the municipal markets in both states. Specialty dealers and pump test service providers were all interviewed in person at the ICWA show. Information about the dealers/contractors we surveyed is presented in Exhibit 4-10. Information about the consultants we interviewed is shown in Exhibit 4-11. All market player results are un-weighted. Instead, we have made every attempt to include the context and experience of those making the comments in the analysis.

Dealers, Contractors, and Pump Test Service Providers

Most of the dealers interviewed were active in providing equipment and sales to both the agricultural and water supply markets. The most common "other" types of pump end users served included wastewater agencies, and industrial customers, (petroleum, petrochemicals, utilities, and mining). The exception to this "sales and service" rule in California was one "dealer" who was a repair service only contractor. In Arizona, two dealers were exclusively sales-oriented, performing no installations or repair of pumps.

The majority (56%) of the California dealers interviewed were also at least somewhat active in markets outside California, including Arizona. A few of these interviews were to regional (e.g., Western states) representatives of national firms. This provided an advantage in that some dealers had some experience and opinions about whether any differences might exist between California and elsewhere. The dealers from Arizona were all active primarily in the Arizona market. Several respondents commented that California's larger overall market for pumps made it the logical place for manufacturers and regional offices to set up shop.

Exhibit 4-10: Dealer/Contractors Surveyed

Business Type	Firm	Business Activity		Markets Served		Geographic Areas Served			% of Business in Each Market		
		Sales	Service	Agri.	Water	CA Only	AZ Only	Both	Agri.	Water	Other
Dealer	CA-D1	X	X	X	X			X	10%	70%	20%
Dealer	CA-D2	X	X	X	X	X			—	—	—
Dealer	CA-D3	X	X	X	X	X			70%	5%	25%
Dealer	CA-D4	X	X	X	X			X	2%	95%	3%
Dealer	CA-D5	X	X	X	X			X	5%	50%	45%
Dealer	CA-D6	X	X	X	X	X			5%	90%	5%
Dealer	CA-D7	X	X	X	X			X	35%	65%	0%
Dealer	CA-D8	X	X	X	X			X	15%	60%	25%
Dealer	CA-D9	X	X	X	X			X	15%	60%	25%
Dealer	CA-D10		X	X	X	X			1%	10%	70%
Dealer	CA-D11	X	X	X	X	X			—	—	—
Dealer	CA-D12	X	X	X	X			X	35%	5%	60%
Dealer	CA-D13	X	X	X	X	X			70%	15%	15%
Dealer	CA-D14	X	X	X	X			X	60%	30%	10%
Dealer	CA-D15	X	X	X	X	X			20%	5%	75%
Dealer	CA-D16	X	X	X	X			X	20%	56%	24%
Dealer	AZ-D1	X	X	X	X		X		80%	5%	15%
Dealer	AZ-D2	X			X		X		0%	75%	25%
Dealer	AZ-D3	X	X	X	X		X		10%	15%	75%
Dealer	AZ-D4	X	X	X	X		X		50%	50%	0%
Dealer	AZ-D5	X			X		X		0%	20%	80%
Dealer	AZ-D6	X	X	X	X		X		30%	20%	50%
Specialty	CA-S1	X	X	X	X	X			—	—	—
Specialty	CA-S2		X		X			X	—	—	—
Specialty	CA-S3	X			X	X			—	—	—
Specialty	CA-S4	X		X	X			X	—	—	—
Specialty	CA-S5	X			X	X			—	—	—
Tester	CA-T1		X	X	X	X			—	—	—
Tester	CA-T2		X	X	X	X			—	—	—

Exhibit 4-11: Consultants Surveyed

Business Type	Firm	Business Activity		Markets Served		Geographic Areas Served			% of Business in Each Market		
		Sales	Service	Agri.	Water	CA Only	AZ Only	Both	Agri.	Water	Other
Consultant	CA-C1				X			X	0%	90%	10%
Consultant	CA-C2							X	0%	95%	5%
Consultant	CA-C3				X			X	0%	95%	5%
Consultant	CA-C4			X	X			X	5%	95%	0%
Consultant	CA-C5				X			X	0%	50%	50%
Consultant	AZ-C1			X	X			X	5%	95%	0%
Consultant	AZ-C2				X			X	0%	90%	10%
Consultant	AZ-C3			X				X	100%	0%	0%
Consultant	AZ-C4				X			X	0%	99%	1%

Consultants

Consulting engineers are almost exclusively engaged in providing services to the water supplier market. One consultant, an Arizona colleague in the same firm as one of the California respondents, worked exclusively with irrigation district customers. All firms interviewed were large scale operations with multiple offices and a nationwide or international practice. These included:

- Black & Veatch (2)
- Brown & Cauldwell (2)
- Camp Dresser and McKee
- CH2M Hill (2)
- Malcolm Pirnie
- Wilson & Company

While smaller scale, local consultants exist, they tend to work more often for the smaller scale end users. One respondent ventured the opinion that these smaller competitors were more likely to lack sophistication in their system designs, and offer their clients less than state-of-the-art specifications.

Consultants are typically involved in new or expanded pumping station design, for water, water treatment, wastewater, or environmental remediation. Much of their work comes from repeat business from existing public entity clients. They typically prepare RFP's and RFQ's, and draw up the equipment specifications for new and expanded facilities. Private water companies are less frequent clients of the large scale engineering firms interviewed. One engineer explained that the private water purveyors are more short-term focused, and have less of an understanding of the paybacks associated with high efficiency designs.

4.3.6 Awareness and Perception of Edison's Pump-Testing Program

California respondents were generally aware of Edison's pump testing program. Four of five consultants (80%) and 13 of 16 dealer/contractors (81%) were familiar with the program. Two of those who were unaware of Edison testing ran businesses that focused primarily — though not exclusively — on the industrial and petrochemical markets. The third was a Western Regional Manager of Municipal and Irrigation Sales for a manufacturer-operated dealership. This respondent's position in a firm of 30,000 employees clearly made him less aware of field operational issues (such as testing) but more knowledgeable of broad industry trends.

Specialty contractors were less likely to be aware of the program (40%), because some of their specialties did not relate directly to pump energy efficiency. Both pump test providers were aware of the program. One himself worked for Edison in the past; the other was formerly a consulting engineer now retired from that position and operating his own pump testing business.

All of the nine California dealers most familiar with the pump test program were highly satisfied with and supportive of Edison's service. Several reported always recommending a pump test when a pump appeared to be "offing" water or asking customers for past test records when encountering a pump that was no longer operable. "We love you guys doing those tests" said one dealer. Several reported using

Edison's program as a means to sell pump repairs or replacements. The remaining dealers who were unaware or less familiar with the program were less enthusiastic about it. This appears to be the result of their focus on particular market niches not targeted by the program (e.g., industrial pumps) rather than any true dissatisfaction with the program.

Nine of the California dealers also offer some of the same testing services as Edison, primarily flow and head measurements. A few take electrical readings as well. All but one agreed that Edison field tests were superior to the available alternatives, including the dealers' own testing capabilities. Typical explanations for these attitudes were that Edison uses better equipment, calibrates their equipment more often, or are better trained for testing than their own field staff. Dealers do some tests themselves because sometimes there isn't time to wait for an Edison test, or because the customer requests such a service. One dealer said that if his tests indicate a diminished efficiency, he will call in Edison to validate the measurement before making a final recommendation to the customer. The one dissenting opinion came from a dealer who had extensive experience with both Edison tests and a prominent private testing service also active in Southern CA. He described a couple of cases where we had to "pick their numbers apart" and the private service held up slightly better under the extra scrutiny. Nevertheless this same dealer still recommends that any of his customers in Edison's area get a test from Edison. He only recommends the private testing service in areas outside Edison territory.

Dealer ratings of the accuracy of their own tests and those they recommend are shown in Exhibit 4-12. Ratings are on a scale of 1-10, 10 high. California dealers ratings of recommended tests are for Edison tests. Arizona dealers ratings are for factory-provided tests. In both states, dealers rate their own testing abilities below that available from others.

Exhibit 4-12: Dealer Ratings of the Accuracy of Self-Administered and Recommended Tests

	Self-Tests			**Recommend Tests**		
	Flow	Head	kW	Flow	Head	kW
CA Dealers	8.0	8.4	8.0	8.6	8.8	8.8
AZ Dealers	8.5	9.0	9.5	9.5	9.5	10.0

Consultants were a bit more critical of Edison's tests, and of field testing in general. Many described only having much faith in factory tests performed under laboratory conditions. These engineers tended to feel that there were too many variables that can't be controlled for in the field, that can affect the accuracy of the measurements. Factory tests before the unit is shipped and installed are quite common for new larger pumps going to municipal clients. Some contracts require these factory tests be "witnessed" by the customer or their representative (e.g., the specifying engineer). This typically adds to the cost of the factory test, ostensibly because the test must then occur at a scheduled time, rather than whenever is convenient at the end of assembly. One consultant said that on a larger job a "balancing company" is sometimes hired as a sub-contractor to the general contractor. This firm may be charged with verifying that the field conditions meet with the operating specifications originally included in the contract. The respondent stated that though the relationship between the general and sub may present a potential conflict of interest, usually the presence of the engineer mitigates any problems.

One consulting engineer described having disputes over field operating conditions and has recommended in such situations having Edison out to do a field test. His comment: "I've got a feeling that some of

EDISON's old tests weren't all that accurate. It used to be pretty straightforward, but now with new motor controls and VFD's it's not the same. Do they really take true RMS readings. I doubt it."

4.3.7 Comparison of California and Arizona

This section considers a number of similarities and differences between CA and AZ in the business practices and attitudes of dealers, contractors, and consultants. The discussion is structured by the topics discussed in the interviews.

Variables Determining Whether High Efficiency Pumps Get Installed

Dealers and consultants in both areas were asked the question: *What are the most important variables in determining whether super high, high, or standard efficiency equipment ultimately gets installed?* Across the board, respondents reported that cost is the major variable driving pumping system purchase decisions. Respondents from either state exhibited no qualitative differences on this point. Where customers make clear they are interested in lowering operating costs, dealers and consultants will generally offer high efficiency designs. When customers are focused on lowest first cost, the designs they get will often already have made these trade-offs. Generally speaking, the higher the energy bill, the more attention customers and their contractors will pay to efficient design. However important exceptions to this rule can occur.

Some high volume pump end users simply don't have adequate access to capital. This tends to be more common among agricultural customers, and was reported most often by dealers who concentrate on serving this market. But some water supply customers can also be constrained by budgetary limits (such as municipal requirements to share a fixed % of revenue with the general fund, or "use it or loose it" operating budget rules).

Some end users in either market don't have the sophistication to understand the economic trade-offs between first cost and operating cost. Again sophistication tends to increase with the size of the energy bill. But many decision-makers are more experienced in the daily requirements of facility or farm management than in the infrequent task of life cycle costing or even simple payback calculation. Dealers approach their customers differently, depending on how they suspect each will respond to different sales pitches.

In the agricultural market, dealers work directly with end users. Several dealers reported that their customers don't know and don't care how efficient the system is. According to one prominent agricultural dealer from the Tulare region, "90% of these farmers are not interested in efficiency. All they care about is the amount of water on the ground and first cost. They have an expression out here. If you get *too* efficient, you can't pump anything". Several mentioned that their clients trust them to pick the best motor and bowl assembly, and they do. Finally the willingness of some agricultural customers to borrow enough to improve their overall return-on-investment can sometimes be a barrier. As a generalization, such financial conservatism is well-documented in the agricultural decision-making literature.

In the municipal market, most designs are drawn up by consulting engineers. Knowledge of and demand for high efficiency designs is reported to be generally much higher. In this market both dealers and

consultants agreed that specifying engineers have the most influence on the overall efficiency of the pumping system. According to one Arizona dealer, "high efficiency depends on how much the engineer knows, which is dictated by the client. If they demand it, they make the engineer deliver." Consultants confirmed that some clients hire smaller scale engineering firms who may charge less but may also not be able to deliver the most efficient designs. According to them, a client's willingness to hire a consultant can be an important first step toward lowering their energy costs. Of course stand-by pumps or others with low operating hours will not be cost-effective to optimize.

Stocking Practices

Dealers and contractors were asked: *Do you routinely stock high and super high efficiency equipment?* Most dealers find no need to stock any substantial amount of pumping equipment. Major manufacturers operate warehouses making available most commonly ordered equipment on very short lead times. "Why should I stock if it only means reducing the delivery time from 2 hours to 15 minutes?" seems to be the general opinion. The exception to this rule is for dealers who work mostly on agricultural pumps. Some of these do stock a few common sizes of pumps (e.g., 100 HP, 200') and replacement parts.

In the municipal market most equipment is custom-built. Though it takes time to order and assemble the system and delays are common, the lead times associated with bid-spec documents are usually adequate. Dealers confirm the comments of distributors and customers that equipment availability does not appear to be a barrier to the installation of high efficiency equipment.

Specifying Practices

Again, no clear pattern distinguishes the specifying practices of dealers and consultants in California from those in Arizona. All but one dealer in each state reported that they *routinely specify high and super high efficiency equipment*. All consultants said they do as well.

Of the two who said they don't spec high efficiency, the California dealer said, "Not unless the customer requests it. We don't push it because we don't make any higher margin on the high efficiency equipment." The Arizona dealer who doesn't spec high efficiency said that consulting engineers do most of the specifying and that most of them work from standard specs. Many dealers active in the municipal market agreed that they themselves rarely do any specifying. "We let the client or their engineers do that. With all the non-collusion situations, the major public jobs don't like to have the contractor specify. They prefer a third party instead."

Most dealers and consultants alike say that they take a cue from the client to decide whether they want higher efficiency. Some typical responses from consulting engineers were: "We always specify 'high' efficiency, but go to 'super high' only at the client's request." "For the most part they trust us to give them the best. Sometimes the client may have a certain preference which keeps them from going most efficient (like going with a 1200 RPM motor when 1800 would be more efficient) but this rarely happens." Several consultants described using fairly sophisticated specification procedures. One uses the Motor Master /NEMA Spec, "and then we go one better., Another looks at the appropriate bowls available from 3 or 4 manufacturers on disk before choosing the number.

A major feature of the municipal competitive bid process is the common requirement that the bid documents not be written so tightly that only one competitor can qualify. To deal with this administrative requirement, engineers must usually draw up the efficiency specification not at the level of the most efficient assembly on the market, but at the lowest common threshold where at least two manufacturers can qualify. If the most efficient unit is more expensive, the less expensive/less efficient unit has an advantage. That is the competitive bid process may constitute a barrier, thwarting even an engineer and a client who both want to optimize plant efficiency.

Several mechanisms exist for working around this problem. The major options are "sole source" contracting and "evaluated bids. Sole sourcing can be an option for municipalities if a case can be made that the contractor or supplier truly offers a uniquely superior piece of equipment. In practice this is can be contentious and time-consuming, usually involving input from legal staff. Several consultants mentioned that private water companies unfettered by municipal administrative rules are at liberty to practice sole sourcing. As a result they usually have an easier time identifying and procuring the most appropriate piece of equipment.

The alternative is to write an evaluated bid, where price and other terms (including efficiency) can be traded-off according to a preset rating system. This is accomplished by applying penalties for failing to meet efficiency thresholds and (less commonly) incentives for exceeding them. The bid for a less efficient, cheaper, but qualifying pump would be penalized for each point that it fell below the target efficiency. Penalty amounts are set according to a scale that takes into account the increase in projected life cycle cost that result from lower operating efficiency. A corresponding approach, favored by some dealers, would be to give a price allowance incentive to any system that could meet all other requirements and still exceed the specified efficiency target. The purpose of evaluated bids is to eliminate the competitive bidding barrier holding back the most efficient equipment and to make the comparison between competitors "efficiency neutral". Where such penalties are written into bids, usually a witnessed manufacturer's factory test is used to confirm the pump efficiency; field tests are usually considered too inaccurate for this purpose.

According to one consultant, evaluated bids aren't any more common now than they were 20 years ago. "We try to satisfy the client. We don't do a rocket age design for a stone age client. Some clients have more 'intestinal fortitude' to deal with the administrative issues to get what they want." Another felt they are becoming more common, but the legal hassles in writing tight "front-end" documents cause many agency clients to take the O&M penalty rather than risk being sued by an unsuccessful bidder. "Unfortunately some are just very lazy and don't want to bother".

Employee Training Practices

A total of 12 California dealers answered the training question: *Do you provide regular employee training to maintain or extend staff knowledge of new technologies and methods?* Eight answered yes. In Arizona, all five said they provide some kind of regular training. Dealers in both states report similar kinds of employee training practices. Most common are informal on-the-job arrangements, either on-site apprenticeship situations or more formal "seminars" given by experienced on-staff technicians. A few mentioned sending some or most of their staff to manufacturer-sponsored training seminars offered from time to time. One California dealer engages in training "constantly", and another said "we're big on

training". One smaller Arizona dealer admitted that for his operation, "passing on articles to my crew is about it".

Marketing Practices

Among Southern California dealers, 11 answered the question *Do you actively market energy efficiency as a feature of the equipment you sell or the designs you specify?* Eight said yes in California and three (of five) said yes in Arizona. However within the affirmative responses some were obviously more committed to demonstrating the benefits of energy efficiency to their customers. One California dealer replied, "Anything we look at, we bring it up." Another replied, "Absolutely. We use brochures and computer programs." However the remainder explained that it depends on the situation and what their client already has in mind. According to one primarily agricultural dealer/contractor, "Most of our calls, they call us. Many are "old school" - they know what they want. 'I want 100HP, 1,200 gpm.' I don't argue with customers." Arizona dealers generally described the same situational approach characteristic of the majority of California dealers. None made any statements as positive as the two from California cited above.

Dealers and consulting engineers were also asked, *"In sales presentations or in developing specifications, do you provide end users with cost/benefit estimates comparing the long term energy cost and payback of various equipment choices?"* In California, 11 of 12 answered yes, while only two of the five Arizona dealers said they use such an approach in their sales presentations. The one dissenting California dealer works primarily with agricultural customers: "It's probably too complicated for us. Everything is different out there these days. We used to do Edison's rates for them, but now it's too much trouble." The rest of the California dealers were more positive about the use of financial arguments to sell higher efficiency, especially if they work primarily with municipal water supply customers. Some of the comments collected from California dealers included these:

- "Absolutely, or tell them to have their own engineers do the numbers."
- "Absolutely, when conditions are right."
- "Frequently yes, but low dollar wins."
- "Yes, we show them, sometimes they don't understand the test reports so we explain it to them."
- "We'll do that with premium vs. standard efficiency, and internal combustion vs. electricity driven equipment."

Arizona dealers seem a bit less eager to offer such payback analysis. The two who said yes, both deal with a customer base that is predominantly municipal. Their comments were:

- "In most cases. If the customer is not interested [we don't bother]. Very seldom are they not interested."
- "Sometimes, it depends on the case."

This second Arizona dealer explained the situation this way. When preparing a bid, the RFP usually lets three others bid. "I can't afford to spend the time really refining the bid if I'm not going to win… unless I've got something that will lock them in, like an 86% efficient bowl." In certain hp and pump size

ranges, certain dealers (and the manufacturers they may have exclusive rights to carry) have an efficiency advantage. In others they do not. Dealers will play up such an advantage when they know one to exist. If not they will accentuate price or other features.

Consultants too seem to reflect this range of opinions. Responses from California included:

- "Not all the time. Often we don't give them a choice, just spec the best option."
- "Overall reliability is the focus for utilities. We design for survivability [not just operating efficiency]."
- "Depends on a clients willingness to hire a consultant. We work for the big guys."

In Arizona their comments were similar:

- "Vast majority yes. Correlated to size of customers and pumps."
- "We are working with a client to come up with the most efficient equipment. O&M costs are real."
- Depends on the client, their sophistication, other things; usually were the ones bringing efficiency to the table."

Ranking Edison's Program and Other Factors Influencing Energy Efficiency

Dealers in Southern California were asked to rate (on a scale of 1 to 5, 1 no effect, 5 very large effect) "*how much of an effect Southern California Edison's Pump Test Program has had on the following…*" Their mean ratings are shown in Exhibit 4-13 below.

Exhibit 4-13: Dealer/Contractor Perceptions of Program Effects

Perceived Program Effects	Dealer/Contractor Ratings
Customer action in replacing and upgrading pumps	4.1
Customer knowledge of pump efficiency choices	4.0
Customer demand for pump testing	3.9
Contractor follow-up and maintenance	3.7
Accuracy in matching pump products to user needs	3.6
Efficiency of pump products stocked and sold	3.3
Total volume of pump products sold	3.1
Efficiency of pump products made by manufacturers	2.9
Prices for high efficiency pumps	2.5

Dealers consider the program's biggest impacts to occur at the level of customers:

- Motivating them to replace or repair pumps that are no longer operating efficiently
- Increasing their knowledge of efficiency choices

- Increasing their reliance on and demand for pump testing

Dealers also acknowledge the program improves their follow-up with customers and their accuracy in choosing the right equipment. In cases where dealers indicated the volume of products had been increased by the program, this effect was connected with the repair and replacement business. In order to probe the early repair/replacement issue further, dealers were asked to answer an admittedly somewhat loaded question to test this important program effect hypothesis:

> Repair/Replacement: *Some pump dealers and end users have told us that they believe Edison's pump testing program results in more informed pump consumers, leads to earlier replacement of inefficient but still operational pumps, and stimulates customer demand for more efficient equipment. Have you seen any evidence of these or other types of effects?*

Taking into account the "aided" manner in which this question was delivered, six of the ten dealers who replied by telephone agreed the program has an effect on replacement sales and repair activity. All three of the major pump dealers interviewed in-person at the ICWA trade show also mentioned increased repair activity as a program benefit. The dealers who reported seeing no effect on repairs or replacements tended to be those with more experience in smaller hp pumps and industrial applications. Several dealers mentioned using the program as a means of selling pump replacements, or component repairs. Comments solicited by this question from the major dealers were:

- "No question, by all means. It drives it. Also with the rate structure (T.O.U.) and rebates too… We are trying to offer a higher efficiency product, compared with our competitor. I say, 'You'll pay for this is 5 years…' I find the Edison test is a great tool. Of 75 [repair] jobs, 50 have Edison tests. We don't like doing 'Band-Aid' work because of the liability."
- "A lot of my big customers call Edison yearly, they say, 'last year it was 1,200 gpm - now it's 1,000" 50-60% of my repairs come after customer receives an Edison report, it helps us out dramatically."
- "I think it makes the customer aware of his costs and tells him what his options are… I think it leads to repairs — not replacements — that should be done but otherwise wouldn't be noticed. In [south San Joaquin city] I have one customer who tests pumps 3 – 4 times a year. If the pump is off by 2 - 3% we fix it."
- "We use the Edison program to sell replacements. It's a sales tool. We sell more, based on Edison's cost analysis report. It convinces the financial decision makers."
- "Yes, they're watching their costs a little better. If they have a test they'll bring it in and we'll act on it. This does lead to some early replacements. It does happen, but I can't tell you how often."
- "I agree. I haven't seen a trend but it's common sense. A sophisticated user will use [the information he gets from a test] and then put that to work the next time. It sticks with them forever."
- "I'm just one of 25 sales engineers in California, overall I haven't seen any real effect."

Arizona dealers and consultants described repeatedly how the customer must notice a drop in production before they call a service person out to investigate. According to one Phoenix-based consultant, "It sounds like a good idea, but I don't know of any people doing that around here. They just draw

measurements when the flow seems to be dropping – not early detection." Some "more sophisticated" customers in Arizona may do some record-keeping, for instance taking daily readings of water meters and electric kWh meters to help them notice such trends and anticipate repairs. But when pump testing is done regularly, as the Edison program encourages, repairs can be made before any serious drop in production has occurred. The survey data suggests that early diagnosis of diminished efficiency is a major effect of the program. This qualitative data suggests that were a statistical difference between the two areas to be measured in the frequency of replacement, or in higher overall plant operating efficiencies, at least a portion of that difference would be attributable to the program.

Dealers were also asked to consider whether the program had any effects on potential product availability barriers or manufacturer designs. The questions were again structured as tests of these hypotheses:

> Comparative Availability: *"Some people have suggested that manufacturers or distributors may market, stock, or distribute more high efficiency equipment in the Edison/California area as compared with areas without widespread pump testing (such as Arizona), in response to pump-test driven customer demand for higher efficiency equipment. Have you seen any evidence of this?"*, and
>
> Manufacturer Design: *"Some people have suggested that manufacturers may design or redesign new equipment in response to pump-test driven customer demand for higher efficiency equipment. Have you seen any evidence of pump-test-informed customers effecting the design of your products?"*

While a few comments in support of such effects were made, the case for the program having major effects at these "higher" levels of the distribution channel is hard to see. While most didn't feel they had enough data or perspective to answer this question, some of the more interesting responses to the comparative availability question were:

- "I don't know. Edison power is among the highest in the nation. People are more cognizant here than elsewhere because of energy cost.
- "Some of the customers we have in Arizona, they look at the same scenarios. Over in Arizona, the pump companies do the testing, it's part of the salesman's duty. The niche is filled by private contractors there."
- "Not sure. Pretty sophisticated people in Arizona too. I couldn't measure that."
- "The only indication is where they [manufacturers] operate. US Motors stocks in Fresno and California. The San Joaquin Valley has more pumps per square mile than anywhere else in the world. More pumps, more testing. Not testing itself. The fact that people are more aware of energy efficiency now is a by-product [of testing]."

Quotable responses to the manufacturer design question were:

- "It an indirect thing. In the municipal market, no doubt, [with] stringent performance testing."
- "Everybody is always trying to increase efficiency, but not directly because of testing, testing helps."

- "Any top-of-the-line manufacturer is doing that [redesigning for high efficiency], but no specific cases [of pump testing effects]. "
- "All my manufacturers keep an eye on that. They say about a new design, 'Same bowl, more efficient'… it has to come from Edison, somebody has to be pushing them."

Considering the two areas, some of the most readily comparable survey questions were those asking dealers to rank a range of factors influencing energy efficiency trends. Using the same scale and asking the questions together suggests that dealers considered their responses relative to one another. The question was phrased this way:

> Many different factors may have influenced the shift toward more efficient water pump systems over the past 5 years. *Please rate the influence you think each of the following has had upon the shift toward higher efficiency pump systems: (using a scale of 1 to 5, where 1="no influence" and 5= "a great deal of influence")*

Arizona and Southern California dealer responses to the question are presented in Exhibit 4-14.

Exhibit 4-14: Comparison of Ratings of Factors Influencing Shift to Efficient Pump Systems

Factors Influencing Efficient Pumping Systems	Southern California	Arizona
Rising energy prices	4.4	4.2
Utility rebate programs	4.0	1.0
Technology improvements made in available pumps	3.7	3.0
Utility programs that offer pump testing	3.6	1.0
Marketing by dealers and distributors	3.3	3.2
Marketing by manufacturers	3.0	3.0
Utility educational programs	2.8	1.0
Changes in federal, state or local codes and regulations	2.6	1.8
Reductions in the prices of high efficiency pumps	2.3	3.2

Rising energy prices are considered the biggest influence in both areas. The influence of utility rebate and pump testing programs is also prominent in the rankings of Southern California dealers, particularly in comparison to their Arizona counterparts.

Sales Patterns

After finding that manufacturer or distributor shipment data was not available in any format that would be of use to this study, the survey attempted to collect estimates of sales volume from the dealers and consultants. It is well known that this type of proximate data can be very difficult to collect, and can be subject to bias depending upon how respondents interpret the data request. To minimize this problem and encourage greater consistency in the delivery of the request, respondents were faxed a two page instrument at the conclusion of the call. Respondents were asked to estimate, for the agricultural and

water supply markets separately, what percentage of their business activity (sales, installations, or specifications) could be apportioned to selected pump and fuel type categories.[18] Finally, they were asked to estimate, according to two horsepower categories, what percentage of the "electric deep well turbine" and "electric centrifugal booster" pumps they handled, fit into three efficiency levels. The horsepower categories were "25 – 100 hp" and ">100 hp". The efficiency levels were defined as:

- Super high efficiency ("state-of-the-art", optimized in all components)
- High efficiency (high efficiency motors only)
- Standard efficiency.

Several respondents, particularly in Arizona refused to send back the form, citing proprietary interests. Despite repeated callbacks to encourage the remaining interviewees to the return the forms, 17 complied:

- California Respondents Total: 13 (10 Dealers and 3 Consultants)
- Arizona Respondents Total: 4 (2 Dealers and 2 Consultants)

To compensate for the small samples at the business type level, responses for dealers and consultants were combined together. Some of the respondents only work in one or another of the two markets. Subdividing the responding group according to the two markets, a tentative comparison between Arizona and California can be made. The numbers of respondents informing the comparisons are shown in Exhibit 4-15.

Exhibit 4-15: Dealers and Consultants Reporting Efficiency Estimates

	California			**Arizona**		
	Dealers	Consultants	Total	Dealers	Consultants	Total
Water Supply Market	8	3	11	2	1	3
Agricultural Market	8	0	8	1	1	2

Un-weighted results of this exercise are shown in the tables below.[19] Without a means to estimate aggregate market volume in the two areas and market share by dealers in each, properly adjusted weights are not possible. Therefore these results are presented with the caveat that they are based on small samples and should not be interpreted outside the context of this study. Nevertheless they do support the qualitative comments made by dealers and others.

[18] Pump Types (Well Pumps, Booster Pumps; Centrifugal Type, Submersible Type). Fuel Types (Electric, Natural Gas, Other). Complete survey instruments are provided in Appendix A.

[19] For complete documentation of this sales pattern data, CF. Appendix G.

Exhibit 4-16: Dealer Estimates of High Efficiency Market Share — Combined Market

All Markets (All Pumps) — Dealer Estimates of Efficiency										
		% Super High Efficiency			% High Efficiency			% Standard Efficiency		
State	n	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
CA	13	0%	100%	38%	0%	60%	25%	0%	100%	37%
AZ	4	0%	40%	8%	3%	50%	62%	10%	97%	30%

Exhibit 4-17: Dealer Estimates of High Efficiency Market Share — Agricultural Market

Agricultural Market (All Pumps) — Dealer Estimates of Efficiency										
		% Super High Efficiency			% High Efficiency			% Standard Efficiency		
State	n	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
CA	8	0%	95%	35%	0%	60%	16%	0%	100%	49%
AZ	2	0%	40%	20%	3%	50%	34%	10%	97%	46%

Exhibit 4-18: Dealer Estimates of High Efficiency Market Share — Water Supply Market

Water Supply Market (All Pumps) — Dealer Estimates of Efficiency										
		% Super High Efficiency			% High Efficiency			% Standard Efficiency		
State	n	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
CA	11	0%	100%	41%	0%	100%	30%	0%	100%	29%
AZ	3	0%	20%	4%	3%	100%	71%	0%	97%	25%

These estimates suggest that standard efficiency equipment in both areas appears to comprise roughly the same proportion of the markets in both geographical areas (just under 50% in the agricultural markets and just under 30% in water supply). However in Southern California, the majority of the remaining pumps appear to fall into the "super high efficiency" category, while in Arizona such optimized systems are said to be much less common. Overall 38% of the pumping systems sold, specified and/or installed by Southern California Edison area dealers were reported to be "super high efficiency", as compared with only eight% in Arizona.

Analyzed at the sub-market levels, water supply pumps in Southern California are reported to be at the super high efficiency level more often than those typically used in agricultural applications (41% versus 35%). This confirms other comments collected through-out the study from dealers and other market players. However the reportedly low proportion of super high efficiency water supply pumps in Arizona stands out (4% as compared to 20% of agricultural pumps). The cause of this finding is unknown. However the large scale of the average farm in Arizona, the recent development of the Central Arizona Project (possibly leading to replacement of old well pumps with new booster systems) or overly conservative decisions by municipal water supply customers could all have an influence. Again the limited sample particularly in Arizona should be kept in mind when attempting to draw any conclusions from these data. Exhibits 4-19 through 4-21 summarize the data shown in the tables above.

Exhibit 4-19: CA/AZ Comparison of Pump Efficiency Levels — Combined Markets

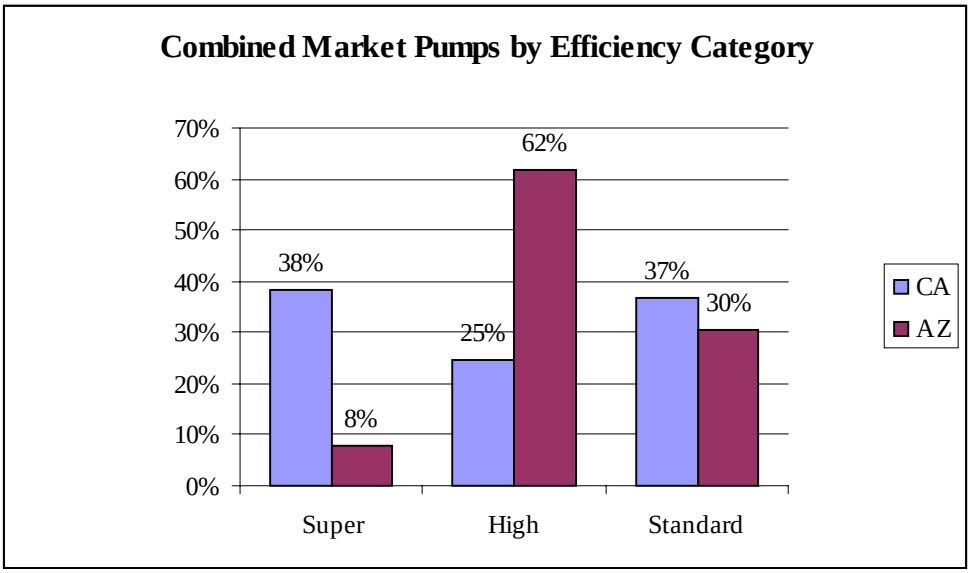


Exhibit 4-20: CA/AZ Comparison of Pump Efficiency Levels — Agricultural Market

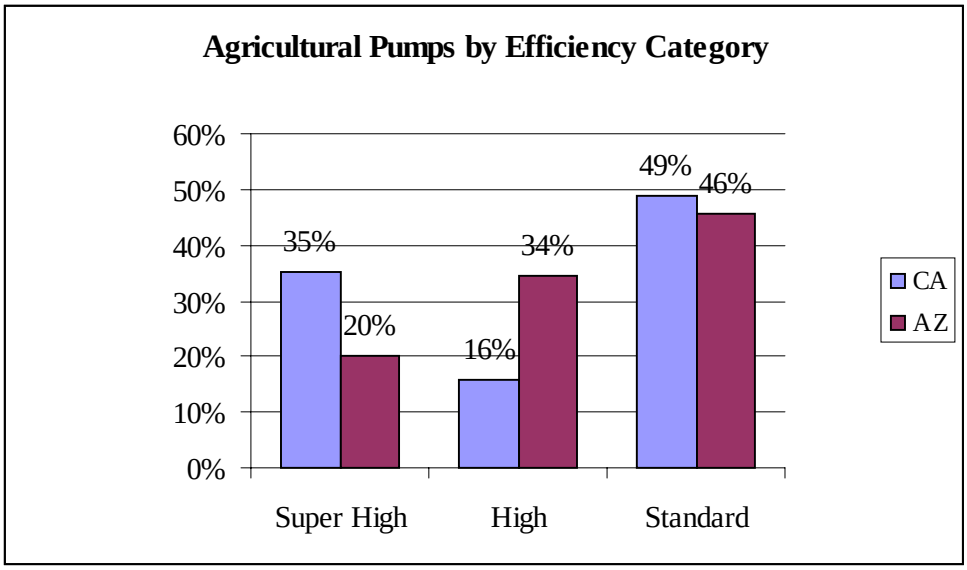
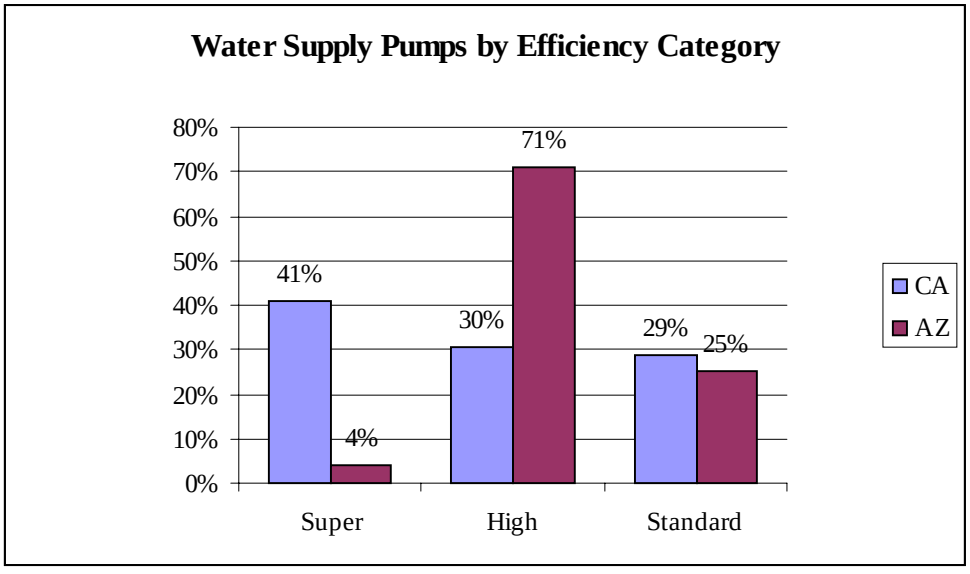


Exhibit 4-21: CA/AZ Comparison of Pump Efficiency Levels — Water Supply Market



Perceived Bottlenecks and Market Barriers

Dealers and consultants were asked to describe if they perceived any barriers or "bottlenecks" to high efficiency equipment. Most felt that no significant bottlenecks were present. Those who did generally agreed that customer knowledge, attitudes and their resulting demand for high efficiency equipment were the biggest impediments. "Information and education are key", said one consultant. Sometimes this was phrased as customers' unwillingness to pay for what was ultimately in their own best interest; in essence this is the definition of a 'bounded rationality' market barrier. Examples included continuing to run or patching together equipment that was long past its useful life or may never have been designed to pump water in the first place (e.g., old truck engines retrofitted to run pumps). Access to credit for farmers was also cited as a problem.

Some customers want off-the-shelf items so they don't need to wait if something should fail. Sometimes this may be justified; at other times it is simply "resistance to change." Consultants described cases where clients placed conditions upon their designs or rejected certain system configurations, despite the fact that they would save energy and money in the long run. Examples of this were municipality requirements for all fixed speed or low RPM drive systems, despite the fact that proven technologies such as VFD's or higher RPM motors would end up costing less. Sometimes the apparent losses in efficiency can be offset by gains in simpler facility operations or increased reliability. At others, such customer choices are probably unjustified and overly conservative decisions. Occasionally there are hang-ups on delivery times but this does not usually reduce the system efficiency. One dealer of smaller specialty pumps also mentioned the high cost of pumps, in particular higher manufacturer margins on higher efficiency pumps.

Finally, the municipal competitive bid process was identified by consultants and active municipal market dealers alike to sometimes constitute a barrier to implementing the most efficient designs. The relative scarcity of evaluated bids, and in particular positive incentives to exceed minimum specifications, constitutes an organizational practices barrier of the classic type. The reluctance of many to write such requirements into contracts, means that in some cases, high efficiency equipment is not being judged on its merits -- its ability to lower overall lifecycle costs.

Speculation on Effects if Program Ended

Dealers who were aware of the program were asked two questions to get them to consider how lasting the effects of the program would be if it were discontinued. The questions were:

Not because anyone is suggesting this, but just to better understand the value of the program, how do you think the practices of <u>manufacturers, wholesalers, and dealers</u> would change if the program was not offered?

and

How would the practices of <u>end users</u> change if the program was not offered?

Since the most prominent effect cited by dealers is the program's encouragement of early repair and replacement of still operational but inefficient equipment, it should be no surprise that this was the issue most discussed in response to these questions. Many respondents were unwilling to speculate, but those who did felt confident that some proportion of end users would continue testing and trending their pump efficiencies. The costs for this testing would be borne by these customers. The tests themselves would be administered primarily by private contractors (such as the dealers themselves) but in some cases, by in-house staff. Many of these would cut back on the frequency of testing from current levels if they had to pay for it themselves. Another group of customers would give up the practice entirely if Edison no longer offered testing free of charge. Three dealers ventured to guess at the proportions of customers who would continue to test themselves. All three estimated that testing would drop by approximately 50%. One of these characterized his response in terms of the number of customers practicing testing, while the other two based their estimates on the number of tests performed. (One actually said, "half or fewer tests"). Several mentioned that over time, even some of those customers who were now convinced of the value of testing would taper off in their regularity of testing. As a result, pumping efficiencies would tend to go down.

As for the effects on the dealers themselves, several mentioned that private firms would quickly expand to fill Edison's niche were the program to be discontinued. "Somebody will have to do it. Maybe it'll be me?", said one. As for any effects on the volume of repair and replacement sales, the dealers agreed that with less information available to customers about the condition of their pumps, efficiencies would drop and more systems would be allowed to continue functioning below par, until production was noticeably effected.

Some of the comments collected from dealers included the following:

- "If Edison didn't do it, there would be more contractors on the market like Pump Check. [Discontinuation of the program] might open a door for smaller business to come in. Manufacturers don't [care about pump testing]. But contractors will have to provide answers on efficiency — self testing by contractors won't fly. [Customers] would have to seek out third-party testing. Fewer tests would occur. A lot more people are more aware due to tests. Users are dependent on tests for preventative maintenance schedules. Work will go on less on a planned basis but more in reaction to 'fires'. Pumps would get fixed, back up to tolerances, but not necessarily optimized."
- "No change. They have to manufacture things that work or sell. It wouldn't affect us much, some fewer sales, but we would take up most of the slack with our own testing. [End user practices] would change quite a bit. They would have to get a test from somebody else. 50% would keep testing [from third-party testers] and pay for it. 50% would not test and would end up paying for it too (less efficient). Utility testing has never been 'free'. It's in their rates somewhere. Those trucks and salaries, it's in there."
- "I would have to get more details on it - that would hurt, we're not making any money off Edison. We'd have to offer the service, but I would lose the value of Edison as a neutral party. Private [testing] companies are [currently] not being used much. Customers would have to pay for it. At least a 50% drop in the quantity of testing. Repairs and replacements wouldn't be made as soon without the program."

- "I don't think things would go backward, but future improvements would suffer. [A reduction in the] cost per kWh could swamp any effect here. At $.05/ kWh, people would waste [energy] away. I know we would become more active [testing pumps], like we were in the past when we operated [former company], we offered tests at no cost. More sophisticated will still do tests. 50% of our customers are in the IID [Imperial Irrigation District]. A lot of them would wonder why their bills were going up if they didn't get tests. [New testing firm] monitors wells, does data-logging. The high end golf courses are buying into this."
- "It would be a lot harder to sell the customer on something because you don't have a third-party test- can't sell it unless you can convince them. The explanation on the back of the test helps too. [Discontinuation of the program] would open the door for a third-party test company. Half or fewer tests would be done. We'd use more electricity, waiting for pumps to go out before fixing them."
- "Of course it's stimulating energy efficiency. But I don't think it would stagnate our manufacturers. We like seeing Edison to these tests. The bottom line is our customers get more educated. We want our customers happy. If you [Edison] didn't do it, it would be slightly less efficient out there. More sophisticated end users already know efficiency is important. Smaller users might slow down some."

Finally several consultants offered their perspectives:

- "[If the program were discontinued, there would be] much less incentive for them to do the right thing [install energy efficient products]. Customers come in informed and won't accept less. [It would be a] harder sell for us without the program. The rebate program is especially useful. They'd forget about it — many of them don't care. They'd see their bills rise and not know why. Very few would pay to test. Look at what goes on now with 2000HP motors. How many would do the High Pot. test to predict the life of the motor? They should, but who does?"
- "I suspect they wouldn't do it as often-would run pumps at levels that were less efficient-but [one specific city] would continue it themselves. They're counting on Edison. I would suspect too that over time things would slip-'as long as it's running-it's OK.'"

4.4 SURVEY OF LENDERS

4.4.1 Profile of Lenders Interviewed

RLW consultants spoke to a range of vice-presidents, senior loan officers, and appraisers at twelve lending institutions in Arizona and Southern California. Some of the individuals surveyed were more familiar with the technical details involved in offering loans than others. All individuals were in a position to make or inform loan decisions. A spectrum of full service national banks, full service state banks, regional farm production credit associations, and local credit unions were reviewed. The lenders contacted and loan products discussed with each are identified in Exhibit 4-22.

Exhibit 4-22: Lenders Surveyed and Loan Types

Name	State	Loan Type
First National Bank of Arizona	AZ	Commercial/Residential Loan
National Bank of America	AZ	Commercial Loans
Bank of America	AZ	Agriculture real estate/Agriculture equipment
Bank of Arizona	AZ	Commercial/Residential Loan
Community Bank of AZ	AZ	Commercial Residential Loan
Farm Credit Services SW	AZ	Agriculture equipment
Valley Farm Credit-Bakersfield	CA	Agriculture real estate
El Dorado Bank Farm Credit	CA	Agriculture real estate/ Agriculture equipment
Bank of San Bernadino	CA	Commercial Loans
Bank of Santa Maria	CA	Agriculture real estate
Valley Farm Credit- Hanford	CA	Agriculture real estate/ Agriculture equipment
Bank of Sierra	CA	Agriculture real estate/ Agriculture equipment

Conversations with bank personnel were oriented towards two prominent types of customers identified as having concerns about water issues: residential/ commercial borrowers and agriculture borrowers. While both groups were concerned with the presence of water on a property, there were qualitative differences in how water pumps and especially pumping efficiency was viewed.

4.4.2 Commercial/Residential Real Estate Loans

Lenders from five institutions (four in California and one in Arizona) were surveyed on this type of loan. The presence of water on a property has a significant influence on the value of a property only insofar as a given property has access to water. Most of the lending officials commented that the majority of loans that are made in the commercial and residential market tend to be made on properties that are located within a water utility district. Therefore, access to water is guaranteed.

Links to a water district can be easily verified through research of developer and public records. Water districts in both California and Arizona tend to be restricted to areas of higher population density. Rural areas rely on pumping groundwater or surface water in order to supply sufficient water. Most of the banks use physical inspections to determine the existence of water reserves. These inspections are typically performed by appraisers. Some appraisers are employed by the lender directly, while others work independently. For the most part, higher level bank officials did not know how the appraisers collected their data but they had confidence in the findings. One individual from a lending institution in Arizona mentioned water pump test data measured in gallons per minute as critical for determining the supply of water that is potentially available. This individual had made a number of loans in rural areas where municipal water sources are not available.

With the exception of the lending official who mentioned pump testing, the other members of the sample expressed no pressing concern about measuring the quantity of the water. For the purpose of making real

estate loans, the fact that water is present whether it be from a certified well or a municipal water district seems to be adequate for most lending institutions.

There appears to be no direct connection between Edison's pump testing programs and decision making patterns of commercial/residential real estate lenders. This is not surprising because the bulk of the projects that are funded by residential and commercial loan officers tend to be in metropolitan areas where pumps are not an issue.

4.4.3 Agricultural Real Estate Loans

Five of the California lenders sampled, and one Arizona bank were questioned about agricultural real estate loans. Several were agricultural lending institutions such as production credit associations. In addition, as to be expected for groups whose livelihood depends on water, both the presence of water and the quantity of water were considered significant factors in assessing risk on real estate loans. For most of the institutions surveyed, a prevailing theme was that there had to be adequate water available for whatever function the land was assigned. For example, grazing cattle demanded less water than irrigating citrus trees. Certain bank officials indicated the need for potential borrowers to demonstrate specific flow rates in gallons per minute.

Larger banks who also served non-agricultural clientele tended to use appraisers to determine the presence and the amount of water. Banks with agriculture specialties tended to use a combination of water district reports, irrigation district reports, and water pump testing data in order to measure the volume of water available from a particular source. Water pump testing data appears to be used exclusively to evaluate groundwater sources.

Water pumps were marked as significant in calculating property value because the pumps are the critical link between an aquifer and a farmer's field or stock lake. The water pump is a tangible indicator that a given property has the potential to be irrigated. To determine whether a given pump is functional, the Bank of America in Arizona used an appraiser's physical inspections. Some California banks also used physical inspections but most requested pump test data measuring volume of flow as inductive proof that a given pump is operating.

No bank official explicitly mentioned energy efficiency as an issue concerning lending institutions. After some reflection, two officials offered the opinion that energy efficiency is indirectly significant. A more efficient pump will be reflected in the profits for a given farm. The banks assumed that a more efficient pump would lead to a higher profit margin, a faster payback, and a lower risk for the lending institution. One bank official commented that pump efficiency is a moot issue for the real estate loan industry because pumps are mobile. On selling a property, a farmer can dismantle and move his or her pump. Because a pump is not necessarily stationary, loan officers focus on fixtures such as wells.

As to the sources of the pump test data, only one respondent offered the name of Southern California Edison. Even on prompting, four of the six bank officials interviewed were surprised to hear that Edison offers pump tests and assumed that the tests that they received came from private contractors such as S.A. Camp. For the purposes of offering loans, it seems that financial institutions do not need highly refined data but accept any data that measures the quantitative output of a well.

When asked how their behavior as a lending body might change if Edison did not offer its service, all respondents said that their banks would continue to require the third party tests and would rely on outside companies. Banks considered the assumed $50-$100 fees charged for the pump testing as quite affordable to their customers.

Even though the Edison program was recognized by two Californian respondents, it does not appear to have any direct effect on how agricultural real estate lenders are making their decisions. Banks appear to only be interested in data on the volume of water available and not in how the data is provided or who collects the data.

4.4.4 Agriculture Equipment Loans

A different set of questions were directed at respondents who identified themselves as equipment loan specialists. Questions were designed to understand what sort of pump purchases and retrofits banks are willing to fund and whether pump test data was used as a factor in decisions to make loans.

Four agriculture loan officers were interviewed in California and two in Arizona. Of the six agricultural loan officers, no one deemed pump test data to be significant in making equipment loan decisions. Rather lending institutions concern themselves with a farmer's operating credit as the primary criteria in making a loan. Indirectly, energy use as well as water costs are components of a borrower's credit, in that they contribute to the ability to repay an obligation. Three of the six California lender representatives qualified their statement by mentioning that pump tests are often required in the case of real estate mortgages to document the presence of a certain amount water especially in a groundwater source.

From the perspective of lenders making loans for many different agricultural purposes, pump retrofit loans, per se, appear to be relatively uncommon. In the case of Valley Farm Credit in Hanford in 1996 only 2 or 3 out of 90 agricultural equipment loans were made for pump retrofits. The Bank of America in Arizona does not make loans explicitly for pump retrofitting but as part of farm improvement packages.

One interesting difference emerged in the choice of preferred pumping fuel for Arizona farmers and California farmers. According to all loan officers in California, farmers who are putting in new pumps tend to opt for diesel, propane, and natural gas pumps over electric pumps because of the costs involved in operating an electric pump in California where electric rates are expensive. The informant from Valley Farm Credit in Hanford noted that pumps in many parts of Southern California are often in stand-by mode throughout the winter and infrequently used during the average summer. Customers still have to pay monthly for electric service and demand charges even when pumps are only used on a seasonal basis.

In Arizona, the Farm Credit Service respondent reported a gradual shift from natural gas pumps to electric pumps. The Bank of America informant explained the popularity of electric pumps as the result of a number of companies having favorable long term electric contracts with utilities and the efforts of a

number of electric companies to offer rebates to upgrade or replace their pumps with electrically-driven equipment.

4.4.5 Lender Market Effects

Pump test data is not an issue for equipment loans although it appears to be a factor in real estate loans where test data serves the purpose of indicating whether water is present, how much water is present, and whether a pump is functioning or not. If Edison's program was to end, it would have little effect on the functioning of financial institutions. There are other sources to get the minimal data that they need in making their decisions. The bank's customers e.g., agricultural borrowers would be responsible for shouldering the financial burden that private pump testing would entail. A loss of Edison data would impact how farmers go about applying for loans not how loans how processed.

Exhibit 4-23: Profile of Use of Pump Test Data by Lending Institution

Name	State	Use pump test data?	Who initiates pump tests?	Source of pump test data	If No SCE Tests?
First National Bank of Arizona	AZ	No	Borrower	Don't use	
National Bank of Arizona	AZ	Yes	Borrower	Private	
Bank of America	AZ	Yes	Borrower	Private	
Bank of Arizona	AZ	Sometimes	Borrower	Well certification	
Community Bank of Arizona	AZ	Sometimes	Borrower	Only used in cases of contention	
Farm Credit Services SW	AZ	Yes	Borrower	Well drillers	
Valley Farm Credit-Bakersfield	CA	Yes	Borrower	Private (e.g. SA Camp)	Use Private Data
El Dorado Bank Farm Credit	CA	Yes	Borrower	Private	Use Private Data
Bank of San Bernadino	CA	No	Borrower	Don't use	Use Private Data
Bank of Santa Maria	CA	Yes	Borrower	PG&E, Private contractors	Use Private Data
Valley Farm Credit -Hanford	CA	Yes	Borrower	SCE, Private contractors	Use Private Data
Bank of Sierra-Visalia	CA	Yes	Borrower	SCE, Private Contractors	Use Private Data

4.5 SURVEY OF REGULATORY AGENCIES

To assess the effects of Edison's pump test program on water regulatory agencies, a substantial amount of background exploration was necessary to understand the structure of California's water agencies and the comparable institutions in Arizona. Interviews were conducted with 16 government individuals ranging from specification engineers on the California Water Project to Adjudication specialists. These are listed in Exhibit 4-24.

Exhibit 4-24: Governmental Water Regulatory Agencies Surveyed

Regulatory Agency	State
State Water Quality Board-Colorado River Basin	CA
State Water Quality Board- Santa Ana Region	CA
DWR-State Water Project	CA
DWR-Northern District Record Departments	CA
DWR-Specificiation and Technical Records	CA
DWR-Southern Field Division	CA
DWR-Water and Plant Engineering Office	CA
DWR-Southern Region Engineering Geology	CA
DWR-Watermaster-Central and West Coast Basin	CA
DWR- Watermaster-Raymond Basin	CA
Watermaster-Chino	CA
Watermaster-San Fernando Basin	CA
Watermaster- Mojave basin (DWR Interim)	CA
Watermaster -San Gabriel Basin	CA
DWR-Adjudication Department	AZ
DWR-Groundwater	AZ
DWR-Surface Water	AZ

4.5.1 Structure and Function of California Water Agencies

The umbrella state organization for the management of water and its accompanying programs such as hydroelectric power and flood control is the California Department of Water Resources (DWR). DWR divides its personnel and financial resources between legislative/administrative affairs and engineering/ fieldwork. DWR is vested with the responsibility of upholding the California Water Code which covers the appropriation of water, determination of water rights, and details of the assigned missions of various state organizations.

DWR coordinates an array of programs including pumping water from Northern California to Southern California, regulating water quality, documenting drilling for groundwater sources, and enforcing adjudication judgments. Pump test data is employed, to a certain extent, in all of these programs. The following sections detail some of the uses of pump test data collected to meet DWR's needs.

State Water Project

The State Water Project (SWP) is managed by a group of civil and mechanical engineers within DWR. Energy efficiency is an important issue. An engineer working in the Department of Specification and

Technical Records commented that every 1% loss in efficiency on a pumping plant pump would lead to $2 million losses for DWR. Hence, DWR pumps are expected to operate at least at 93% efficiency. An informant from the Southern Field Division who is responsible for evaluating 18 pumping stations from Oroville to San Bernadino was not aware that Edison offered pump tests.[20] Instead, he mentioned that his office maintains a relationship with Edison's Energy Services personnel.

Regional Water Quality Control Boards

The State Water Resources Control Board (SWRCB) was created in 1967 by combining the Water Rights and Water Pollution Control Boards into a single body. The SWRCB and the Nine Regional Boards have jurisdiction over all surface, ground, and coastal waters of the State. The mission of the Board is to protect the quality of the State's surface, ground, and coastal waters, and to allocate water rights by issuing water right permits for appropriative surface water rights. Both the State and Regional Boards are backed by the Dickey Water Pollution Act of 1949, the Porter-Cologne Water Quality Act of 1969, and the Federal Clean Water Act of 1972.

The State Board develops policies and oversees programs conducted by nine Regional Water Quality Control Boards, one of which is located in each of the nine major watersheds of the State. For our sample we selected five of the regions in Southern California. Each Regional Board is staffed with engineers and environmental specialists. The Regional Boards develop basin plans, issue waste discharge requirements, take enforcement action against violators, and monitor water quality. They are responsible for carrying out State and Federal law as well as the policies set by the State Board.

Water quality experts who work for the Southern California Water Quality Boards located in Los Angeles, Santa Ana, San Diego, Colorado River Basin, and the Central Coast use pump test data in a limited fashion. These agencies are charged with monitoring waste discharges and ensuring that water quality standards are met. In a case where an individual or company is suspected of causing degradation to an aquifer by putting in a development such as a landfill, pump test data is required from the individual or firm involved in a given project. The respondents at the Water Quality Boards did not have detailed information about the sources of the information provided to the board.

Department of Water Resources Regional Offices

The DWR maintains regional Records Offices to collect and store data on all the wells in the state. These files contain pump test data from well drillers which are included in a document called a "drilling log". These documents are typically prepared by the well drillers at the time a new well is drilled to document well depth and to estimate yield. These logs are then sent by well owners to either the regional offices in the North (Red Bluff) or South (Glendale) and kept in confidential files. These documents are required by the law for any new well that is being sunk. Counties require that all wells be permitted. Edison's data could be used to confirm drilling logs but usually is not. This is because well owners are usually focused not on long term efficiency issues but instead on ensuring that their well certifications are processed in a timely fashion.

[20] According to Edison staff, Edison no longer tests the SWP pumping plants. These facilities now rely on internal personnel for tests of pump efficiency.

Geologists, hydrologists, and other data analysts at the regional offices of DWR also use Edison pump test data for hydrological modeling studies. A Senior Engineering Geologist from the DWR Southern Region office commented that pump tests are important for measuring conductivity, well yield, and storage coefficients in order to gauge the hydraulic properties of a given aquifer. This data is necessary for modeling flows of pollutants through aquifers, and estimating the effects of groundwater pumping practices. Edison's data on energy efficiency ratios relieves DWR of having to do time consuming and costly "draw down" tests on wells. When this informant requested pump tests from residents of particular groundwater aquifers, she noted that two out of every three of the tests submitted were Edison tests. The remaining tests were evidently provided by private contractors.

Watermasters

A final regulatory use of pump test data is illustrated by the Watermasters of Southern California's adjudicated basins. Adjudicated basins are aquifers where water rights disputes have been taken to court. Watermasters are individuals or organizations who are charged directly by the court with upholding adjudicated judgments. In the Central Basin, West Coast Basin, and parts of the Raymond Basin in Los Angeles, DWR was selected as the Watermaster. All Watermasters are public institutions (rather than private contractors) who receive their revenue by collecting pump assessments which serve as "pump taxes."

Because they are working with limited groundwater resources in a contentious environment, Watermasters make frequent use of pump test data. Six Watermasters were spoken to from the adjudicated basins of San Fernando, Mojave, San Gabriel, Chino, Raymond (which includes Pasadena), and Central/West Coast Basins. Four of the six Watermasters mentioned involvement with Edison pump testing data. These Watermasters were from the largely agricultural basin of Mojave, Los Angeles-based basins of Central/West Coast and Pasadena, and the Chino basin.

These Watermasters noted that in such adjudicated basins, all wells are required to have water meters installed and to submit quarterly production reports. In order to measure production, the Watermasters require one of four different forms of documentation:

- A water meter reading (inline)
- An electric pump test (kWh)
- A time-of-use meter recording (Hr)
- An alternate testing method that acceptable to the Watermaster and certified by an engineer.

Most customers opt to submit meter readings or electric pump tests. In the Mojave basin and Central/West Coast basins, pump tests are frequently employed to crosscheck and calibrate water meters by both agricultural personnel and water districts.

Pumps that are operating up to the specified efficiencies are critical for ensuring that each party to an adjudication treatment gets its promised quantity of water. In the case of the Chino basin, the Watermaster mentioned that water rights are divided between three pools: agricultural, industrial, and appropriative (local/city water districts). The appropriative pool is very sensitive to whether the

agricultural pool has measured its pumping production accurately because the appropriative pool is entitled to whatever water the agricultural sector does not use in a given year. If the production numbers issued by the agriculture sector prove to be incorrect and the appropriative pool ends up overdrafting their entitlement to a water source, local and city water districts will be required to replenish whatever excess water they made use of at a rate of $350-400 an acre-foot. This is significantly higher than the $20 per acre-foot rate for agriculture users. In the case of local and city districts, the financial burden of inaccurate pumping filings is ultimately translated into higher costs for all water consumers who draw on city waterlines.

When asked about changes in practice if Edison pump testing was not offered, there was a range of reactions. The San Gabriel Watermaster which is not affiliated with Department of Water Resources commented that in her basin, the energy efficiency of pumps is not an issue for the Watermaster but for the well owner in her basin. She noted that in terms of regulating overall costs, it is in the best interest of a well owner to employ energy efficiency practices. In the Mojave, Chino, Raymond, and Central/West Coast basin, there was greater uncertainty. All four of these basins use Edison data. Three of the four of these basins are affiliated with DWR with Mojave's arrangement being part of an interim agreement that has yet to be fully implemented.

The Watermaster for Central/West Coast basin commented that even though he doesn't get Edison results directly, the 149 members of the adjudicated agreement which he oversees do get Edison data and forward it to the Watermaster board. Without this data available, the Watermaster inferred that private data would be used, but was uncertain how water meters would be calibrated.

The Watermaster for Chino basin commented that a loss of Edison pump test data would, "represent a major hardship for Chino." She noted that the inability to access Edison's data would result in extra costs being levied on farmers. These would likely be applied in the form of pump assessments to cover the Watermaster's cost for having to conduct a somewhat antiquated estimation procedure using "crop/animal data conversions." This procedure apparently involves estimating the volume of water used based on per unit assumptions of how much water is takes to raise certain crops and livestock.

The Watermaster for Mojave noted if Edison did not perform testing that the Watermaster would not change its regulations to reflect this but would still require production documentation. Water districts and agribusiness would have to pay for the testing. The Mojave Watermaster predicted that pump systems would not be optimized because users would not necessarily recognize the loss of efficiency until they had incurred substantial losses. The Watermaster had already seen a difference in participation from small producers after Edison discontinued performing pump test for owners of "5 hp or less pumps." Now smaller pump users must hire private firms to conduct pump test for fees between $100 and $300 dollars.

The Raymond Basin Watermaster works in a territory that includes other power companies in addition to Edison. He noted that 75-80% of the tests that he receives come from Edison while 20-25% come from other sources such as private companies. The private companies only supply water meter readings while Edison provides water meter and energy readings. He commented that Edison reports are far more comprehensive and are critical in the Raymond Basin where 95% of the pumps are electric and power is expensive.

4.5.2 Structure and Function of Arizona Water Agencies

Like California, Arizona has a Department of Water Resources which is broken down into numerous departments including surface water, ground water, and adjudication. Because of the scarcity of water in Arizona, both groundwater and surface water are adjudicated. Over the last twenty years, Arizona courts in conjunction with the DWR have been trying to resolve jurisdictional issues involving ground water and surface water rights.

Limited pump tests are used to regulate contentious surface water rights disputes. Groundwater well owners are required to submit readings of water meters and readings of energy use (billing data). A conversion formula is used and if there is a large discrepancy between a water meter reading and reported energy use, a DWR auditor will go the given farm or water pumping center and investigate the cause. DWR expects farmers to maintain at least a 68% efficiency. This appears to be the assumption used to convert kWh billing data to volume of water. Informants could not be more explicit about the process. Water regulators confirmed that pump tests are not administered by the utilities.

4.5.3 Regulatory Agency Market Effects

If the Edison program were not offered, this would have a large impact on smaller customers who will still be required to conduct expensive tests in order to comply with adjudication compacts and with the California water code. It appears that without the program, some changes in the way that water codes are regulated and modeled would likely occur. Regulation agencies may have to rely on more costly, less precise, and more time consuming methodologies in order to extract the same information that is being provided by Edison currently.

In addition to the lack of utility provided pump testing, one possible reason why pump tests are not used as systematically in Arizona as in California may be the state of flux that the Department of Water Resources is undergoing in Arizona. Until the domain of groundwater regulatory jurisdiction is clearly defined from that of surface water, there appears to be some confusion about what various departments are responsible for monitoring. Due to the lack of regular pump testing, it appears that the methods for verifying groundwater drafts in Arizona's adjudicated areas are less accurate than the methods used in Southern California.

Exhibit 4-25: Uses and Sources of Pump Test Data in California and Arizona

Regulatory Agency	State	Use of Pump Test Data	Use SCE Data
SWQCB-Colorado River Basin	CA	Yes-to measure yield and water table degradation	No
SWQCB- Santa Ana Region	CA	Yes- Modeling studies	No-Welldrillers
DWR-State Water Project	CA	Yes-to monitor contamination	Don't know
DWR-Northern District Record Departments	CA	Yes- Use for drilling logs	No-PG&E, private
DWR-Specificiation and Technical Records	CA	Yes-Measure pump efficiency on SWP	No-inhouse
DWR-Southern Field Division	CA	Yes-Measure pump efficiency on SWP	No-inhouse
DWR-Water and Plant Engineering Office	CA	Yes-Measure pump efficiency on SWP	No-inhouse
DWR-Southern Region Engineering Geology	CA	Yes- Modeling studies (conductivity, etc.)	Yes
DWR-Watermaster-Central/West Coast Basin	CA	Yes-To cross check meter data	Yes
DWR- Watermaster-Raymond Basin	CA	Yes- Measure energy use	Yes-75-80%
Watermaster-Chino	CA	Yes-Measure water production	Yes
Watermaster-San Fernando Basin	CA	Yes- Measure kWh	Don't know
Watermaster- Mojave basin (DWR Interim)	CA	Yes- Verify water production	Yes
Watermaster -San Gabriel Basin	CA	Yes-Measure water quality, production	Don't know
DWR-Adjudication Department	AZ	Yes-Surface water adjudication	Private
DWR-Groundwater	AZ	Yes-Record amount of water pumped and used	Private
DWR-Surface Water	AZ	No	NA

5. MARKET TRANSFORMATION ASSESSMENT

This chapter discusses the implications of the data collection findings – presented in Chapters 3 and 4 – for conclusions regarding program effects on market transformation. In order to address that topic, a sequence of steps is followed.

- First, Section 5.1 defines the **terminology** used for the market transformation assessment.
- Using that terminology, Section 5.2 then lays out the **research agenda** for examining market transformation effects.
- Section 5.3 lays out the list of **hypothesized effects** on the behavior of each type of market actor.
- Section 5.4 then shows how those hypothesized effects on behavior correspond to the various categories of "**market barriers**," thus representing potential "market effects" of the program.
- Section 5.5 presents study **findings** concerning the extent to which the program has in fact caused "**lasting market effects**," which thus represent evidence of "market transformation."
- Finally, Section 5.6 discusses study **conclusions** regarding the remaining market barriers un-addressed by the program and the ongoing relevance of the program as a tool to cause such transformation.

5.1 DEFINITION OF MARKET TRANSFORMATION

The Hydraulic Services program has a variety of effects on customers and other market actors. Of particular interest, however, is the extent to which it has caused "*market transformation.*" The report, A Scoping Study on Energy-Efficiency Market Transformation by California Utility DSM Programs (J. Eto, R. Prahl, and J. Schlegal, Lawrence Berkeley National Laboratory, LBNL-39058, July 1996), provides a basic definition of "market transformation." It states that:

> *Market transformation* means a reduction in *market barriers* due to a *market intervention*, as evidenced by a set of *market effects*, that *lasts* after the intervention has been withdrawn, reduced, or changed. {italics added}

In order to understand these concepts, it is necessary to examine the definitions of terms. The discussion which follows draws heavily from the definitions developed in the above-cited report.

5.1.1 Market Barriers

In this report, the term *market barrier* is used to describe any characteristic of the market for an energy-related product, service or practice that helps to explain the gap between the actual level of investment in or practice of energy efficiency and an increased level that would appear to be cost beneficial. The following working list of market barriers to energy efficiency is taken directly from Eto, et al., 1996:

- Information or search costs
- Performance uncertainties
- Asymmetric information and opportunism
- Hassle or transaction costs
- Hidden costs
- Access to financing
- Bounded rationality
- Organization practices or custom
- Misplaced or split incentives
- Product or service unavailability
- Externalities
- Nonexternality mispricing
- Inseparability of product features
- Irreversibility.

A discussion of each of these in the context of the hydraulic pumping equipment and services market is provided in section 5.5. Market barriers are to be distinguished from "market failures" as described below.

5.1.2 Market Failures

A *market failure* is a condition of a market that violates one or more neoclassical assumptions (e.g., perfect information, costless transactions, no externalities, rational behavior, etc.). These assumptions define an ideal market for products or services. Market failure is a formal economic concept. It is widely agreed that the existence of a market failure provides necessary but not sufficient justification for government intervention.

Market barriers, on the other hand, were defined by practitioners attempting to characterize what they believed was wrong with current energy service markets (i.e., what explained the "efficiency gap"). Not surprisingly, market barriers defined under these practical conditions do not appear to derive from a unified conceptual framework of human behavior as is required by the formal structure of neoclassical economic analysis, although some market barriers are formally recognized as market failures by economists (such as externalities).

5.1.3 Market Intervention

A *market intervention* is a deliberate effort by government or utilities to reduce market barriers and thereby change the level of investment in (or practice of) energy efficiency.

Utility energy-efficiency programs are examples of market interventions; that is, interventions are defined as activities designed to reduce market barriers. An intervention's success in reducing market barriers, therefore, hinges on whether it leads to or causes a net beneficial outcome from a societal perspective. A net beneficial outcome requires that the increase in the adoption, procurement, or practice of energy efficiency is not offset by other losses (such as the cost of the intervention or its consequences).

The Hydraulic Services program was not designed based upon these formal terms. Nevertheless for the purposes of this report we take the position that the program can be considered to be a market intervention to the extent that it can be shown to have caused market effects or reduced market barriers.

5.1.4 Market Changes

For purposes of this report, the term "*market changes*" refers to a change in some characteristic of the market for an energy-related product, service or practice. The change may be in terms of its availability, features, prices, marketing, sales channels, financing, knowledge and/or attitudes towards it.

The concept of "market changes" was not included in the Scoping Study, but we have added it for this report, in order to denote cases where there have been changes in the market, regardless of whether or not they represent changes in *market barriers* and whether or not the program represented an *intervention* that can be credited with causing them.

5.1.5 Market Effects

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

Market effects, as defined in the Scoping Study, are evidence of whether and to what extent a market barrier(s) has been addressed effectively. If there is no observable market effect, then by the definition the relevant market barriers have not been reduced to a noticeable degree. For example, a market effect may not be observed because reductions in some market barriers may be accompanied by off-setting increases in others.

If there is an observable market effect, it is necessary to be able to attribute this effect to a particular market intervention(s) in order to use this finding as evidence that the intervention reduced the market barrier(s). This definition allows for both positive and negative market effects.

Strictly speaking, individual purchases of and subsequent load impacts from energy efficiency measures acquired through a utility energy-efficiency program are also among the market effects of the program. However, we are far more interested in market effects that are "outside" the program, effects beyond the individual act of participation by the customer. These effects could include changes in dealer stocking practices of the measure promoted and changes in manufacturing practices in response to increased demand for the measures; they could also include additional energy-efficiency measures or practices adopted by the participating customer.

5.1.6 Market Transformation

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

This definition is based on the need to have a standard by which to judge market interventions in a regulatory environment; it is not intended to describe the actions of private-sector market actors seeking to profit from their efforts to "transform" markets. This definition covers three possibilities:

- If there are no lasting market effects, then the market has not been transformed (because the reduction in market barriers has been only temporary);
- If there are lasting effects but further intervention is still warranted, then the market has only been partially transformed; and
- If there are lasting effects and the most important and relevant market barriers have been reduced to the point where further intervention is no longer deemed to be net beneficial to society, then the market has been completely transformed.

These distinctions reflect our concern to ascertain the permanence of market effects from energy-efficiency programs.

5.2 RESEARCH AGENDA FOR MARKET TRANSFORMATION

The focus of this study was on developing a broad understanding of the effects of the program on the markets for water pumping equipment and services. The Hydraulic Services program was not explicitly designed to affect market transformation. Thus, a significant portion of the preceding chapters examined the many ways in which the program caused or contributed to impacts on market player behavior, regardless of whether or not that behavior represented market transformation. In addition, though, this study also investigated whether the program did in fact lead to market transformation, even though that goal was secondary to the program's other explicit and evolving objectives over many years.

In order to examine the extent of market transformation, the study examined the ways in which the program's activities constitutes *market interventions,* addressed pre-existing *market barriers,* and led to *market transformation* through the long term reduction or elimination of such barriers. However, because the pump testing program was not designed to achieve market transformation, it was not possible to start with a discussion of the "market barriers" that the Edison program was designed to address. Rather, the study started out by collecting information on the extent of *market changes* and the extent to which those changes in market player behavior represented reductions in *market barriers.* The attribution of causality – attribution of program credit for *intervention* in the market, causing *market effects*" – was then addressed. Finally, the attribution of *lasting effects,* representing *market transformation,* was addressed.

5.3 HYPOTHESES OF PROGRAM EFFECTS

Market transformation effects can occur in many different ways, affecting the market or the behavior of some market actors at any level of the chain of demand and distribution, including:

1. Edison Customers
2. Dealer/Vendor/Contractors
3. Distributors
4. Manufacturers
5. Other Market Players (lenders, regulators, private pump testers).

In order to explore the program effects, this section lays out a series of hypotheses regarding how the program can change the behavior of market actors at each of these five levels. It is then followed in the next section with an explanation concerning how the hypothesized effects can represent *market interventions* addressing *market barriers*.

5.3.1 Customer Level Effects

Potential customer-level effects of this type can be assigned to three major categories:

- Direct changes in participants' awareness, attitudes, knowledge, or future decision-making behavior — *with respect to pumping-related equipment* — resulting from program participation
- Indirect participant spillover effects — *with respect to other types of equipment or other business practices*— resulting from program participation
- Indirect non-participant spillover effects — *with respect to any types of equipment or business practices*— resulting from the fact that the program was in operation.

Direct Participant Effects

The most significant and measurable direct effects on a customer would occur as changes in:

- Average overall pumping plant efficiency
- Mix of equipment types or fuel types
- Frequency rates of equipment replacement.

Of course the documentation of these kinds of effects would indicate *immediate or past* program impacts. But market transformation cannot have occurred unless the program has also changed customers' *future* decision-making such that these kinds of effects would continue were the program to end.

Therefore the primary customer-level market effect hypotheses for this study pertain to the adoption of new and persistent cultural practices. It can be argued that the program has *transformed* customers' behavior where such practices were not routinely employed prior to program participation. This leads to eight possible types of effects on cultural practices:

Hypothesis 1: Enhanced minimum efficiency or fuel type criteria for future equipment purchasing decisions

Hypothesis 2: "Predictive maintenance" procedures (including periodic pump testing, "trending"/record keeping, and/or other maintenance practices)

Hypothesis 3: "Prioritization" procedures for running most efficient equipment first

Hypothesis 4: Pre-installation inspection procedures for determining well conditions prior to dealer system specification and sizing

Hypothesis 5: Post-installation validation procedures for verifying that dealers have properly specified and installed pumping equipment

Hypothesis 6: Troubleshooting procedures for determining the cause of equipment problems

Hypothesis 7: Volume validation procedures for verifying that water intake and output records are accurate

Hypothesis 8: Improved cost/benefit analysis procedures for calculating the return-on-investment of efficiency-related investments.

Actual adoption of new cultural practices would be the most dramatic form of a customer-level program effect. But customers' increased knowledge of, or improved attitudes toward, any of the above cultural practices, short of actually adopting them as persistent or routine, can also be considered to be beneficial, potentially lasting, market effects. Thus, there are also hypotheses of information-related effects:

Hypothesis 9: Increased knowledge of alternative dealers (benchmarking dealers' best practices)

Hypothesis 10: Increased knowledge of available technologies (benchmarking best available equipment)

Increased knowledge of dealer or technology alternatives can lead to increased leverage with dealers. For customers, this can improve the outcomes of specific dealer interactions. It can also provide a stimulus for dealers to improve their knowledge, habits, and practices so as to maintain customer satisfaction and remain competitive.

Indirect Effects

The main indirect program effects on participants (i.e., participant spillover effects) would occur when the program affects practices concerning other types of equipment:

- Customers generalize the pumping specific knowledge or practices developed as a result of the pump test program to other energy efficiency behaviors or technologies
- Are introduced to other Edison programs or services (e.g., rebate programs) as a result of pump test staff contact.

The first type of effect can occur when practices can be similarly applied to other equipment, such as when a customer learns as a direct result of a pump test the value of a predictive maintenance strategy, and then applies either a similar diagnostic testing plan to another aspect of their operation. Some examples of these kinds of indirect impacts would include practice changes such as:

- Testing non-electric pumping equipment,
- Trending all energy input costs, or
- Performing life-cycle cost analysis on other non-pumping-related equipment purchases.

Another type of indirect participant effect can occur when the test program essentially functions to generate leads into Edison's other rebate programs (e.g., when the pump test technician notices another savings opportunity while on-site and informs the customer of the rebate option. Also many business customers often first learn of residential program offerings through contact with their utility representatives at work.

To the extent that the program popularizes any of the above information or practices, it can also stimulate the diffusion of those practices to non-participants. For instance, an indirect effect of the program can be to stimulate demand for non-program supplied pump testing among non-participants. Thus there are hypotheses of indirect effects:

Hypothesis 11: Any other indirect benefits of participation.

Hypothesis 12: Spillover of program-related practices to the operations of non-participants.

5.3.2 Dealer / Contractor Level Effects

Because the program is offered to customers, it cannot have direct "market effects" on dealers, per se. However, the program can have indirect effects on dealers by affecting their competitive incentive to satisfy a whole class of customers (participants) who:

- Understand the significance of test results and their impact on costs and profits
- Demand and have the ability to verify that specific efficiency or operational parameters are met, and
- Are more aware of their technology, purchasing, and financing options.

Thus, measurable effects on dealers could occur through changes in the:

- Frequency or mix of equipment sales (e.g., more sales, more sales replacing operational but inefficient equipment, high efficiency units comprising a greater percentage of total sales, etc.)
- Stocking patterns (e.g., new types or models of equipment) as a result of pump-test influenced customer demand
- Marketing practices, including marketing strategy, media or message of customer communications, etc.

Whether such effects would continue sans the program would depend on the extent to which dealers have institutionalized attitudes or practices which support these kinds of impacts into the future. Therefore it is important to consider whether dealers have adopted persistent cultural practices, where such practices were not routinely employed prior to the program's influence. There are eight related hypotheses of indirect effects on dealer practices:

Hypothesis 13: Enhanced minimum efficiency, new design, or fuel choice criteria for future equipment stocking, specifying, marketing or installation decisions

Hypothesis 14: Other design practice changes involving new technologies (e.g., ASD's, Teflon coatings, pressure reduction measures, storage alternatives for off-peak operation, SCADA control systems, etc.) as a result of pump-test influenced customer demand

Hypothesis 15: Self-administered pre-installation testing procedure for determining well conditions prior to system specification and sizing

Hypothesis 16: Self-administered post-installation testing procedure for verifying that equipment is operating properly

Hypothesis 17: Self-administered test-driven troubleshooting procedure for determining the cause of equipment problems

Hypothesis 18: Recommending third party post-installation validation testing for assuring the customer that the dealer has properly specified and installed pumping equipment

Hypothesis 19: Procedure to maintain or extend staff expertise to ensure that employees are up to date on new technologies and methods

Hypothesis 20: Improved cost/benefit analysis procedures for use in dealer sales presentations.

Short of actually adopting any of the above cultural practices as persistent or routine, dealers' increased knowledge of, or improved attitudes toward these behaviors can also be considered to be beneficial market effects. However such incremental effects would not be considered to be significant market transformation for the purposes of this evaluation.

5.3.3 Manufacturer/Distributor Level Effects

As with dealers, the pump test program can affect these actors only indirectly, through effects on program-stimulated customer or dealer demand for improved equipment. This leads to two hypotheses related to manufacturers and distributors:

Hypothesis 21: Changes in manufacturers' or distributors' marketing or distribution practices

Hypothesis 22: Changes in manufacturers' system or component design practices

The first type of effect can occur when a manufacturer or distributor makes a deliberate decision to market, stock, or distribute a greater volume of high efficiency equipment in the Edison / California-area as compared with areas without widespread pump testing, in response to pump-test driven customer demand for higher efficiency equipment. This type of effect would also include a manufacturer deciding to actively feature energy efficiency as a product sales feature, in response to pump-test driven customer demand for higher efficiency equipment, where this was not previously done.

The second type of effect can occur when a manufacturer actually redesigns a product in response to pump-test driven customer demand for higher efficiency equipment. It is recognized that while customer/dealer demand for improved equipment can in theory stimulate national manufacturers and regional wholesalers to compete with energy efficient products, it is difficult to determine the portion of that demand that has been driven by Edison's localized pump test program.

5.3.4 Other Market Player Level Effects

For this program, the category of "other" market players can be divided into three groups:

- Financial intermediaries,
- Regulatory parties, and
- Independent Pump Contractors.

Financial Intermediaries

Financial intermediaries active in the pumping market consist primarily of production credit lenders, banks, and other sources of capital. In theory, lenders can use pump test data to help determine a borrower's production-related expenses and ability to repay a loan. Since payback calculations included in the letters customers receive after a pump test do itemize input assumptions, they could be used to help justify loans for retrofit investments. Lenders and realty agents could also use pump test data to certify the presence of water on a property or determine well conditions, and only secondarily are concerned with the condition of the pumping plant. A direct influence on lenders can also be said to exist to the extent that the program has caused more data to be available to enable or facilitate the lending of money. Overall, then, there are three possible hypotheses concerning financial intermediaries:

Hypothesis 23: Request historical pump test data

Hypothesis 24: Commission testing of wells and pumps when past test data is not available (either by Edison or independent contractors)

Hypothesis 25: Offer better terms or relaxed approval criteria for customers who use pump test data to demonstrate retrofit paybacks

Regulatory Parties

Governmental agencies charged with consumer or environmental protection can make use of pump test data for:

- Validating water deliveries as part of PUC-driven cost-of-service ratemaking
- Determining when and the extent to which groundwater overdraft limits have been exceeded in "adjudicated basins".

Our only hypothesis related to this group is that the program could have caused governmental agencies to:

> *Hypothesis 26:* Mandate requirements that customers supply pump test data for governmental purposes.

Independent Pump Contractors

Independent pump test contractors represent another important group of non-financial intermediaries. These firms operate either outside Edison's territory (e.g., PG&E, SDG&E, or the "resale cities" such as Glendale or Pasadena) or within Edison territory where unsatisfied demand opportunities are created by program backlogs or participation criteria. There are three hypotheses concerning structural effects on them:

> *Hypothesis 27:* Stimulated customer demand for testing services which Edison cannot supply[21] enabling new independent pump test contractors to emerge.
>
> *Hypothesis 28:* Improved pump testing methods and practices such as more accurate measurement techniques, more effective customer communications, improved program administration techniques, etc.
>
> *Hypothesis 29:* Educated and trained personnel who subsequently left Edison to join or form new independent pump testing firms.

[21] Either due to SCE's geographical/regulatory constraints or SCE's choice not to supply this demand for testing services due to internal resource allocation constraints.

Market Barriers Associated with the Hypothesized Program Effects

Whereas the preceding section laid out hypotheses regarding program effects on market player behavior, this section explains how those behavior changes relate to the *market barriers* that were previously introduced in Section 5.1, and can thus represent *market effects* of the program.

5.3.5 Categories of Market Barriers

As cited in the definitions section of this report (5.1) , Eto, et al. (1996) provide a list of *barriers* which are said to occur in the markets for energy efficiency goods and services. Working from the same list, Herman, et al. (1996)[22] calls for future studies to fine-tune the categorization of market barriers. To simplify our discussion of the barriers to pumping efficiency, Exhibit 5-1 maps the 14 barriers identified in the Scoping Study into five more general categories of barriers. These are:

1. Informational Barriers
2. Behavioral Barriers
3. Structural Barriers
4. Pricing-Related Barriers
5. Product/Service Feature-Related Barriers

Exhibit 5-1: Categories of Market Barriers

Categories of Market Barriers		
	Scoping Study Working List	***Market Barrier Type***
A.	Information or search costs	Imperfect Information
B.	Performance uncertainties	Imperfect Information
C.	Asymmetric information and opportunism	Imperfect Information
D.	Hassle or transaction costs	Imperfect Information
E.	Hidden costs	Imperfect Information
F.	Access to financing	Imperfect Information
G.	Bounded rationality	Uneconomic Behavior
H.	Organization practices or custom	Uneconomic Behavior
I.	Misplaced or split incentives	Incomplete Pricing
J.	Product or service unavailability	Inadequate Market Structure
K.	Externalities	Incomplete Pricing
L.	Nonexternality mispricing	Incomplete Pricing
M.	Inseparability of product features	Intractable Product Feature
N.	Irreversibility.	Intractable Product Feature

It is beyond the scope of this study to resolve the semantic and conceptual distinctions between the terms *market barrier* and the more formally defined *market failure* recognized by economists. The terms we have used to develop our categories are intended to accentuate the similarities of the two concepts.

[22] Herman, P., and Feldman, S., et al.(1996) "Residential New Construction Market Characterization". Oakland, CA. Barakat & Chamberlin December 6, 1996. (CADMAC report no. TRR66.52.H2).

Ultimately we expect that most of the market barriers we identify will be shown to be particular examples of accepted market failures in conformity with some of the leading typologies in use (Bator 1958; Harris and Carman 1983; Sanstad and Howarth 1994). Future studies will have to explore and resolve the redundancy that is inherent in the continuing use of these two distinct sets of terms.

5.3.6 Market Barriers and Hypothetical Program Effects

Exhibit 5-2 lists the types of market barriers associated with each of the potential market effects suggested to date. As to be expected of an informational program, the majority of these effects are thought to address the informational and/or behavioral limitations experienced by *customers*. Most of the remaining effects on other actors further "up" the distribution chain are believed to be indirectly the result of these *suppliers* responding to the increased demand of customers for higher efficiency pumping goods and services. Each type of barrier is discussed in the pages to follow.

Exhibit 5-2: Mapping of Hypothetical Market Effects to Market Barriers

	Actor Level	Market Effect Hypothesis	Market Barriers Addressed
1	Customer	Enhanced minimum efficiency or fuel type criteria for future equipment purchasing decisions	Informational; Behavioral
2	Customer	"Predictive maintenance" procedures	Informational; Behavioral
3	Customer	"Prioritization" procedures	Informational; Behavioral
4	Customer	Pre-installation inspection procedures	Informational; Behavioral
5	Customer	Post-installation validation procedures	Informational; Behavioral
6	Customer	Troubleshooting procedures	Informational; Behavioral
7	Customer	Volume validation procedures	Informational; Behavioral
8	Customer	Improved cost/benefit analysis procedures	Informational; Behavioral
9	Customer	Increased knowledge of alternative dealers	Informational; Behavioral
10	Customer	Increased knowledge of available technologies	Informational; Behavioral
11	Customer	Any other indirect benefits of participation	Informational; Behavioral
12	Customer	Spillover of program-related practices to the operations of non-participants	Informational; Behavioral
13	Dealer	Enhanced minimum efficiency, new design, or fuel choice criteria for future equipment stocking, specifying, marketing or installation decisions	Informational; Behavioral; Structural
14	Dealer	Other design practice changes involving new technologies	Informational; Behavioral; Structural
15	Dealer	Self-administered pre-installation testing procedure	Informational; Behavioral; Structural
16	Dealer	Self-administered post-installation testing procedure	Informational; Behavioral; Structural
17	Dealer	Self-administered test-driven troubleshooting procedure	Informational; Behavioral; Structural
18	Dealer	Recommending third party post-installation validation testing	Informational; Behavioral; Structural
19	Dealer	Procedure to maintain or extend staff expertise	Informational; Behavioral; Structural
20	Dealer	Improved cost/benefit analysis procedures	Informational; Behavioral; Structural
21	Mfr/Distributor	Changes in manufacturers' or distributors' marketing or distribution practices	Behavioral; Structural; Feature-Related
22	Mfr/Distributor	Changes in manufacturers' system or component design practices	Behavioral; Structural; Feature-Related
23	Lenders	Request historical pump test data	Pricing-Related; Behavioral
24	Lenders	Commission testing of wells and pumps when past test data is not available	Pricing-Related; Behavioral
25	Lenders	Offer better terms or relaxed approval criteria for customers who use pump test data to demonstrate retrofit paybacks	Pricing-Related; Behavioral
26	Govt. Agencies	Mandate requirements that customers supply pump test data for governmental purposes	Pricing-Related
27	Other Pump Test Service Providers	Stimulated customer demand for testing services which SCE cannot supply enabling new independent pump test contractors to emerge	Structural
28	Other Pump Test Service Providers	Improved pump testing methods and practices	Informational
29	Other Pump Test Service Providers	Educated and trained personnel who subsequently left SCE to join or form new independent pump testing firms	Informational; Structural

Informational Barriers

The most direct effects of the program occur through addressing the informational barriers that are experienced by customers, and to a lesser effect, by dealers and other pump test providers. The program addresses the following informational barriers:

- Information search or hassle costs relate to the costs inherent to acquiring new information regarding pumping energy efficiency. The program should reduce the costs to customers of collecting both general (best practices benchmarking) and site-specific information.

- Performance uncertainties or hidden costs pertain to the risks perceived by customers in adopting new practices or purchasing new technologies, and the imperfect information available concerning them.

- Asymmetric information and opportunism occurs because dealers or manufacturers have more information on product features (technical specifications, failure rates, availability, etc.) and product alternatives.

- Access to financing can be a barrier for customers who are engaged in the sale of a property where well conditions are unknown or who lack a complete understanding of the payback terms associated with a pumping system improvement. This barrier is essentially informational in nature.

Behavioral Barriers

No individual acts in a strictly rational, self-interested manner. Culture and society offer numerous constraints on purely self-interested behavior, and individuals and organizations moderate their impulses to maximize their economic utility to various degrees. Behavioral barriers occur when market actors make decisions or complete transactions that are contrary to their economic self-interest. Some theorists classify such barriers as informational, arguing that these occurrences violate the ideal market assumption of *perfect information*. We prefer to use a separate category to draw attention to the fact that in such a case it is the ideal assumption of *economic rationality* that is actually violated. The distinguishing feature is that even when actors have sufficient information, the following behavioral barriers prevent them from making strictly rational economic choices:

- Bounded rationality is uneconomic behavior occurring at the level of the individual. Whenever specific customers, dealers or lenders are aware of the benefits of any of the practices the program encourages, but haven't acted on that information, bounded rationality is occurring. Habits, customs, and the way individuals personally process information can all contribute to the gap between *knowing* and *doing* what is in one's best economic interest.

- Organization practices represent uneconomic behavior occurring at the level of the organization. Processes analogous to bounded rationality also occur within organizations. Examples are when a dealership persists in implementing a policy of specifying or ordering the same type of

equipment even while individual staff members know that superior alternatives (higher performance, higher margin) exist.

Structural Barriers

This category refers to the types of barriers that prevent the following ideal market conditions from occurring:

1. Perfect competition (competing actors have equivalent bargaining power), and
2. Zero entry barriers (new suppliers can readily enter the market to meet increases in demand).

Structural barriers can result from the way markets are regulated, the way firms or groups of firms are organized, or through other institutional conditions which limit the supply of goods and services from reaching buyers. The primary effect of structural barriers is that they limit the options available to buyers at subsequent levels of the distribution chain. Only a single market barrier from the Scoping Study list falls under this category:

- Product or service unavailability is essentially evidence of a supply-side limit. If a market is structured in such a way that the buyer's supply options are limited, this barrier is in effect. This constraint could occur primarily when a pumping equipment manufacturer or distributor does not make or is unable to provide a piece of equipment or service the customer wishes to purchase. If customers are constrained in their ability to switch to other suppliers (by means of regulations, higher transportation costs, high market entry costs for new suppliers, etc.) their options are effectively limited. The classic examples of this type of barrier are stocking or distribution practices that prevent informed customers from being able to purchase the goods they demand.

Pricing-Related Barriers

This category joins together all of the "side effects" which can occur when the full costs[23] of an item are not included in the price at which a good or service is offered for sale. These barriers can occur whenever the following "ideal marketplace" conditions are not met:

1. Absence of externalities (internalization of full costs within prices)
2. Zero transaction costs (no additional cost barriers to a transaction)
3. Divisibility (objects of exchange can be divided into separate components which can be exchanged separately)
4. Excludability (actors can exclude others from the benefits of their transactions)

The barriers of this type are the following:

[23] Here we use the term "full costs" to mean what Harris and Carmen (1983) describe as "all consequences of the exchange process (including pre-exchange production and post-exchange consumption or use)".

- Externalities are the result of an incomplete accounting of the positive or negative consequences of production or consumption. Insofar as some of the benefits of energy efficient products are not recognized in purchase and investment decisions, the decision-makers can end up under-valuing those products, causing their demand levels to be lower than what they would have been had their full benefits been recognized and valued.

- Non-externality mispricing refers to intentional, unintentional or regulatory-driven mis-pricing. Subsidies and taxes generally fall under this category.

- Misplaced or split incentives cause the costs of an energy-related investment to be allocated to one party and the benefits to another. For instance, this can occur when a municipal department sees that the benefits of their cost-savings and revenue-enhancing actions flow back to the city's General Fund. This situation results in no incentive to increasing efficiency.

Feature-Related Barriers

These barriers refer to the physical properties of the goods offered for sale in the pumping market.

- Inseparability of product features refers to the fact that products are often offered as packages of features that cannot be divided one from the other. Hypothetically manufacturers could create such a barrier by offering high efficiency components only in a model combined with other features which buyers may not want to purchase.

- Irreversibility describes the fact that most product purchase decisions cannot be reversed if their value should go down at some future date.

5.4 FINDINGS ON MARKET EFFECTS AND TRANSFORMATION

While the Hydraulic Services program was not specifically designed to address market transformation issues, the program has in some ways affected barriers to achieving energy efficient pumping systems. This section discusses how the data analysis findings (from Chapters 3 and 4) relate to the goal of overcoming market barriers, by means of the hypothesized program effects (as laid out in preceding sections 5.3 - 5.4). First, findings concerning the applicability of the market transformation paradigm are summarized. Then, findings are presented on how the program has addressed and mitigated five types of barriers: (1) information barriers, (2) behavioral barriers, (3) structural barriers, (4) pricing-related barriers, and (5) product feature-related barriers. It is noted that some of the effects are likely to be ephemeral while others are likely to be longer lasting. That is followed by a discussion of the overall program effects, and the extent to which they are likely to be lasting effects.

5.4.1 Application of the Market Transformation Paradigm

Before examining how the Hydraulic Services program has affected market transformation, it is important to provide a perspective on the applicability of the program design and setting to address market

transformation. Most fundamentally, the concept of market transformation revolves around the idea that there can be systematic aspects of the product "distribution chain" which act as barriers to the optimal economic adoption of energy efficient technologies. By overcoming those systematic barriers, it can then be possible to increase the adoption of energy efficient technologies in a way that is both economical and lasting. In theory, any type of demand-side management program can address market transformation (as noted by Eto, Prahl, and Schlegel, 1996). However, it must also be acknowledged that some types of program designs can be better than others in targeting specific market barriers in the distribution chain, and bringing about lasting change in the functioning of markets.

The data collection and analysis findings in Chapters 3 and 4 indicate that:

- The Hydraulic Services program was designed to be a customer information program, which would provide a needed service and educate customers about energy efficiency, while promoting Edison as a vendor. As such, it was not specifically designed to address other market barriers (besides information availability), the behavior of other market actors (besides customers), or any goals for lasting and permanent transformation in the processes of production, distribution and selling of pump products. There is some evidence that the program has in fact had some limited effects on other parties and other goals (as discussed later in Section 5.5). In evaluating their significance, however, it is important to note that many of them were not specifically intended effects of the program design.
- In contrast to an "idealized" paradigm of market structure[24], in which there is a straight-forward distribution channel (of manufacturer to wholesaler to retailer to customer), the distribution of pump systems follows a more complex combination of routes. For some submarkets (such as large municipal water supply), there are competitive bidding requests issued by public agencies and their consultants directly to manufacturers. In some cases, there is also a "distributor" who is actually a manufacturers representative. In other submarkets (such as agricultural irrigation), the purchase may be made by a contractor who also functions as a dealer, buying direct from a wholesaler who has a business relationship with one or more specific manufacturers. The variation in these arrangements within and between submarkets occur because of the wide differences in the components that comprise pumps systems for the various applications. They make it hard to assess overall program-wide effects on market barriers, since those barriers, and the program's effects on them, do in fact differ by submarket.
- The program's history of intervention also contrasts with the prevailing paradigm of market transformation. This model follows from the above assumptions about how a conventional product market is usually structured. While in such markets there are choices between energy efficient products and standard products, there is no such formal classification of products in the field of hydraulic pumps. First of all, the customers purchase and install a pump "system" rather than a single pump product. The system typically consists of a pump impeller/bowl assembly, a motor, a water distribution system, and set of controls. These components can often be mixed, matched and sized in various ways that can affect overall efficiency. Unlike refrigerators, motors and lights, there are no established standards or assignment systems for calling some pump systems "energy efficient" and others "standard efficiency." The wide variation in types, sizes and configurations of systems makes such classification problematic. There are also no established categorization systems for

[24] Cf. Eto, Prahl, and Schlegal, p.17.

grouping sizes and types of pumps, and their efficiency levels within those groups, to allow for consistent comparison and tracking of sales patterns. When such standards and classification schemes are lacking, it becomes difficult to effectively define as well as track behaviors that would comprise market transformation.

It is logical to conclude that market transformation can be best accomplished when there are program interventions designed and targeted to address specific market barriers in the production, distribution and sales processes that are applicable for specific products. Estimates of the saturation of an energy efficient product or prevalence of a behavioral practice can then be established. Such estimates then become the baselines against which a market changes can be measured. Multiple program interventions, each separately targeted, can be designed and packaged together to address broader market transformation needs for particular industries or types of products. The current Hydraulic Services Program did not have that intent or design, so the assessment of its market transformation effects is constrained accordingly. The discussion of market effects which follows generally describes overall effects (combining all submarkets), although significant differences between agricultural and water supply customers are also noted.

5.4.2 Informational Barriers

By its very design, the most direct effects of the program are through its effect on increasing information flow to customers, and to a much lesser effect, to dealers and other pump test providers. In that respect, the program addresses the barrier caused by lack of information available in the marketplace to inform individual customer purchase and practice decisions. The program had the following effects on these specific informational barriers:

Effects on Information Search or Hassle Costs

- The program reduced costs to customers of collecting both general (best practices or "benchmarking") data on available products and site-specific (pump test) information. This occurred through training and concentrating experience in the hydraulic services staff, and subsidizing the expense of individual pump tests. Customer surveys indicate that the two most frequently-acknowledged program benefits were "reduced time or cost of collecting information" (reported by 24% of all customers) and "reduced hassle of getting pumps tested." (reported by 23% of all customers). In each case, the benefit was reported by more by water supply customers (accounting for over 1/3) and less by agricultural customers (just 1/6); however all of the large customers in both market segments reported these benefits.

- Interviews confirmed that the Hydraulic Services group is a well-known and respected "technology transfer" institution within the pumping community in Southern California. Though on a smaller scale, the role it plays is comparable to that of the agricultural extension service, which concentrates and disseminates current knowledge in agricultural practices. Edison staff have developed, retained, and transferred that institutional knowledge throughout the industry. In effect Edison personnel have become "one-stop-shops" for a wide range of information on energy-related and operational issues. By offering pump testing services for no fee, customers were provided with a very low transaction cost to acquire this information (i.e., only the time it takes to allow access and review the results of

the tests). In that way, the program reduced costs of assembling and verifying the information that customers then use to make purchase and maintenance decisions.

- The customer information benefit of pump testing is clearly attributable to the Edison program. None of the Arizona surveys of either water suppliers or agricultural end users reported pump testing being offered by their utility. In fact many were surprised to hear it existed in Southern California. When asked about pump testing there, most larger water suppliers reported that they were only familiar with factory testing of pumps, which they only receive prior to a new piece of equipment being installed.

- Indirect information flows to non-participants were also cited by Edison staff. While non-participants usually did not get pumps tested, they did gain awareness of energy efficiency through information diffusion. Such diffusion occurs as customers talked to one another, read trade journals, maintained facilities in other service territories, and shared dealers and other market professionals with program participants. Actual program spillover effects on non-participants could not be distinguished because the program has been in existence for so long, leading to a situation where many customers who are not recent program participants may have been participants at some time in the past.

Effects on Performance Uncertainties or Hidden Costs

- The program reduced customer uncertainty about the value of purchasing high efficiency equipment and systems, as a consequence of 1) Edison staff accumulating and disseminating their experience of previous installations in other facilities, and 2) Edison's recommendation of specific practices or technologies. Because Edison was perceived as deriving no direct commercial benefit from the choice of any specific product offering, Hydraulic Services personnel were considered to be one of the most independent and reliable sources of information available. Customers reported this benefit as the second most common type of program benefit (after information search and hassle costs). "Reduced doubt and uncertainty when making purchases" was reported by 21% of the participants (16% for agricultural and 28% for water supply customers). However, over 2/3 of the large customers reported this.

Effects on Asymmetric Information Availability

- The program indirectly addressed the concern of customers where they lack sufficient information to evaluate dealer and manufacturer claims and offers. While the program did not intervene in customer-dealer relationships, Edison staff did assist in serving customers seeking a critical assessment of what dealers have proposed (pre-installation inspection tests) or already installed (post-installation validation or troubleshooting tests). A significant share (27%) of the water supply participants reported that the program "reduced the information disadvantage with dealers and suppliers." However, nearly none of the agricultural customers (0.6%) reported it.

- Dealers and contractors also indicated that the program had effects that theoretically result in a reduction in the dealer's information advantage. On a scale of 1 to 5, (5 high) dealers rated the pump testing program effects on "customer knowledge of pump efficiency choices" (4.0), "contractor

follow-up and maintenance" (3.7), and "accuracy in matching pump products to user needs" (3.6). These dealer reports suggest that the program does affect the information balance between dealers and end users.

- Four of five manufacturers aware of the program also commented that Edison pump testing results in complaints from customers that their pumps are not operating up to specifications. A minor nuisance to manufacturers, this finding indicates a program benefit to end users. With Edison's third party measurements and written reports in hand, customers are able to document their complaints. Apparently this occurs in ways that are noticeable even at the level of at least the regional manufacturer's representative.

- Edison staff reported that customers regularly ask the Edison personnel to discuss additional options that may not have been proposed by dealers or consultants. Both dealers and customers also acknowledged this role of the program. However, these and other direct dealer effects are considered ephemeral, since they occur primarily in response to troubleshooting driven pump tests when a problem is diagnosed requiring a dealer or manufacturer to take some remedial action.

Effects on Access to Financing

- The program had only a minor effect on access to financing. It was hypothesized that confirmation of well conditions would enhance access to property loans. In fact, 3% of the agricultural customers and 9% of the water supply customers reported that the program improved their access to financing, but that appeared to be a consequence of access to information about available options. Interviews with lenders confirmed that pump test results had little effect on land property loans.

- Any effect of the program on agricultural equipment loans for retrofitting inefficient pumps was also not remarkable to lenders. Although Edison staff reported examples of customers using tests to justify a loan application, most lenders appear to consider other criteria such as the credit worthiness of the borrower to be more important than the paybacks for a specific piece of equipment.

These findings indicate that the program did reduce informational market barriers, leading in specific cases to individual customer decisions to improve pump efficiencies. Customers and dealers also credited these individual program interventions with encouraging their appreciation of the value of information (primarily test results, but also new technology information). And many are expected to continue valuing this kind of information even without continued support from the program. It is through this mechanism that the program has effected knowledge and attitudes and caused the lasting mitigation of the informational market barriers experienced by customers and dealer/contractors.

Throughout the project we have drawn a clear distinction between the instantaneous effects of the program on *individual purchase decisions* and the more *enduring "structural" features of the market.* Clearly when the program intervenes in the dealer/customer relationship, the program operates primarily to influence individual knowledge and decision-making. But what is a market but the sum of numerous such individual purchase decisions? It is precisely their simultaneously componential and aggregated nature that makes markets so dynamic, and makes market transformation so elusive. If customer

information programs are to make any contribution to achieving market transformation, it will always be through such "micro-level" effects which begin at the point-of-purchase. Only through the sum of these individual interactions do such programs have the potential to impact the more lasting elements we have described as actors' knowledge, attitudes, intentions, or behaviors or as more structural changes in routine practices or rules. These longer term effects on informational barriers should be the goal of information-directed market interventions.

While the program operated directly on customers, it may also have had spillover effects on other market players. In general, the pumping equipment market is clearly very interactive. The micro-level processes surrounding individual pump tests and purchase decisions do in fact create marketplace dynamics (e.g. increased demand for high efficiency components or improved system design, etc.) which could ultimately cause more lasting structural or attitudinal changes at other "higher" levels of the market (i.e. with distributors and manufacturers). However, the existence of such higher level effects is speculative at this point. No significant data was found to document such effects on these other market players.

5.4.3 Behavioral Barriers

Behavioral barriers occur when certain factors cause market actors to make decisions or complete transactions that are contrary to their economic self-interest. Frequently, such behavior occurs due to *imperfect information* (i.e., the "information barriers previously addressed). However, there are other times when the cause is a violation of the assumption of *economic rationality* attributable to the rigidities of individual or organizational customs and practices. The program effects on behavioral barriers included the following:

<u>Effects on "Bounded Rationality" (uneconomic decision-making)</u>

- Dealers reported that the program caused testing-driven pump repairs and replacements to occur in cases where they typically otherwise would not, despite the energy savings and cost-effectiveness benefits. Some dealers reported that over 50% of their repair work came after an Edison pump test. In some cases this included replacing malfunctioning or under-functioning equipment that customers simply "had not gotten around to doing" until the problem and its costs were underscored by Edison's pump test results.

- Customers reported that the program encouraged them to institute predictive maintenance and to a lesser extent other economically rational but often overlooked practices. While the program was not the only influence customers cited when adopting these new practices, it is notable that 20% of the water supply participants and 4% of the agricultural participants reported that the program "changed their attitudes about technologies and business practices." Higher proportions were reported among the largest pump customers (100% agricultural; 36% water supply).

- Behavioral practice effects were most noticeable in the water supply submarket. Within this group, 62% of the Edison participant respondents reported that they "always or usually" practice predictive maintenance, as compared with only 15% in Arizona. Confirming the role of the Edison program is

the finding that among participants in the water supply submarket, 27% of Edison respondents who practice predictive maintenance rated the program "very important" in their decision to adopt it.

- The program also appears to have had a small effect on priority pumping and cost-benefit analysis practices by water supply customers. Though Edison pump test participants reported practicing these procedures no more often than their Arizona counterparts, 10% rated the program "very important" in their decision to adopt these practices.

Effects on Organization Practices.

- Many of the above comments concerning the program's effects on bounded rationality market barriers apply equally to the organizational practices barrier. In fact, to the market players interviewed, there is often no clear distinction between the two; the "organizations" they work with and within are made up of decision-makers who are themselves individuals. To the extent that preventative maintenance, priority pumping, and cost-benefit analysis become *institutionalized*, they can be said to have overcome this organizational barrier. Overall 23% of water supply customers but only 3% of agricultural customers felt that the program had "changed the way they are organized or do business". This suggests that were the program to be discontinued, the typically more bureaucratic water supply agencies should be expected to continue implementing these practices at a higher rate than agricultural customers.

- There was clear evidence of a significant organizational practice barrier associated with the water supply submarket leading to uneconomical institutional decisions. Interviews of manufacturers, distributors and consultants consistently indicated that the competitive bidding process used by municipal water customers frequently led to product specifications and selection criteria that ignored or under-valued higher efficiency levels as well as the tradeoff of lower long-term ownership cost vs. higher initial purchase cost. The result is that competitive bidding practices exist which do represent a barrier to adoption of higher efficiency pumping equipment. While a mechanism exists for ameliorating this barrier, the "evaluated bid", the program was not designed to address this issue. As a result, there appears to have been no program effect on this barrier in the Edison service area.

These findings indicate that the program did cause some shifts in individual practices and organizational customs, especially those regarding preventative maintenance. Since preventative maintenance, priority pumping and cost-benefit analysis typically pay for themselves in the long-term, customers who convert to implementing these practices *learn* to value them. To the extent that this learning at the individual level is *institutionalized* at the level of the organization, it has a greater likelihood of persisting both in the absence of further utility intervention as well as in the absence of the individual who was directly effected by the program. As a result a reasonably high percentage can be considered likely to continue these practices without further intervention from the utility. Preventative maintenance is probably the most tenuous of the three, since it is dependent on the testing currently provided at no cost by Edison. Dealers estimated that in the event the program was ended, such testing would likely continue at approximately half the rate at which it currently occurs. This suggests that at least initially, roughly 50% of the preventative maintenance testing which Edison currently performs would persist in the absence of the program. However dealers also cautioned that over time this number would likely continue to drop

without some intervention in support of this rational but often undervalued practice. Even economically rational behaviors which have been learned and even institutionalized can cease to be practiced when their benefits are not made immediately apparent.

5.4.4 Structural Barriers

Structural barriers occur when market conditions constrain the set of available products and their distribution. This can occur as a consequence of the way markets are regulated, the way firms or groups of firms are organized, or through other institutional factors that limit the options available for consumers. In this case, the program effects related to just one type of structural barrier:

Effects on Product Availability.

- A classic structural barrier occurs when stocking practices prevent informed customers from being able to purchase the goods they demand. That problem was not prevalent in the water supply submarket due to its heavy reliance on custom factory orders. However dealers and distributors serving the agricultural submarket did occasionally report being under competitive pressure to stock a limited amount of high volume equipment to minimize inventory. This was said to sometimes lead to unavailability of some high efficiency pumps and components, particularly when such products are needed for immediate installation. Insofar as this behavior was a rational response to low demand for such equipment, the real problem can be viewed as "low demand" rather than "low stocking." Nevertheless, a lack of stocking still presents a minor hurdle to the promotion and gradual growth of sales for higher efficiency equipment in the agricultural submarket.

- Because the program was offered to customers, it could not have had any direct "market effect" on the dealers, distributors or manufacturers. It could have had an indirect effect and temporary effect on their product offerings as a consequence of changes in customer demand for higher efficiency equipment. In fact, customer and dealer surveys indicated that the program did help accelerate pump repairs and higher efficiency pump replacements. However, contrary to these comments from dealers, distributors and manufacturers generally reported that their overall sales and stocking patterns have not been changed by the program. They consistently noted that any differences in the characteristics of pumps sold in Southern California and in other states were due primarily to differences in pump needs, customer sizes and energy costs. This assertion is countered by the limited data collected from dealers and consultants which suggest that sizable differences exist in the percentages of standard, high, and super-high efficiency equipment sold, stocked and specified in the two states (cf. the discussion of Sales Patterns contained in Section 4.4.3). Future studies designed to collect a larger quantity of efficient equipment saturation data will be necessary to resolve this apparent discrepancy.

The program did appear to have had an indirect effect on stimulating demand for other pump testing outside of its territory. For example since Edison's program dates back to 1911 and PG&E's pump testing program did not begin until another 12 years later, it is plausible to assume the program may have influenced PG&E's long ago decision to also begin testing pumps. Similar effects are said to occur when municipal or other private utilities request pump test training assistance and then subsequently develop a testing program on their own, as occurred last year with Nevada Power. Finally there is the genesis of independent firms providing testing services on contract to SDG&E, and also expanding to serve some

Edison customers on a fee-for-service basis. Edison's role in stimulating the independent market for pump testing services appears to be quite direct and substantial (in particular through the activities of former Edison employees). The evidence for the case of effects on PG&E is obviously circumstantial. On the other hand, in the case of effects on SDG&E's testing program which is administered by an independent contractor who is also a former Edison program supervisor, this effect is too direct not to acknowledge.

- The program did not appear to have had any negative impact on the extent of private pump testing within its service area. While the hypothesis that the subsidized testing program may have been suppressing the development of a private market for testing services, the evidence from Arizona and other states indicates that relatively little private pump testing occurs when no such program exists. What little pump testing is performed in Arizona would appear to at most equal the amount already conducted by private testing contractors within Edison's area for customers who prefer to pay for on-demand testing. The fact that customer demand for pump testing exists so strongly in Southern California appears to be largely the result of Edison having offered these services for so long.

By its very design, the program could not directly address structural barriers in the marketplace. However, there appears to be some evidence that the program's presence could have indirectly helped increase outside interest in pump testing programs located elsewhere.

5.4.5 Pricing-Related Barriers

Inefficient decisions may result whenever the total net costs of a product are not fully reflected in the price seen by customers. Such incomplete pricing represents a barrier to acquisition of energy efficient products when it causes those products to be seen by customers as more expensive than should be the case. The applicable pricing barriers affecting the water pump market, and program effects on them, were as follows:

Financing

- Higher efficiency pump equipment is usually characterized by a higher purchase price but lower operating cost (and lower overall lifetime cost) than less efficient equipment. However, customers, dealers, distributors and manufacturers all noted that the initial cost has dominated the purchase decisions of nearly all farmers as well as those of many municipal water agencies. The reason was reported to be a tight cash flow, and necessary focus on near-term financial performance. Thus the barrier has been a lack of any internal or external means to finance the additional investment (incremental cost of higher efficiency equipment) that could return savings in the longer term. While industrial and commercial HVAC systems in some parts of the country have been financed through "shared savings plans" -- whereby some of the expected value of future savings (payback returns) could be realized in a lower initial cost – no such options appeared to be available for the water pump purchasers. Uncertainty in forecasting future precipitation and temperature are further barriers to the offering of such an option for pump systems. The Hydraulic Services Program was not designed to, and did not, have any direct effect on reducing the financing barrier.

Externalities

- Higher efficiency pump equipment have potentially provided a number of cost savings to parties other than the purchaser. Some program staff interviews indicated a perception that by stimulating more efficient energy and water use through out Southern California, the public benefits from water and food that in the long run becomes less expensive to produce, and operating costs otherwise used on less efficient operations are freed up for other purposes, leading to a wide range of micro- and regional-level economic benefits. To the extent that such public benefits do occur, they represent external savings that are not recouped in a perceptible way by the purchaser of higher efficiency equipment. In that case, the barrier has been a lack of any public incentive mechanism to underwrite or subsidize incremental costs of purchasing higher efficiency equipment, even though it may have been in the public interest to do so. This study has not estimated the extent of such externality benefits. However, it is clear that the Hydraulic Services Program was not designed to, and did not, have any direct effect on reducing this barrier.

Other Mis-pricing

- Subsidies and taxes can represent a distortion of effective prices. The data collected for this study did not uncover this type of market barrier occurring in pricing of pumping equipment. However some program staff noted that many have argued that water itself has been systematically mis-priced through out much of the history of California, constituting a significant barrier to water and energy efficiency, among other consequences.

- The active use of pump test data by governmental agencies is an example of how the program appears to have indirectly helped the regulatory efforts of Watermasters to allocate rights to water in adjudicated basins and to enforce water quality monitoring by the Department of Water Resources. This study found that these important public benefit functions are substantially subsidized by the pump testing program. Some 49% of water supply customers and 14% of agricultural customers reported that they routinely practice volume validation pump testing in satisfaction of these regulatory purposes. In Arizona, water volume measurement appears to be substantially less accurate than in Southern California. Perhaps correspondingly, adjudication law in Arizona is not well defined and these public benefits appear to be substantially unaddressed at this time.

The confirmation from Watermasters that in the absence of the program they would in most cases continue to require pump test measurements suggests that this program effect would be likely to last beyond the life of the program. Presumably customers would be required to pay for the tests themselves to meet these regulatory requirements. It appears that the water quality monitoring and hydro-geological modeling studies performed by DWR and others and which currently use Edison pump test data have no corresponding regulatory mandate to require end users to provide this data. These findings suggest that through the provision of no-cost pump testing the program is essentially helping to internalize the regulatory costs of water management, albeit through the mechanism of Edison's electric rates.

Misplaced or Split Incentives

- Distributors and water agency customers reported that there has been no incentive for some water supply agencies to pay more for higher efficiency pump equipment, since revenues from water sales

go into the city's General Fund. As a consequence, money saved from efficiency investments have not been returned to the operations budget, and so there has been no incentive for paying the incremental costs of acquiring higher efficiency equipment. The program did not address this barrier.

- It was also hypothesized that a similar barrier could occur when a customer pays the electric bill but rents the pump from a landowner as part of their lease arrangement. The pump's owner would then have no incentive to improve the pump's efficiency, as the customer would be the one to benefit. However, customer and dealer surveys did not indicate any reports of this latter type of split incentive as a barrier to acquiring higher efficiency equipment.

The program was not designed to, nor is was it found to have had any effects on these types of barriers.

5.4.6 Feature-Related Barriers

These barriers refer to the physical properties of the goods offered for sale in the pumping market. In this case, the study uncovered just one type of feature-related barrier:

Separability of Product Features

- Pump systems are comprised of a variety of components, often including a pump impeller and bowl assembly, a separate motor, controls and distribution system parts. Manufacturers noted that in some cases it is possible to acquire a highly efficient impeller/bowl assembly and attach a low efficiency motor, or vice versa. Given the wide variety of different types and sizes of pumps, there is no universal or standard system for classifying their overall long-term efficiency and lifetime cost. Some manufacturers also noted that there are pump systems being produced that have high efficiency ratings on paper, but which are made out of cheaper and lighter-weight components which make them likely to degrade in performance over time and not last as long as some other, heavier-duty equipment. For such cases, the expected long-term payback and lifetime cost of the equipment may be inferior despite a higher factory-rated efficiency number. The barrier facing efficiency in water pumps is thus a lack of standardization in classification and long-term rating of units, which could be used by purchasers to make more effective decisions. The program did not directly address this barrier, but it did indirectly help to mitigate its consequences through the provision of more information to customers. The testing enables them to document any diminished levels of efficiency over time.

5.4.7 Lasting Program Effects

In general, *market transformation* occurs when a program has effects on overcoming *barriers* to acquisition of energy efficient equipment, and those effects last beyond the duration of the program. Since we cannot ever know for sure what would last "beyond the duration of the program" without discontinuing the program, it is necessary to estimate the extent of lasting effect by noting the extent to which there are "structural" changes in the market. Different types of changes have different likelihood's of being lasting, structural changes:

- Shifts in *regulations* are generally lasting structural changes.

Shifts in *product offerings and stocking practices* (by actors in the product distribution chain - manufacturers, distributors and dealers) often are lasting, although they can sometimes be reversed and changed.

- Changes in *standard customer attitudes or practices* (affecting the product demand chain) can be lasting, but may not be if they depend on continuation of some subsidy or free service.

The extent of these kinds of changes are discussed below.

5.4.8 Persistence of Effects on Customer-Level Barriers

The findings from this study indicate that the program did clearly have a direct and positive value in reducing the market barrier of limited information availability on the cost-effectiveness of improving equipment efficiency. The testing itself also clearly reduced the barrier of uncertainty regarding existing pump performance or for validating the performance of new installations. This effect can be thought of as mitigating the otherwise prohibitive cost of obtaining this information. The program furthermore clearly helped to overcome some of the behavioral barriers of customer practices which ignored consideration of preventative maintenance, an otherwise cost-effective business practice.

Thus the program's direct effects on customer informational and behavioral barriers were key benefits. However, because the program was aimed at directly affecting the attitudes and behavior of customers rather than actors in the distribution chain (manufacturers, distributors and dealers), it is difficult to confirm whether or not the effects would continue without the program. The nature of the changes in customer attitudes toward testing or preventive maintenance practices makes it likely that many of the existing customers have been lastingly influenced by the program. This is especially true in their elevated demand for pump testing *vis-à-vis* Arizona, an effect which appears to be largely program driven. However were the program no longer available, new customers moving into the area would not find their informational and behavioral barriers substantially reduced. Over time, the continued entry of new customers could thus diminish the program effect. This process is less of an issue where customer organizations have institutionalized these practices. Where this has occurred, it increases the likelihood that these effects will persist through time, even as the specific individuals effected by the program may no longer occupy their positions.

As a result, only a portion of these program effects can be considered to constitute market transformation. The data available indicates:

- 60% of Edison-area non-participants report pump testing through non-Edison sources,
- 51% of existing pump test participants report they would continue testing without Edison support,
- Dealers estimate that approximately 50% of customers would continue testing if Edison support were discontinued, resulting in roughly a 50% drop in the overall number of tests performed, and
- 17% of Arizona customers (weighted to be of comparable scale to Edison's high consumption program participants) report pump testing without any utility assistance.

This range of estimates suggests that the "naturally-occurring" or "market-sustainable" level of pump testing in Edison's area may be as low as the 17% of customers determined in Arizona. On the other hand it may be as high as the approximately 50% of existing participants who are expected to continue

testing if Edison were to end the program, plus the 60% of Edison-area customers estimated to already test without Edison assistance. If we consider the total population of 35,253 premises in the agricultural and water supply segment, this high estimate of persistent pump testing equals 3,431 (50% of the 6,861 premises currently tested) plus 17,035 (60% of the remaining 28,392 non-participants). This equals a total of 20,466 persistent pump test premises, or 58% of all premises in the segment. Assuming that the average energy intensity (MWh/premise) of the tested pumps was to remain the same (a conservative assumption) this high estimate of persistent pump testing would equal 55% of the total 2,660 GWh consumed in the segment.

However this 60% estimate of non-participant testing should be considered high since it is based on a very small sample. This rate of private pump testing cannot be supported by the qualitative data collected from dealers and others on the size of the private pump testing market. Instead, if we assume half the rate of Edison area non-participant testing (i.e.30% instead of 60%) a more moderate estimate of persistent testing would result: 34% of premises and 40% of energy.

This suggests that roughly a third of pumping premises would continue to be tested in the absence of the program, accounting for approximately 40% of the energy consumed by the segment. Even so, this estimate is probably still optimistic in the long run. Dealers hastened to point out that even among those convinced of the benefits of pump testing, the persistence of their efforts would not be 100%. Without some periodic reminders of the benefits of pump testing and predictive maintenance, attention to these rational and cost-effective practices will still continue to diminish over time.

5.4.9 Persistence of Effects on Dealer-Level Barriers

In terms of indirect effects, the testing program did appear to change the behavior of dealers and contractors, who adopted practices of encouraging customers to have their pumps tested, and of working with pump test results to help make appropriate purchase, replacement and maintenance decisions. However, there was no clear evidence of overall changes in the mix of products being manufactured, stocked and offered to customers, or in the practices of lenders. Marginal effects on sales could not be measured, due to the very long period of time during which the program has already existed, and a lack of standardization of products for comparison across areas. Limited reports from dealer/contractors and consulting engineers suggest that some differences between the two areas in the mix of products may exist, and that to a small extent this may be due to the effect of the program. However, manufacturers and distributors generally reported that the program had not substantially affected their overall sales patterns, although it had affected pump maintenance and replacement practices.

The duration of these effects is considered no more persistent than those associated with customers. Dealers respond to customer demand for pump testing and actually have a vested interest in their diminished information options. It is therefore expected that dealer practices of recommending pump tests and using pump test data would likely continue at a rate in proportion to that for customers commissioning the tests. Clearly some dealers would take advantage of the fact that Edison was no longer offering the service. These dealers would likely position themselves as high quality value-added service providers, and continue to market the benefits of pump testing. Others however would move to specialize on those customers who are most concerned with first costs, and those who's attention to operating efficiency may wane in the absence of Edison's free service.

5.4.10 Persistence of Other Market Effects

One significant effect quite likely to continue regardless of Edison support for pump testing is the requirement of Watermasters in adjudicated basins to require pump tests to validate water meter readings. This presumably lasting effect of the program effectively constitutes a public benefit subsidy, the cost of which is passed on to all Edison customers through rates. In the event the program was discontinued, a sizable number of the 29% of all program participants (49% of water supply customers) who reported using pump tests for this purpose would likely be required to continue providing the data to their Watermasters. This is considered a market effect with a high likelihood of persisting in the absence of the program. Of course political opposition to paying the cost of such tests could lead to policy decisions which could have an unforeseen effect on the persistence of this market effect.

5.5 REMAINING MARKET BARRIERS

The Hydraulic Services Program was designed and operated as a customer information and assistance service, rather than as a market transformation program. While the program did in fact help to address some barriers to energy efficiency, it was not intended to (and did not) address others. If there is a goal of effecting permanent change in the structure of market demand and market supply for highest efficiency water pumps, then those additional issues may need to be addressed. They include issues concerned with:

- Availability of access to financing or first cost reduction for energy efficiency equipment,
- Organizational practices for municipal bidding which penalize energy efficiency,
- Lack of standards for defining and distinguishing high efficiency pumping equipment, and
- Lack of incentive for contractors and consultants to promote acquisition of energy efficient products over less-costly standard products.

Edison's Hydraulic Services program has established a long tenure in the market and won a well-regarded reputation as a reliable and unbiased third-party. Past investments in underwriting the program are responsible for the building of these perceptions. The pump test program should be considered to be among the most substantial factors driving water pumping customers' favorable perceptions of the Edison brand. From this position of established brand equity, the program provides an excellent vehicle for the delivery of future market transformation initiatives and/or other product service and service offerings to customers and other pumping market actors alike.

The Hydraulic Services Program clearly performs a needed service and affects the behavior of customers in the short term by encouraging the replacement of individual pumps and over time by aiding in the adoption of energy saving practices. In so doing it effectively addresses some of the market barriers relating to imperfect information and uneconomic behavior. However, the evaluation of program effects also turned up evidence of a number of other remaining market barriers which the program was not designed to address. Nevertheless the program's long tenure serving the water pumping community and established reputation as a non-biased third-party position the program as an excellent vehicle for the delivery of other market transformation initiatives to both customers and other market actors. Those remaining barriers are as follows:

- Financing for the Agricultural Sector – lack of capital to finance the cost-beneficial incremental costs of acquiring higher efficiency pump equipment. Discussions with lenders found that the burden of determining the cost-benefit ratio for efficiency improvements lies with the borrower. Even if borrowers prepare such an analysis on their own, the life-cycle benefits of pump energy efficiency improvements are generally not considered by agricultural lenders. For those farmers whose business decisions are constrained by access to capital, lenders' current practice of ignoring pumping plant life-cycle costs constitutes a barrier to energy efficiency.

- Organizational Practices for Municipal Bidding – rigidities of conventional bid specification rules that give preference to lower purchase costs without consideration of the present value of reducing total lifetime costs. Consultants described how current competitive bidding practices typically require a municipality to qualify several competing proposals as "comparable" even when they may not be equally energy efficient. Though procedural mechanisms exist for overcoming this barrier, they are not common in current practice.

- Standards for Distinguishing High Efficiency Pump Systems– lack of standards (or labeling) for customers to identify comparable equipment models in a class, distinguish those considered to be "high efficiency" models, and compare differences in lifetime performance. Unlike standards for high efficiency motors which have been developed and widely publicized to end users and consultants, no comparable standards exist for facilitating comparisons between pumping equipment alternatives. As a result there is a wide range of discrepancy in what may be called "high efficiency" for any given pumping application. While some manufacturers offer standardized product specification sheets or even software tools for choosing the proper model from their line of offerings, making comparisons between manufacturers is not easy. A widely available tool for comparing pump efficiencies, similar to the Motor Master software for motor selection, would help to mitigate this informational and behavioral barrier.

- Stocking Inertia - lack of stocking of models that are currently sold less often (including high-efficiency models), which limits their availability for "quick-turnaround" replacements. A few dealers (active primarily in the agricultural market) reported that stocking and ordering delays sometimes affect the options available to end users. The degree to which this is a true market "barrier" to energy efficient equipment sales or simply an unavoidable consequence of low demand for high efficiency equipment should be the subject of future research. The issue was not considered a barrier by most dealers and customers surveyed, and is therefore not considered to be a major market barrier at this time.

- Consultant Training - lack of appreciation by some contractors and consultants of the value of long-term payback from investing in the acquisition of higher-efficiency and longer-lasting equipment; these parties often specify equipment for customers (and write bid specifications for water suppliers). This informational and behavioral barrier with contractors and consultants suggests that they may be important targets for future market interventions intended to increase the energy efficiency of pumping systems.

- Access to Pump Tests - lack of access to pump tests by smaller customers (demand exceeds supply for the current program).[25] As consumption drops, the payback on equivalent investments in pump testing is harder to recoup. Future studies should explore the cost effectiveness of pump tests administered through utility, self-administered and private sources, and the effects of changes in qualification criteria on the scale of customers served. Simple practices such as trending monthly comparisons of water and kWh meter readings may be an inexpensive alternative to offer customers whose consumption falls below levels that are cost-effective to physically test on a regular basis.

- Program Awareness - lack of awareness by manufacturers, regional-level distributors, and local lenders, who otherwise might use that knowledge to affect planning and marketing of higher efficiency pumps and related products (including special loans). Though customer awareness of Edison's program is high, program effects on other trade allies would likely result from additional outreach and cooperation.

- Product Development - perception by many manufacturers of limited demand for higher efficiency equipment; current improvements in pump efficiency are largely related to advances in motors (rather than other pump parts). Future market interventions may be designed to mitigate some of the downstream barriers limiting consumer demand for high efficiency equipment. As such plans are developed, manufacturers should be consulted and informed of the potential in such changing markets. Publication of data from Edison's pump test database will provide solid evidence contradicting the popular perception that recent pump efficiency improvements are the result of improvements to motors alone.

- Product Tracking - lack of consistent product size/type classification for monitoring product stocking and sales by equipment type and efficiency levels. This barrier is associated with the lack of standards barrier described above. Any such standards developed should form the basis for consistent data collection which will be of great value to future market studies of barriers and energy efficiency trends in the pumping end use.

[25] Cost-effectiveness thresholds were not assessed as a part of this evaluation.