How Can We Tell if Free Information is Really Transforming Our Market?

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ABSTRACT

This paper presents the results of a market effects study of the Southern California Edison's Hydraulic Services Program. Begun in 1911, the "Pump Test" program is believed to be one of the country's oldest continuously operating industrial and agricultural energy efficiency programs. It currently provides energy efficiency information and 4,000 - 5,000 free pump tests per year to over 650 agricultural and municipal water pump end users, reaching 52% of all energy consumed in the sector. The study began with a market characterization, and developed and tested 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 were completed with almost 200 relevant market actors: customers, dealers, contractors, distributors and manufacturers, as well as consultants, lenders, regulators, utility personnel and academics. The results of over 28,000 pump tests were also analyzed. Designed with assistance of the California Demand-side Management Advisory Committee (CADMAC), this was one of the first four market effect studies extensively reviewed by consultants to the California Board for Energy Efficiency (CBEE).

Introduction

As consensus grows that market transformation should be the primary goal of publicly funded efforts to achieve energy efficiency, pre-existing programs must be adapted to fit the new paradigm, or ended. The first step in deciding what to do with these on-going programs is to determine what effects – if any – they have had to date on their respective target markets. This is best accomplished through a "market effects study" designed to distinguish *"market changes"* from program-related *"market effects,"* and to forecast the persistence of any such effects after the program has ended. This study investigated the market effects associated with Southern California Edison's Hydraulic Services Program.

Background

Southern California Edison's Hydraulic Services (Pump Test) Program has been in existence since 1911, making it one of the nation's longest running energy efficiency programs. It is also one of the largest, providing 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, and 52% of all energy consumed. 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

[1] The original work on which this paper is based was completed while Mr. Conlon was a Senior Consultant with RLW Analytics.

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 the overall ("wire to water") 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.

Targeted End Users

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 utility service area, while water supply customers are concentrated in the southern "metro" area.

Targeted Pump Types

The program focuses on the most commonly used types of water pumps used for agricultural crop irrigation and municipal water supply. 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 mostly for electric motor driven pumps.

Scope and Definitions

The focus of this study was on developing a broad understanding of the effects of the program on the markets for energy efficient water pumping equipment and services. In addition to its focus on these specific markets, the study was intended to break new methodological ground as well. It was one of four original projects designed to test the suitability of the framework for examining utility program market effects developed in the Scoping Study on Energy Efficiency Market Transformation (Eto, Prahl, & Schlegel, 1996). Accordingly the project has been extensively reviewed by a team of consultants under contract to CADMAC and by members of the CBEE (Peters et al. 1998a; Peters et al. 1998b; Peters, et al. 1998c).

For the purposes of this study, we defined "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. Because of the program's long history in Southern California, it was impractical to rely on measurements of baseline conditions prior to the program's inception. Instead we chose a cross-sectional approach. Responses of market players from the Southern California area were compared to those of a comparison area (Arizona) 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 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 term *market change* 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. 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). We used the term "market change" in this study 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.

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 paper 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.

Methodology

The study began with a limited 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.[2] 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. [3] 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 (Xenergy 1998; EPRI 1997; Solomon and Zoldoske, 1994). Preexisting 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.

Figure 1 outlines the major tasks of the project.

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[2] Readers interested in a thorough discussion of the comparison methodology are encouraged to seek out Appendix C to the original report (Southern California Edison, 1998).

[3] The pump test database contained participant test results over the period of 1990 - 1997, covering 28,156 tests and 664 customers. See Conlon, Weisbrod, and Samiullah 1999 for a detailed assessment of this data.

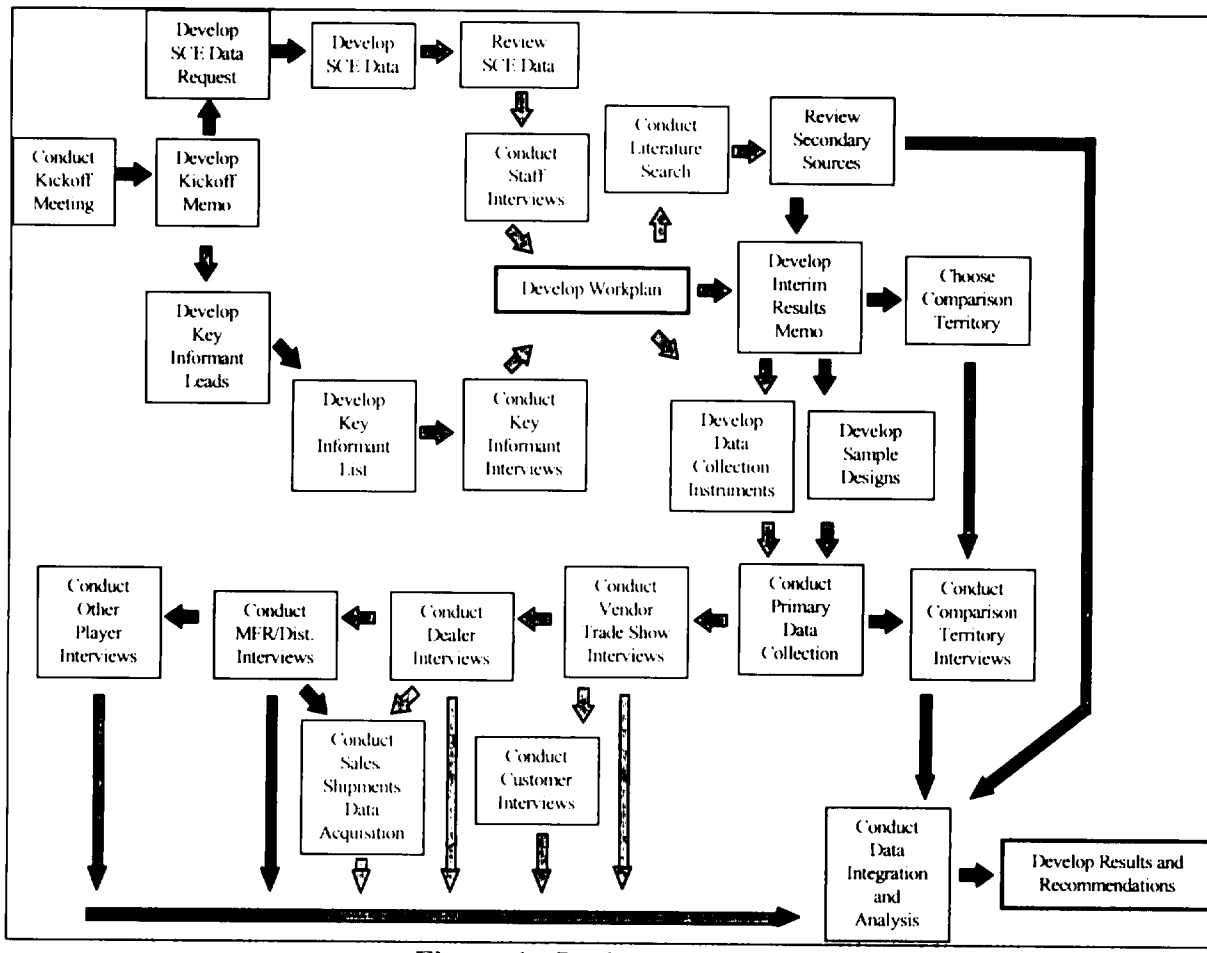

Figure 1. Project Flowchart

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 Table 1. Many additional informal interviews were completed with academics, utility personnel, consultants and other key informants.

Table 1. 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

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. These 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 that 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.

Selected Results

For **customers**, the major market barriers to achieving cost-effective energy efficient pumping systems were found to be informational (imperfect information) and behavioral (bounded rationality). 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.

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. 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.[4] 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.

Table 2. 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.

The survey of **regulatory agencies** in California and Arizona revealed that the California agencies do indirectly benefit from Edison's pump test program. 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.

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

[4] 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").

tested by a non-Edison source. Even if this estimate is high, the pattern of non-Edison pump testing appears to have changed.

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 60% (if the Edison-area non-participant estimate is to be believed). 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.

Key Methodological Lessons Learned

Market Changes vs. Market Effects. While the term "market change" did appear in the Scoping Study, the formal concept of "market changes" *vis-à-vis* "market effects" was never fully developed. In our earlier work (Conlon & Weisbrod 1996) we had found this distinction to be crucial in order to avoid confusion and focus attention on the issues of causality and attribution that must be central to any evaluation of market transformation program effects. We are pleased to see more recent

discussions continuing to highlight this conceptual distinction (Peters, et al. 1998b). One simple device that could improve the representation of this idea would be to present all observed market changes in a single table, calling out those caused by the program intervention (market effects), and further highlighting those forecasted to persist after the intervention is discontinued (sustainable market effects). We expect this distinction will be easier to manage in time-series studies as opposed to cross-sectional ones such as this.

Limitations of Cross-Sectional Designs. Because of the long history of the program, and the impossibility of fixing a retrospective baseline in time, we found we had no alternative but to employ what was fundamentally a cross-sectional design. But despite our scrupulous efforts to select a valid comparison area, we found that such comparisons are inherently inferior to time-series comparisons for the purposes of measuring market transformation. Though we documented ample differences between our test and control areas, and collected plenty of data suggesting the program was responsible for at least a portion of these differences, the credibility of our story was undermined by the inherent limitations of our approach.

This is because the crux of market transformation is *change*, not *difference*. When measuring change, there is no substitute for knowing where you started. For this reason, retrospective market effects evaluations of ongoing DSM programs are of only limited use. Our real need is to develop comprehensive assessments of the real barriers to cost-effective energy efficiency that remain in these specific markets, and to identify the baseline metrics we will need to track to ensure our interventions are successful.

Value of a Comprehensive Market Characterization. In our attempt to implement our interpretation of the Scoping Study framework and to focus on market effect hypotheses, we chose to simplify our characterization of the pump equipment market. In hindsight, a more comprehensive market characterization would have been of more use than the exhaustive list of hypothetical market effects we generated. By identifying actually perceived barriers rather than hypothetical barriers, we could have concentrated our focus on those areas most in need of attention. Nevertheless we believe the hypothesis generation exercise was valuable in that it allowed us to consider how each of the market barriers in the Scoping Study list might apply at any of the various market player levels in a single market. We suspect this approach may be more useful in the future once intervention efforts have matured in a given market when most of the more obvious barriers have been identified and addressed. But when evaluating resource acquisition programs undergoing redesign as market transformation programs, researchers should first address the market barriers that are the lowest hanging fruit. A comprehensive market characterization will find these opportunities.

Prior Evaluation Results. Over the past 15 years, program designers and evaluators have collected tremendous amounts of data on the very markets we now explicitly seek to transform. All too often we overlook this legacy in favor of new data collection, sometimes even relying on respondent recall while an old saturation survey with hard baseline data sits collecting dust. Pouring over stale old reports and data sets may not have the cachet of a new survey, but it can be of greater use if the goal is to understand the evolution of a market and market actor attitudes. Our work reanalyzing Edison's old survey data confirmed that better understanding the past can be quite valuable in planning for the future.

Usefulness of Qualitative Data. As noted elsewhere (Herman, et al. 1997) the need to consider attribution and sustainability in market transformation assessment challenges us to tell a good story. Typically that requires the systematic analysis of both statistical and qualitative data. Attribution and sustainability estimates will likely never be as defensible as the gross and net impact estimates we have grown so accustomed to under the resource acquisition policy framework. But that is no excuse to give up trying. As we continue to apply and refine new quantitative methods for modeling market changes, we will also need to become more adept at building and critiquing qualitative arguments to defend our claims of market transformation.

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