MARKET EFFECTS AND MARKET TRANSFORMATION: THEIR ROLE IN ENERGY EFFICIENCY PROGRAM DESIGN AND EVALUATION

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March 2009

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Acknowledgements

The authors would like to thank the following individuals for their advice and assistance in completing this White Paper:

- Ed Vine: California Institute for Energy and the Environment
- Ike Turiel: California Institute for Energy and the Environment
- Steve Meyers: California Institute for Energy and the Environment
- Ken Keating
- Ralph Prahl

List of Exhibits:

Executive Summary

In its recent decisions pertaining to the objectives of upcoming energy efficiency programs, the California Public Utilities Commission (CPUC) has placed a strong priority on market transformation, defined as:

> Long-lasting sustainable changes in the structure or functioning of a market achieved by reducing barriers to the adoption of energy efficiency measures to the point where further publicly-funded intervention is no longer appropriate in that specific market.

This White Paper summarizes the experience of utilities and other publicly-funded program sponsors in the design, delivery, and evaluation of programs aimed at achieving market transformation. The information presented is drawn from an extensive review of literature in the field and neighboring disciplines, as well as from interviews with program sponsors and regulators familiar with the issues addressed. It is meant to serve as a source book of concepts, strategies, and practical solutions for challenges that typically arise in programs whose objectives include market transformation. We focus on the use of evaluation and other types of research to guide program development and delivery and to assess progress and results.

We also offer a number of specific recommendations for consideration by the CPUC and the California utilities as they move forward to design and implement the 2009 – 2011 programs. These recommendations are meant to facilitate the alignment of policies and procedures in regard to energy efficiency program design, program evaluation, and sponsor incentive structures with the CPUC's stated goal of encouraging the achievement of market transformation.

Key Findings

The authors base their recommendations on the following findings, which appear consistently in the literature and in interviews with practitioners.

1. **Ratepayer-supported energy efficiency programs, including those operated by the California investor-owned utilities (IOUs), have contributed significantly to market transformation in key energy end-uses, and continue to do so.**

   Over the past 20 years, ratepayer-supported program sponsors, working in concert with public and private sector organizations, have accelerated the adoption and, through

changes in codes, standards, and supplier behavior, secured high *national* market share for the following technologies:

- Electronic fluorescent ballasts;
- Compact fluorescent light bulbs;
- High-efficiency household appliances, including clothes washers, refrigerators, dishwashers, and room air conditioners;
- Premium efficiency integral horsepower electric motors; and,
- Energy-efficient residential windows.

At the regional level, ratepayer programs have achieved similar results for a wider variety of products and services, including energy-efficient residential construction and commercial lighting design.

In some cases, such as electronic ballasts, ratepayer programs contributed to the process primarily by subsidizing consumer purchases as part of a demand-side resource acquisition strategy. In others, such as resource-efficient clothes washers, ratepayer-funded program sponsors formulated and pursued a long-term strategy that encompassed direct contacts with domestic manufacturers to support product development, development of product standards and testing procedures, retailer merchandising support, broad-based consumer education, and customer incentives.

2. **Success in achieving targeted market changes (market effects) and longer-term market transformation requires the consistent collection and analysis of market data and intelligence, and the integration of that analysis into program design and operation.**

   Practitioners interviewed in preparing this White Paper all report the extensive use of market research and analysis – both existing and specially commissioned – to inform planning and management decisions throughout the program cycle. The key decisions supported by market research are as follows:

   - ***Selection of products for program support.*** In addition to considerations of technology performance and cost-effectiveness, market-related considerations taken into account include the current development of supply channels for the product in question, size of the market, market actor perceptions of product advantages and barriers to adoption, and the availability of exit strategies, such as those offered by changes to codes and standards.

- ***Development of program plans.*** Programs designed to change the behavior of market actors are most likely to succeed when their approach reflects market realities. Market characterization studies that address issues of market size, customer segmentation, supply chain structure and operations, incremental costs, patterns of customer behavior, and current levels of product assessment provide the data required to develop effective program plans. They are also needed to establish baseline conditions against which program accomplishments can be measured.
- ***Monitoring program performance to support mid-cycle corrections***. Programs designed to change market actor behavior often require a number of years to gain traction. However, once they do, documented experience shows that key conditions such as market share for efficient products, level of customer recognition, and extent of supply chain support can change rapidly. Evaluations undertaken at the end of a 3 – 5 year program cycle may register these changes too late for effective use in program planning and management. Therefore, jurisdictions with extensive market transformation program portfolios often commission short-term, limited-scope studies to keep tabs on market development and build data resources for final evaluations.

3. Research at the regional level strongly suggests that energy efficiency programs influence the measure adoption behavior of nonparticipating customers and supply chain establishments within regions served by such programs – at least, at certain stages of market development.

Studies of market share for a variety of products including compact fluorescent lamps (CFLs), efficient clothes washers, and premium efficiency electric motors at the state and regional level have found that the purchase of efficient models accelerates among nonparticipating customers in regions where programs are available, while such purchases lag in regions where programs are not active. In some of these cases, measure adoptions by nonparticipants were observed to exceed those of participants. Typically, as market development proceeds, the pace of efficient technology adoption picks up in areas without programs, thus reducing the ability of conventional social science research methods to detect and quantify program effects on market share in the later stages of market transformation.

4. **Evaluation methods have been developed and successfully deployed to quantify the net effect of energy programs on measure adoption within the program area(s), including program-related adoptions by non-participants.**

   Researchers in the field have developed estimates of net program effects using a wide range of well-established methods including:

   - Cross-sectional methods that use indicators of measure adoption from regions with no active energy efficiency programs to establish a baseline for comparison to the program area.
   - Expert judging methods, such as the Delphi process, which used structured solicitation of expert opinion to establish a baseline.
   - Case study methods which use a variety of primary and secondary sources to develop a "weight of evidence" argument concerning the extent of program influence.
   - Surveys of program participants and nonparticipants within the program area to develop estimates of spillover, that is, adoptions "outside the program" that customers attribute to program influence.

   Of course, these methods have relative advantages and disadvantages in specific applications, as well as varying requirements in terms of time and resources required for proper implementation. However, from the standpoint of basic research technique, they are capable of generating estimates of net program effects that are equal in validity, reliability, and accuracy to the estimates of *participant only* effects that the CPUC currently uses as the index of energy efficiency program performance.

Recommendations

Our recommendations focus on three elements of the regulatory process that we believe will facilitate the realization of the Commission's policy to promote market transformation. These are (1) the approach to program sponsor performance assessment and compensation, (2) research in support of program planning, and (3) evaluation.

Program Sponsor Performance Assessment and Compensation

Recommendation #1: Include spillover and other benefits of demonstrated market effects among achieved savings and net benefits counted for the Performance Earnings Basis. Under the Performance Earnings Basis (PEB) now in force in California, assessment of

program sponsor performance and determination of compensation are linked to a single quantity, namely: verified participant energy savings less a factor reflecting free ridership, evaluated over the entire program portfolio. This definition of benefits to be counted towards savings goals is inconsistent with the definition of program goals and guidelines used for the 2009 – 2011 programs. If program sponsors are to be encouraged to expend program resources on efforts that are likely to generate market effects, then the performance of those measures should be assessed and their success compensated.

Based on our review of experience with planning, delivery, and evaluation of market transformation programs, we recommend that the CPUC and utilities undertake the following processes ***as early as possible in the development of plans for the 2009 -2011 programs*** to enhance the likelihood of success of market transformation efforts and to promote fair and useful evaluations of their outcomes:

a. Identify programs in the utility portfolio that are likely to generate market effects during the three-year program cycle, and focus market-oriented planning and evaluation efforts on those programs.
b. Commission initial market characterization research for those products and services for which the structure of the market and the motivations of the market actors are not well understood or documented, at least in terms of their response to the product in question.
c. For programs deemed likely to generate market effects, develop program logic models that explicitly identify the mechanisms by which the programs will achieve market effects.
d. For programs deemed likely to generate market effects, develop preliminary evaluation plans that specify the preferred approach(es) to estimating net savings.

Market Transformation Program Planning

Recommendation #2: Establish a process to identify products or services for which program support should be withdrawn or reduced over the program cycle and to formulate plans for an orderly withdrawal from the market. In assessing whether to reduce program support, we recommend that the following be taken into account:

- Market share of the product within and outside of program areas.
- Recent trends in prices and availability.
- Likelihood of inclusion in a near-term codes or standards rulemaking.

- Market readiness of more efficient substitute technologies.

This assessment should be made by program sponsors working closely with the Peer Review Group and representatives of the CPUC evaluation consultant team.

Recommendation #3: Provide market research support to validate proposed growth strategies for products and services supported by the Emerging Technologies Program. The case for public investment to support new technologies will be greatly enhanced by research to validate proposed growth strategies. Specific kinds of issues to be researched in this regard would include: feasibility of technology licensing and other methods to gain rapid increases in volume; motivations and capabilities of downstream market actors such as retailers and contractors to promote and install the technology; and presence, price, and performance characteristics of competing or similar products on the market.

Market Effects Evaluation

Recommendation #4: Conduct one or more pilot studies involving cross-sectional analysis of the market share for energy-efficient practices in California compared to other jurisdictions. Several High Impact Measures – refrigerant charge and airflow checks (RCA), steam trap replacement, and hot water pipe/tank insulation – involve customer adoption of installation and maintenance practices as opposed to purchase of efficient equipment. Cross-sectional studies of the prevalence of these measures would strengthen estimates of the net benefits of programs to support these measures. They would also provide strategic insights into the need for and design of such programs.

Recommendation #5: Conduct research to define and assess the validity of indicators of sustained market effects other than changes in codes and standards. Analysts have proposed a number of indicators of sustained market changes other than changes in codes and standards. However, we know of no systematic efforts to operationalize and measure these indicators or to apply them in program planning decisions. We recommend conducting a research study based on existing sources to reconstruct trends in market share, incremental prices, customer awareness, and vendor practices for energy-efficient products and services that have achieved high levels of acceptance. Such a study would provide program sponsors and regulators with some historical reference against which progress with current programs can be compared.

1. Introduction

In its Interim Opinion that establishes the policy framework for the 2009 – 2011 round of rate-payer-funded energy efficiency programs, the California Public Utility Commission (CPUC) firmly embraces market transformation as a principal program strategy. (CPUC, Decision 07-10-032) Referring to earlier decisions, the Commission defines market transformation as:

> Long-lasting sustainable changes in the structure or functioning of a market achieved by reducing barriers to the adoption of energy efficiency measures to the point where further publicly-funded intervention is no longer appropriate in that specific market.

This White Paper summarizes the experience of utilities and other publicly-funded program sponsors in the design, delivery, and evaluation of programs aimed at achieving market transformation as described above. It is meant to serve as a source book of concepts, strategies, and practical solutions for challenges that typically arise in such efforts. We focus on the use of evaluation and other types of research to guide program development and delivery and to assess progress and results. We also provide a number of specific recommendations for consideration by the CPUC and the California utilities as they move forward to design and implement the 2009 – 2011 programs.

1.1 Overview of the Document

This White Paper is organized as follows:

- **Definitions and examples.** Section 2 presents formal definitions of market transformation and market effects – changes in the structure and operations of targeted markets that can be attributed to energy efficiency programs. The section also presents real world examples of market transformation, the major classes of models used to explain such developments, and definitions of related concepts, such as spillover, that feature in discussions of the market effects of energy efficiency programs.
- **Planning of market transformation programs.** Sections 3 summarizes the approaches that program sponsors and regulators have used to ensure that market transformation strategies are appropriately integrated into energy efficiency program designs and delivery procedures. In particular we focus on the development and use of market information to guide program planning.

- **Evaluation of market transformation programs.** Sections 4 through 6 address the following important elements in the evaluation of market transformation programs.
  - ***Structuring the evaluation.*** Section 4 summarizes and provides guidance in regard to key questions to be addressed in planning evaluations of the market effects of energy efficiency programs. These include: identification of programs that are likely to have market effects; identification of the targeted markets and likely extent of program influence; characterization of the market and baseline conditions; application of logic models to develop testable hypotheses; defining the objectives and scope of the evaluation.
  - ***Developing indicators of market effects.*** Section 5 examines how evaluators measure market effects of various kinds, including various approaches to defining and estimating market share for energy-efficient products and practices. The section also reviews practical approaches for assuring reliability, validity, and accuracy of indicators developed from various kinds of empirical data.
  - ***Assessing the attribution of observed market changes to programs.*** Section 6 reviews the methodological approaches available for assessing the causal links between program activities and observed market changes. In particular, we focus on the relative strengths and limitations of the available methods in regard to specific applications defined by overall evaluation objectives, program type and stage of market development.
- **Recommendations for California Programs.** The final section of the report draws on the practical experience summarized in Sections 2 – 6 to identify and support recommendations designed to enhance the ability of the CPUC, California utilities, and other program sponsors to achieve the broad goals that the Commission has established for the 2009 – 2011 energy efficiency programs.

1.2 Methods

In preparing this report, the authors and their team reviewed over one hundred publications from the following categories:

- Regulatory opinions, decisions, testimony
- Program plans
- Program evaluation and program-related market research reports
- Academic textbooks and journal articles in evaluation and related areas of economics and social science

- Industry association and professional journals
- Energy efficiency conference proceedings and presentations.

Appendix 1 contains an annotated bibliography of 90 of these publications.

The project team also conducted interviews with energy efficiency program sponsors and regulators in the following regions in which energy efficiency programs have vigorously pursued market transformation objectives over a number of years. These included: New York State, Massachusetts, Vermont, Wisconsin, the Pacific Northwest, and British Columbia. The interviewees are listed in Appendix 2. The topics covered in these interviews included:

- Policies promulgated to promote market transformation through energy efficiency programs.
- Market transformation as a program objective in relation to resource acquisition, load management, emission reduction and other objectives.
- Short-term planning and program monitoring practices.
- Evaluation approaches applied to market effects.
- Treatment of market effects in estimating program savings.
- Treatment of market effects in calculating compensation for program sponsors.

2. Market Effects Definitions, Models, and Real Life Examples

This section presents definitions and models of market effects and market transformation, as well as examples that are referred to in subsequent sections. We begin with a review of the range of definitions of market effects and market transformation that energy program analysts and practitioners have advanced. Based on this review, we propose working definitions of those terms that, we believe, best support the objectives of this study. We next present short case studies of energy-efficient products that have achieved lasting widespread market acceptance with significant support from energy efficiency programs. These case studies provide substance for the definitions of market effects and market transformation. They also serve as a point of reference for the final part of this section, which discusses the theoretical models that energy efficiency program sponsors have used to support program design and evaluation.

2.1 Definitions of Market Transformation and Market Effects

Regulators and program sponsors active in energy efficiency need clear definitions of "market effects" and "market transformation". Operational definitions of these terms support important decisions regarding the allocation of limited program funds to specific markets and technologies, the design of those programs, the conduct of their evaluations, and the assessment of their costs and benefits. The concepts of "market effects" and "market transformation" as they are used in energy policy and programs were developed initially by program managers and analysts based upon their own practice and experience. Perhaps the first formal presentation of the concept of market transformation occurred at the 1992 ACEEE Summer Study. (Eckman et al. 1992) There, a trio of veteran energy efficiency analysts and managers observed that some programs operated over the previous decade in the U. S., Canada, and Europe had apparently resulted in significant and permanent increases in market acceptance of energy-efficient technologies. These programs included the Northwest Power Planning Council's efforts to gain adoption of residential building codes that were 40 percent more efficient than existing codes.

Among a number of useful insights presented, the authors concluded that programs that included multiple coordinated market interventions over an extended period were more likely to affect the ongoing behavior of market actors than were programs that consisted of a single type of intervention in the short term.

Stimulated in part by the ACEEE session, other energy efficiency program managers and analysts began to search for opportunities to leverage program resources and lock in efficiency gains by harnessing the motivations and capabilities of customers, suppliers, and regulatory bodies active in their target markets. Practitioners found that they needed some kind of theory about how programs worked to achieve sustainable market changes that favored the sale of efficient products (market transformation) in order to plan programs that might accomplish that result in their own jurisdictions. Moreover, they needed clear definitions of progress in both the long and short terms to support program design and evaluation. As program managers struggled to extract common elements and guidance from their experiences and the documented experience of others, definitions and theories of market transformation through energy efficiency programs proliferated through the energy efficiency literature.

In their report *A Scoping Study on Energy-efficiency Market Transformation by California Utility DSM Programs (Scoping Study),* Eto, Prahl, and Schlegel (1996) advanced basic definitions of market effects and market transformation that were referenced most frequently at the time. These were as follows:

- **Market Effect** - a change in the structure of a market or the behavior of participants in a market that is reflective of an increase in the adoption of energy-efficient products, services, or practices and is causally related to market intervention(s) (e.g., programs). Examples of market effects discussed in the *Scoping Study* include increased levels of awareness of energy-efficient technologies among customers and suppliers, increased availability of efficient technologies through retail channels, reduced prices for efficient models, build-out of efficient model lines, and – the end-goal – increased market share for efficient goods, services, and design practices.
- **Market Transformation** - a reduction in market barriers resulting from a market intervention, as evidenced by a set of market effects, that is likely to last after the intervention has been withdrawn, reduced, or changed.

This pair of linked definitions contains the four key elements that, in our opinion, form the core of market transformation theory and practice as they relate to the CPUC's interests as of 2008. These are:[1]

[1] Schlegel et. al (1997), in a review of energy efficiency program evaluation methods, explicitly identified these same four elements as the most common components of market transformation definitions.

- **Energy efficiency goal:** Market transformation (MT) is not an overall policy goal in the context of public benefits programs. Rather, it is one strategic approach among several for reducing energy consumption and achieving concomitant public benefits, such as greenhouse gas emission reductions.
- **Market change objective:** Market transformation strategies and programs achieve energy savings by changing the structure of markets and/or the behavior of market participants. One example of a change in the market structure brought about by market transformation programs is the development of the residential code compliance industry in California.[2] These firms grew largely in response to requirements for code compliance modeling in California's Title 24 Building Code. Some of them have gone on to develop their own energy efficiency offerings for residential and commercial customers. Changes in practices associated with market transformation programs include the rapid increase in stocking and promotion of ENERGY STAR lighting products and appliances by large retailers. These efforts have led to significant increases in sales of these products nationwide, and even greater increases in states with active energy efficiency programs.
- **Strategic intent:** Market transformation strategies are built upon assumptions concerning the ways in which specified sets of market actors will respond to program offerings over time. For example, the ENERGY STAR Labeled Homes programs offered by many sponsors nationwide are designed to facilitate the movement of local builders through a series of steps including:
  - Learning of construction practices required for ENERGY STAR certification;
  - Adoption of energy efficiency as a competitive differentiator;
  - Adoption of ENERGY STAR-required construction practices in non-certified homes to maintain competitive advantage.

  ENERGY STAR Labeled Homes programs typically include elements that target long-term changes among homebuyers, realtors, and local building departments to support builder efforts.
- **Lasting market change:** Market transformation strategies target lasting or "sustainable" market change, that is: change that is not likely to be reversed in the face of reduced program support or movement of "exogenous" factors, such as energy prices, which affect

[2] The Building Code and Appliance Standard amendment processes as now constituted in California clearly qualify as market transformation efforts under the four criteria listed above.

the value of efficient products and practices to customers. Program analysts and sponsors became concerned about the issue of sustainability when a study of the market for high-efficiency residential gas furnaces in Wisconsin found that market share had decreased with the reduction in program activities. (Prahl & Pigg 1997) In developing functional definitions of sustainability, analysts have referred to specific changes in market structure rather than to periods of time that an efficient technology holds its market share. The clearest indicator that a change in customer or supplier behavior is sustainable is the incorporation of that change in product standards and building codes. Other indicators or predictors of sustainability include reduced price and production cost differentials between efficient technologies and their competitors, availability of non-energy benefits relative to competing technologies, such as improved comfort or durability, and increased customer awareness of economic and environmental benefits associated with the efficient technologies. (Hewitt 2000)

Analysts have not always been careful or consistent in the distinctions they draw between *market changes, market effects,* and *market transformation.* We recommend the following definitions for these terms and use them as defined in the remainder of this White Paper:

- **Market changes:** *changes in the structure or operations of markets during the course of an energy efficiency program that indicate increased levels of adoption of energy-efficient products and practices by customers and/or increased levels of promotion and delivery by suppliers*. The increase in market share for an energy-efficient product is a market change. Organized evidence of such a change is a *market change indicator.*
- **Market effects:** *market changes as described above that can be attributed with some certainty to the activities of the program under review*. These programs need not explicitly target market transformation. For example, in the examples discussed below, rebate programs to encourage customers to purchase technically-proven, widely-available technologies such as electronic ballasts and efficient clothes washers were launched primarily to stimulate rapid reductions in energy consumption at cost-effective levels of expenditure. However, the increased volume of sales associated with these programs induced manufacturers to increase production capacity, thereby lowering costs and expanding distribution channels, which in turn had the effect of further increasing customer demand, leading to additional cycles of capacity expansion and cost reduction. These are market effects even though the goals of the rebate programs did not explicitly include market transformation.
- **Market transformation:** *market changes that were targeted by a program or programs, that can be attributed to those programs, and that are likely to persist in the absence of continued program activity.*

Conceptually then, market effects can be understood as market changes that are attributable to the program or programs in question. Market transformation adds the dimensions of strategic intent and sustainability to one or more market effects.

2.2 Examples of Market Transformation

In order to illustrate concepts associated with market effects and market transformation, we examine two real-world examples of sustained market transformation: electronic ballasts and resource efficient clothes washers. Figure 1 displays summary information on both cases. The general trajectory for both cases is similar, beginning with sponsor involvement in product and standards development, moving through heavy use of incentives from public benefits funds to generate customer and vendor interest in the project, and securing of gains through advocacy of Federal product standards. However, the narratives differ significantly in terms of the roles played by utilities. In the case of electronic ballasts, most of the technology development work

Figure 1
Summary of Market Transformation Cases

	Electronic Fluorescent Ballasts	Resource-Efficient Clothes Washers
GENERAL INFORMATION		
Market/End-Use	Commercial & Industrial/Indoor Lighting	Residential/Appliances & Hot Water
Principal Supply Chain Actors	Manufacturers → Distributors → Retailers (Key segmentation for big box v. independent retailers)	Manufacturer → Distributors → Installation Contractors (with some influence from engineers, designers, voluntary standards)
STAGES IN MARKET DEVELOPMENT: TIMING, MARKET SHARE, AND ROLES OF KEY PROGRAM SPONSORS		
Introduction	*1977 – 1987: 3% in 1987*	*1987 – 1996: 2% in 1996*
US DOE: RD&D	Prototypes developed in national labs: 1983 DOE supports further R&D by manufacturers Bulk purchases for federal facilities	
Utilities	Initiate rebate programs 1986	Western Utility Consortium explore potential savings from broader use of RECWs available from European Manufacturers. With EPRI, conduct THELMA demonstration program: town-wide replacements Coordinate with manufacturers through the Consortium for Energy Efficiency to develop efficient product specs and test methods Coordinate through CEE to develop national initiative using specs and offers of customer rebates
Fed & State Standard Setting	CA and other states adopt higher ballast standards that can be met by magnetic models	Standards revised in 1991; take effect in 1994 – only modest increase in efficiency provided for.
Early Acceptance & Take off	*1988 – 1998: 47% in1997*	*1997 – 2005: 36% in 2005*
US EPA: Voluntary Prog.	Green Lights program promotes use of electronic ballasts in commercial buildings	1st ENERGY STAR specification adopted. Sponsors seasonal promotions with utilities
Utilities	Rebate and technical assistance programs: ~$2 billion in rebates paid.	Number of local programs increase from 12 in 1998 to over 100 in 2004 Through CEE, develop Tier II – IV efficiency specifications By 2005, reduce or eliminate rebate programs, confine support to Tier III models.
Codes & Standards	CA whole building lighting power density standards require use of electronic ballasts	2004: Federal minimum standards increased.
Maturity	*1999 – 2011: Federal Standards Take Effect*	*2006 – Present: 38% in 2006*
Utilities	Utilities decrease and, in some cases, eliminate rebates for electronic ballasts/T8 linear fluorescent fixtures	Most utilities eliminate rebates; some continue merchandising support & seasonal promotions Continue to advocate for higher federal standards and ENERGY STAR specifications
US Codes & Standards	National product standards enacted in 2005 → sale of magnetic ballasts effectively prohibited by 2011.	2007: Federal minimum standards raised to original ENERGY STAR levels.

was sponsored by the Federal government and further advanced by manufacturers. Efficient clothes washers were available from European manufacturers prior to program sponsors becoming interested in the technology. Utilities took the lead in developing or revising the technical infrastructure – product standards and testing methods -- for rebate and merchandising programs designed to boost market share. Another important difference between the programs is that the retrofits or replacement electronic ballast measures constituted one of the main sources of demand-side management (DSM) resources through 2005 due to the ubiquity of linear fluorescent lamps and the ballasts' relatively long effective life. Potential savings from clothes washers were much more modest, thus – while it was quite cost effective - the measure was not as compelling as a resource acquisition opportunity.

2.2.1 Electronic Ballasts

Fluorescent lamps, which are the dominant technology for commercial and industrial indoor lighting, require ballasts to operate. Ballasts control the amount of current flowing through fluorescent lamps, providing high voltage when lamps are activated and subsequently reducing voltage to operational levels. Magnetic ballasts were the first technology developed to manage current flow in fluorescent lights. However, because fluorescent lights operate much more efficiently at higher frequencies, efforts began in the 1970s to develop electronic ballasts that allow fluorescent lamps to function at frequencies 1,000 times higher than what was possible with magnetic ballasts. Electronic ballasts can increase efficiency by ten percent compared to magnetic ballasts, and electronic ballasts offer additional features such as dimming and remote control capabilities.

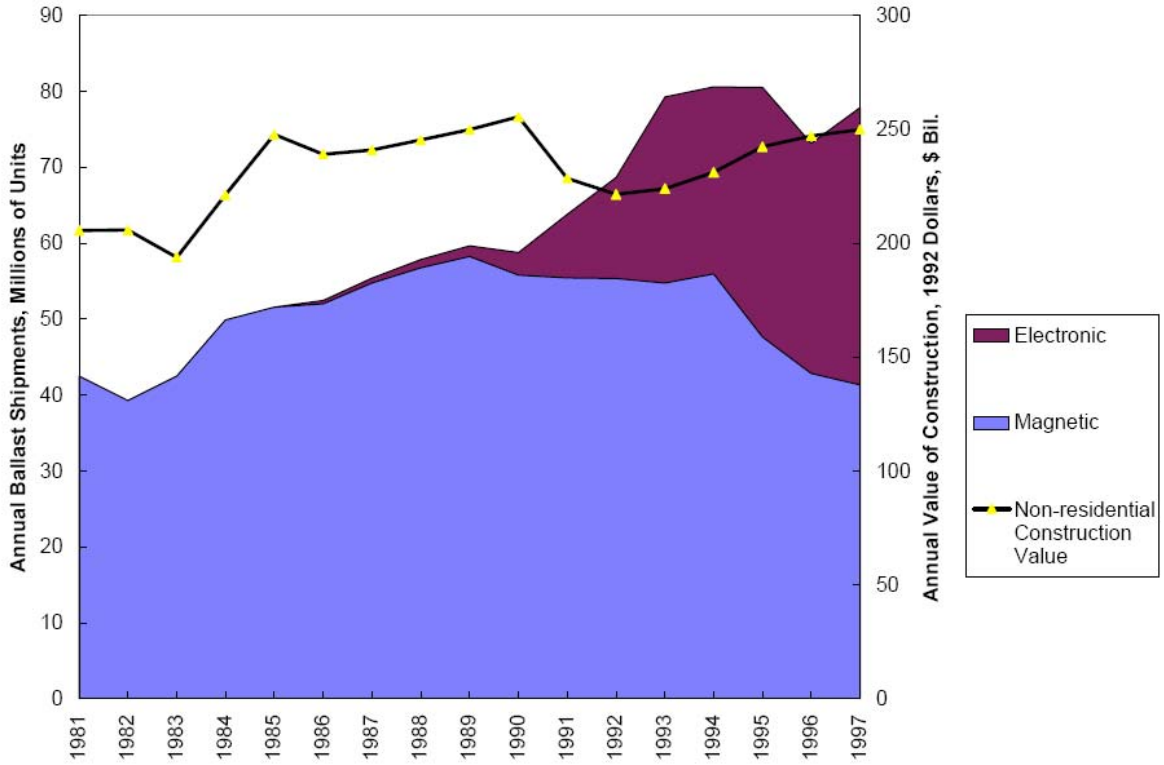
The U.S. Department of Energy (DOE) initiated efforts to develop and promote electronic ballasts beginning in 1977, and, in 1983, DOE publicly unveiled an efficient fluorescent lamp electronic ballast. That same year, California adopted energy-efficiency standards for fluorescent lamp ballasts. Several other states followed suit over the course of the decade. However, manufacturers were able to meet these standards with improved magnetic ballast technology, so that little market progress had been achieved by the end of the 1980s. (National Research Council 2001)

Between 1988 and 1996, utilities across the country vigorously promoted the adoption of electronic ballasts, primarily to generate cost-effective energy savings within the regulatory context of integrated resource planning (IRP). The core of this intervention consisted of utility rebate programs that paid out nearly $2 billion in incentives for efficient fluorescent lighting technologies. (Atkinson et al. 2000) These rebates subsidized the purchase of approximately half of all electronic ballasts shipped domestically over this period, which accounted for 16

percent of *all* ballast shipments during these years. Utilities also undertook customer education programs, engaged directly with ballast manufacturers, and helped to develop stricter building codes. In addition, the federal government directed customer education campaigns, state and regional bodies strengthened efficient lighting codes, and a series of progressively more stringent national standards for fluorescent ballasts came into force beginning in 1990.

The collective result of these various programs was a rapid growth in the demand for electronic ballasts nationwide. Increased demand was evident in two trends. First, the demand for ballasts far outpaced what was required to meet the needs of commercial new construction levels. This relatively sudden change in the relationship between construction volumes and total ballast shipments suggests that the increase in the number of ballasts was due to early replacement of ballasts in existing commercial construction. As Figure 2 shows, most of the increase in total ballast shipments was attributable to a surge in electronic ballast shipments. Second, the market share of electronic ballasts increased markedly. For example, the market share of 4-foot electronic ballasts grew from 13 percent in 1991 to 47 percent in 1997. Between 1992 and 1994, approximately 60 percent of electronic ballasts were rebated nationally. Thus the rapid increase in market share coincided with the major program efforts of the utilities. (XENERGY 1998)

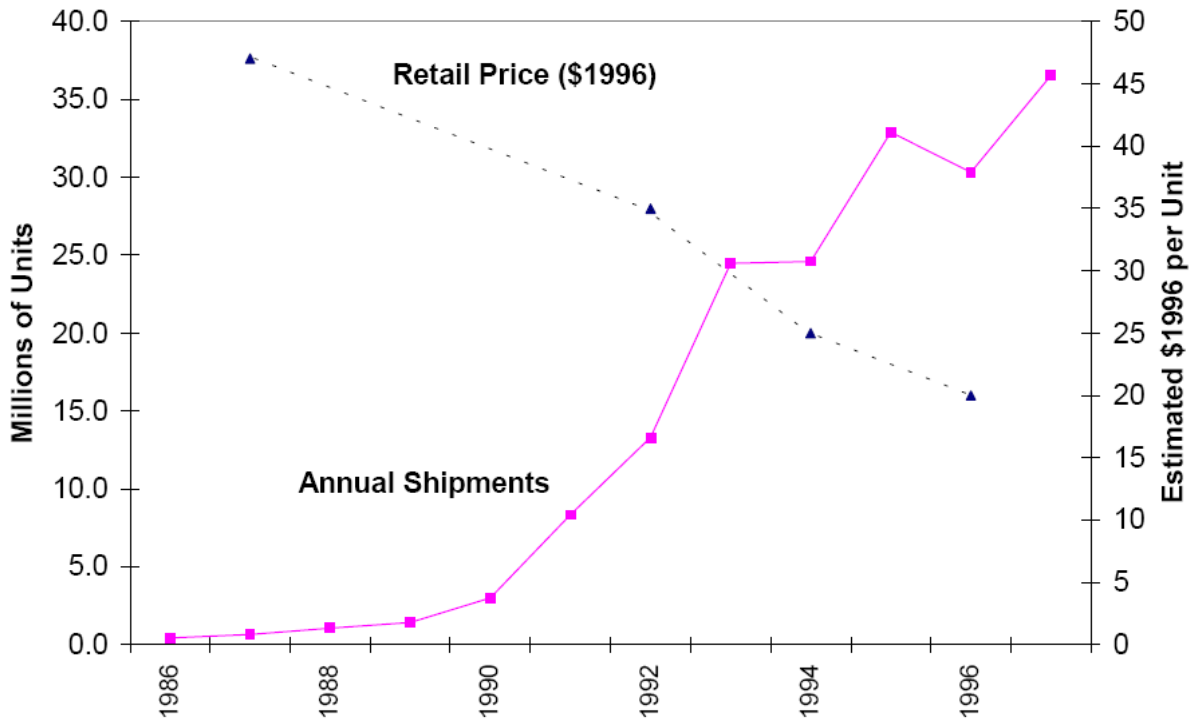
Figure 2
Trends in Electronic Ballast Shipments and
Nonresidential Construction Expenditures, 1981-1996



Source: XENERGY, Inc. *PG&E and SDG&E Commercial Lighting Market Study,* 1998.

Increased demand for electronic ballasts stimulated greater competition among ballast manufacturers. In turn, greater competition led to improved product reliability, enhanced features, expanded promotional efforts, and lower prices. Figure 3 shows this steady drop in prices, as well as growth in annual shipments. Retail price declines led to decreases in incremental measure costs as well. For instance, the price differential between a two-lamp electronic ballast and a magnetic ballast fell from $10 in 1992 to $5 in 1996. By 2000, electronic ballasts for many typical fixture configurations cost less than magnetic ballasts.

Figure 3
Electronic Ballast Shipment and Price Levels



Source: XENERGY, Inc. *PG&E and SDG&E Commercial Lighting Market Study,* 1998.

This example demonstrates the cumulative impact that market effects can have on underlying market structure and actor behavior. A combination of utility and government market interventions, grounded in utility rebate programs, generated substantial changes in the efficiency ratings of lighting products offered for sale to commercial building owners and, thus, transformed the market for fluorescent lamp ballasts. Market effects observed in this period included increased demand for electronic ballasts, greater competition among manufacturers, improved products, and lower prices.

Through a series of amendments to the Energy Policy Acts of 1975 and 2005, as well as federal rulemaking procedures, national product standards for fluorescent ballasts have evolved to the point that the manufacture of magnetic ballasts will effectively be prohibited by 2011.(U. S. Department of Energy 2008) In the meantime, utility-sponsored energy efficiency programs have generally reduced incentives offered for electronic ballasts, focusing support on “hard-to-reach” market segments, such as small businesses.

2.2.2 Resource Efficient Clothes Washers

Conventional, vertical-axis clothes washers are inefficient in a number of respects. They use more water than is needed and allow considerable amounts of water to remain in the load after the spin cycle, which requires additional energy for drying. Energy is also needed to heat wash water and to power motors and drives. The development of horizontal-axis, or H-axis, clothes washers promised efficiency gains of 50 to 70 percent relative to conventional washers. However, in the mid-1980s, H-axis machines, as well as Resource Efficient Clothes Washers (RECWs) based on vertical axis designs, were available only on a limited basis in the U. S. from European manufacturers at very high prices.

In the late 1980s, preliminary efforts were undertaken by several utilities and regional energy-efficiency organizations to promote the adoption and use of H-axis washers. These activities helped to stimulate the interest of domestic manufacturers in RECWs, and paved the way for a more comprehensive, multifaceted market intervention launched in the mid-1990s. This intervention was executed by a wide array of market actors, including utilities, regional groups, national energy-efficiency organizations, and government agencies. As Figure 4 indicates, the number of local programs increased from 12 in 1998 to 90 in 2006. (Consortium for Energy Efficiency 2008) The overall intent of these and other programs was to reshape the market for clothes washers in a more energy-efficient mold. Activities included specification development and product testing, industry outreach, consumer education campaigns, state and federal standards, promotional efforts, and, most important, rebates.

Figure 4
RECW Market Interventions and Effects

	1998	2000	2002	2004	2006
Local Programs in Effect	12	50	70	100+	90
ENERGY STAR & Other Federal Events	1st ENERGY STAR specification (1997)	DOE announces new min. standard	National promotions initiated	Federal min standard increased	(2007) Fed min standard and ENERGY STAR increased
Manufacturers producing ENERGY STAR models	8	14	17	21	24
Number of ENERGY STAR models	18	35	84	125	212*

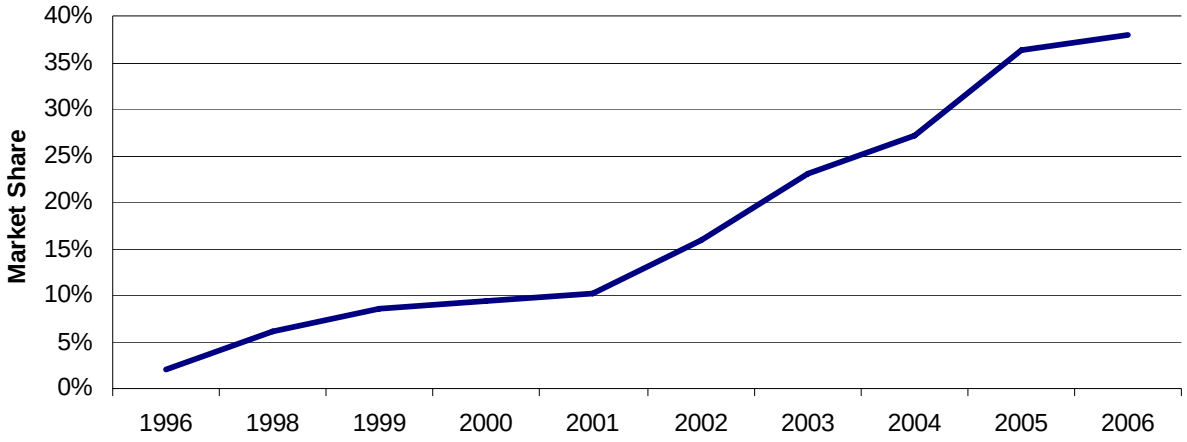
* Includes only those that meet the revised 2007 specification.

Sources: Shel Feldman Management Consulting et al. *The Residential Clothes Washer Initiative: A Case Study of a Collaborative Effort to Transform a Market.* 2001, updated by Consortium for Energy Efficiency.

As in the case of electronic ballasts, the demand for RECWs increased in response to these interventions. This was most evident in terms of market share. Figure 5 shows a surge in Resource Efficient Clothes Washers from 1996 to 2006. The market share of high-efficiency, ENERGY STAR-qualified clothes washers expanded from 6.2 percent in 1998 to 37.9 percent in 2006 (U. S. Department of Energy 2008b)

Utility program and regional market transformation program staff also worked directly with DOE and manufacturers to influence federal standard-setting procedures. This work led to the adoption of more efficient federal standards in 2004 as well as an increase in ENERGY STAR qualifying levels in 2007. These changes have increased baseline efficiencies as well as the level of savings achieved through the purchase of ENERGY STAR-qualifying equipment.

Figure 5
RECW Market Share, 1996-2006



Source: U. S. Department of Energy, ENERGY STAR Resources for Appliance Manufacturers and Retailers

This growth in demand produced concomitant changes in the supply chain. As shown in Figure 5 above, the number of manufacturers producing ENERGY STAR-qualified clothes washers increased from 8 in 1998 to 24 in 2006. Similarly, the number of energy-efficient models offered for sale increased from 18 to 212 over this period. Distributors and retailers heightened their RECW promotional activities. Ultimately, prices declined as well. For instance, the minimum price of an energy-efficient model fell from $699 in 1998 to $599 in 1999, a decrease of 14 percent in just one year. (Shel Feldman Management Consulting et al. 2001)

Together, these demand-side and supply-side changes appear to have permanently transformed the clothes washer market. Evidence that the gains in RECW market share are likely to be sustainable include the following:

- Over the past several years, energy efficiency program sponsors have steadily reduced the level of incentives paid for RECWs and, in many cases, have limited the availability of incentives to seasonal promotions. Despite this reduction in program activity, the market share of RECWs has continued to rise.
- Federal standards have been increased, thus increasing baseline efficiencies in the market. Additional changes to federal standards currently under consideration will further increase baseline efficiencies to resource efficient levels.
- In recent years, the market share of RECWs has grown significantly faster in states and regions with no local incentive and promotion programs than in states with such programs. This development likely reflects manufacturer and retailer efforts to promote resource efficiency as part of a package of premium features associated with higher unit prices and profit margins. (KEMA 2005)
- Some program sponsors continue to provide rebates for RECWs. However, eligibility is restricted to the highest-efficiency models, which use significantly less water and energy than base qualifying products.

2.3 Models of Market Effects and Market Transformation

In this section, we describe the models advanced by program planners and analysts of the mechanisms by which energy efficiency programs achieve market effects and market transformation. We also comment briefly on their strengths and limitations for providing guidance in market transformation program design and evaluation. These models abstract key elements from market transformation narratives such as those presented above and provide a logical framework for developing programs to achieve market effects. Of the three models discussed, the first – microeconomics of customer behavior – has been used most often in program evaluations. Program planners and evaluators also refer often to the microeconomics of supplier behavior, especially in developing indicators of market effects involving contractor, distributor, and manufacturer response to the programs in question. Finally, diffusion models are a mainstay of marketing campaign design and market share forecasting in the private sector. Recently, they have found some application in energy efficiency program design and evaluation. We present one of these examples in Section 5. Whether or not they are explicitly

invoked by program sponsors and regulators, all three models carry implications for program design and evaluation, as discussed below.[3]

2.3.1 Microeconomics of Consumer Behavior

Overview. The *Scoping Study* discussed above was one of the first attempts to present a systematic model of market effects, and it was widely referenced by program designers and evaluators. The model focuses primarily on the ways in which programs change circumstances – designated as "market barriers" -- that lead consumers to forego purchases of cost-effective energy efficiency measures. Cost-effectiveness in this case is defined by the standard customer and societal tests, which do not take into account such non-money factors as consumers' search or hassle costs and perceptions of performance risk. The *Scoping Study* authors identify and describe 14 varieties of market barriers. These can be grouped into a smaller number of categories with common effects on consumers and, therefore, common implications for program strategies and policies to overcome the barriers, as shown in Figure 6. (Goldberg 2003)

[3] The implications of the various models for program design are discussed in Section 3; for program evaluation in Sections 4 - 6.

Figure 6
Market Barriers and Program Implications

Category/Barrier	**Description/Examples**	**Program/Policy Strategies**
Risk		
Performance uncertainties	Insufficient information or experience to assess future product performance	Customer education Voluntary standard setting, testing and labeling, e.g. ENERGY STAR Demonstration projects Rebates to reduce amount at risk
Asymmetric Information & Opportunism	Seller incentives to withhold information on efficient products if they compete with established products	
Hidden Costs	Unanticipated costs of using new technologies	
Irreversibility	Long life of capital purchases deters selection of unfamiliar technologies.	
Reduced Benefits		
Split incentives	Landlord/tenant-type situations	Consumer education Development of decision support tools, e. g. MotorMaster,
Organizational Practices	Costs of changing long-standing procurement rules	
Bounded Rationality	Decision rules do not take into account energy efficiency and related benefits	
Availability		
Lack of availability Inseparability of features	Manufacturers and suppliers do not perceive business motivations to supply efficient products.	Rebates to stimulate customer demand Voluntary standard-setting & labeling
Transaction Costs		
Hassle Costs Search Costs	Consumer costs of finding and procuring efficient products, incremental to costs for conventional products	Rebates to offset search and hassle costs Voluntary standard setting & labeling Marketing campaigns to inform customers of product advantages, where to buy, etc. Loan guarantee & targeted financing programs
Access to financing	Difficulties of lending for energy efficiency products, versus other kinds of assets	
Market Failures		
Externalities	Environmental and other externalities not reflected in energy prices	Pricing and ratemaking reforms
Non-externality Pricing	Rate making does not expose consumers to marginal costs	

Recent examples of the use of this framework in evaluations include the following.

- **Consumer Products Program Evaluation.** The Northwest Energy Efficiency Alliance (the Alliance) has conducted annual Market Progress Evaluations of regional programs to promote efficient consumer products, including CFLs since 2003. These studies have used consumer surveys to track changes in the level of awareness of CFLs as one potential indicator of program effects on barriers to product acceptance. In 2005, utilities in the region supported by the Alliance launched a new promotion that expanded marketing into retail channels and geographic regions that had participated heavily in previous efforts. Between 2004 and 2005, the percentage of customers who reported being aware of CFLs increased from 65 percent to 88 percent. The percentage of customers who reported purchasing CFLs increased from 32 percent to 58 percent. In 2006, the percentage of self-reported purchasers increased again to 67 percent, even though the percentage of aware customers held even. These findings suggest a linkage between product awareness and purchase, as well as a linkage between the intensity of well-targeted promotional campaigns and levels of customer awareness. (KEMA 2007)

- **Small Business Direct Installation Program.** In a recent evaluation of a direct installation program for small businesses in Southern California, participating and non-participating establishments both identified lack of capital, split incentives (due to tenant status) and lack of knowledge of cost-effective measures as the principal barriers to completing energy efficiency projects. In addition to implementing projects through the program, fifty percent of participants reported improving their knowledge of energy efficiency measures through program participation, which will facilitate identification of further savings opportunities. (Quantec 2006)

Strengths of the model. This model provides a useful, checklist-type framework for assessing conditions in a given market, as well as an approach to identifying appropriate program strategies. Many plans for both resource acquisition (RA) and market transformation (MT) programs have used the approach of enumerating market barriers identified through market studies or experience in the field on the one hand and program activities designed to address those barriers on the other hand. This approach also provides the basis for clear definitions of indicators of market effects. Some program sponsors, such as the Long Island Power Authority (LIPA), build tables of barriers and indicators of reductions in those barriers into their evaluation plans. Finally, some analysts have used this construct to estimate the portion of end-use energy embodied in devices that residential customers either do not select or do not control due to the range of decisions that are usually delegated to builders, contractors, or landlords. Murtishaw and Sathaye (2008), for example, estimate that 40 percent of residential heating end-

use is provided by equipment that the associated energy customers did not choose and that an additional 8 percent of end-use energy is not under the paying customer's control. (Murtishaw & Sathaye 2008) For these market segments, market strategies other than incentives to end users are required to achieve efficiency gains.

Limitations of the model. A number of commentators have noted limitations of the model both as a guide for program design and, to a lesser extent, as a guide for program evaluation. Loren Lutzenhiser and other analysts, for example, approach the analysis of energy consumption decisions from a more sociological viewpoint. They maintain that factors such as the "invisibility" of current energy consumption, the social nature of many decisions that affect consumption by households and businesses, and the determining nature of larger social systems all play a larger role in actual energy consumption than the economic calculations of individuals and organizations. (Lutzenhiser 2002)

One other key limitation is that while the model attributes a number of market barriers to supply-side market actors, it does not explicitly address their behavior and motivations and how these reinforce or reduce barriers experienced by the customer. Thus, it provides little theoretical reference for designing program elements addressed to the supply side.

2.3.2 Diffusion of Innovation

Overview. Economists, social scientists, and natural scientists have been studying the process of diffusion of new products and technologies in human societies since the late 1940s. Many energy efficiency programs can be viewed as efforts to accelerate the pace of diffusion of energy-efficient products and processes. Thus, formal studies of this process promise to provide useful insights for developing approaches to program design and evaluation.

Initial studies in this field were prompted by the results of empirical and historical studies of the diffusion of agricultural and industrial processes on the one hand, and of contemporaneous research on the market share of consumer products. These studies all found that the time path of cumulative technology adoptions followed the by-now familiar logistic function or S-curve. Much of the work in the area over the past 50 years has focused on developing and testing theories to explain this pattern of diffusion.

There are many theories which, when expressed in mathematical formulas, yield the S-curve. It is useful to review some of the more prevalent current theories, which differ somewhat in their implications for program strategies and evaluation approach. (Geroski 2000, Research Triangle Institute 1991)

- **Epidemiological models.** One large class of diffusion theories and research rests on contagion models, where the mechanism of adoption is driven by social contact between individuals or firms that have already adopted the technology and those who have not. The most common formulation of the contagion approach is the "mixed influence" model, of which the well-known Bass curve is an example. These models take into account external influences on model adoption, such as prices of alternative products, as well as the pace and density of interactions among those who have adopted the product and those who haven't.

  The most well known work in this field, Everett Rogers's *Diffusion of Innovations,* now in its fifth edition, overlays a wide range of insights and refinements drawn primarily from marketing research onto the basic epidemiological model. Some of the most useful of these for program design and evaluation include the following:

  - *The adoption process.* Rogers posits a five-stage sequence that individuals go through the adoption process: knowledge (awareness), persuasion, decision, implementation, confirmation (evaluation). These stages can be used to structure research on the effects of programs over time. For example, Hall et al. (2001) assessed the effects of a program by the Federal Energy Management Program (FEMP) to encourage federal agencies to make use of Energy Service Performance Contracting (ESPC) procedures to implement major energy efficiency improvements in their facilities. To do so, they used periodic surveys of agency employees in position to use ESPC in terms of their adoption stage. Changes in the distribution of the population of targeted employees among the adoption stages were used as indicators of program effects. (Hall et al. 2001)

  - *Balance of risk and reward.* The most important factor in individuals' adoption decisions is the balance of risk and reward. Risks accrue due to the lack of knowledge about the performance of the new technology. The individual's appreciation of rewards will vary, depending on their value systems and ability to reap and confirm the potential rewards.

  - *Product attributes.* Various product attributes may increase or decrease the costs and risks associated with adoption. Rogers identifies the following key attributes: relative advantage compared to the incumbent technology; compatibility with existing social and physical systems; complexity of use, delivery, and installation; trialability – the opportunity to try before buying; and observability – the ability to actually observe performance.

  - *Organizational learning.* On the supply side of the market, the self-reinforcing nature of diffusion processes can be enhanced by organizational learning. Specifically, the longer

a firm supplies a particular good, the greater the chance it has to identify production cost savings, which in turn supports the realization of economies of scale. The cost trend in electronic ballasts discussed above illustrates this phenomenon. Similarly, the National Renewable Energy Laboratory's *Annual Report on Wind Power* showed decreasing costs as cumulative capacity installed doubled from 2000 to 4000 MW between 1998 and 2001. However, by 2006, cumulative capacity installed had increased to nearly 12,000 MW, leading to price increases associated with shortages of input resources. (NREL 2008)

- *Adopter groups.* Market actors are segmented by their propensity to adopt at different times after technology introduction. These segments are designated as innovators, early adopters, early majority, later majority, and laggards. Each is characterized by different positions on a number of dimensions: value placed on the benefits of the technology, risk tolerance, and prestige value ascribed to adoption of innovations. Related to these concepts are theories on the influence of opinion leaders on the adoption groups. Rogers maintains that opinion leaders are particularly important in swaying the early majority, which is important in reaching the inflection or tipping point in the adoption function.

The concept of adopter groups is closely related to stages of the product lifecycle: introduction, early acceptance, take-off, and maturity which are in turn related to stages of development of the supply chain and customer acceptance. The product lifecycle provides a framework for structuring the selection of program designs and evaluation methods which is discussed in Sections 3 and 6.

- **Economic models.** A second large class of diffusion models are based on the econometric analysis of the individual consumer's or firm's adoption decision. The basic structure of these models posits that consumers or firms differ in an unobservable characteristic that affects their profitability when adopting a new technology. This unobservable propensity to profit is assumed to be normally distributed among the individuals in the population and to be associated with observable consumer or firm characteristics, such as firm size or level of investment in the incumbent technology. The response of an individual firm or consumer at time *t* can thus be modeled using a probit or logit approach.[4]

[4] Probit and Logit are types of General Linear Models that can be used to estimate the probability of an individual's action based as a function of categorical or continuous variables that describe that individual.

Analysts have frequently considered the following adopter attributes in developing economic models of adoption:

- *Firm size.* Larger firms may adopt new technologies earlier than smaller firms because they can detail staff to monitoring technical developments, have greater financial resources and thus perceive less risk of loss due to poor performance, and have a strategic interest in gaining strategic advantage. Similar arguments can be made for wealthy individuals, who are overrepresented among innovators and early adopters.

- *Switching costs.* These include not only the purchase of new technology but the loss of the unamortized value of the old. Retraining and learning costs may also be barriers. Various proxies can be found for these variables, including the saturation of the incumbent technology and the level of education among users. Higher levels of education are associated with the greater ability to assimilate and realize the benefits of new technologies. Again, there are analogs to individuals with high educational attainment, who are overrepresented among early adopters. (XENERGY 1995)

Econometric models can also account for the effect of product attributes on the time path of adoptions. For example, products that do not need to be adapted to current technical or social systems generate low switching costs. This approach can also model the effects of strategies employed by supply side actors and energy efficiency programs to promote more rapid adoption. Changes in price will lower the threshold at which benefits exceed costs, as will improvements in product features (increased benefits), and intensive promotion (reduction of search costs).

Strengths of the model. Perhaps the major strength of diffusion models is that, despite the extreme simplifications they make in representing very complex processes, they can reproduce and predict the observed trajectory of product adoptions surprisingly well. Moreover, since the contagion-based models are deterministic in form, they can be calibrated using relatively few observations, and then used to forecast market share. (Goldberg 2003b) This is an extremely useful feature for planning and for generating forward-looking estimates of program benefits.

Limitations of the model. The major limitation of diffusion models is that, for the most part, the decisions of supply-side actors remain largely exogenous.[5] Thus, at least to date, most of the analyses based on diffusion models focus on analysis of customer adoption of technologies already in the market. Some recent studies have incorporated advanced forms of diffusion modeling, such as social network models, into the analysis of the effects of different social settings on the pace of development of new products and basic research approaches. (Fogarty et al. 2002)

2.3.3 Microeconomics of Supplier Behavior

Overview. Many market transformation programs that target market effects on the supply side draw their theoretical basis from the branch of academic economics known as industrial organization, which studies the way firms behave based on the markets in which they operate and the nature of their initial complement of resources.[6] The literature in this field stretches back to the early 20th century, with the first neoclassical models of firm behavior in competitive markets and oligopolies. A summary of this work is far beyond the scope of this report. However, it is worthwhile to identify some key insights that have informed market transformation program designs.

The most widely-known practical application of the insights and analysis generated by industrial organization studies is contained in Michael Porter's *Competitive Strategy*. (Porter 1980) Porter identifies 5 "forces" that shape the environment for the formulation and implementation of competitive strategy. These forces are basically non-mathematical expressions of the staples of industrial organization theory: the effects of industry concentration on firm behavior, profit maximization versus growth strategies, behavior of oligopolistic firms, the effects of government regulation on competition, and so forth. They are as follows.

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[5] There are some exceptions to this tendency. Some economists have adapted population growth models to representing the activities of firms in competitive and oligopoly markets, where the process of competing away advantages gained through developing new products limits diffusion of innovations.

[6] We note that this body of work is seldom explicitly referenced in energy efficiency program plans and studies. However, the concepts of the sustainability of market changes discussed above and the attribution of market changes to program activities discussed in Section 5 draw heavily on theories about supplier behavior drawn from the study of industrial organization.

- **Rivalry.** Industry attributes that lead to intense rivalry include: large number of firms in the market, slow market growth, high fixed costs of production, low switching costs for customers, low levels of product differentiation, high costs of abandoning operations (high exit costs), and slow growth in total market size.

- **Threat of substitutes.** Availability of close substitutes for a given product constrains the ability of its producers to raise prices. The most threatening types of substitutes are those produced by firms in other industries: for example, the Internet as a substitute for audio CD distribution.

- **Buyer power.** Buyers exercise power in the market when there are relatively few of them, when they buy large portions of standardized output, and when they have the potential for backward integration (i.e., they purchase or initiate operations farther up the supply chain).

- **Supplier power.** Suppliers are powerful when there are relatively few of them, when customers face high costs for switching, and when they have credible potential for forward integration (i.e., they purchase or initiate operations farther down the supply chain).

- **Barriers to entry.** Firms in an industry experiencing relatively high profits face the threat of entry by firms not currently in the market, which will intensify competition and reduce general profit levels. All industries have barriers to entry by new competitors which help make competitive life more manageable for incumbents. These barriers include government regulations (franchises in utility and communications industries, licenses for broadcast frequencies), patents and other protections for intellectual property, economies of scale that favor incumbents, and the level of specialization for production assets.

The three generic competitive strategies are:

- **Cost leadership.** This strategy entails developing product designs, parts sourcing, production methods, and delivery channels that contribute to unit costs below the industry average. The cost leader can use this advantage to gain high profits by selling at industry average prices or by selling below market price to increase market share.
- **Differentiation.** Firms pursuing a differentiation strategy invest in developing products and services that provide greater value to customers than those of competitors. The unique elements of the product enable the firm to charge premium prices, which offset the investment in product development and marketing.

- **Focus strategies.** Focus strategies involve the selection of a niche market in which to concentrate efforts and the use of cost leadership and differentiation strategies to engender high customer loyalty, which in turn lead to high barriers to entry for competitors.

Taken together, the five "forces" characterize the environment in which supplier strategies and energy efficiency programs operate. In Porter's framework, the success of a business strategy, regulatory regime, or voluntary program depends to a large extent on the degree to which they take into account the current array of forces in the target industry and the way in which the market is likely to evolve. The concepts behind the "elements of sustainability" of energy efficiency program market effects discussed above are drawn directly from this line of analysis.

Although they are seldom referenced formally, the concepts of competitive strategy inform the design of nearly every market transformation program that seeks to engage supply-side actors. The following are some examples of these principles in action.

- **Product differentiation: ENERGY STAR Labeled Products.** The ENERGY STAR program facilitates product differentiation strategies for manufacturers of mass market products. In order to earn adequate returns to their expensive capital plants and marketing infrastructures, they need to be able to serve the full range of customer demands in terms of features and price points. Moreover, they operate in highly cost-competitive international markets. Some manufacturers gained a short-term advantage by bundling energy efficiency with other desirable features into premium-priced models. (Shel Feldman Management Consultants et al. 2001)
- **Service Differentiation: ENERGY STAR Homes, Home Performance with ENERGY STAR, Diagnostic-driven HVAC Maintenance.** These programs promote the adoption of energy-efficient practices in construction and service industries in which small, local establishments account for the majority of firms, units delivered, and industry revenues. Rivalry in these local markets is fairly intense due to the high volatility in market activity levels and competitive price pressures. Participants in these markets have neither the resources nor the business motivation to develop the capacity to market and deliver energy-efficient services on their own. However, in the case of ENERGY STAR Homes, mid-sized firms with some ability to invest in new procedures have seized on the opportunity to create differentiation with competitors, driving significant increases in market share over a period of 3 to 5 years. (Quantum Consulting 2000, Nexus Market Research et al. 2007)

Strengths of the model. Of course, the summary above barely skims the surface of the competitive strategy literature, not to mention the huge body of work on industrial organization.

However, it is clear that, even in its simplified versions, applied microeconomics of supplier behavior provides a wealth of insights on which to build program strategies, as well as testable hypotheses for program effects. The work in this field also helps planners and analysts to identify the key aspects of markets to be researched and summarized in market assessments used to support program and evaluation designs. In particular, these include industry structure and concentration, the roles, structure, resources, and motivation of various groups in the supply value chain, and the business strategies that these groups have pursued in the past. (XENERGY et al. 2001)

Limitations of the model. This branch of academic and applied economics is so broad and we have described so little of it that it is not entirely appropriate to discuss its limitations. The one area in which models based on diffusion processes may have an advantage over supply-side models is in the area of forecasting market share of new technologies. Competitive strategy provides theoretical support for the analysis of the extent to which suppliers will invest in developing and promoting new technologies. However, it does not generally support the development of models of the pace of adoption over time.

2.4 Market Effects Concepts in Planning and Evaluation of Resource Acquisition Programs

Before going on to the evaluation of market effects and market transformation, it is useful to discuss how they relate to concepts that are typically encountered in the design and evaluation of resource acquisition programs. In the energy efficiency arena, the term “resource acquisition program” denotes a program strategy that focuses on generating measurable energy savings in the short term, primarily by providing incentives directly to customers to adopt proven energy efficiency technologies. The technologies may include efficient substitutes for standard products or efficient design and installation practices in new construction and renovation. The incentives offered are generally financial, but free or subsidized technical assistance may also be part of the package.

Much has been made in various policy and industry forums about the differences between resource acquisition and market transformation strategies. (Horton) Among the differences with the greatest implications for program oversight and evaluation are the following.

- **Timeframe.** Resource acquisition programs are generally designed to achieve high levels of energy savings as quickly as possible. Market transformation efforts necessarily take

longer to generate savings, since the early phases of those efforts often involve recruitment and training of suppliers to deliver the measures in question.

- **Performance risk.** Sponsors and regulators have accumulated sufficient documented experience with resource acquisition programs to develop forecasts of participation and energy savings within a range that is acceptable for establishing performance targets for shareholder incentives and other forms compensation. The performance of market transformation programs is less well documented. Moreover, the methods for assessing market effects have undergone less standardization than those for estimating physical energy savings and, as discussed below, the outcomes of market effects assessments are highly sensitive to market conditions that are both location and time-specific. Thus, it is difficult to build local program planning assumptions out of market effects findings from other program areas and periods.

Given the protracted time frame and uncertainty associated with both the realization and measurement of market effects, many regulators and sponsors have been reluctant to link performance incentives or any element of compensation to achievement of market-oriented goals. Without that linkage in place, program sponsors and regulators in some jurisdictions, such as California, have found it expedient to focus on program effects on participants only.

Despite the very real differences between the resource acquisition and market transformation approaches to program design, both have, in fact, contributed to the achievement of significant market effects and longer term market transformation. The MT examples presented above illustrate the close link between the two approaches. Specifically:

- RA programs have played an important role in many long-term market transformation strategies. This is particularly true of manufactured products with long supply chains between the manufacturer and the consumer. Financial incentives encourage customers to purchase efficient products which, in turn, helps convince retailers and contractors of the value of promoting those products. This “demand pull” is ultimately experienced by manufacturers who then perceive potential benefits to be gained through competition on price and product features.
- Program activities specifically targeted to achieving market effects, such as increased consumer awareness and vendor promotional support for efficient technologies, may enhance the results of RA-style programs. For example, the utilities’ engagement of manufacturers in product development and promotion and the development of the ENERGY STAR brand and standards were key elements in the development of the market for resource-efficient clothes washers. Similarly, programs that promote ENERGY STAR

products through a combination of consumer incentives and retailer merchandising support achieve higher levels of participation and sales than programs that rely exclusively on one or the other approach. (Wilson-Wright et al. 2005)

The following paragraphs review terms and concepts that have been used frequently in evaluations of resource acquisition programs, although the phenomena they describe are, for the most part, market effects as defined in this White Paper.

Spillover. The term "spillover" refers to a range of potential market effects of energy efficiency programs. Analysts and regulators identity the following types:

- **Participant Spillover.** Participant spillover occurs when customers who have received financial and/or technical support for adopting an energy efficiency measure later purchase and install similar measures without using program incentives or services. To be counted as program effects, there must be some evidence that the customers in question took these actions as a result of their earlier participation in the program.

- **Nonparticipant Spillover.** Nonparticipant spillover occurs when customers who have not participated in a particular RA program adopt the energy efficiency measures that the program supports as a result of the program, due to their exposure to program-related public relations, vendor promotions, or word-of-mouth about the program and the benefits of efficiency measures.

Energy efficiency analysts and managers elaborated these spillover concepts in the early 1990s in response to a number of developments. First, program sponsors received reports from vendors and installation contractors involved in delivering RA-type programs that they were selling significant volumes of efficient products without program support. (Feldman 2004, XENERGY 1999) Second, attempts to apply econometric methods (such as discrete choice analysis) to estimation of net program effects required that the behavior of non-participants be taken into account. (Cambridge Systematics 1994) For the purposes of this White Paper, spillover or purchases made "outside the program" can be viewed as an indicator of market effects, namely increases in product adoption.

Free Ridership. Free riders are program participants who would have installed the same energy efficiency measures if there had been no program. (TecMarket Works Team 2006) Free ridership is the portion of a program's gross energy savings that can be attributed to the actions of free riders. "Partial free riders" are those customers who would have installed some program-supported measures on their own, but not as many, not as highly efficient, or not as soon. As is the case for spillover, the concept of free ridership applies primarily to customers as opposed to

suppliers, and to programs for which it is possible to distinguish participants from nonparticipants.

In the first year or two of an energy efficiency program, free riders are those customers who would have purchased the supported products based on their own motivations and unsubsidized supplier marketing efforts. As a program continues, a certain portion of participants will be customers who would have purchased the supported technology in the current period without program support, based on the diffusion processes stemming from program operations in previous periods. Thus, some portion of free ridership observed in the current period is a market effect.

Market Effects as Defined in the *California Protocols.* The *California Energy Efficiency Evaluation Protocols,* which serve as the current methodological reference for evaluations of programs funded by public benefit charges in the state, endorses the definitions of market effects and market transformation put forth in the *Scoping Study.* However, the *Protocols* stress that market effects occur at the *market level* of aggregation and are best understood as the joint result of the several relevant programs that may be operating at the local, regional, and national levels. The protocols do not prescribe a method for using findings on market effects at the market level to characterize results of individual programs under evaluation. Rather, this analytical step is identified as an area requiring further research and practical experience with alternative methods.

2.5 Other Concepts Related to Market Transformation

Sustainability of market changes. Although there have been relatively few rigorous analyses of the sustainability of market effects over time, proposed approaches to the analysis of this issue rely heavily on competitive strategy thinking. For example, David Hewitt, in his 2000 paper "The Elements of Sustainability" identified the following indicators that a program's market effects may persist after it ends or scales back, all but one of which refer to supply-side conditions:

- Is someone making money by offering it?
- Has a private market developed to continue the facilitation?
- Has the profession or trade adopted it as a standard practice?
- Would it be difficult or costly to revert to earlier equipment or practices?

- Are end-users requesting or demanding it?
- Have the risks to private market actors been reduced or removed?

Generally, the adoption of the technology in a government building code or product standard is also a good indicator of sustainability. For other practical approaches to assessing the sustainability of market changes, see Section 3.

Exit Strategies. With the onset of electric industry restructuring in the mid-1990s, utility companies and their customers could not be assured of capturing the direct economic benefits of reduced energy consumption and avoided capacity expansion. The regulatory framework of IRP began to unwind and, with it, the regulatory support of utility energy efficiency programs. Regulators in many states expressed the policy intent that restructuring would reduce or eliminate the need for publicly funded energy efficiency programs. They hoped that consumers would curb consumption as electricity prices were freed to reflect market costs, and that energy retailers would offer efficiency services in an effort to secure market share. Between 1994 and 2000, utility expenditures on DSM programs fell from $2.5 billion to $900 million. During this period, some regulators began to request or require that program sponsors include in their program plans an “exit strategy”. These were to include a set of indicators that the target markets had been “transformed”, as well as a plan for terminating program efforts and incentives over time.

As it turned out, restructuring led neither to widespread customer exposure to wholesale market prices nor to the entry of energy retailers into the efficiency industry. Moreover, there are relatively few recorded instances of program sponsors terminating *all* activity in the market for a given technology. For example, the Northwest Energy Efficiency Alliance stopped providing financial incentives for resource-efficient washers in 2001 when their regional market share reached 14.2 percent. However, the Alliance continues to provide some merchandising support and advocates for the adoption of more stringent voluntary and mandatory standards. (Pacific Energy Associates 2001) Similarly, the Alliance suspended CFL rebates. However, the Alliance continues to be active in the regional market by providing merchandising support to retailers of appliances and residential lighting. More generally, the best practice among energy efficiency program sponsors has included the monitoring of market share and prices in relation to qualifying specifications and incentives to ensure that changing market conditions have not overtaken program design. Finally, many program sponsors participate in joint programs to support the development and testing of new products, such as LED lighting, which can be promoted through supply channels cultivated in past programs.

3. Planning of Market Transformation Programs

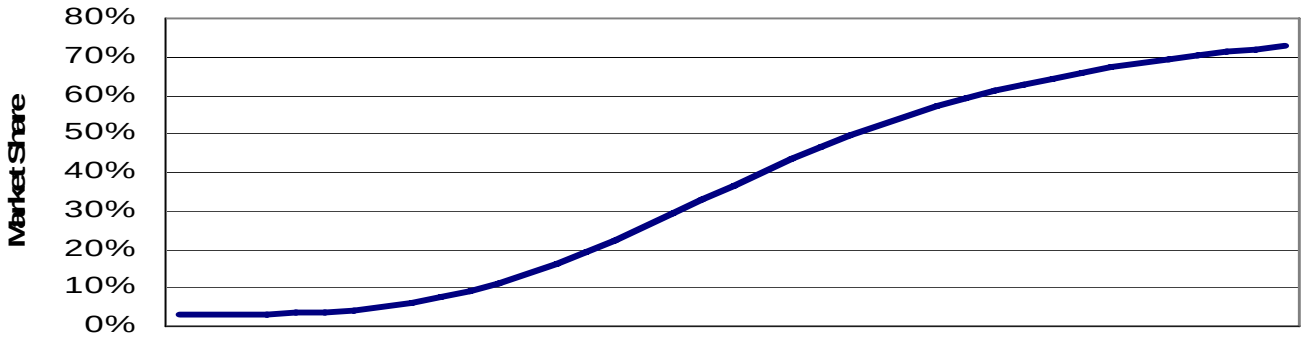
In this section, we summarize approaches that program sponsors, evaluators, and regulators have used to ensure that market transformation strategies and market effects are taken into account in energy efficiency program planning and evaluation. We begin with a review of the various kinds of market transformation programs that program sponsors have fielded and criteria for matching program types to specific short- and medium-term objectives. We then discuss criteria that can be used to identify products and services for support from market transformation programs. We conclude with descriptions of a sequence of activities that program sponsors have undertaken to gather, organize, and analyze market data and intelligence to detail program designs and evaluation plans. We are reluctant to designate this portion of the White Paper as a "best practices" review, since we did not do a complete survey of programs in effect. However, program sponsors in jurisdictions that have pursued market transformation goals consistently over a number of years converged on a number of common approaches, and the practices reported by individuals from various jurisdictions showed many consistencies.

3.1 Program Approaches to Market Transformation

Governments and regulated industries have long used public revenues to fund programs that advance the invention, commercialization, and adoption of a wide range of technologies deemed to have broad public benefit. Successful program designs must take into account the nature and current state of development of the technologies addressed and their markets. Figure 7 summarizes a number of articles by Nadel and Geller (1994) and others on the appropriate match of program approach to market conditions for the technology in question.

Ratepayer-funded programs have been driven, for the most part, by relatively short-term energy saving goals. Thus, they have typically occupied the middle two quadrants of the program design/stage of the market development matrix shown in Figure 7. In the 2006 – 2008 round of energy efficiency programs, the CPUC and the investor-owned utilities (IOUs) consolidated a number of earlier efforts into a statewide Emerging Technologies Program. This move expanded the footprint of ratepayer-funded programs earlier into the product life cycle by calling for planned cooperation with the California Energy Commission and other entities involved in energy technology research, development and demonstration (RD&D). Similarly, the 2006 – 2008 programs contained a statewide Codes and Standards element, through which the IOUs supported changes in state building codes and appliance standards and the enforcement of selected changes.

Figure 7
Program Portfolio and Product Life Cycle



Introduction	Early Acceptance	Take Off	Maturity
SUPPLY CHAIN: MARKET CONDITIONS Smaller competitors or new entrants producing No standardization Very high prices Performance problems Distribution mostly in non-standard channels Limited product lines Little marketing support	1 – 2 larger competitors enter Product standards develop Prices high relative to standard Improved performance Limited distribution Limited model line build out Some marketing support	Most large competitors offer product Product standards adopted voluntarily Prices are higher but in line with standard models Product lines built out Good distribution Manu. Marketing support	All major competitors in market Mandatory standards Prices approach those of standard Producers compete on price and features Distribution via all channels Retailer marketing support
SUPPLY CHAIN ORIENTED PROGRAMS Government lab R&D Sponsored corporate R&D Technology road mapping Mediate technology standard setting Development of performance metrics and testing protocols	Vendor technical and sales training Co-advertising Vendor merchandising support Development & promotion of voluntary product efficiency standards Product testing	Vendor technical and sales training Co-advertising Vendor merchandising support Upstream product subsidies Initiate consideration of higher product standards Develop common service specifications	Mandatory codes and standards Promulgate higher voluntary standards
CUSTOMERS: MARKET CONDITIONS Low level of awareness Skepticism of product claims Only early adopters buying	More customers aware Continued skepticism of product claims Small expansion of market beyond early adopters	Strong demand in advanced segments Some demand in all segments	Strong demand in all segments
CUSTOMER-ORIENTED PROGRAMS Purchase of prototypes or early models Develop and publicize case studies of applications	Bulk purchase Customer education Rebate programs General EE public relations	Customer education Rebate programs General EE public relations	Continued customer education Rebate programs for higher efficiency units only

Most of the ratepayer-funded program sponsors and regulators interviewed for this project reported taking a mixed approach to program design, based on assessments of current market conditions. For example, programs to advance energy efficiency in commercial new construction typically included incentives for both customers and designers, as well as technical support and training to increase the capacity of architects and engineers to deliver energy-efficient designs. Similarly, program sponsors in the Northeast report cooperating amongst themselves in regional partnerships to support research, development, and testing of new lighting technologies, as market share and saturation of current-generation efficient technologies (such as T-8 fluorescent lamps and CFLs) have risen. In the Northwest, the Bonneville Power Administration pursued similar strategies at the regional level in regard to building codes, and the Northwest Energy Efficiency Alliance (the Alliance) later elaborated this approach, pursuing the full range of program approaches shown in Figure 7.

3.2 Selection of Technologies for Program Support

For the past 15 years, ACEEE, the Alliance, and other organizations closely involved with market transformation programs have developed and applied systematic approaches to identifying energy-efficient technologies and measures that are worthy of program support. (Sachs 2005) The selection criteria that these analysts apply have remained consistent over time. They are:

- Technical potential for energy savings,
- Cost of conserved energy (an indicator of economic potential), and
- Likelihood of success.

The assessment of the likelihood of success is generally a qualitative scoring process that considers the following elements: nature of the barriers to adoption by customers; nature of the barriers faced by suppliers to production, delivery, and promotion; progress in development, commercialization, and promotion of the technology to date; non-energy benefits associated with adoption/promotion; and the presence of potential exit strategies such as the integration of the technology into codes and standards in the foreseeable future. ACEEE's most recent study also considered the potential for adoption by a limited number of sophisticated customers as an indicator of likelihood of success (Sachs 2007).

In our interviews with regulators and program sponsors, we found that none of the jurisdictions involved subjected their programs or potential programs to the kind of formal review described above. However, most jurisdictions assessed the value of continued support for various

technologies in the course of regular program planning using the kinds of criteria identified above.

3.3 Integration of Research and Evaluation with Program Design and Management

Program sponsors and regulators in all of the jurisdictions researched for this paper report that they set short-term objectives in terms of market effects and longer-term market transformation goals in their program planning processes and that they monitor the performance of programs in relation to those goals and objectives on a regular basis. While these jurisdictions differ substantially in the details of their approach, they all pursue a core set of activities required to frame and provide guidance for market transformation programs. The following paragraphs summarize and provide examples of those activities. They are presented roughly in the order in which they are undertaken in the process of developing program plans. Figure 8 summarizes the content of each step, the information and analytic support it requires, and the most likely sources of that information and analysis. Much of this work is later incorporated into evaluation plans and methods, as discussed in Section 4.

Technology Assessment and Demonstration. Planning for effective market transformation programs requires significant lead time. Sponsors must identify new or improved technologies before they become widely available, develop appropriate program-qualifying specifications and testing procedures, and confer with firms in the supply chain to ensure the feasibility of delivery. All of the program sponsors that we contacted in preparing this paper report that they regularly engage in a prospective assessment of performance, features, cost, and market-readiness of emerging technologies. Some, such as the Alliance, have funded testing and the commercialization of new technologies and services directly as part of their program activities. These technologies have included end-use

Figure 8

Key Steps and Information Requirements in Market Transformation Program Planning

Type of Study/ Information Source	Technology Assessment	Market Characterization	Program Advisory Committees	Market Progress Assessments	Summative Evaluations
PROGRAM DESIGN & PLANNING					
Select Products and Markets to Support Assess potential energy savings Assess cost effectiveness Assess technical and market risks to program success Assess motivations/barriers for supply chain & customers → likelihood of program success Identify stage in product cycle	◉ Product performance & risks Presence of efficiency standards & test procedures Product costs Future efficiency trends	○ Market boundaries Market size Market segmentation Supply chain structure Motivations/Barriers for acceptance Baseline indicators: levels		○ ***(From other regions)*** Market boundaries Market segmentation Supply chain structure Motivations/Barriers for acceptance Baseline indicators: identification	○ ***(From other regions)*** ***(From other regions)*** Market segmentation Supply chain structure Motivations/Barriers for acceptance Baseline indicators: changes over time Estimate of changes attributable to program
Develop Program Theory/ Logic Model Identify activities, outputs, outcomes Specify hypothesized causal links Specify indicators of market change Specify hypotheses concerning timing of market changes	◉ Product performance & risks Efficiency standards Product costs Future efficiency trends	○ Market segmentation Supply chain structure Motivations/Barriers for acceptance Baseline indicators: levels	◉ Market segmentation Supply chain structure Motivations/Barriers for acceptance Baseline indicators: identification	◉ ***(From other regions)*** Market segmentation Supply chain structure Motivations/Barriers for acceptance Baseline indicators: changes over time	◉ ***(From other regions)*** Market segmentation Supply chain structure Motivations/Barriers for acceptance Baseline indicators: changes over time Estimate of changes attributable to program
Develop/Revise Program Design Identify basic program strategies Specify incentives, technical assistance and other services Set participation and savings goals by year	○ See above	◉ Market boundaries Market size Market segmentation Supply chain structure Motivations/Barriers for acceptance	◉ See above	○ Market segmentation Supply chain structure Motivations/Barriers for acceptance Baseline indicators: changes over time Customer and vendor response to program	○ See above

◉ = High Importance
○ = Medium Importance

applications such as the MagnaDrive motor application speed controller as well as various kinds of design and equipment diagnostic services. Others, such as the utilities in the Northeast, have contributed funds and market data to national product development and commercialization efforts, such as the Lighting Research Center operated by the Rensselaer Polytechnic Institute in New York.

The California IOUs have a long record of supporting technology development and commercialization, stretching back to the Super-Efficient Refrigerator Project in the early 1990s. Currently, the California Energy Commission's (CEC) Public Interest Energy Research (PIER) program has a strong, well-funded legislative mandate to support early stage research and development of efficient products and practices. The utilities have worked closely with the CEC to support the installation of a number of technologies that have been advanced through support from PIER.

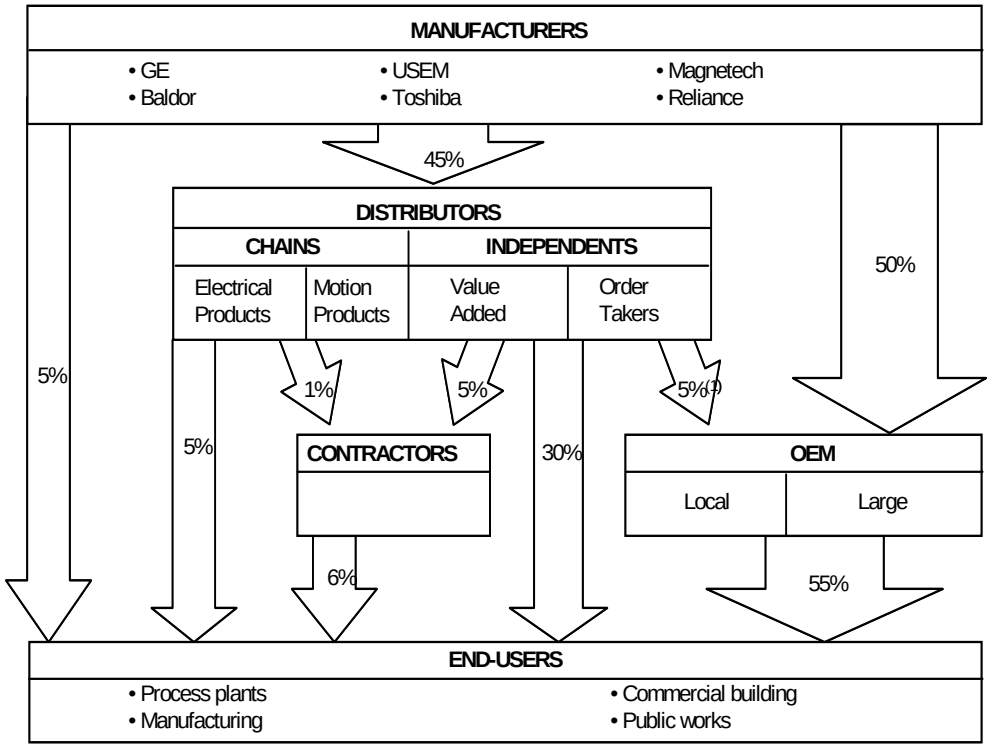
Recent work by DOE in support of the development of LED lighting products reflects a systematic approach to identifying and minimizing the kinds of potential performance problems and the lack of standards that afflicted early generations of CFLs and slowed their acceptance by retailers and consumers. The *Next Generation Lighting Initiative* contains multiple initiatives that involve manufacturers, retailers, and utilities. (McCullough et al. 2008) Among its objectives are: the identification of appropriate applications for current and envisioned LED technologies; development of test standards for light output, effective useful life, and other performance elements; recruitment of distribution and retail channels for the project; and development of retailer support and consumer education materials. DOE has budgeted over $60 million for these activities, compared to the less than $5 million that the agency invested in the support of CFL technology. This program represents an activist approach to developing an understanding of the relationship between technical performance and marketability for a new product.

Market Characterization. Sponsors and regulators in jurisdictions that have pursued market transformation programs frequently undertake market characterization studies to support the formulation of program strategies. Market characterization studies typically contain the following elements:

- **Analysis of the supply chain structure.** This analysis identifies the key groups of market actors involved in the production and delivery of the products and services in question. These groups include not only businesses directly involved (such as manufacturers,

distributors, designers, retailers, and installation contractors), but organizations that affect the design and product specifications as well (such as professional associations, code and standard setting authorities, and inspectors). The analysis should define the role of each group in product delivery, their motivations and disincentives to promote and deliver efficient products and services, the nature and extent of their influence over technology adoption decisions, and the volume and type of market transactions in which they participate. Figure 9 depicts the results of such an analysis for the industrial electric motor market. (XENERGY 2001)

Figure 9
Supply Side Structure of the Industrial Motor Market



- **Analysis of Customer Segments.** This analysis identifies the key segments of the customer population and characterizes them in regard to their propensity to adopt the technologies under review. Among residential customers, segmentation variables typically include housing type, urban/rural location, income, age, education, and other socioeconomic characteristics that may affect the adoption decision. Among commercial and industrial customers, segmentation variables typically include firm size, commercial building type, and

industry classification. Market analyses typically attempt to characterize these segments by number of households or establishments, the portion of the technology's total energy use and savings potential that they represent, motivations for adoption, and barriers faced.

Baseline development. All of the jurisdictions contacted for this study use formal market assessments to establish baseline estimates of market indicators, such as market share for energy-efficient products and services, levels of awareness, and other intermediate indicators of adoption. In many cases, these studies are combined with formal market characterizations such as those described in the previous paragraph. In many jurisdictions, these studies are updated on an annual or biannual basis in the form of Market Progress Evaluations carried out by independent contractors. In others, progress is tracked through more informal means, such as analysis of program records, contacts with supply side market actors, and reviews of market share statistics prepared by vendor organizations or other government agencies at the local, regional and national levels. We note that the California IOUs commissioned many such studies from 1998 through 2001 under the direction of the California Board for Energy Efficiency. Moreover, some of this type of work continues in support of the development and maintenance of the Database of Energy Efficiency Resources or DEER.[7]

Develop program logic models. Program logic models are graphic representations of the causal links between program activities, short-term responses to those activities among market actors, and longer-term market effects. Program sponsors routinely use logic models to array information and insights gained from market characterization and trace their implications for the design of various program components and the timing of their deployment. Figure 10 shows a logic model developed by the New York State Energy Research and Development Authority (NYSERDA) to support the design and administration of its ENERGY STAR Products Program.

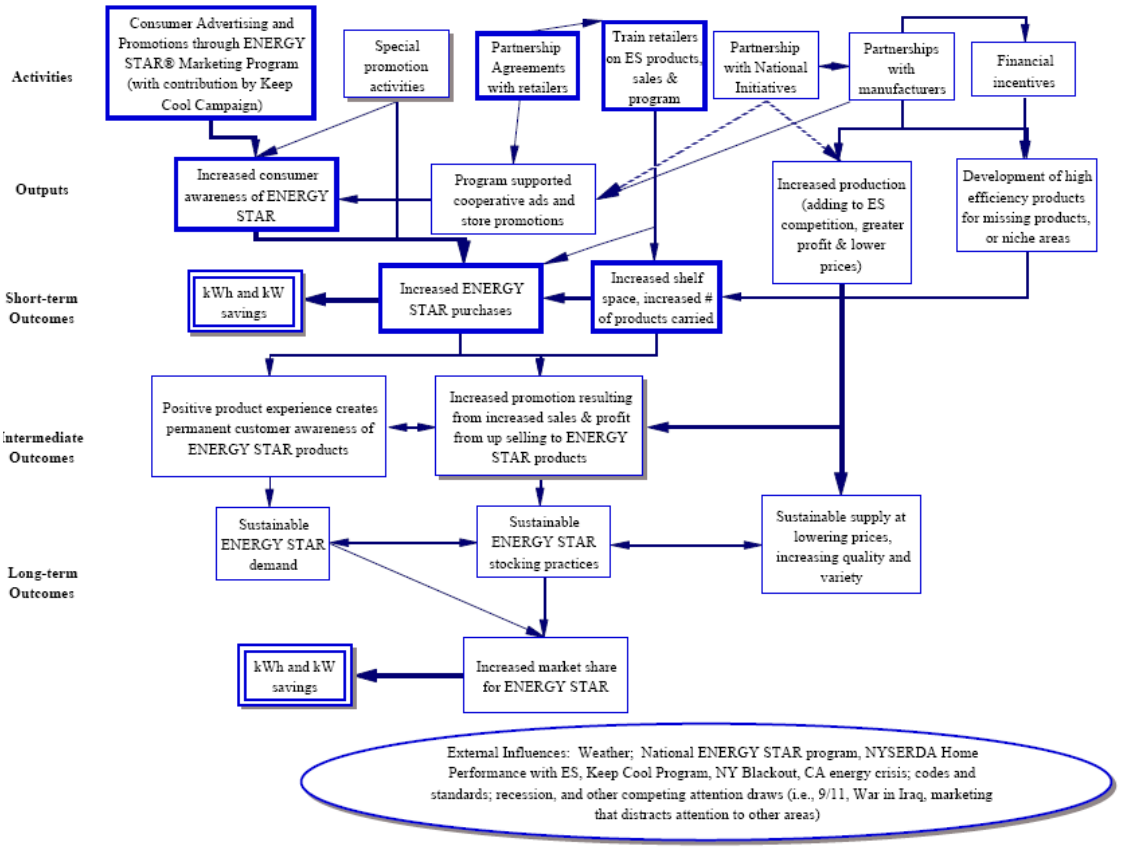
Program sponsors report using logic models in the following ways to support program planning:

- Ensure that all key groups of market actors are addressed by one or more program component.
- Ensure that key motivators and barriers for each group are addressed in the program design.

[7] Current version accessible at www.energy.ca.gov/deer.

- Formulate indicators of market change that can be used to characterize the baseline and formulate program goals and objectives in a quantitative manner.
- Identify gaps in the market data that need to be filled through program-related contacts with market actors or independent data gathering activities as the program progresses.
- Provide a framework for negotiation among sponsors and evaluators regarding the establishment of quantitative goals for participation and observed market changes.
- Identify areas of overlap and potential synergy among different programs that operate in the same market sectors. (Albert et al. 2004 & 2006)

Figure 10
Program Logic Model of Home Performance with ENERGY STAR



Regulators in Wisconsin and Massachusetts generally require that program sponsors develop and use formal logic models in developing program plans, although regulators in both states

urge flexibility in the revision of logic models to reflect program experience gained in a timely manner. Program sponsors in the Northwest and New York use program logic modeling as a matter of course in program planning. The Long Island Power Authority converts its logic models into matrices of indicators of market change that are to be achieved within various time frames ranging from 2 – 3 years from program inception through 10 years of program activity. Efficiency Vermont prepares periodic "Market Briefs" based on internal research and program staff experience to support program planning. As discussed below, some jurisdictions have used market effects indicators identified through the program logic modeling process to develop program performance metrics that are used in calculating program sponsors' compensation.

One key by-product of the logic modeling process is a list of market change indicators that will need to be developed as the program operates. As discussed in Sections 4 – 6, the availability of data on market conditions and levels of measure adoption for successive time periods before and after program launch, both within and outside the program area, greatly enhances the ability of available methods to identify and quantify program market effects. Thus, it is useful to anticipate the kinds of evaluation activity that will be useful, inventory the data needed to carry out those activities, and identify gaps that need to be filled. In many cases, useful information such as vendor stocking patterns, prices of efficient and standard measures, and unit sales can be developed through day-to-day program operations and contacts with participating vendors. Early attention to inventorying data needs can also be used to identify contingencies, such as the lack of vendor cooperation in furnishing sales data, and to prepare for efforts to generate alternative sources of measure adoption indicators. Section 4 discusses these issues in greater detail.

Convene program advisory committees. Many market transformation program sponsors, including the Alliance, the Energy Trust of Oregon, and the consortia of utilities in the Northeast convene program oversight committees that are consulted at regular intervals on program planning, operation, and evaluation issues. These committees typically include representatives of the targeted industries as well as program implementers and analysts. The committees serve as a sounding board for program design concepts, a source of timely feedback on market conditions and response to the program, as well as a source of advice on the identification of market change indicators and more general evaluation issues.

Develop and revise program designs and operating procedures. As discussed in Sections 4 – 6, comprehensive evaluations of program market effects generally involve multiple primary and secondary data collection efforts, including: literature review and in-depth interviews to

support market characterization, estimating or updating of baseline technology adoption levels, interviews or surveys with various groups of supply and demand-side market actors to assess program effects, and collection and analysis of sales or other types of market share data. These steps can take a year or more to design, execute, and analyze. In the meantime, market conditions may have changed significantly, especially as a product market approaches the "Take Off" stage identified in Figure 6.

To address the need for timely information to support program design, as well as market feedback to support changes in operating procedures, the Alliance developed the practice of commissioning annual "Market Progress Evaluation Reports" for its major market transformation initiatives. The practice has been adopted to some degree by other jurisdictions with significant market transformation portfolios. Market Progress Evaluation Reports (MPERs) differ from typical summative evaluations in that they do not attempt to present a comprehensive view of program activities and accomplishments or to make an assessment of the degree to which the program has used its resources effectively to meet its stated goals. (Rossi et al. 2004) Rather, they present the results of targeted data collection designed to render quickly the current state of the target markets. Thus, they generally contain some (but not all) of the data collection elements referenced in the paragraph above, along with updated information on program activities and participation. In addition, most contain some consistently collected information on the level of product adoptions in the market. These could include sales information or rough estimates of sales based on: (1) the review and manipulation of data from participating vendors, (2) customers, (3) secondary sources, and (4) expert judging.

Program managers at the Alliance, NYSERDA, and utilities in the Northeast that use variations of this approach have found that it yields information of sufficiently high quality and reliability to use in making adjustments to program designs and day-to-day operations.

Summative Evaluations. Most of the jurisdictions researched for this study have used data on market share and/or sales (developed, in some cases, to support program design and administration) to estimate net program effects on adoptions and net program energy savings. Examples of this approach include:

- Impact evaluation of residential CFL programs: Vermont, Wisconsin, and Massachusetts. (KEMA 2008, KEMA 2005, Glacier Consulting 2005)
- Impact evaluation of ENERGY STAR appliance programs: Vermont and Massachusetts. (KEMA 2005, Wilson-Wright et al. 2005)

- Impact evaluation of programs to promote NEMA Premium Efficiency Motors: New York (NYSERDA 2007)

- Impact evaluation of various residential and commercial programs: BC Hydro (Sulyma, 2008)

The extent to which the results of these studies were used to quantify energy savings versus goals was not clear from our conversations with local principals. A representative of BC Hydro reported that cross-sectional methods were used to estimate non-participant spillover for a number of programs and that savings associated with those adoptions were counted against program goals. Several regulators mentioned that the results were taken into account in planning for the subsequent rounds of the subject programs.

Generally, regulators and sponsors alike reported that they had confidence in estimates of the net program effects based on cross-sectional analyses only in instances where the sales data collected through consistent methods were available for program areas and non-program areas. None believed that the analysis of indicators other than sales or market share were useful in assessing net program effects.

Assessment of sustainability of market changes and formulation of exit strategies. Among the sponsors of market transformation programs, the Alliance has developed the most consistent approach for reviewing initiatives to assess sustainability and to determine whether program activities should be reduced, terminated or redirected in light of that assessment. Generally, the Alliance assesses the sustainability of market changes based on a comparison of currently observed conditions to specific barriers to market development identified in the program plan and logic model.[8]Thus, for example, the Alliance's analysis of the CFL market in the Northwest in the late 1990s identified the following market barriers:

- **Product performance issues.** CFLs were taking an unacceptably long time to reach full light output, were too large for many fixtures, and experienced high rates of failure.
- **Customer awareness.** Customer awareness of CFLs remained low in many market segments and regions.

[8] Personal communications with Northwest Energy Efficiency Alliance Staff.

- **Availability.** Several potentially important distribution channels for CFLs did not carry them, including supermarkets and smaller hardware stores.
- **Price.** Unit prices were sufficiently high to discourage even customers who were aware of the product and its benefits from purchasing it.

To address these barriers, the Alliance put in place a multi-part initiative that included the development with manufacturers of product standards that were ultimately incorporated into ENERGY STAR specifications, support of a centralized product testing program, merchandising support for retailers, and upstream product incentives. Market Progress Evaluation Reports developed in 2001 – 2005 included data collection and analysis efforts oriented specifically to monitoring the barriers identified, including: estimation of total CFL sales based on solicitation and analysis of retailer sales records, shelf surveys to assess availability and pricing, results of testing and counts of qualifying models, and customer satisfaction surveys of recent CFL purchasers. In 2006, the Alliance determined that the barriers that they had identified to broader acceptance of CFLs had been significantly reduced or eliminated and that program support for the technology was no longer needed. Utilities in the region were free to continue their own rebate programs, and some did, but the Alliance eliminated its upstream incentives and regional merchandising support.

In the case of resource-efficient clothes washers, the Alliance set out specifically to influence an impending review of federal product standards as the principal lever for increasing efficiency for that end use. The Alliance began a program of merchandising support and point-of-sale rebates in 1997, when the market share for qualifying washers was only 2 percent in the Northwest and nationwide. By 1999, market share in the Northwest had reached double digits, primarily due to positive customer response and increased levels of availability from domestic manufacturers. At that point, the Alliance felt that it could make the case for potential widespread customer acceptance to federal rulemaking authorities and withdrew from the market. Individual utilities in the Northwest continued to provide their own rebates.

The point here is that there is not single criterion or set of indices to be met in determining whether and when to reduce program support to a given market. Rather, the combination of a solid program plan and timely monitoring of current market conditions provide the basis on which to make decisions regarding exit strategies and alterations of other elements of program design and delivery.

4. Structuring Market Effects Evaluations

In this section, we present an overview of the steps required to structure and carry out a rigorous and useful evaluation of the market effects of an energy efficiency program.[9] This framework reflects the guidance provided by the *California Energy Efficiency Evaluation Protocols,* which serves as the primary reference for the evaluation of the 2006 – 2008 programs. In our presentation, we stress the links between the theory and practice of market transformation programs as discussed in Section 2 and the general approach to the evaluation of those programs presented in the *Protocols.*

We begin with a brief review of the particular evaluation challenges posed by market transformation programs. ~~This~~ Sections 5 and 6 provide more thorough information on two of the key methodological issues entailed in the evaluation of market transformation programs: (1) the definition and estimation of meaningful indicators of market effects, and (2) the assessment of the degree to which observed market effects can be attributed to the programs under evaluation (assessment of causation).

4.1 Key Challenges of Market Effects Evaluation

The following paragraphs summarize the key high-level challenges associated with the evaluations of market transformation programs, with an emphasis on the differences from the evaluations that focus more intently on RA programs.

The program cycle versus the pace of market change. In California, energy efficiency programs are planned, delivered, and evaluated in cycles of three years. As the examples in Section 2 illustrate, observable changes in markets and market transformation, in particular, can take much longer. Some kinds of programs, particularly those that promote services to be delivered by small firms, take several years to attract participants, who must then adopt the practices and deliver them to customers. ENERGY STAR Homes programs, for example, seldom produce appreciable levels of project volume and savings until their third year in

[9] Sections 3, 4, and 5 address issues related to evaluating the market effects of any type of energy efficiency program, whether or not they are designed explicitly to be market transformation programs.

operation. (Nexus Market Research 2007) In setting evaluation objectives, program managers must take into account the current stage of market development.

Program domains versus market boundaries. As the narratives of transformation in the fluorescent ballast and clothes washer markets demonstrate, the process ultimately involves all groups of actors in the supply chain: manufacturers, distributors, specifiers, installation contractors, and retailers. However, program sponsors are seldom in a position to address efforts directly to all of these groups. Observed effects among market actors in the program domain – e.g., distributors who receive rebates for selling efficient HVAC equipment – may be caused in part by product development, pricing, and promotion activities of manufacturers, who are not directly addressed by the program. In a similar vein, design firms that participate in commercial new construction or custom rebate programs often operate at a national or international scale. Their adoption of practices advanced by a given program is likely to be influenced by international standard setting bodies or by central corporate decisions in which local programs play little if any role.

Multiple programs in the market. Many public benefits charge programs address markets and market actors that are targeted simultaneously by energy efficiency programs operated by other sponsors. The ENERGY STAR labeling programs operated by the U. S. Environmental Protection Agency have played a vital role in local programs by setting standards and testing procedures, promoting the ENERGY STAR brand at a national level, and coordinating time-limited promotions such as 'Change-a-Light'.[10] On the commercial side, the National Electrical Manufacturers Association (NEMA) has played a similar role for NEMA Premium Efficiency Motors. In California, the CEC has taken the initiative to incorporate energy-efficient products and practices into building codes and appliance standards at relatively early stages of product development. Even if we were to treat the other sponsors' programs as 'exogenous' influences for evaluation purposes, it would still be difficult to separate out the effects of one program versus another when both operate simultaneously. However, in all of the above examples, the California utilities have collaborated intentionally, extensively, and over a prolonged period with the sponsors of other programs.

[10] The Change-a-Light campaign is an annual seasonal promotion of CFLs featuring national advertising support from the Environmental Protection Agency and customer incentives and retailing support from local sponsors.

As we will see, the basic approach to the evaluation of market effects advanced in the California *Protocols* and, in general, practiced elsewhere has evolved to address these challenges.

4.2 Steps in the Market Effects Evaluation Process

A market effects evaluation encompasses the following key steps:

- Defining the scope of the market effects evaluation
- Refinement of the program theory and logic model developed in program planning, including the formal definition of the program domain and market boundaries
- Characterization of the market and baseline estimation;
- Assessment of market effects
- Quantification of net adoptions attributable to the program
- Estimation of energy savings
- Sustainability assessment

Here, we necessarily describe these steps in a particular order. In practice, they are likely to proceed simultaneously or under different sets of rules entirely. It is up to the program and evaluation managers to draw these different strands of activity together into a coherent evaluation plan. Figure 11 shows the objectives and information requirements for these steps, as well as for the use of the evaluation results to shape the next "cycle" of program designs.

4.2.1 Defining the scope of the Market Effects Evaluation

Definition of the program domain and market boundaries. Market transformation efforts explicitly target markets, as opposed to the customers or supply-side market actors who participate in a program in a given time period. Thus, it is important to define clearly:

- **The program domain** – those groups of market actors that we can reasonably expect to be affected by program activities; and
- **The target market** – the entire supply chain for the products and services in question, as well as all segments of customers who purchase them.

The decisions and business activities of groups in the market that are not part of the program domain constitute a set of exogenous factors to be identified and taken into account in assessing the attribution of observed market effects to the program under evaluation.

In practice, the distinction between the program domain and the rest of the market may become blurred and even a bit controversial. For example, some local program managers have maintained that their support of energy-efficient equipment over a number of years induced manufacturers to increase production, which in turn led to reduced unit production costs and prices. Perhaps, in response to these developments, end users in other geographic areas increased their pace of adoption, causing a spillover of program effects. If this hypothesis is true, then the cross-sectional comparisons of market share between program and non-program areas will tend to understate program effects. It is difficult to demonstrate such a detailed narrative empirically, thus, decisions regarding the appropriate program domain are often resolved through negotiation among various stakeholders in the development of the evaluation plan, or later in the attribution phase.

4.2.2 Refinement of Program Theory/Logic Models

Overview. As discussed in Section 3, most program sponsors with significant market transformation portfolios use program theory/logic models to support the design and administration of their offerings. One of the key early steps in the evaluation of market transformation programs is to refine the theory/logic model in light of program experience accumulated to that point. The model can then be used to guide the development of research questions and definitions of market change indicators.

The process of market transformation involves many groups of market actors distributed over broad geographic areas and unfolds over a long period of time. In contrast, the established modes of social science and economic analysis of program effects generally focus on exploring the association between program activities on the one hand and a limited number of indicators of changes in the target populations on the other. Moreover, with some exceptions, the evaluations are limited to analyzing events of the relatively recent past. To manage this mismatch between the phenomena of interest and the capabilities of available analytical methods, market effects

Figure 11
Steps in Market Transformation Program Evaluation

Type of Study/ Information Source	Technology Assessment	Market Characterization	Program Advisory Committees	Market Progress Assessments	Summative Evaluations
EVALUATION					
Refine Program Theory/ Logic Model Identify program domain & market boundaries Specify hypothesized causal links Specify indicators of market change Specify hypotheses concerning timing of market changes	⦿ Product performance & risks Efficiency standards Product costs Future efficiency trends	⦿ Market size Market segmentation Supply chain structure Motivations/Barriers for acceptance Baseline indicators: levels	○ Market segmentation Supply chain structure Motivations/Barriers for acceptance Baseline indicators: identification	⦿ Market segmentation Supply chain structure Motivations/Barriers for acceptance Baseline indicators: changes over time	⦿ Market segmentation Supply chain structure Estimate of changes attributable to program
Market Characterization and Baseline Estimation		⦿ Market size Market segmentation Supply chain structure Motivations/Barriers for acceptance Baseline indicators: levels	○ Market segmentation Supply chain structure Motivations/Barriers for acceptance Baseline indicators: identification	⦿ Market segmentation Supply chain structure Motivations/Barriers for acceptance Baseline indicators: changes over time	
Define Scope of the Market Effects Evaluation Identify stage of product cycle and program development Identify appropriate evaluation objectives.	⦿ Product performance & risks Unit energy savings Product costs	⦿ Market segmentation Supply chain structure Motivations/Barriers for acceptance Baseline indicators: levels	⦿ Market segmentation Supply chain structure Motivations/Barriers for acceptance Baseline indicators: identification	⦿ Market segmentation Supply chain structure Motivations/Barriers for acceptance Baseline indicators: changes over time	
Apply Evaluation Results to Revision of Program Plans Assess movement of market change indicators, market share. Assess extent to which barriers identified in the logic model have been diminished. Determine whether program should continue Identify appropriate changes in program components	○ Presence of efficiency standards & test procedures Product costs Future efficiency trends			⦿ Market segmentation Supply chain structure Motivations/Barriers for acceptance Baseline indicators: changes over time	⦿ Market segmentation Supply chain structure Estimate of changes attributable to program Assessment of sustainability

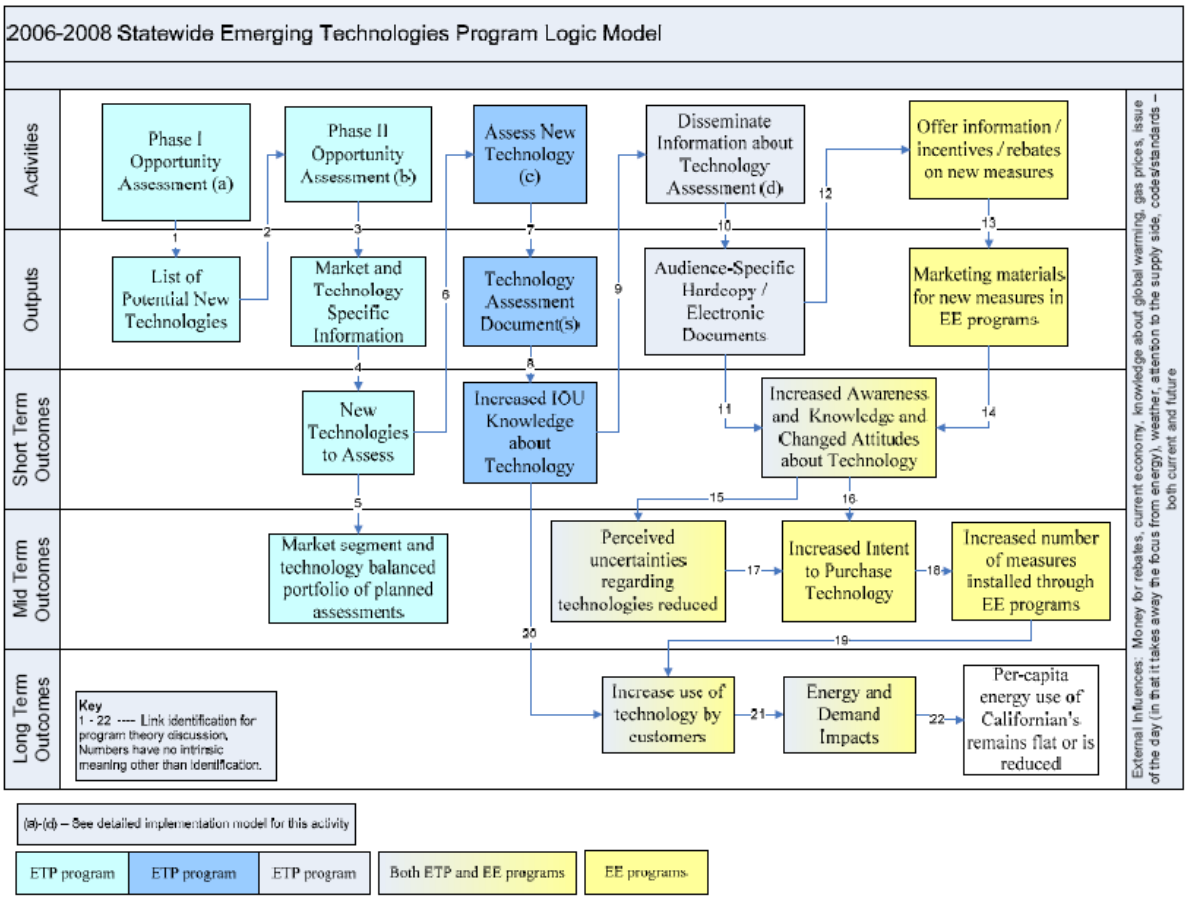
⦿ = High Importance

evaluators have relied heavily on the techniques of Program Theory Evaluation (PTE), particularly to structure the assessment of causal links between the program and observed market changes.

Researchers working in a variety of fields have developed the theory and practice of PTE over a period of fifty years. Writing in 1967 on the evaluation of social action programs, E. A. Suchman laid out the basic approach: "The evaluation study tests some hypothesis that activity A will attain objective B because it is able to influence process C which affects the occurrence of this objective. An understanding of all three factors – program, objective, and intervening process – is essential to the conduct of evaluative research." (Suchman 1967) In their widely referenced 1997 article, Feldman and Herman advocate the use of this approach in assessing the market effects of an energy efficiency program, using the homey analogy of "telling a story." (Herman et al. 1997)

There are many ways to structure logic models. Among the most common is a two dimensional matrix. One dimension represents the distinctions between program activities, intervening processes, and outcomes (or objectives in the above formulation). The other represents the passage of time. Boxes arrayed in the matrix represent activities of various market actors, and lines or arrows are used to represent hypothesized causal relationships. Figure 12 shows a logic model developed for the evaluation plan for California's 2006 – 2008 Emerging Technologies program. In this case, the movement from the Emerging Technologies Program (ETP) to Energy Efficiency (EE) programs corresponds roughly to the passage of time as technologies demonstrated in the former begin to receive promotional support from the latter. Many if not all of the numbered arrows can be formulated as hypotheses that are capable of being tested using analytic methods discussed in Section 6.

Figure 12
Example of a Program Theory/Logic Model



Energy efficiency program evaluators have most often used program theory/logic for the following purposes:

- Identify the stage that the program has reached in its planned long-term trajectory of activities and effects.
- Develop and operationalize appropriate indicators and operational definitions.
- Identify and formulate testable hypotheses that are appropriate for the stage that the program has reached.
- Identify data that needs to be gathered early in the program, such as current price levels, to support later, more summative analyses.

- Where methods involving quantitative comparisons across areas with and without energy efficiency programs or between periods before and after program implementation, pursue other types of methods to demonstrate causality, e.g., demonstration of the achievement of short-term outcomes, changes in intermediate processes, and elimination of other possible explanations of observed outcomes. Evidence of these kinds of changes are sometimes referred to as "proximate indicators" of market effects. (Rogers et al. 2000)

4.2.3 Characterization of the Market and Baseline Estimation

Market characterization and baseline measurement provide important inputs to both program design and evaluation. The *California Protocols* define market characterization as a "qualitative assessment of the structure and functioning of a market". (TecMarket Works 2006) ***Market characterizations*** typically encompass the following kinds of information and analysis:

- **Structure of the supply chain.** Membership and functions in the supply chain of key groups of market actors including manufacturers, distributors, specifiers, installers and retailers, regulators and professional associations. Additional elements of market structure include the number of firms and the level of concentration in the various groups, the percentage of total supply chain revenues and the direct customer sales accounted for by those groups.

- **Dynamics of the supply chain.** Motivations and barriers to the development and promotion of efficient products and services based on competitive position and/or government mandates.

- **Structure of the customer market.** Identification and size of the key customer segments, and the percentage of total market revenues accounted for by those segments.

- **Dynamics of the customer market.** Motivation and barriers to the adoption of efficient products and services based on needs, resource constraints, and established purchasing practices within the major customer segments.

- **Product attributes.** Performance and price characteristics of products and services currently in the market and of products and services in various stages of development. Trends in price and performance over time.

If a market characterization has been completed within the past 3 years, it may not need to be redone, depending on the sponsors' judgments regarding recent changes in the market and their potential influence on program effects.

Baseline estimation refers to the quantitative estimation of various indicators of the level of market acceptance of the products and services promoted by the program under evaluation. These indicators include market share (the percent of total product or service sales accounted for by energy-efficient versions), saturation (the percent of the installed base of the technology accounted for by the efficient technology), indicators of availability such as the number of efficient models found on retailer sales floors, and indicators of awareness, such as the percentage of potential customers or suppliers who report various levels of knowledge of the product. These indicators are generally estimated through relatively large sample surveys or through the inspection of sales data in the relatively few markets for which they are available. See Section 4 for more detail on indicators of market conditions.

If the ultimate objective of the evaluation is to estimate net product or service adoptions attributable to the program, then an estimate of sales or market share for a period close to program launch is required. Similarly, if the objective is to register changes in intermediate processes, such as stocking of efficient products or promotion of efficient designs by installation contractors, evaluators must develop indicators of these conditions as they were at the time of program inception. In fact, it is best to have data on these indicators from pre-program periods in order to identify the kind of baseline trends discussed above.

The term "baseline" as it is generally used in energy efficiency program planning and evaluation denotes both the level of the selected indicator at the time a program is evaluated and the trend that indicator would take over time in the absence of program interventions. For example, the effect of program efforts on codes and standards that identify "efficient" construction practices and products are a potential subject for evaluation of market effects, along with trends in market share and saturation.

The market share of the equipment or practices promoted by a program is the single most useful piece of information for program planning and evaluation. If such information is available in a consistently measured fashion, for past periods and for geographic areas in addition to the program's domain, so much the better. Market share data series provide program planners with significant clues concerning the current state of the market in their program domain and about

the appropriate program designs to promote the products and services in question. For evaluators, market share data, whether developed expressly for the evaluation at hand or by others, is a prerequisite for estimation of net program effects on adoption.

Development of baseline market share or other key indicators, such as the price of standard and efficient equipment, is difficult and expensive. Program sponsors must either conduct relatively large sample surveys of end users and suppliers or negotiate with suppliers for the release of highly sensitive sales data. For consumer products, sales data are more reliable than other sources of data because end users are seldom able to report accurately on the quantity, timing, and efficiency level of their purchases. The expense and elapsed time required to develop such data often do not fit into the budget and schedule of a single evaluation study. The California utilities have attempted to address the need for baseline data through projects that collect data on the adoption of efficient technologies over time. These technologies include residential lighting and commercial sector products. (Itron 2007) While these projects have provided useful data, attrition of reporting suppliers over time has led to gaps in the record and difficulties in interpretation.

Two baseline series stand out in terms of longevity and consistency over time. These are the ENERGY STAR appliance market share statistics, compiled annually at the state level by the U.S. Department of Energy, and the National Renewable Energy Laboratory's *Annual Report on U. S. Wind Power Installation, Cost, and Performance Trends.* (NREL 2008) The ENERGY STAR appliance series has some limitations based on its source: only large retailers who are enrolled as ENERGY STAR partners are obliged to report sales of qualifying and non-qualifying equipment. Independent retailers are not included, and membership in the partners group has changed over time. Nevertheless, this series has provided the basis for sophisticated analyses of market effects and the management of programs targeting the products involved. (www.energystar.gov 2008) The NREL report is remarkable not only for its consistency and longevity but for the range of market condition indicators. These indicators include the number of wind power installations, the share of power that wind provides, unit costs of installations, unit costs of energy sold, manufacturers' market share, as well as regional and international comparisons of many of these indicators. Taken together, the wind data provide excellent support for the analysis of market effects of renewable energy programs and policies, such as state-level Renewable Portfolio Standards that attempt to accelerate the development of local wind projects.

4.2.4 Assessment of Market Effects.

The assessment of a program's market effects entails two tasks. The first is the quantification of the change in the indicators of market conditions: market share, prevalence of intermediate practices, changes in price, and so forth. The second is the demonstration of causal links between program activities and observed changes in the indicators of market conditions. The four principal approaches to the assessment of market effects are discussed in detail in Section 6.

Quantification of net adoptions attributable to the program. The quantification of the net adoptions of energy efficiency measures attributable to the program is a special case of the estimation of market effects. It is a necessary step if the ultimate objective of the evaluation is to estimate net energy savings attributable to the program. In order to carry out this quantification, the following kinds of information are required:

- ***Estimate of total market size.*** Most approaches to quantifying program effects on adoption yield results in terms of changes induced in the percentage of market share(s). These results must be translated into units sold or installed in order to support estimates of energy savings. Estimates of total market size are required for that step. Moreover, estimates of total market size serve as a sanity check for the results of approaches that do not rely on population variables, such as estimation of free ridership and spillover among program participants. ~~For example, xxxx.~~

- ***Estimates of baseline market share.*** In cross-sectional approaches, the current market share in non-program areas serves as the estimate of a baseline. In historical or time-series approaches, the market share around the time of program inception must be estimated.

- ***Estimates of current market share.*** These estimates may be developed from any source that takes the entire population of interest into account: surveys of end-users, surveys of suppliers, and collection of sales data. Analysts must exercise care in using sales data and survey data from suppliers, so that the information pertaining to program and non-program areas are clearly identified and defined. This can be difficult for certain kinds of goods and services such as commercial lighting, commercial HVAC, and industrial motors. In these cases, establishments at the lowest level of the supply chain serve large geographic areas, which include customers who are not served by the program under review.

Estimate of energy savings. In market effects evaluations, energy savings are generally calculated by applying unit energy savings figures to the estimate of net adoptions developed in the previous step. The unit energy savings figures often come from the impact evaluations of resource acquisition programs, but can be developed using engineering-based calculations or taken from deemed savings databases. See Section 4 for details on this process.

Sustainability assessment. Recently, program sponsors have begun to request formal assessments of the sustainability of observed market effects as part of market-oriented program evaluations (Any references?). These assessments are necessarily prospective. They involve compilation and interpretation of information on the various indicators of sustainability mentioned in the discussion of this topic in Sections 2 and 3.

5. Measurement: Indicators of Market Effects

This section examines how evaluators have measured market effects. At one level, this involves defining each individual market effect in such a way that it can be measured. The end goal of market transformation is sustainable energy savings, but savings occurring through a change in the structure of the market. The individual market effect—and its indicators—take on meaning only in relation to other market effects and their indicators as expressed in program theory; as Herman et al. (1997) put it, "first you need a story." Part of the "story" is how program activities are linked to expected effects; if the case is not made effectively, then observed changes, no matter how well they are measured, cannot be claimed as market effects.

5.1 Types of Indicators

Common categories of market effect indicators include awareness/knowledge, attitudes/beliefs, availability, incremental cost or price changes, market share/sales, saturation/prevalence of practices, and changes in codes and standards. Some of these, such as awareness/knowledge and availability, are more *proximate* indicators, with typical program theory postulating that they must increase as a necessary precondition for increases in *ultimate* market effect indicators, e.g., indicators of changes in the patterns of adoption, such as market share and saturation. The following are some examples of how common indicator types have been used in evaluations.

5.1.1 Proximate Indicators of Market Effects

- **Awareness and Knowledge** The Consortium for Energy Efficiency (CEE) conducts an annual national consumer survey determining whether respondents recognize the ENERGY STAR label without prompting ("unaided recognition") or with prompting ("aided recognition"). The study assesses the effect of program activity by comparing recognition in "High Publicity," "Low Publicity," and "Other" areas. (EPA Office of Air and Radiation 2008)
  - A goal of the Northwest Energy Efficiency Alliance's ENERGY STAR Consumer Products Lighting Project has been to "increase consumer awareness of CFLs as measured by the rate of consumer awareness and purchase." By 2007, 90% of consumers in the Northwest were aware of CFLs and 67% had purchased them. (KEMA 2008)
  - A progress indicator of the Northwest Energy Efficiency Alliance's ENERGY STAR Homes Northwest Program is builders and their subcontractors having the expanded

knowledge and skills necessary to treat key energy efficiency and quality issues, particularly the performance testing of HVAC ducts and equipment. (EcoNorthwest 2008)

- **Attitudes/Beliefs**
  - As part of the evaluation of the California IOU's Standard Performance Contract Program, which provided incentives to commercial building owners to undertake large-scale retrofit projects managed by themselves or by third-party contractors, analysts tracked facility owners' assessment of the credibility of energy efficiency information provided by different types of firms over a period of five years. The study found that the credibility of energy performance contractors declined considerably over the period 1999 to 2005. (Itron 2008)
  - The CEE's annual national consumer survey elicits consumers' attitudes towards ENERGY STAR, including their likelihood to recommend ENERGY STAR products to a friend, and whether they agreed that buying ENERGY STAR products makes them feel like they are protecting the environment. (Consortium for Energy Efficiency 2008)
- **Availability**
  - The sponsors of the Massachusetts ENERGY STAR Appliance Program tracked the proportion of models available in retail stores that are labeled ENERGY STAR. Methods have included sales floor inventories and checking their availability at individual stores through the websites of major retailers. (Nexus Market Research et al. 2004, Mauldin et al. 2007)
  - NYSERDA tracks whether commercial and industrial end users and trade allies perceive an increase in the availability of energy efficiency measures. (NYSERDA 2006)
- **Trade Ally Promotional Effort**
  - In assessing the market effects of the IOU's residential new construction programs, the CPUC is measuring the extent to which builders market energy efficiency as a feature of their homes. (RLW Analytics et al. 2008)
  - NYSERDA tracks the extent to which participating and nonparticipating energy service companies have increased their marketing of energy-efficient measures to commercial and industrial end users. (NYSERDA 2008)

- **Incremental Cost**
  - The sponsors of the Massachusetts ENERGY STAR Lighting Program have estimated the incremental costs of CFLs compared to incandescent bulbs using regression analysis, with price as the dependent variable and bulb features such as lumens, number per package, store type, and brand as independent variables. The analysis found a difference of $4.39 for a 25-Watt CFL compared to a 100-Watt incandescent in 2005, and a difference of $2.80 in 2007. (Nexus Market Research et al. 2007)
  - With respect to wind and solar power technologies, the European Union funded a study going beyond simple tracking of incremental costs by developing "progress ratios," which reflect the "experience curve" of an industry by calculating a ratio of cost reductions to increases in productive capacity. A progress ratio of 0.9, for example, means the industry experiences a cost reduction of 10% for each doubling of cumulative capacity; a ratio of 0.8 reflects a 20% reduction. While included here under "incremental costs," this is an example of the interrelatedness of multiple indicators. Progress ratios underline the fact that cost reductions are driven by technological development and increasing sales. (Lako 2002)
  - The Database of Energy Efficiency Resources (DEER) developed and maintained by the California Energy Commission has compiled information on total and incremental costs for energy-efficiency measures since 1996. The methods used to define standard and efficient technology specifications and to collect and process pricing data are fairly rigorous. We are not aware, however, of any extensive use of data series based on DEER for analysis of market effects.

5.1.2 Ultimate Indicators of Market Effects

- **Market Share and Sales**
  - Market share and other indicators developed from data on the current purchases or sales of the technologies addressed by energy efficiency programs are the most direct indicators of market effects. See Section 4.2 for a detailed discussion of these kinds of indicators.
- **Saturation and Prevalence of Practices**
  - The saturation of CFLs, an indicator tracked by a number of program sponsors including those in the Northwest and Massachusetts, reflects the combined effects of cumulative sales/market share, removal, and storage of CFLs. (Nexus Market Research 2008)

- The Wisconsin Focus on Energy program has asked managers of pulp and paper mills the extent to which they adhere to a set of industry best practices in energy efficiency. (Agnew et al. 2006)
- The Massachusetts sponsors of the ENERGY STAR Labeled Homes Program regularly ask builders about their building practices that affect efficiency, including framing, insulation, windows, and HVAC. Periodically, they also conduct a study involving onsite visits to new homes in order to establish a baseline of current practices. (Nexus Market Research 2007)

- **Changes in Codes and Standards**
  - The four IOUs in California have coordinated programs to support upgrades of California's Title 20 Appliance Efficiency Standards and Title 24 Building Energy Efficiency Standards. The evaluation involves estimation of: Naturally Occurring Market Adoption (NOMAD)—the market penetration of the efficient appliance or measure if standards had not been adopted; degree of compliance with the code or standard (through on-site visits); and expert judgment on the influence of the programs on the code and standard changes. (RLW Analytics et al. 2007)

5.2 Concepts and Measures of Market Share

As mentioned earlier, market share is an ultimate indicator of market effects in contrast to more proximate indicators such as awareness and availability. An increase in awareness by itself, however important in the long term, cannot be directly translated into energy savings.

Some potential sources of market share, sales, and shipment data include the following:

- **End Users:** It is possible to use telephone surveys to estimate whether end users have purchased energy-efficient products and less efficient alternatives, as well as how many they have purchased. However, the approach is fraught with reliability issues arising from faulty recall, and validity issues arising from the lack of knowledge about what constitutes an energy-efficient measure. Reliability issues can be mitigated by asking respondents about relatively short purchase periods (e.g., the past three months rather than the past year), and validity issues can be mitigated by asking respondents for model numbers (Nexus Market Research et al. 2003) or by following up with on-site visits to verify purchases. (The Cadmus Group et al. 2008) It is also possible to estimate market shares through on-site visits at a random sample of homes or buildings, although the costs required to achieve sufficient sample sizes can be cost prohibitive.

- **Distributors and Contractors:** The Energy Center of Wisconsin has been collecting and analyzing distributor and contractor sales data to track the market share of energy-efficient furnaces for many years. (Energy Center of Wisconsin 1997) The representativeness of such an approach is reduced if some of the major players are not included—and indeed, one of the major distributors does not provide data for the Wisconsin study.

  For many types of goods and services, particularly commodities such as efficient lighting fixtures and motors, self-reports of shares of sales by distributors and contractors constitute relatively accurate and useful sources of market share data, especially if sales data are not available. However, analysts face many challenges in converting these data into market share indicators. First, distributors and contractors generally cannot provide data on unit sales of efficient versus standard models in the context of a survey (i.e., sales are not collected or reported in this manner). This would require compilation and analysis of sales data for which few are equipped and fewer have time. Second, distributors and contractors are extremely heterogeneous in terms of sales volume for a given technology. Thus, the average percentage of unit sales that are efficient for a sample of vendors, even if it is stratified by the number of employees or other measures of size, cannot be expected to yield a good estimate of market share. To address these problems, analysts can use ratio estimators of market share that take into account the unit sales of sample vendors.

  In a recent application of this approach, analysts estimated the market share of efficient fluorescent fixtures used in commercial and industrial high-bay lighting applications in Wisconsin and Illinois. To do this, a sample of electrical contractors in each state was asked to:

  - Estimate the number of projects that they had done in the past year in which they installed high-bay lighting.
  - Estimate the percentage of those jobs for which they had recommended efficient fluorescent fixtures (as opposed to high intensity discharge lighting technologies).
  - Estimate the percentage of relevant projects in which they actually had installed efficient fluorescent fixtures.

  To estimate market share using the results of this question sequence, the analysts calculated the ratio of the number of projects using the efficient fluorescent fixtures to the total number of projects that included installation of high bay lighting. This ratio can then be expanded to the population of contractors using simple or stratified random sampling and sample expansion procedures. (KEMA 2009)

Analyzed in this fashion, the results of vendor surveys can be compared directly to sales data generated from other sources, such as customer surveys or manufacturers' shipments for sanity checks. For example, a number of recent studies have compared builder reports of construction and sales practices in regard to energy efficiency and ENERGY STAR homes to the results of home buyer surveys that cover the same topic. One consistent finding from this approach is that builders believe that they vigorously market energy-efficient features while home buyers perceive such efforts as infrequent and unfocused. (KEMA 2009b)

The ratio estimation approach can also be used to generate market shares for proximate indicators, such as vendor familiarity with efficient technologies or adoption of marketing practices. For these types of variables, results of the ratio analysis are typically expressed, for example, as follows: "Vendors representing 34 percent of fixture sales report using lighting layout software to identify efficient designs."

- **Retailer-provided sales data:** Program sponsors in Massachusetts estimate CFL sales and market share through intensive model counts and shelf space measurement in samples of retail stores, coupled with interviews of store managers. Wisconsin's Focus on Energy program collects and compares CFL sales data from selected chain stores in Wisconsin and their counterparts in Michigan. (Glacier Consulting 2008, Nexus Market Research et al. 2009) Both approaches are subject to non-response bias if some stores refuse to cooperate. DOE provides state-by-state market share data on ENERGY STAR appliances sold at major national retailers. One issue with this approach is that independent stores are not represented—in fact, not all national chains are represented. Another issue is that only market share percentages, not number of units, are reported. This may complicate some kinds of analysis – e.g., the analysis of energy savings.
- **Point-of-Sales Data:** AC Nielsen and Vista provide point-of-sales data from various store types throughout the U.S., and Itron has been using the data to track market share and sales of CFLs in California compared to the rest of the U.S. An issue with these data has been the absence of major retailer segments.
- **Manufacturers:** Manufacturers have data on distribution, not sales, so the data may not represent where products are sold; distributors and dealers often sell to contractors, end-users, or retailers in different states. This is less of a problem in a large state like California where the population centers are relatively far from state borders; it is much more of a problem for the smaller states in the Northeast where many population centers are near state borders, because manufacturers may establish regional distribution centers to serve multiple states. Certain products with more local and more numerous distributors—such as motors—may be less susceptible to the border-crossing phenomenon than those with

broader regional distribution—such as appliances. A bigger issue is having to deal with multiple decision makers and the risk of having incomplete data if major manufacturers refuse to cooperate.

- **Manufacturer trade associations**: Manufacturer trade associations, like the manufacturers they represent, can only provide distribution data, not sales data, so their data may not reflect where products are sold. The approach has the advantage of dealing with one set of decision makers. However, obtaining positive decisions from manufacturer trade groups has proven very difficult in the past. CEE negotiated with the National Electrical Manufacturer Association (NEMA) to provide state-by-state market share data for NEMA-Premium motors; in the end the data they provided was counts for NEMA-Premium motors, not for non-NEMA-Premium—in other words, the numerator, not the dominator, such that market share could not be calculated. Nonetheless, Wisconsin's Focus on Energy program was nonetheless able to use the data by comparing growth in sales in NEMA-Premium motors in Wisconsin and the U.S. as a whole (PA Consulting 2006). Numerous program sponsors have been hopeful of getting air conditioner market share data from the Air Conditioning and Refrigeration Institute (ARI) and gas furnace market share data from the Gas Appliance Manufacturers Association (GAMA)—but as of yet without success.

5.3 Measures of Energy Savings

As discussed above, market effects evaluations generally use unit energy consumption or savings data from impact evaluations and other sources to generate energy savings calculations from estimates of measure adoptions attributable to the program. The following are some examples of this practice.

- **Energy savings from refrigerator promotions.** In one of the earliest examples of market-based evaluations, refrigerator sales data were obtained from participating retailers to estimate the energy savings from a program to promote energy-efficient refrigerators. The analysts obtained records of the size, features, and energy efficiency rating of all units sold by the participating retailers. Based on these data, they estimated the annual energy consumption of the units sold. They then substituted the average efficiency of units sold nationwide by size and feature categories, as calculated from data available at the time from the Association of Home Appliance Manufacturers. The difference between the two sets of fleet energy consumption estimates was interpreted as the net savings attributable to the program. (van Liere et al. 1993)

- **Energy savings from technical training on compressed air system management.** In an evaluation of DOE's Compressed Air Challenge program, analysts used a survey to identify industrial customers who reported making capital and operating improvements to their compressed air systems based on insights and recommended practices learned in the training sessions offered by the program. Using details provided by survey respondents about the capacity, components, end-uses, and operating schedule of the compressed air system, as well as self-reports of capital projects and operating procedures adopted, the analysts developed estimates of energy savings for each respondent. (XENERGY 2001b)

5.4 Practical Approaches to Assuring Reliability, Validity, and Accuracy

Reliability means the degree of consistency of measurement, while validity in the most general sense means the extent to which a method measures what it is intended to measure,[11] and accuracy is the closeness of a measured value to its true value. Issues of accuracy, reliability, and validity pertain to all kinds of social science research. They are of particular concern in research to characterize a program's market effects for a number of reasons. First, with the exception of sales and market share data, indicators of market changes are not based on some broadly shared concept of market effects. Rather, they are usually defined in relation to program theory and logic models, and it is up to the analyst to demonstrate the relationship between the definition and the model. Second, the data used are seldom ideal in terms of sample frame, measurement methods, and time frame in relationship to program activities. Proper interpretation of results requires that the analyst make clear the deviations from the preferred data collection practices. Finally, many analyses of market effects require the use of data from multiple sources which were not originally developed for the particular analysis in

[11] The research literature is replete with discussions of specific types of validity, including internal validity (evidence that the causal variable in fact caused the effect variable within a given study), statistical conclusion validity (the extent to which the measured effect generalizes to the population from which the sample was drawn), construct validity (whether the operationalization of a construct represents what is intended by the theory), external validity (the extent to which the results may be generalized beyond the studied population), content validity (the extent to which a test includes all important elements of a concept), convergent validity (the degree to which a measure correlates with other measures as predicted by theory), and more.

question. Again, proper interpretation requires identification of such instances as well as an honest assessment of their potential effects on the outcomes of the study. In the following paragraphs, we provide some examples of methods that researchers have used to address issues of accuracy, reliability, and validity as they arise in assessments of market effects.

Accuracy. Typically, analysts of market effects must select the best method from a number of imperfect options for developing indicators of market share. It is difficult, for example, for customers to provide accurate characterizations of the efficiency of largely hidden types of equipment, such as central air conditioning, much less the practices used in their installation. (KEMA 2009) Potential approaches for improving accuracy in these cases include the following:

- **Triangulation:** This involves using more than one method to develop estimates of the same indicator, thus helping to establish the validity of the findings. As an example, the sponsors of the Massachusetts ENERGY STAR Lighting Program have developed estimates of CFL sales through both retailer surveys and consumer surveys. (Nexus Market Research et al. 2009)

- **Calibration of one data set with another:** Sometimes an estimate of an indicator can be validated, and if necessary adjusted, against a known quantity. The sponsors of the Massachusetts ENERGY STAR Lighting Program, as mentioned previously, used retailer surveys to estimate CFL sales. These sales included program-promoted CFLs, for which the sponsors had store-by-store sales figures; they calibrated the non-program sales (unknown value) by the program sales (known value) whenever possible. (EcoNorthwest 2004)

- **Asking questions that respondents are likely to be able to answer:** Evaluators sometimes ask for information that respondents are unable to provide. If there is any question about the respondents' ability to provide an accurate answer, the researchers should assess the likelihood of error. For example, the Massachusetts program sponsors asked householders whether they had purchased new refrigerators and if so whether they were ENERGY STAR labeled, and also asked them to provide model numbers; many people were mistaken about whether or not their new refrigerators were ENERGY STAR, in both directions. Sometimes, respondent recall, not knowledge, is the issue. At this point, in states with active programs, most respondents recognize CFLs. However, asking them how many they have purchased in the past year may be too much to expect. As a result, New England sponsors recently asked respondents about CFL purchases in the previous three months, a shorter time period for recall.

- **Validating self-reports with on-site verification:** Related to the above study, after asking householders how many program-supported CFLs (based on price and store name) they had purchased in the past three months, the New England sponsors visited a sample of those homes and found 91% of the *number* of CFLs that they had expected to find based on survey responses, which suggested that self-reports of CFL purchases may be becoming more accurate as customers become more familiar with the product.

Absence of bias. The key consideration in assessing the potential bias of the measurement method is whether the full population of relevant suppliers or customers is available to be sampled. For example, membership lists for professional organizations may provide good sample frames for designers who are active in their professions and likely interested in energy efficiency. However, to characterize the market as a whole, such a sample would need to be supplemented by more comprehensive listings, such as Dun & Bradstreet.[12] However, for some industries and professions, general directories such as Dun & Bradstreet may not provide a comprehensive list. For example, researchers analyzing the effects of Pacific Gas & Electric's Energy Center programs on local design practices identified many more small local design firms through searches of professional association directories than appeared in the Dun & Bradstreet databases. (TecMRKT Works 1998) The point here is that researchers must exercise due diligence in assessing the coverage and accuracy of sample frame sources and may have to do considerable work to assemble sample frames that are appropriate for their study.

Replicability. Many evaluation designs rely on comparison of the prevalence of awareness or practices between a baseline period and a post-program period using the results of market actor surveys. This type of comparison requires replicability of the original research design, so that the results of the baseline and post-program studies can be directly compared. This, in turn, requires consistently-developed sample frames. Sample frames developed by large, stable

[12] Dun & Bradstreet (D&B) collect data from business establishments as part of their credit rating business and publishes these data in a number of different database products. D&B data are a standard source of sample frame information for business establishment surveys, however, there are some limitations on their use. Data on small establishments (those with 10 or fewer employees) are often missing or inaccurate in terms of employment, an important stratification variable. This is especially true in the construction trades which scale up and down rapidly as demand requires. Branches of larger firms also pose problems as to characterization and inclusion. Finally, the match of establishments to energy-using facilities and energy decision makers is not one-to-one.

commercial listing organizations such as Dun & Bradstreet best meet this criterion for commercial customers. For residential customers, random digit dialing is likely the best approach because it will capture unlisted numbers.

Comparability to other areas. Cross-sectional analysis is a powerful tool for assessing program effects. Data resources such as DOE's state-level ENERGY STAR appliance market share series, the national ENERGY STAR consumer survey, and the National Electrical Manufacturers Association state-level series on NEMA Premium Motor shipments are extremely valuable, but rare.

Adequate sample sizes: Many evaluation sponsors have standards for sample sizes to achieve a given level of precision (related to reliability), such as +/- 10% at a 90% confidence level. Sometimes, the sample of interest is only part of the larger sample, so it is important to make sure that these subgroups have adequate sample sizes.

High response rates: If survey nonrespondents differ from respondents in a systematic way, the survey suffers from nonresponse bias. Unfortunately, because nonrespondents have not been interviewed, there is no way to know if this is the case. The only good way to mitigate the potential problem is to achieve high response rates, so that even if nonrespondents differ from respondents, their numbers are too small to make a major difference in the overall results.

6. Assessing Program Attribution

6.1 Overview of Available Methods

In this section, we review the methodological approaches that are available for assessing the causal links between program activities and observed market changes. The four major approaches that are available are:

- **Analysis of self-reported free ridership, participant spillover, and non-participant spillover among market actors in the program domain.** This approach relies on local market actors' own descriptions of the influence of the program on purchase (end users) or promotional (suppliers) decisions to characterize the extent of the program's effect. These data are gathered through surveys of program participants and nonparticipants. Adoptions within the program *less* free ridership *plus* participant spillover *plus* non-participant spillover capture much of the net effect of the program on adoptions, but, as discussed below, not all of it.

- **Cross-sectional comparisons of market conditions in the program domain to those in comparison areas.** This approach uses comparisons of market share of the targeted technologies or other indicators of adoption among groups of market actors not addressed by the program as a baseline for estimating the net effects of the program on adoptions in the program area.

- **Structured expert judging.** Structured expert judgment studies assemble panels of individuals with close working knowledge of the technology, infrastructure systems, markets, and political environments addressed by a given energy efficiency measure to estimate baseline market share and, in some cases, forecast market share with and without the program in place. Structured expert judgment processes employ a variety of specific techniques to ensure that the participating experts specify and take into account key known facts about the program, the technologies supported, and the development of other influence factors over time. The Delphi process is the most widely known method of this family of methods.

- **Historical Tracing: Case Study Method.** This method involves the careful reconstruction of events leading to the outcome of interest, for example, the launch of a product or the passage of legislation, to develop a 'weight of evidence' conclusion regarding the specific influence or role of the program in question on the outcome. Historical tracing relies on

logical devices typically found in historical studies, journalism, and legal argument. These include:

- Compiling, comparing, and weighing the merits of narratives of the same set of events provided by individuals with different points of view and interests in the outcome.
- Compiling detailed chronological narratives of the events in question to validate hypotheses regarding patterns of influence.
- Positing a number of alternative causal hypotheses and examining their consistency with the narrative fact pattern.
- Assessing the consistency of the observed fact pattern with linkages predicted by the program logic model.

Researchers use information from a wide range of sources to inform historical tracing analyses. These include public and private documents, personal interviews, and surveys.

Figure 13 summarizes our judgment regarding the application of the four principal attribution approaches to the evaluation of market effects at different stages of market development, as well as typical applications identified in the literature review. These judgments are discussed in detail in the following sections.[13]

Figure 14 summarizes the resources required to execute the studies that use these methods. The following subsections describe each of the methods in detail, focusing on applications, data requirements, schedule, cost, and risks to successful completion.

[13] The stages of market development or product life cycle are adapted from a number of marketing management texts. See, among many other texts, Linda Gorchels. *The Product Manager's Handbook: The Complete Product Management Resource.* Lincolnwood, IL: NTC Business Books. 2006.

Figure 13

Applications of the Principal Attribution Approaches

	Stage in Market Development/Product Life Cycle				
Approach	**Introduction**	**Early Acc.**	**Take Off**	**Maturity**	**Typical Applications/*Limitations***
Self-reports of free ridership & spillover	---	○	○	○	– Develop net-to-gross ratios to be applied to *ex post* energy savings estimates. *Subject to self-reporting bias in regard to program influence.* *End-users find it difficult to recall quantity, timing, and efficiency rating of units purchased.*
Cross-Sectional Methods	---	◉	◉	○	– Quantify net adoptions attributable to the program or estimate strength of relationship between program activities and selected outcomes. *Generally requires a large number of observations of similar decisions or events as well as a quasi-experimental structure.* *Difficult to account for effects of past efforts and cooperative efforts of other organizations.* *Generally does not yield useful results for products that are well-established and may be approaching maturity.*
Structured Expert Judging	---	○	◉	◉	– Specify baseline or counterfactual trends in market development and market share of products in question. – Forecast market acceptance. *Difficult to validate retrospective judgments.* *Difficult to identify and account for factors affecting individuals' judgments.*
Historical Tracing: Case Study Methods	◉	---	○	◉	– Identify and weight the relative contribution of factors or programs affecting a single but complex outcome, such as legislation or regulatory ruling. – Identify and weight relative contribution of factors affecting decisions made by a small number of individuals or organizations; e.g. standard setting. – Identify and weight the relative contribution of factors affecting growth in market share, especially where direct questioning of decision makers is difficult. *No formal basis for quantifying effects or for assessing relative contributions of multiple factors.*

◉ = High
○ = Medium
--- = Low

Figure 14

Resource Requirements for Implementing the Principal Attribution Approaches

Approach	Types of Data Used	Time Frame	Cost Considerations
Self-reported Spillover & Free Ridership	*All sources under Historical Tracing, plus* – Surveys of program participants – Surveys of nonparticipants	Minimum time to complete after initial research: – Surveys: 3 - 4 months to design, field, and analyze	Depends on the scope of programs covered. Reasonable range of costs: $50,000 to $200,000 per study
Cross-sectional Approaches	*All sources under Historical Tracing, plus* – Surveys of supply-side market actors – Surveys of customers – Development of sales, stocking, and price data – Stated preference data from potential users or buyers for supported technology	Minimum time to complete after initial research: – Surveys: 3 - 4 months to design, field, and analyze – Stated preference studies. 3 - 4 months to design, field, and analyze.	Depends on the range of analysis approaches to be attempted and scope of programs covered. Reasonable range of costs: $100,000 to $500,000 per study
Historical Tracing	– Project documentation – Market studies – Technology assessments – Regulatory proceedings: testimony, technical documents, decisions – General and industry press – 'Gray Literature' – program evaluations, conference proceedings & presentations, professional journals – Interviews with selected market actors – Interviews with market and political observers – Interviews with program staff and staff of other programs operating in the market	Time frame can be flexible, with a minimum of two months for document collection and review, with selected interviews. Actual time required will depend on several factors, including – Availability of documentary sources – Extent of documentary research undertaken – Number of interviews scheduled – Elapsed time since the end of program involvement. The longer the elapsed time, the more difficult the research.	Most flexible approach in regard to cost. Reasonable range of costs: $30,000 - $100,000 per program
Structured Expert Judging	*All sources under Historical Tracing, plus* – Results of structured judging sessions – Results of 2nd round research suggested by judges	Minimum time to complete expert judging component after initial research – 6 - 9 months, depending on the following: – Number of face-to-face meetings – Session scheduling issues – Additional research requested by judges – Number of rounds needed to clarify judgments	Many sunk costs for scheduling, facilities, and information packet development. Reasonable range of costs: $100,000 to $300,000 per program

6.2 Self-reports of Net Program Effects

6.2.1 Methodological Overview

Basic description of the method. All approaches to assessing net program effects involve an attempt to compare what has happened in the market in the *presence* of the program to the baseline—that is, what hypothetically would have happened in the *absence* of the program. Developing a reasonable baseline can be one of the most difficult and costly aspects of market effects evaluations. In the case of self-reporting of net program effects, end users and supply-side market actors are asked to say how the program has influenced their installation of energy-efficient measures. There are three primary components to estimates of the difference between the program case and the non-program (baseline) case in the self-report approach, all of which have been discussed earlier:

- **Free ridership.** *Free riders* are program participants who would have installed the same energy efficiency measures if there had been no program. *Partial free riders* are those customers who would have installed some program-supported measures on their own, but not as many, as highly efficient, or as soon; the portion that they would have done in the absence of the program is included in the baseline, and the portion that they would not have done is attributable to the program. The energy savings from measures installed by participants who would not have installed the program-supported measures in the absence of the program are all attributable to the program.

- **Participant Spillover.** Participant spillover occurs when end users who have participated in a program later purchase and install measures that are supported by the program without using program incentives or services. To be counted as program effects, there must be some evidence that the customers in question took these actions as a result of their earlier participation in the program. The savings resulting from these actions are attributable to the program.

- **Nonparticipant Spillover.** Nonparticipant spillover occurs when end users who have not participated in a particular program adopt the energy efficiency measures that the program supports as a result of the program due to their exposure to program-related public relations, vendor promotions, or word-of-mouth about the program and the benefits of efficiency measures. Again, the savings resulting from these actions are attributable to the program.

The net savings formula is typically as follows:

Net energy savings = Gross energy savings x (1 + spillover rate – free ridership rate)

Evaluations relying on self-reports nearly always include estimation of free ridership, and usually address participant spillover; if they address nonparticipant spillover, they usually do so in a limited way. For example, the sponsors of the Massachusetts energy efficiency programs have developed a standardized method, to be used for all commercial and industrial programs, for estimating free ridership and spillover. (PA Consulting 2001) The standardized Massachusetts free ridership method—conducted among end users or design professionals/equipment vendors, depending on who is the decision maker—takes into account the effects of the program on the following: timing of purchases, quantity of measures installed, and efficiency level of measures installed. The method also explicitly assesses the effects on customer adoption decisions of potential variations in measure subsidies, previous plans, and exposure to expert influence. Estimation of spillover – both participant and non-participant – is based upon responses to questions that address the quantity of equipment installed "outside the program", the efficiency levels of that equipment, and the perceived influence of the program on those adoption decisions.

The self-report approach presupposes that respondents are fully aware of program influence, which may be valid for a resource acquisition program in which customers receive incentives directly tied to the purchase and/or installation of the efficient measure, or early in the life of a market transformation program, when awareness and availability of a technology are low, and incremental prices are high. In later phases of a market transformation program, however, programs tend to become less visible to customers as incentives and marketing effort decline. At that point, program respondents can no longer be expected to be aware of the full extent of the program influence or to be capable of judging their likely actions in its absence. For example, program participants and nonparticipants are not in a position to know how much a program has done to make efficient products available to them and how much it has done to lower prices. The longer a program is in existence, too, the more difficult it becomes for respondents to reconstruct their decision-making in the program's absence; the program becomes part of their way of thinking, and—in the case of designers, vendors, and installers—their way of doing business.

Even so, for programs requiring participants to fill out applications or coupons, free ridership is easier to address than nonparticipant spillover, because the requirement of awareness of program influence is at least minimally met in that participants know they are participating. Nonparticipant spillover is much more difficult to assess because program awareness cannot be

assumed. As a result, evaluations relying on self-reporting are likelier to include free ridership estimates than nonparticipant spillover estimates, in which case program savings estimates are reduced by free ridership but not increased by nonparticipant spillover. With some types of programs, free ridership measurement is not a viable option because even participants may not be aware of the program. For example, in CFL markdown programs where the incentive is paid to the manufacturer or retailer and is transparent to the consumer; customers purchase the program-supported CFL like they would any other product in the store, and they cannot readily be identified as participants for purposes of a survey.

The paragraph above describes one instance of a more general limitation of the self-reporting and the free-ridership/spillover framework, namely: we can posit many plausible situations in which a program influences adoptions without the adopter being aware of the program. For example, programs to promote retail products have been shown to encourage much higher stocking levels and, over time, lower price levels. (Rasmussen et al. 2004) Customers who were unaware of the product or its benefits prior to the program, or whose "willingness-to-pay" threshold lay slightly under earlier price levels, will buy the product in the current period without using rebates. Similarly, commercial customers who purchase diagnostic-driven HVAC maintenance services from contractors may be totally unaware of the program sponsors' involvement in training contractors and subsidizing their adoption of the diagnostic systems. Thus, at a definitional level, the free ridership/spillover framework does not capture the full extent of program influence on efficient technology adoptions. Some regulators have recognized this limitation and have accepted the free ridership/spillover framework for use in evaluating programs whose goals are primarily resource acquisition. However, these same regulators express a preference for analyses of market effects in assessing the net benefits of programs that have market transformation objectives. (Prahl 2008)

6.2.2 Logistics

Compared to some other approaches, the logistics of self-reported estimates of market effects are relatively straightforward, and their costs are fairly predictable.

- **Data requirements.** The typical data collection method for self-reported market effects evaluations is through telephone surveys, although sometimes in-person interviews may be used, especially in conjunction with other evaluation tasks such as the on-site verification of measure installations. It is necessary to be able to identify participants in order to target them for questions about free ridership and participant spillover. The decision-maker must

also be identified and then interviewed. Sample sizes vary, but the minimum sample size would typically be enough to provide a precision of +/-10% at the 90% confidence level.

- **Elapsed time requirements.** Because they are dependent on respondent recall, surveys estimating self-reported free ridership and spillover should be conducted within the first few months after program participation, before respondents forget the details of their decision-making process.
- **Costs.** Studies involving self-reported free ridership and participant spillover typically cost in the range of $50,000 to $150,000, but can be substantially higher if multiple programs are involved. Addressing nonparticipant spillover, if it includes only additional measures designed or installed by participating designers and vendors who are already being interviewed, would add only modest amounts to a study cost—probably in the range of $10,000 to $30,000. Addressing nonparticipant spillover among nonparticipating end users and designers/vendors roughly doubles project costs. In addition to fielding additional surveys, researchers must develop and secure sample resources and design new questionnaires.
- **Risks affecting satisfactory completion.** Because program participants have received program incentives, they are generally willing to participate in program evaluations. The risks associated with a self-reporting approach have less to do with the difficulty of implementation than with the issues of reliability and validity. Specifically, customers who experience high motivation to save energy for financial or environmental reasons may be more likely than others to participate in survey interviews, thereby introducing bias into findings.

6.3 Cross-Sectional Approaches

6.3.1 Methodological Overview

Basic description of the method. Cross-sectional approaches refer to a broad family of social science research and analysis that has long been used to quantify the effects of social and economic programs and to assess the causal relationships between program activities and observed outcomes. In the case of energy efficiency programs, cross-sectional approaches involve study designs in which an efficient product's unit sales, market share, or some other indicator of adoption *for a market in which no programs are active* is used to represent the baseline against which to compare levels of adoption observed in areas served by the program. To the extent the comparison accounts for other possible influences on the differences between

the program and non-program areas in observed levels of adoption, those differences can be attributed to the effects of the program.

Examples. The following paragraphs provide brief descriptions of studies that have used cross-sectional comparisons of unit sales or market share of efficient equipment to estimate net program effects and to establish causal relationships between program activities and differences in levels of adoption.

- ***Program Effect on Sales of Compact Fluorescent Lamps (CFLs).*** An evaluation of Efficiency Vermont's programs to promote CFLs used the difference between 2004 sales of CFLs per household in Vermont versus sales of CFLs per household in all other states in which no programs were active as a measure of net program effects. (KEMA 2005) This approach had a number of limitations. First, it did not control for systematic differences between Vermont and states in the non-program area such as energy prices or demographic composition that might have affected the observed difference in levels of adoption. Second, data sources for CFL sales in program and non-program areas, as well as program-related sales in other states with programs, had serious gaps, such as lack of participation from key retailer types. Third, programs to promote CFLs had been active in Vermont more or less continually since the early 1990s. Thus, the observed difference in sales in 2004 reflected the cumulative effect of those programs rather than efforts in 2004. The analysts attempted to assess the effect of the data problems mentioned above through sensitivity analysis. It was found that potential variations in the input data within a reasonable range did not greatly affect the key finding, which was that net CFL sales attributable to the program led to net-to-gross ratios significantly greater than the 1.19 assumed in program planning documents – in the range from 1.30 to 1.36. Analysts in Wisconsin attempted similar types of analysis with comparable results. (Glacier Consulting 2005)

- ***Use of vendor data to estimate sales in program and non-program area.*** A recent study of the market effects of the Wisconsin Focus on Energy's Business Sector Rebate programs sought to assess whether those programs had had a significant effect on the level of adoption and other indicators of market acceptance for three technologies: (1) efficient high bay lighting (substitution of fluorescent for high-intensity discharge), (2) efficient (high EER) packaged HVAC units, and (3) variable frequency drives (VFDs) for fan and compressed air systems. (KEMA 2009) The study used the results of surveys of contractors and distributors to develop ratio estimators of market share for the three technologies listed above, as well as other indicators, such as the market share of related controls and vendor

perceptions of the business value of promoting energy-efficient products. The study found that the market share for efficient high-bay lighting was significantly higher in Wisconsin than in the comparison state (Illinois), as was the market share of high-efficiency packaged HVAC units in the smallest size category covered. Smaller differences were observed between Wisconsin and Illinois in other HVAC size categories; there were virtually no observed differences in the level of adoption of VFDs between the two states. Findings in regard to the secondary indicators of market effects were consistent with the market share results. This study was used to assess patterns of difference in levels of adoption and promotion of efficient products rather than to estimate net sales attributable to the programs, and, in the case of high-bay lighting and efficient HVAC, the balance of evidence demonstrated that the program had had an effect on market share.

- ***Estimating net effects of programs to promote ENERGY STAR clothes washers.*** Between 2003 and 2005, evaluators estimated the net effect of state-level rebate/retail promotion programs on the annual sales of ENERGY STAR appliances in Vermont (2001 and 2004) and Massachusetts (2003) using annual state-level market share data available from the U. S. EPA. These data provide the share of total refrigerator, clothes washer, dishwasher, and room air conditioners sales accounted for by ENERGY STAR models by ENERGY STAR Retail Partners. These partners are generally large retail chains. They account for 40 to 90 percent of unit sales depending on the type of appliance and the state.

  The earliest of these studies used a simple model that estimated state-level market share for a given appliance and year as a function of: (1) a dummy variable representing the presence of a rebate program serving 80 percent or more of the households in the state for two of the three years prior to the study, (2) median income, and (3) a measure of educational attainment. The analysts then enumerated the model for Vermont, setting the program variable to 0. The difference between the observed market share and the model-estimated share 'without the program' was taken to represent the net effect of the program on market share cumulative over the period of program inception (1998). In the years 1999 – 2001, this simple model explained a large portion of the observed variation in the market share of ENERGY STAR clothes washers among states (Adjusted R^2 ranging from 0.67 to 0.72). It did not work as well for the other appliances, which received less generous rebates and offered lower potential savings. After making adjustments for the differences in market share between chain stores and Vermont independent retailers, the incremental market share attributable to the program ranged from 10.0 percent in 1999 to 15.1 percent in 2000 and 13.9 percent in 2001, suggesting that the program's influence on net adoptions may

have begun to attenuate in the last year analyzed. These calculations yielded net-to-gross ratios in the range of 63 percent to 69 percent. (Rosenberg 2003)

It should also be noted that the period in which these findings of significant market effects were made were marked by a rapid rise in market share (24 percent to 32 percent) and by an increase in the percentage of ENERGY STAR models sold "outside the program" (1 percent to 37 percent). Similar patterns have been observed for market-oriented programs to promote CFLs in the Northwest, California, and Vermont.

The team analyzing the effects of the Massachusetts appliance programs introduced a number of refinements to this model. (Wilson-Wright 2005) First, they developed a suite of variables to represent the level of program effort, including the amount of rebates paid, the percentage of households covered, the presence of field merchandising support, and the presence of various marketing campaigns. Second, the team included a wider range of market descriptors such as electricity prices in the model. Finally, the analysts attempted to distinguish the effects of past program efforts from those of the current program year by including the percentage change in market share over the three years prior to the study. This model achieved a very high R^2 for clothes washers (97.4 percent).[14] It yielded an estimate of total net market share attributable to the program of 14.5 percent: 10.4 percent for the variable capturing past program effects and 4.1 percent for the effects of current program components. The Vermont analysts used essentially the same approach to analyze the effects of programs in that state in 2003 and 2004. (KEMA 2005) Their estimate of 2003 market effects was similar: 9.5 percent net market share with most of that attributable to the effects of prior years' programs. However the net effects for the 2004 program on market share were estimated at only 5.5 percent.

The most likely explanation for the decline in the apparent effect of the program was the accelerated pace of growth in the market share of ENERGY STAR clothes washers in the non-program states. Between 2000 and 2004, that share had tripled from 9 to 27 percent; whereas it had doubled in the program areas, and the pace of growth had continued to slow. This pattern became more pronounced by 2006, when market share in non-program areas had reached nearly 34 percent, compared to 50 percent in the program areas. A recent

[14] This approach does raise issues of autocorrelation that were not formally addressed in the study.

study that used similar methods to estimate the net effects of California's 2006 – 2008 programs to support CFLs generated similar kinds of results. CFL sales per household on average varied hardly at all between program and non-program areas. The regression analysis found that the presence of programs had no significant effect on observed CFL sales per household once variables representing the presence of ENERGY STAR retailers and customer demographics were included in the model. (The Cadmus Group 2009) These developments show that the success of cross-sectional methods in yielding clear estimates of program effects depends on the overall level of development for the market in question.

- ***Other econometric models of net effects.*** In the mid-1990s, a number of utilities commissioned studies of net program effects based on discrete choice modeling techniques. (Cambridge Systematics 1993, XENERGY 1995) In these studies, survey data from individual residential and commercial customers in program and non-program areas were used to build models of program effects on the probability of adoption, controlling for regional variations in energy prices, measure prices, and other elements that would affect the customer's economic calculations. While these studies provided some useful results, their methods were complicated, expensive, and opaque to the average policy analyst. Moreover, the modeling results were highly sensitive to small changes in assumptions and input data. The approach has not been applied in the current round of renewed interest in evaluating the market effects of energy efficiency programs.

6.3.2 Logistics

As the above examples suggest, the logistical requirements for cross-sectional studies are substantial.

- **Data requirements.** The basic data requirement for cross-sectional studies is reliable data on the extent of measure adoption in the program area and non-program area(s). State-level market share data are now available for ENERGY STAR-labeled appliances and NEMA Premium Motors, although both data sources have limitations. For example, the quantification of program effects on appliance market share requires sales data from independent retailers as well as from the national chains that contribute to the DOE's database. The U.S. EPA has recently assembled national sales data on compact fluorescent lamps. For all other devices and services, it is likely that the analyst will need to develop measures of adoption in both the program area and the non-program area. Sales records provided by retailers and distributors are generally considered to be the highest

quality data for this application, but they are also the hardest to get. Program sponsors interested in receiving such data from vendors should approach these market actors in the course of program development and, to the extent possible, condition participation in the program on agreement to provide sales data. This approach has worked fairly well for residential lighting and appliance programs, but less well for motors and commercial lighting efforts.

In the absence of sales data, survey data from supply side actors and/or customers is the next best source for measures of adoption. While they entail less risk than reliance on sales data, these sources present a number of problems. Vendors are often unable or unwilling to provide good information on sales volume over the phone; they appear less reluctant to provide market share estimates. End-users generally have problems providing accurate information on the efficiency level, quantity, and timing of equipment purchases. In particular, many studies containing on-site inspections as well as telephone surveys find that residential customers tend to over-report purchases of efficient goods and services. In these instances, it is useful to obtain estimates of market share from a variety of sources to select the one that is best supported by the data.

- **Elapsed time requirements.** Studies that require the development, fielding, and analysis of surveys in multiple areas generally take a minimum of 9 months to complete due to the complications of sample development and research of general market conditions such as growth in the targeted industries or local building codes required to prepare questionnaires. Development of sales data represents a scheduling wild card. It is very difficult to predict how long it will take to obtain compliance from vendors, how long it will take them to compile the data, and the amount of work that will be required to clean them.
- **Costs.** Given the intensive data collection requirements for cross-sectional studies, it is difficult to conduct one for less than $150,000 under current conditions. Recent studies with which we are familiar range in cost from $200,000 to $500,000 for assessments of a single product, service, or related set of products.
- **Risks affecting satisfactory completion.** The largest risks to successful completion of projects of this type are the following:
  - Inability to obtain the required data, especially if the study relies upon voluntary provision of sales data by vendors.
  - Incompatibility of the method with the current stage of market development. As discussed above in the case of resource-efficient clothes washers, a formal cross-

sectional analysis of data from program and non-program areas will yield inconclusive results as the measures in question gain market share in non-program areas.

- Lack of appropriate non-program areas. As of early 2009, 35 states have ratepayer-funded energy efficiency programs, and that total is expected to increase to over 40 in the next few years. At that pace, there are few states of any significant population that will qualify as "non-program" states, and it is possible that market conditions in those states will be influenced by market effects in the program states.
- Bias in estimates of measure adoption can occur due to a number of problems common to survey research: e.g., response bias, lack of respondent knowledge, and the perceived social pressure to respond positively. Response bias is best addressed through careful sample development and strict adherence to rigorous methods in sample fulfillment and substitution. Problems in estimation related to the quality of individuals' responses are best addressed through triangulation with other methods and sources.

6.4 Structured Expert Judging

6.4.1 Methodological Overview

Basic Description of the Method. Structured Expert Judgment methods – of which the Delphi Technique is the most familiar – have a long history in marketing research. They have been used to forecast sales and the market share of a wide range of products and services, with particular application to items for which historical sales data are either scarce or of uncertain value for predicting the future. Such cases include products with substantially new features or with relatively small target markets.

Recently, researchers have adapted expert judgment methods to estimating the net effects of energy efficiency programs on their targeted markets. Their basic approach has been to ask panels of experts to forecast two trajectories of market acceptance for the products or services in question: one that takes into account the effects of the program and one that does not. The latter represents the baseline. If forecasts of market acceptance are available from other sources, as will be the case for devices or practices covered by appliance standards and building codes, then experts will be in better position to forecast the baseline. The difference between the cumulative sales or applications of the products over the forecast period then represents the net effect of the program.

General texts on marketing research methods typically accord expert judgment methods high marks on the accuracy of the forecasts that they produce, relative to other, more model-based

approaches. (Research Triangle Institute 1991) This is because individuals with a long working knowledge of the products and markets in question are able to bring to bear a wealth of experience on their predictions. However, substantial effort is required from the researcher to validate the sources and to structure their response. Specific measures to enhance the value of a collection of expert judgments include the following:

- ***Selection and screening of judges.*** Generally, researchers attempt to assemble a panel of judges who bring to their assignment a diversity of views and experience on the questions at hand. For example, a panel convened to assess the effect of a project to increase the energy efficiency of a mass market product would include representatives of manufacturers, distributors, and retailers, as well as academic or professionals familiar with the technology and its markets. Moreover, the judges must be screened to ensure that they do not have a financial or professional interest in the outcome of the assessment of the program's effects.
- ***Clarification of assumptions concerning drivers of market acceptance.*** A judge's view of the likely trajectory of market acceptance will depend on his or her assumptions about trends in drivers of market acceptance, such as the price of energy or the features and price of 'the next best product'. Researchers have used a number of approaches to clarify these assumptions. One is to provide judges with a number of scenarios concerning the development of drivers over the forecast period, and to request that the judges provide forecasts under each scenario. A second is to probe the judge's rationale for the forecast in a follow-up round of questioning.
- ***Reducing disparity among judges in knowledge of the product, the market, and the project.*** Expert judges enter the assessment process with distinctly different levels of knowledge and understanding of the product, the market, and the operation of the project. These differences can make it difficult to bring the full range of their knowledge and experience to bear on their forecasts. To address this issue, researchers generally prepare fact packets that detail the technology that the program has supported and its differences from other products in the market, the structure of the market, the history of the new technology in the market, and the design and accomplishments of the R&D project.
- ***Iterative rounds to increase reliability.*** The first round of forecasts usually yields a broad range of predictions – too broad to be viewed as a reliable guide to the future. To increase the reliability of the forecast, researchers typically conduct at least a second round of inquiry and, in some cases, additional rounds. In these rounds, the individual judges are shown the average values of the forecasted indicators. They are asked to provide the rationale for their forecasts and are offered the opportunity to revise their forecasts. This process generally yields a tighter distribution of the forecasted variables, although outliers are seldom eliminated entirely.

Example #1: Massachusetts Utility Forecast of Market Share for ENERGY STAR Labeled Homes (Blake et al. 2003)

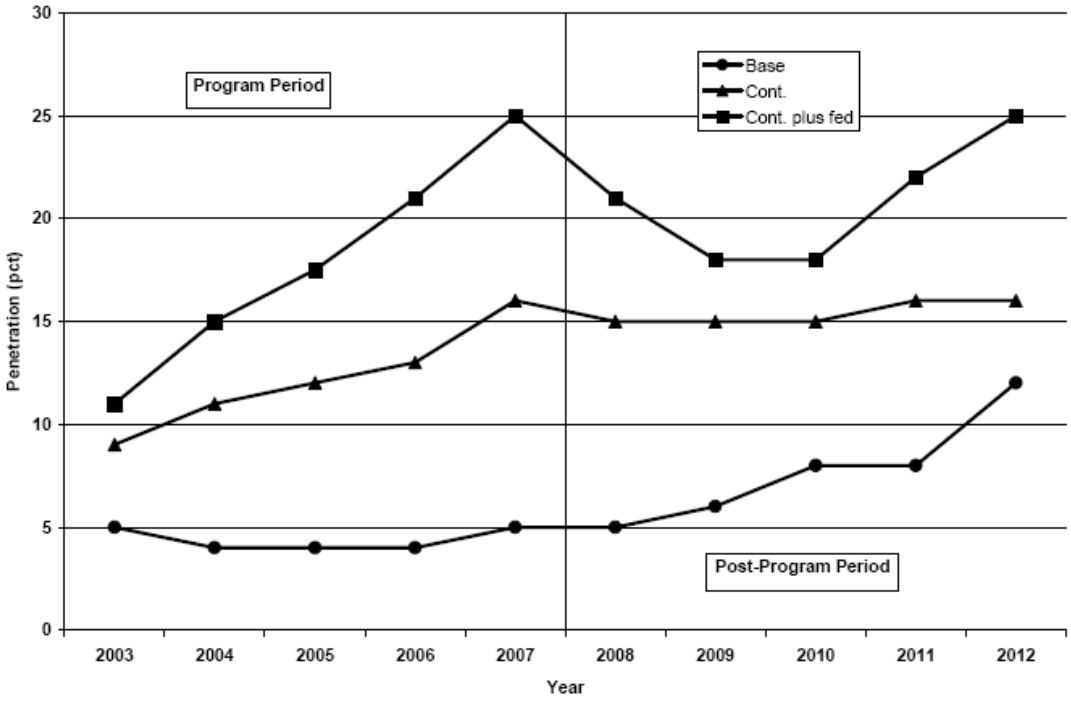
Objectives of the study. The objective of the study was to develop a ten-year forecast of the market share of ENERGY STAR labeled homes in Massachusetts under three scenarios. This study used a Delphi process involving a panel of market experts to forecast the ENERGY STAR market share for the three segments under three scenarios:

- Termination of all public support in the year after the study;
- Maintenance of current program activities for five years;
- Maintenance of current programs plus the provision of additional builder incentives through Federal legislation.

Massachusetts regulators required these forecasts as part of the program's cost-effectiveness assessment.

Approach to assessing program attribution. In this case, the researchers framed the forecast scenarios to reflect the concept of net program effects. That is, the scenarios included one in which the program was terminated and one in which it continued as currently constituted for five years. The inclusion of the scenario with federally-legislated support provided the judges with an "upper bound" against which to compare forecasts with the program in place. To provide further support and consistency to the forecasts, the researchers provided the judges with extensive descriptions of the target market, forecasts of key variables such as interest rates, and detailed program descriptions. Figure 15 shows the median projections of market share for each scenario that this process produced.

Figure 15
Forecasted Market Share of ENERGY STAR Homes in Massachusetts



Example #2: California IOUs' Statewide Codes and Standards Program: Assessment of Market Adoption and Non-Compliance Rates (Quantec 2007)

Objectives of the study. The California IOUs commissioned q study to support the impact evaluation of their statewide Codes and Standards program. That program seeks to improve energy efficiency by influencing the periodic updates of California's Title 20 appliance and Title 24 building standards. While this program does not seek to influence individual end-user choices directly, it is hypothesized to have a strong market effect, namely: accelerating the pace at which suppliers adopt code-required practices and/or stock inventory of equipment that complies with new standards. A Stakeholder Review Committee consisting of representatives of the IOUs works to propose code updates and monitor changes in energy use and market trends as a result of the codes.

The specific objective of this study was to estimate key parameters needed to assess program impacts. The two parameters of interest were:

- The “initial level” of market acceptance of the product or service in question at the beginning of the forecast period (2006); and,
- The “naturally occurring adoption rate” of the product or service in question, that is: the annual trajectory that the product’s market share would have taken had it not been incorporated into the appliance or building standard. This constituted the baseline trend of market share.

Evaluations of the program’s net impact assumed that the adoption rate with the code provisions in place would be 100 percent less a “noncompliance rate” specific to the product or service in question.[15] The products and services covered in this round of the evaluation included residential hardwired compact fluorescent fixtures, lighting controls under skylights, duct improvements in residential and nonresidential structures, various consumer electronics, pool pumps, pulse start metal halide fixtures, commercial dishwasher spray valves, and duct furnaces.

Approach to assessing program attribution. The researchers compiled expert opinion on the initial level and baseline trend of market acceptance using a web-based tool created for the study. The tool allowed the experts to manipulate the parameters of the familiar Bass model of market penetration to specify the initial level of market acceptance, its maximum value, and its shape in the interim. The tool provided the experts with a verbal description of the selected shape. Once the experts decided that the shape conformed to their forecast, they clicked a selection button, which saved that shape to the study data file.

The researchers used statistical processes to estimate the average curve from the stored responses. They then sent a follow-up email to the participating experts showing them their curve superimposed on the average. The participating experts could then revise their prediction and/or provide feedback on why they believed the naturally-occurring market acceptance would differ from the average. The researchers then processed this information into final versions of the naturally-occurring market adoption curve for the various products and services in the study.

[15] The study also included a component to estimate noncompliance rates based on inspection of construction permits, finished buildings, and appliance sales records.

Strengths for application in market effects evaluation. The principal strengths of expert judgment approaches applied to the assessment of energy efficiency programs are the following:

- ***Accuracy relative to more data-intensive methods.*** As mentioned above, academic marketing researchers generally rank expert judgment equal to or, in some cases, better than more data intensive modeling approaches for accuracy of results, based on retrospective review. While it is true that there are no "right" baseline estimates, the ability of the basic method to yield acceptable results in other forecasting contexts provides support for its use where it is otherwise appropriate.
- ***Development of actionable insights.*** The iterative process very often calls forth detailed insights into market structure and dynamics as the participants provide evidence to support their forecasts.

Limitations for application in market effects evaluation. The literature review uncovered many applications of structured expert judging approaches to assess the outcomes of market interventions. These studies addressed the full range of program types, as well as the full range of retrospective and prospective energy and economic benefits. Some types of expert judging methods, such as the Delphi technique and related approaches, are specifically designed to capture and structure opinions regarding future trends in the market acceptance of products and services. However, there does not appear to be any basic constraint to using expert judgment to 'backcast' baseline conditions.

Compiling expert judgments is not a statistical process in the sense of producing estimates that can be expanded to the population using sampling-related statistics. (North Carolina State University) Nor does the process facilitate sensitivity analysis in the same way that model-based approaches can. Use of scenarios fulfills somewhat the same function as sensitivity analysis, but without the flexibility and detail that models provide in analyzing changes in outcome variables in response to changes in various inputs.

Practical challenges. The key practical challenges to using expert judgment approaches in the assessment of energy efficiency programs are as follows:

- ***Recruitment of appropriate panels.*** Depending on the nature of the product or markets addressed, it may be difficult to identify and recruit an appropriate expert panel.
- ***Management of logistics and schedule.*** The logistics of a structured expert study are complicated, especially if the approach entails face-to-face meetings or multiple iterations.

Combined with difficulties in recruiting the panel, the logistics of study administration can make it difficult to maintain a tight study schedule.

- ***Promotion of transparency.*** Even when program staff suggest scenarios and provide fact packets, it is not practical to identify all of the important assumptions that judges bring to their forecasts. This lack of transparency can complicate the interpretation of results.

6.4.2 Logistics

As the discussion above implies, application of expert judging methods to the evaluations of market effects can be both costly and logistically challenging. The following insights into these challenges are drawn from the review of the literature, interviews with analysts who have directed such studies, and our own experience.

- **Data requirements.** According to analysts with experience in structuring expert judging studies, there are two great challenges in regard to data gathering. The first is to recruit a suitable panel, especially in cases where products are relatively new to the market. The second is to assemble background packages that are sufficiently detailed to support and guide useful judgments, but not so detailed as to discourage the judges from using them.
- **Elapsed time requirements.** It is difficult to compress the time needed for the principal tasks entailed in this kind of study. Even relatively straightforward approaches generally take at least six months, and project schedules of 9 to 12 months are more common.
- **Costs.** Given the high level of preparatory research and logistical support required, it is difficult to complete a rigorous expert judging study for less than $100,000. Studies with which we are familiar ranged in cost from $250,000 to $500,000 for assessments of a single market, program, or suite of programs.
- **Risks affecting satisfactory completion.** As discussed above, structured expert judging processes have established a good track record for forecasting and producing actionable insights. The major risks to completion involve resources: analysts often underestimate the time and expense required to structure and manage the process.

6.5 Historical Tracing: Case Study Methods

6.5.1 Methodological Overview

Historical tracing, also referred to as process tracing or the case study method, is a primarily qualitative approach that involves reconstructing cause-effect relationships in order to confirm, disconfirm, and/or modify hypotheses. Results are presented in a narrative fashion, describing in detail the causal chains that connect independent and dependent variables. Hypotheses typically identify a finite set of political, administrative, financial, and economic factors that are believed to bear varying degrees of causal weight in explaining specific outcomes. A researcher employing historical tracing examines the available empirical data and seeks to establish the extent to which evidence supports competing propositions about historical outcomes. When hypotheses have been tested, and subsequently verified, rejected, or revised, the causal processes are retraced in the form of a story, with the various steps linking cause(s) and effect discussed in chronological order. The final product of historical tracing has been referred to as an "analytic narrative," reflecting its combination of analytical rigor focusing on discrete variables and processes, and accessible narrative structure exhibiting conventional form and detailed description.

The case of Resource Efficient Clothes Washers (RECWs) discussed above (see Section 2.2.2) offers a simplified example of historical tracing used to assess causal arguments. The basic logic behind the intervention was that rebate programs for RECWs would stimulate greater demand, particularly in the form of greater market share, which would in turn stimulate supply-side changes including modified product offerings and lower prices. These market effects would be durable, and, hence, the clothes washer market would be transformed. Research demonstrates that these causal relationships did materialize and market transformation did occur. The researchers' hypotheses were confirmed using empirical data, establishing explanatory links between independent variables (rebate programs and other measures) and dependent variables (greater market share, lower prices, and other market effects). In this manner, the historical outcome, clothes washer market transformation, was traced directly back to its original cause, program interventions, and hypotheses can be regarded as confirmed.

Research on California's Nonresidential Standard Performance Contract (NSPC) Program provides a more detailed example of applied historical tracing. (Rufo 1999) Begun in 1998, the NSPC Program involved California IOUs offering fixed-price incentives to end users or third-party energy efficiency service providers (EESPs) in exchange for measured kWh energy savings achieved by the installation of energy efficiency projects. The program was subjected

to a number of evaluations over the period 1999 to 2003. The evaluations had two main objectives: to conduct a comprehensive baseline assessment of the nonresidential retrofit market for performance contracting and related services; and to conduct a systematic process, market, and impact evaluation of the NSPC Program.

In practice, the evaluations focused largely on assessing the extent of market effects generated by the program. The evaluation team started by developing a unique program theory for the NSPC Program. This theory was represented by diagrams illustrating possible feedback mechanisms and other causal processes set in motion by the program. The program theory was intended to make explicit and verifiable the market transformation logic behind the NSPC Program. Using this framework, researchers identified two distinct sets of hypotheses regarding market effects. The first set concerned hypothesized changes in attitudes, behavior, and characteristics among EESPs resulting from program incentives. The second set involved similar changes among end users caused by the program. For all hypotheses, the NSPC Program, or particular program elements, was treated as the independent variable, and potential market effects exhibited by EESPs and end users were treated as dependent variables. The causal chains connecting these variables were derived from the program theory.

In order to assess the level of empirical support for these hypotheses, researchers selected multiple market indicators that could be employed to estimate evidentiary strength. Each hypothesis was tested against real-world data using market indicators and additional evidence. Moreover, the researchers made an explicit assessment of the quality of data from each source developed for the study. This provided an element of transparency that is all too often lacking in studies of this type.

In attempting to trace out hypothesized links between the program and market effects in California's nonresidential retrofit market, researchers found limited evidence that causal chains were operating as predicted. For instance, according to one hypothesis, the NSPC Program should have produced observable changes in EESP business strategies including greater emphasis on performance contracting as a service delivery vehicle. Evidence gathered primarily from three sets of interviews with participating and nonparticipating EESPs failed to demonstrate any significant change in business strategies resulting from the program. The absence of empirical data sufficient to allow a convincing reconstruction of the theorized causal linkages flowing from incentives and other program elements to EESP business strategy meant that the original hypothesis was regarded as unsupported by the facts.

Another hypothesis suggested that exposure to the program would cause end users to elevate the role of energy efficiency in their procurement practices. Data collected through surveys and

interviews with nonresidential customers showed little evidence that procurement had been affected in this way. Again, the inability to offer a persuasive recreation of causal connections running from the program to customer procurement policies rendered the procurement hypothesis dubious. Other end-user hypotheses could not be evaluated due to a lack of longitudinal data. Overall, the strength of the evidence gathered to evaluate hypotheses was considered weak, and the propositions were judged questionable. Given the systematic nature of these findings, the evaluation team concluded that the program theory underlying the market transformation component of the NSPC Program might be fundamentally flawed.

In addition to this market assessment based on historical tracing, the program evaluation entailed other research goals. Interviews were used to identify critical process-related issues. End-user surveys were used to determine baseline characteristics of the nonresidential retrofit market. Most notably, NSPC Program resource acquisition activities were measured and assessed. Specifically, multiple tracking databases were integrated to provide a quantitative summary of program activity, which permitted the calculation of a provisional net-to-gross (NTG) ratio.[16] Thus, the historical tracing approach can be successfully combined with other qualitative and quantitative methods in program evaluation.

Strengths for application in market effects evaluation. The historical tracing approach is particularly useful for the following aspects of market effects evaluation:

- ***Validation of program theory logic models in the early stages of program or market development.*** In the early stages of program and/or market development, targeted market changes such as the commercialization of product designs, manufacturers' licensing of product designs, or acceptance of test procedures to measure energy efficiency simply are not susceptible to quantification or formal testing. In these cases, historical tracing, as exemplified by the NSPC case above, is the only method available to explore the relationship between market development and program activities.

[16] The NTG ratio is the ratio of net program savings to gross program savings. Gross program savings are essentially the change in energy consumption caused by the installation of measures supported by the program. Net savings are the changes in consumption associated with the installation of measures that would not have been installed in the absence of the program. See TecMarket Works, 2004. op. cit.

- ***Analysis of the unique contributions of a given program in a market targeted by multiple programs.*** Generally, this type of analysis is interesting primarily in the later stages of program and market development. Historical tracing is the only practical approach to address the unique contribution of one program out of many active in a given market.
- ***Development of actionable insights.*** Historical tracing requires in-depth questioning of market actors regarding their motivations and inhibitions to promoting or adopting energy-efficient products and services, as well their perceptions of the subject program. This information can be very useful in developing recommendations to improve program effectiveness.

Limitations for application in market effects evaluation. By itself, historical tracing cannot be used to develop quantitative estimates of program effects. However, detailed information on market structure, market actor behavior, and self-reported program responses can be very useful to supplement and to serve as a sanity check on quantitative analyses program attribution.

Practical challenges. The key practical challenges to using historical tracing in the assessment of energy programs are as follows:

- *Identification and recruitment of interviewees from all groups of key informants.* The usefulness and credibility of historical tracing analysis depends on the analysts' ability to capture the views of all key groups, since the assessment of the strength of evidence lies primarily in checking the consistency of these views.
- *Promotion of transparency.* Since historical tracing does not rely on formal methods of hypothesis testing, it is up to the reader to assess how convincing the analyst's reconstruction of events is. To do this, the reader must be aware of the informants' role in the market, their economic interests, and the potential effects of the program on those interests.

Reliability. Unlike statistical studies, there are no formal criteria in case studies for assessing reliability, that is: the likelihood that another researcher would arrive at the same conclusions if presented with the same data. In case studies, the researcher by definition exercises a great deal of discretion in selecting and shaping the information to be presented from the large trove of data he or she collects. While there are general rules for creating transparent analytical

narratives, there are no widely accepted procedures such as “test-retest” or development of statistics of internal consistency which are available to more quantitatively oriented social scientists.[17]

- Logistics

Historical tracing is the most flexible of the available ‘attribution’ methods in terms of logistics.

- **Data requirements.** The data required for historic tracing studies consist primarily of in-depth interviews with program principals, staff of other programs operating in the market, and market actors, as well as documents of various kinds**.**
- **Elapsed time requirements.** Adequate time to identify documents and interviewees must be allowed. Generally, 3 - 6 months will be sufficient.
- **Costs.** Depending on the breadth of issues and length of time covered, the costs for these kinds of studies can range from $50,000 to $200,000.
- **Risks affecting satisfactory completion.** As mentioned above, a really convincing analysis of causation using historical tracing requires information and opinion from representatives of the full range of relevant market actor groups and programs. However, the risk of getting no useful information or insights out of this approach is very low.

[17]See, for instance, Robert H. Bates, et al. *Analytic Narratives.* Princeton, NJ: Princeton University Press. 1998.

6.6 Considerations in Attribution Method Selection

One conclusion to be drawn from the discussion above is that no one attribution method will be the superior choice in all evaluation situations. Rather, program sponsors, regulators, and analysts will need to exercise judgment in selecting a method or combination that best meets their objectives, given the nature of the program and constraints of schedule, budget, and data availability.

6.6.1 Selection of Market-Oriented versus Self-Reporting Frameworks

The first major decision in choosing attribution methods involves selecting one of the market-oriented approaches – cross-sectional analysis, expert judging, or historical tracing – versus the self-reported free ridership/spillover framework. This decision turns primarily on the sponsors' and evaluators' judgment regarding the program's potential to generate significant levels of measure adoption "outside the program" – that is: adoptions that cannot be captured in program records. If sponsors and evaluators believe the potential for such adoptions is high, then it will be best to select a market-oriented approach to assessing attribution. Factors to be taken into consideration in this decision include the following.

- **Program Objectives and Logic Models.** Some energy efficiency programs offer few opportunities to stimulate market effects, by dint of the measures they support or their mode of operation. Examples of the former include refrigeration recycling or low-income home retrofit programs. Examples of the latter include custom retrofit programs targeted to large commercial and industrial customers. In these cases, program sponsors concentrate on providing technical, logistical, and financial support that end users require to implement site-specific efficiency measures and expend little program effort in building broader customer or vendor support for those measures. For these kinds of programs, market-oriented methods such as cross-sectional analysis, expert judging, or historical tracing are unlikely to increase analysts' understanding of program effects or to provide useful information for quantifying the net program effects on adoption.
- **Visibility of the program to customers.** As discussed above, the quantification of spillover requires that customers be able to recognize the program in question and characterize its effect on their adoption decisions. Many kinds of programs currently in the field, such as upstream CFL subsidies and merchandising support, commercial new construction, and commercial HVAC maintenance programs, are not visible to customers. They may recall interactions with vendors who participate directly in the program, but generally customers

will not detect the program activities that shape the offers that they receive. In these cases where customers cannot reasonably be expected to characterize program effects on their adoption decisions, evaluators will need to use market-oriented methods to develop estimates of net program effects.

6.6.2 Selection among Market-Oriented Approaches

In selecting among the market-oriented approaches to assessing program attribution, program sponsors and evaluators should remember that the objective of these methods is to develop a counterfactual baseline trajectory of measure adoptions for comparison to actual observations of sales, purchases, or market share. As such, no one method is necessarily going to be more "accurate" than another. Rather, analysts will be looking to make the best use of available information, to avoid known sources of bias, and to exploit the strengths of the various methods. The following paragraphs offer concrete guidelines based on experience in the application of market-oriented methods.

- **Stage of market development.** Cross-sectional comparisons yield useful and sensible results in the relatively early stages of market development. However, as discussed above, once growth in the market share in non-program areas begins to accelerate, the approach is likely to find small or no statistically significant net effect. The number of applications of this approach recorded in the literature is too small to support generalizations concerning the range of market shares over which the approach is useful. However, once national market shares begin to exceed 25 to 30 percent, it is prudent to rely on other methods as an alternative or in addition to the cross-sectional comparison.
- **Data availability.** The cross-sectional approach requires data on measure adoption in program and non-program areas. Although the technique can be applied to self-reported sales data from vendors, actual sales records are much preferred. The use of self-reported purchase data from customers without other sources (such as self-reports from vendors) is not recommended, since this approach is subject to all of the data accuracy problems associated with self-reports.
- **Prospective introduction of product standards or building codes.** The announcement of the effective date of a new product standard or building code provision tends to set in motion a number of short-lived activities that can confound the quantitative assessment of market effects. One is the dumping of units in an inventory that will become non-compliant after the effective date. Dumping increases the apparent incremental cost of compliant units (as the price of non-compliant units is reduced) and decreases temporarily the market share

of compliant units. Such vendor behavior was observed in electric motor market studies undertaken around the effective date of the EPACT standards. (XENERGY 2001c) In the face of impending effective dates for product standards or codes, expert judging methods, combined with research on historical research on trends in market share and prices, may offer a useful approach. Expert judges can be called upon to provide insight into the trend of sales or market share in the absence of announced changes in codes and standards.

- **Value of information by-products.** Both self-reported and cross-sectional methods can yield a great deal of information that is useful for understanding market dynamics and program structure. For example, the types of interviews typically conducted to support self-reported estimates of free ridership and spillover can be structured to capture a great deal of information on how customers receive, value, and use information and assistance from a program in measure adoption decisions. Similarly, even if market share information from other jurisdictions is not applied directly to estimate net program effects, it can be very useful in assessing the overall value of continued measure support.

7. Conclusions and Recommendations for California Programs

In this section, we present our recommendations for program planning for market transformation and evaluation in regard to market effects.

7.1 The California Policy Context

In its most recent opinions and decisions on energy efficiency programs, the CPUC has strongly embraced market transformation as a program strategy. The CPUC laid out the framework for the 2009 – 2011 round of programs – goals, planning process, delivery approach, cost-effectiveness assessment, and sponsor compensation – in an Interim Opinion delivered October 18, 2007. (CPUC Decision 07-10-032) The statement of goals and approach to program sponsor compensation are consistent with a long-term, market transformation orientation, and the required operating procedures called out in the Opinion reflect current best practices in market-oriented program planning, as described in Section 3 of this paper. Specific examples include the following.

Goals and Objectives

- **Specific reference to market transformation goals.** The Interim Opinion emphasizes the need to pursue market transformation goals as so defined:

  > Long-lasting sustainable changes in the structure or functioning of a market achieved by reducing barriers to the adoption of energy efficiency measures to the point where further publicly-funded intervention is no longer appropriate in that specific market.

- **Market-oriented program objectives.** The Interim Opinion identifies three specific "programmatic initiatives" that will require market transformation strategies to achieve: the adoption of zero net energy design and building practices for residential and commercial new construction and the "reshaping" of the HVAC industry to "ensure optimal equipment performance." Unlike prior statements of program objectives, these target specific markets, as opposed to concepts advanced in previous regulatory formulations, such as "all cost-effective energy efficiency" or "resource of first choice". The approach certainly implies a more market-oriented approach than the narrow concept of cost-effectiveness advanced in the integrated resource planning approach.

Sponsor Compensation

- **Long-term focus.** The Interim Opinion encourages the utilities to engage in long-term planning. To reinforce this policy on a practical level, the Opinion expressly allows utilities to plan and recover costs for programs that do not yield savings during the three-year program cycle but are expected to yield savings within five years of inception.
- **Definition of cumulative savings goals.** The CPUC proposes to set goals in terms of cumulative savings that decay as measures installed with previous programs reach the end of their useful lives. One way that utilities can overcome shortfalls associated with savings decays is to promote market changes, such as the adoption of more efficient product standards, so that efficient products installed in the current round of programs will be replaced by equipment with similar efficiency.

Program Planning Procedures

- **Required collaborative planning approach.** The CPUC requires the formation of committees of market actors known as Peer Review Groups (PRGs) to assist the utilities in program planning. This will bring increased levels of market knowledge into the planning process.
- **Program portfolio criteria.** The Interim Opinion challenges the stakeholders to select a "portfolio balance in ways that promote innovation, new technologies, and effective efficient program implementation."

7.2 Recommendations

Clearly, the CPUC's policy for program planning procedures and sponsor compensation in the 2009 – 2011 period aligns closely with the market transformation strategy as described in Section 2 and good program planning practices described in Section 3. Our recommendations focus on three elements of the regulatory process that we believe will facilitate the realization of policies set forth in the Interim Opinion. These are: (1) the approach to program sponsor performance assessment and compensation, (2) research in support of program planning, and (3) evaluation.

7.2.1 Program Sponsor Performance Assessment and Compensation

Recommendation #1: Include spillover and other benefits of demonstrated market effects among achieved savings and net benefits counted for the Performance Earnings Basis. Under the Performance Earnings Basis (PEB) now in force in California, assessment of program sponsor performance and determination of compensation are linked to a single quantity, namely: verified participant energy savings less a factor reflecting free ridership, evaluated over the entire program portfolio. This definition of benefits to be counted towards savings goals is inconsistent with the definition of program goals and guidelines used for the 2009 – 2011 programs reviewed above. If program sponsors are to be encouraged to expend program resources on efforts that are likely to generate market effects, then the performance of those measures should be assessed and their success compensated.

Based on our review in the previous sections of experience with planning, delivery, and evaluation of market transformation programs, we recommend that the CPUC and utilities undertake the following processes ***as early as possible in the development of plans for the 2009 -2011 programs*** to enhance the likelihood of success of market transformation efforts and to promote fair and useful evaluations of their outcomes.

a. **Identify programs in the utility portfolio that are likely to generate market effects during the three-year program cycle, and focus market-oriented planning and evaluation efforts on those programs.** Such programs are likely to be characterized by one or more of the following elements.
   - The products supported have been in the market long enough to have initial performance problems identified and addressed by manufacturers and installers.
   - There are well-established delivery channels for the product, and at least a few firms in the channel have begun to promote it.
   - It is possible that the product can be incorporated into mandatory codes and standards or into voluntary specifications such as ENERGY STAR within the next five years.
   - Levels of adoption or market share are low (less than 10 percent) in regions outside the program area.

b. **Commission initial market characterization research for those products and services for which the structure of the market and the motivations of the market actors are not well understood or documented, at least in terms of their response to the product in question.** Such markets would include, for example, supply chains

for residential and commercial HVAC products and services that are targeted by big bold initiatives. Similarly, the potential supply chains for zero-net energy residential and commercial construction are not clearly defined or understood.

c. **For programs deemed likely to generate market effects, develop program logic models that explicitly identify the mechanisms by which the programs will achieve market effects.** The logic modeling process will be used to identify indicators of market change to be developed over the three year period as well as in summative evaluations of program performance. To the extent possible, the model should include expected values or goals for program outputs, participation, and indicators of market change. Program sponsors and Peer Review Groups should collaborate in developing the models to ensure that they reflect the knowledge of individuals and groups with close working knowledge of the targeted markets. Finally, these models should be included in filed Program Implementation Plans and reviewed by CPUC staff prior to final acceptance.

d. **For programs deemed likely to generate market effects, develop preliminary evaluation plans that specify the preferred approach(es) to estimating net savings.** As the examples discussed in Section 6 make clear, the efficacy of the basic analytical methods in delivering credible estimates of program effects on measure adoption depends on a number of factors, including: the stage of national and international market development during the evaluation period, the availability of current and historical sales or market share data, support for the product in other jurisdictions (hence the availability of appropriate comparison regions), and experience with analogous products or markets to be mustered in generating baselines through case study or expert judging methods. These factors need to be considered in determining whether market-oriented methods can be used to estimate net savings and, if so, what method will be preferred.

   This effort should be undertaken as early as possible in program development and should involve representatives of the program sponsor, the program delivery contractor, the Peer Review Group, and the Commission's evaluation consultant. The plans should include the following:

   - Specification of market change indicators to be developed.
   - Assessment of quality of currently available data to develop the market change indicators.
   - Assessment of the type and level of effort required to data that are not currently available.

- Assessment of the strengths and limitations of the four attribution analysis methods in relation to the product under review.
- Recommendation regarding the preferred method to be used in the attribution analysis.

7.2.2 Market Transformation Program Planning

Recommendation #2: Establish a process to identify products or services for which program support should be withdrawn or reduced over the program cycle and to formulate plans for an orderly withdrawal from the market. As discussed in Section 3, program sponsors in other jurisdiction make this assessment in the course of annual program reviews, guided primarily by data on market share and the status of barriers identified in the initial market assessment. The results of the recently completed draft report of the CFL market effects study show that sales of CFLs per household in non-program areas have attained the same levels as those currently experienced in California and other states. (The Cadmus Group 2009) Moreover, federal standards taking effect in 2012 will effectively restrict the use of incandescent bulbs in many applications. While these findings do not necessarily negate the resource value of additional program support for CFLs in the short term, they do suggest that energy efficiency program portfolio resources might better be expended elsewhere. Studies reviewed in this report suggest that a variety of other measures should be subjected to a similar review. These include: T-8 lamps and ballasts; variable speed drives in most industrial process applications; and ENERGY STAR Clothes Washers.

In assessing whether to reduce program support, we recommend that the following be taken into account:

- Market share of the product within and outside of program areas.
- Recent trends in prices and availability.
- Likelihood of inclusion in a near-term codes or standards rulemaking.
- Market readiness of more efficient substitute technologies.

This assessment should be made by program sponsors working closely with the Peer Review Group and representatives of the CPUC evaluation consultant team. If the decision is made to reduce or eliminate program support, the sponsor and the Peer Review Group should develop a plan for the orderly winding down of program support, in order to ensure the continued willingness of supply-side market actors to participate in future programs. Of course, these plans should be subject to review by the CPUC staff.

Recommendation #3: Provide market research support to validate proposed growth strategies for products and services supported by the Emerging Technologies Program. The case for public investment to support new technologies will be greatly enhanced by research to validate proposed growth strategies. Specific kinds of issues to be researched in this regard would include: feasibility of technology licensing and other methods to gain rapid increases in volume; motivations and capabilities of downstream market actors such as retailers and contractors to promote and install the technology; and presence, price, and performance characteristics of competing or similar products on the market.

7.2.3 Market Effects Evaluation

Recommendation #4: Conduct one or more pilot studies involving cross-sectional analysis of the market share for energy-efficient practices in California compared to other jurisdictions. Several High Impact Measures – refrigerant charge and airflow checks (RCA), steam trap replacement, and hot water pipe/tank insulation – involve customer adoption of installation and maintenance practices as opposed to purchase of efficient equipment. Cross-sectional studies of the prevalence of these measures would strengthen estimates of the net benefits of programs to support these measures. They would also provide strategic insights into the need for and design of such programs.

Recommendation #5: Conduct research to define and assess the validity of indicators of sustained market effects other than changes in codes and standards. As discussed in Section 2, analysts have proposed a number of indicators of sustained market changes other than changes in codes and standards. However, we know of no systematic efforts to operationalize and measure these indicators or to apply them in program planning decisions. We recommend conducting a research study based on existing sources to reconstruct trends in market share, incremental prices, customer awareness, and vendor practices for energy-efficient products and services that have achieved high levels of acceptance. Such a study would provide program sponsors and regulators with some historical reference against which progress with current programs can be compared.

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Table of Acronyms

Acronym	Spelled-out Name	Definition
ACEEE	American Council for an Energy-Efficient Economy	Energy efficiency research and advocacy organization
ARI	Air-Conditioning and Refrigeration Institute	Industry association of cooling and refrigeration equipment manufacturers
CEC	California Energy Commission	The state energy agency of California
CEE	Consortium for Energy Efficiency	Research and advocacy organization focused on support of development of product and service standards supported by local energy efficiency programs
CFL	Compact Fluorescent Light	Compact fluorescent light bulb, fixture, or lighting technology
CPUC	California Public Utilities Commission	
DEER	Database of Energy Efficiency Resources	Compilation of detailed cost and savings characterizations for a wide range of energy efficiency measures, calibrated to California climate conditions and building inventory
DOE	U. S. Department of Energy	
EESP	Energy Efficiency Service Provider	Company participating in the NSPC programs
EPACT	Energy Policy Act (of 2005)	Federal energy legislation that contained a number of provisions strengthening product energy efficiency standards.
ESPC	Energy Service Performance Contractor	Contractors who design and install energy efficiency measures and provide some protection to customers against the project performance risk
FEMP	Federal Energy Management Program	Program focused primarily on increasing energy efficiency of Federal facilities and operations
GAMA	Gas Appliance Manufacturers Association	Industry association of gas appliance manufacturers
HVAC	Heating, Ventilation, and Air Conditioning	
IOU	Investor-Owned Utility	Privately owned utility subject to regulation by state utility commissions

Acronym	Spelled-out Name	Definition
IRP	Intregrated Resource Planning	Approach to electricity system planning that explicitly takes energy efficiency into account in planning for resource adequacy and places a value on efficiency based upon avoided supply costs.
LED	Light Emitting Diode	Lighting technology based on solid state components
MT	Market Transformation	
NEMA	National Electrical Manufacturers Association	Major trade association for manufacturers of electrical equipment
NREL	National Renewable Energy Laboratory	
NSPC	Non-Residential Standard Performance Contract	Energy efficiency program operated by California utilities to encourage energy efficiency investments among large commercial and industrial customers
NYSERDA	New York State Energy Research and Development Authority	
PEB	Performance Earning Basis	Estimation of energy savings upon which shareholder incentives for operation of energy efficiency programs are based in California
PIER	Public Interest Energy Research	Research and development program operated by the California Energy Commission
PTE	Program Theory Evaluation	Approach to program evaluation based on definition and testing of program logic
RA	Resource Acquisition	
RECW	Resource-Efficient Clothes Washer	

Appendix 1: Literature Review

The following pages provide an annotated bibliography of most of the sources referenced in the text. They are grouped by the following broad topic areas:

- Evaluation
- Market and Technology Studies
- Policy Analysis
- Theory

For each publication, we provide a full bibliographic citation, a thumbnail description of its contents, and indicators regarding particular relevance to the following issue areas: mechanisms and models of market transformation, market effects indicators, analysis of attribution, and regulation.

Evaluation

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Grover, Stephen, and Charisa Flaherty, 2003. "A Comparison of Rebates and Non-Rebate Promotions in a Residential Lighting Program." In *Proceedings of the 2003 International Energy Program Evaluation Conference.* Seattle: August 2003.	Analysis of CFL sales data and program activities carried out as part of the evaluation of the Northwest Energy Efficiency Alliance's Residential Lighting Program.		X	X	X
Dickerson, Chris Ann, Frederick D. Sebold, Alan Fields, Lisa Skumatz, Shel Feldman, Miriam Goldberg, Ken Keating, and Jane Peters. *A Framework for Planning and Assessing Publicly Funded Energy Efficiency*. Report prepared for Pacific Gas and Electric Company, March 1, 2001.	The predecessor to the 2004 California Evaluation Framework, California's 2001 Framework for Planning and Assessing Publicly-Funded Energy Efficiency provides a thorough overview of evaluation theory and approaches for both market transformation and resource acquisition aspects of energy efficiency programs.	X	X	X	X
Clarke, Ann, Timothy Pettit, Robert Allgor, David Hill, and Ralph Prahl. "A Theory-based Evaluation of LIPA's Solar Pioneer Program: Measuring Early Progress in the Transformation of the PV Market on Long Island." A Paper presented at the 2005 International Energy Program Evaluation Conference. Chicago. 2005.	This paper examines the application of theory-based evaluation to demonstrate how it can be a useful tool in measuring the progress of a solar photovoltaic program, as well as provide feedback for program modification and improvement.	X	X		X

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
McRae, Marjorie R., Peters, Jane S., Sutter, Mary, and Ridge, Richard, 2005. "Building Efficiency Program Process and Impact Evaluation: End of Second Program Year", *Submitted to Degens, Phillip, Energy Trust of Oregon*, *Inc*. December 30, 2005	This report describes an impact evaluation conducted at the latter half of the Building Efficiency Program's second year and a process evaluation completed in early 2005. This report evaluates the program's free rider and spillover effects, the penetration of efficient lighting projects in ETO's service territory, and program satisfaction. It also includes program recommendations.	X	X		
Agnew, Ken, Paula Ham-Su, and Miriam Goldberg. *Focus on Energy Statewide Evaluation: Business Programs: Lighting and Motor/Drive Channel Market Effects Contract Metrics Assessment*. Report prepared for State of Wisconsin, Department of Administration, Division of Energy, November 10, 2006.	This report provides the Focus Business Program market effects contract metrics assessment for fiscal year 2006 for the motor/drive channel, the lighting channel, the agricultural program, and the pulp and paper industry cluster. Assesses market effects metrics for Wisconsin Focus on Energy Business Programs. For motor/drive and lighting channels, two methodologies are used: share-oriented metrics rely on sales volumes and stock shares, and "market presence" metrics compare participating vendors to the population of potential vendors. For pulp & paper industry, methodology quantifies use of best practices guidebook.		X		
Sulmya, Iris, M., Fielding, D., Johnston, J. Gin, Haeri, H., Lee, A., 2003. "Buying Success: Bulk Purchase Programs As Agents of Market Transformation". In *Proceedings of the 2003 International Energy Program Evaluation Conference.* Seattle: August 2003.	Between 1989 and 1995 BC Hydro's Power Smart program conducted a number of initiatives to promote and encourage the use of screw-based integrated compact fluorescent light bulbs (CFLs) by residential customers. Individual programs were evaluated, and energy savings attributable to programs were estimated and reported where possible. Traces the role of bulk CFL purchase programs in the acceleration of market transformation		X	X	

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Pacific Consulting Services and Shel Feldman Management Consulting, 1999. *ENERGY STAR® Residential Lighting Fixtures Program Market Effects Assessment: Market Progress Evaluation Report #2.* Portland, OR: Northwest Energy Efficiency Alliance.	Develops indicators of market progress, including: increasing consumer awareness; increasing number of manufacturers; increase in variety of products available; retailer in-store promotions, shelf placement, & feedback to consumers; increased specification in new construction; prices drop to levels competitive with standard fixtures; increase in market penetration. Develops concepts and criteria for exit strategies.	X	X	X	X
KEMA, Inc. 2007. *ENERGY STAR® Consumer Products Program: Market Progress Evaluation Report.* Portland, OR: Northwest Energy Efficiency Alliance.	This report is the second of two Market Progress Evaluation Reports that document the status and assess the progress of the ENERGY STAR® Home Products Program at the Northwest Energy Efficiency Alliance. The Program fosters consumer acceptance of appliances that qualify for the EPA's ENERGY STAR label (clothes washers, dishwashers, refrigerators, and room air conditioners). Good examples of sales data collection and analysis for CFLs and Appliances.		X	X	
Nexus Market Research, Inc. and Dorothy Conant, 2007. *Evaluation of the Massachusetts ENERGY STAR® Homes Program: Executive Summary.* Joint Management Committee.	This document is a market progress evaluation report (MPER) on the Massachusetts ENERGY STAR® Homes Program run by the Joint Management Committee (JMC) in Massachusetts. This report contains the findings and analysis of the ENERGY STAR Homes Program evaluation work conducted in 2006, with the individual evaluation reports on which the findings and analysis are based as appendices. Uses repeated surveys to track increase in importance of energy efficiency among new home buyers; and improvements in construction practices		X	X	

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Nexus Market Research, Inc., RLW Inc., and Dorothy Conant, 2007. *Market Progress and Evaluation Report for the 2007 Massachusetts ENERGY STAR® Lighting Program. Cape Light Compact, National Grid, NSTAR Electric, Unitil, Western Massachusetts Electric.*	This 2003 Market Progress Evaluation Report (MPER) tracks changes in the Massachusetts residential lighting market. This report explains and assesses the extent of the current transformation of the Massachusetts lighting market as a result of the Massachusetts ENERGY STAR® Lighting Program. Found that both out-of-program sales in MA and increases nationally indicate that the market is being transformed.	X	X	X	
XENERGY Inc., 2002. "Final Report: Phase 1 Evaluation of the Efficiency Vermont Efficient Products Program". *Prepared for Vermont Department of Public Service, Montpelier, Vermont.* June 10, 2002	This is the Final Report of the Phase 1 Evaluation of Efficiency Vermont's (EVT's) Efficient Products Program (EPP). This evaluation assesses the accomplishments of the program from its inception in March 2000 through December 2002. The program addressed lighting (CFL bulbs and efficiency fixtures) and appliances (clothes washers, refrigerators, dishwashers, and room air conditioners). This evaluation characterizes the baseline market conditions for each of the program areas; assesses the effects of the program on markets; evaluates the success of programming efforts on consumer choice; and recommends program improvements. Bulb sales from a sample of retailers were analyzed and compared with other data sources to estimate the market effects of the lighting portion of the program. Appliance market share was estimated using cross-sectional net effects modeling analysis.		X	X	
KEMA, Inc., 2005. "Final Report: Phase 2 Evaluation of the Efficiency Vermont Residential Programs". *Prepared for Vermont Department of Public Service, Montpelier, Vermont.* December 2005	This report is a program evaluation of Efficiency Vermont's Residential energy efficiency programs with goals to estimate EVTs net effects on CFL purchases, Energy Star appliance purchases, new construction practices and to identify opportunities for new programs and improvement of		X	X	

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
	existing programs. Updates cross-sectional methods and analysis from the previous round of analysis				
Wilson-Wright, Lisa, Shel Feldman, Lynn Hoefgen, and Angela Li, 2005. "Front-Loading Marketing: Assessing Cumulative Effects of ENERGY STAR Appliance Promotions on State-by-State Penetration Levels." In *Proceedings of the 2005 International Energy Program Evaluation Conference. B*rooklyn, New York: August 2005.	Evaluators of programs to promote ENERGY STAR - compliant appliances have typically struggled with how to asses the cumulative effects of such programs on market penetration and, therefore, on energy and cost savings. Cumulative effects reflect the momentum built by programs over time. Examined average rate of change in market penetration from 1998 to 2002 to assess the effect on change in penetration in 2003. The results demonstrate that the 1998-2002 changes in penetration had a significant and positive incremental effect on 2003 market penetration of CW and RAC. That is, the greater the previous increase in change in penetration, the greater the 2003 market penetration, suggesting faster rates of increase in the past are also associated with higher contemporaneous penetration, which may be interpreted as momentum effects or, perhaps, sustainability	X	X	X	
Teideman, Kenneth and Iris Sulyma. Evaluation of BC Hydro's CFL Promotion Program. Vancouver: BC Hydro, 2007.	This report is a market effects evaluation on BC Hydro Power Smart's residential Compact Fluorescent Lamp (CFL) initiatives for 2001 through 2004. The report addresses the degree to which the availability, accessibility, affordability, awareness and acceptance of CFLs has changed over the past three years and determines the market effect attributable to BC Hydro's CFL programming. Uses cross-sectional analysis of self-reported customer purchase and retailer shelf space data.		X	X	

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Ellefsen, Jennifer, Brad Kates, Steve Lacy, Michael Mernick, and Priscilla Richards. "New Means for New Ends: Adopting Evaluation Strategies for a New Generation of Market Transformation Programs." Paper presented at the 2001 International Energy Program Evaluation Conference. Chicago, 2001.	This paper examines market transformation evaluation, and the special considerations that play a role in assessing today's more comprehensive, holistic, and integrated program offerings.	X			
Xenergy, Inc., 2002. *Phase 4 Market Effects Study of California Residential Lighting and Appliance Program.* San Diego: San Diego Gas and Electric Company.	This report presents the results of the Phase 4 Evaluation of the California Statewide Residential Lighting and Appliance Program. Program years analyzed in this study include 1999, 2000, and 2001. Data collection included customer surveys, mystery shops, and manufacturer and retailer interviews. The study concludes Market shares in California have increased substantially over time for ENERGY STAR® appliances and lighting products..		X	X	
Hewitt, David. *Proposed Market Assessment and Evaluation Guidelines for Market Transformation Initiatives in the Northeast*. Report prepared for Northeast Energy Efficiency Partnerships, June 23, 1998.	This paper discuses how to evaluate the success of market transformation efforts, and to suggest guidelines for market transformation market assessment and evaluation efforts. It focuses on the Northeast and the regional initiatives developed there, but many of the issues and possible solutions discussed will have broader applications. The goals and objectives for a MT initiative will generally focus the evaluation on market barriers and market effects. To determine indicators of the effects, an evaluation may look for a reduction in market barriers, changes in awareness of the market intervention by different market actors, or other changes in indicators of market effects. Overall, the report found that MT initiatives require ongoing evaluation efforts to	X	X	X	X

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
	assess their progress towards goals and objectives.				
Grover, Stephen and David Cohan, 2001. "Shedding Light on ENERGY STAR Markets: Evaluation Lessons from a Retail Lighting Market Transformation Program. In *Proceedings of the 2001 International Energy Program Evaluation Conference*. Salt Lake City: August 2001.	This paper presents evaluation analysis for one energy efficiency lighting program offered in the Pacific Northwest. The evaluation focuses on Phase II of the Energy Star Residential Lighting Program (Phase II) sponsored by the Northwest Energy Efficiency Alliance (the Alliance). This program offers support to retailers in a variety of forms to conduct sales of Energy Star-qualifying CFL bulbs and fixtures. The speed in which the CFL market is developing is evidenced by the dramatically changing scope of this evaluation over the life of this project.		X	X	
TecMarket Works Framework Team. *The California Evaluation Framework*. Report prepared for the California Public Utilities Commission and the Project Advisory Group, June, 2004.	The 2004 California Evaluation Framework provides a comprehensive set of guidelines for conducting evaluations of California's energy efficiency programs. It contains a protocol for evaluation of market effects.		X	X	X
Rosenberg, Mitchell. "The Impact of Regional Incentive and Promotion Programs on the Market Share of ENERGY STAR® Appliances." Paper presented at the International Energy	This paper reports the results of the evaluation of the net impacts on efficient appliance sales of Efficiency Vermont's Efficient Products Program (EPP). It presents the methods and results of the cross-sectional analysis of efficient appliance market share and its implications for program		X	X	

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Program Evaluation Conference, Seattle, Washington, August 20-22, 2003.	effects. It also assesses the strengths and limitations of the method used.				
Shel Feldman Management Consulting, Research into Action, Inc., XENERGY, Inc., 2001. "The Residential Clothes Washer Initiative: A Case Study of the Contributions of a Collaborative Effort to Transform a Market" *Prepared for Consortium for Energy Efficiency.* June 2001	This report reviews the effects of CEE's Residential Clothes Washer Initiative (RCWI) and identifies CEE's contributions to increasing the availability and penetration of resource-efficient clothes washers in the North American market. This report is a good example of the application of the case study method to assessing the effects of various program sponsors' contributions to a long-term, complex program effort.	*X*	*X*	*X*	
PA Consulting. *Third Interim Evaluation Report for the Energy Efficiency Performance (EEP) Program of the Wisconsin Focus on Energy Pilot,* Madison, WI, 2001	The evaluation entailed case studies of sponsors of the Energy Efficiency Performance (EEP) program. The main finding was that the program has had very little lasting impact to-date on sponsors' business practices, because EEP projects are seen as appropriate only for certain types of customers and measures.				
Hewitt, Dave, Pratt, Jeff, and Smith, Gary, 1998. "A Second Washwise Market Progress Evaluation Report". *Prepared from the Northwest Energy Efficiency Alliance*, July 28, 1998	This study addresses the WashWise program. This is the second review of the market effects for resource-efficient clothes washers (RECWs). In order to influence program design and understand market indicators, phone surveys were done with 400 participant/purchasers of RECWs and 402 general consumers. An intercept survey of 43 consumers, telephone interviews with retailers, major manufacturers, and 4 large retail chains were also done.		*x*		

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
DeCotis, Paul A., Mahone, Douglas, 2005. "An Integrated Portfolio Approach to Evaluating Energy Programs. New York's Experience". In *Proceedings of the 2005 International Energy Program Evaluation Conference*. New York: August 2005.	The New York Energy $martSM Program presents unique evaluation challenges due to the wide range of program offerings and NYSERDA's need for efficient and effective evaluations with limited resources. In response, NYSERDA has developed an integrated evaluation approach that differs substantially from traditional, program-by-program evaluations. This paper describes the integrated evaluation framework, its benefits and limitations, and shares the experiences of NYSERDA and its evaluation contractors with readers.		x		x
McRae, Marjorie R., and Peters, Jane S., 2001. "Market Progress Evaluation Report: Architecture + Energy Program, Final Report". *Submitted to Northwest Energy Efficiency Alliance,* June 30, 2001	This report provides information on the Architecture and Energy Program (A+E), the goal of which is to encourage design professionals to use "energy efficient/sustainable building practices." Based on a survey of 43 participants and 50 non-participants that asked architects detailed questions about their design practices, the report concluded that the projects of participants more frequently incorporate energy-efficient design practices than do the projects of non-participants. This finding was statistically significant. In addition, qualitative data strongly suggests that participants compared with non-participants use a greater number and variety of energy-efficient features in their designs that have any such features. Participants themselves credited their energy-efficient design practices to the influence of the A+E program. The report also offers a number of specific recommendations for the A+E program.	*X*	*X*	x	

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
TecMarket Works. *BetterBricks Building Operations Initiative: Market Progress Evaluation Report*. Report prepared for the Northwest Energy Efficiency Alliance, April 25, 2007.	This first Market Progress Evaluation Report (MPER #1) documents the progress of the BetterBricks Building Operations Initiative. Employs service provider interview data to establish baseline snapshots of existing services, proposal development processes, and identifiable business and customer benefits. Use of more granular market progress indicators was impeded by definitional ambiguities.	.	X		
Brost, Matt, April Thanarat, Pete Jacobs, and Catherine Chappell. "Contrasting Approaches to Estimating Program Net Savings in NRNC." Paper presented at the International Energy Program Evaluation Conference, Seattle, Washington, August 20-22, 2003.	The Building Efficiency Assessment Study's (BEA) key objectives are to develop gross whole building energy and demand impact estimates, impact estimates of both incented and non-incented measure categories, estimates of both free-ridership and spillover at the measure and end-use level, and provide a process evaluation of the Savings By Design (SBD) program. Identifies weaknesses of the difference-of-differences approach to estimating program net savings, specifically, the approach fails to provide measure-specific information and spillover data. Two alternative methodologies are developed, self-reported analysis relying on survey responses, and difference-of-differences supplemented with self-reported spillover. Concludes that as market transformation accelerates and spillover grows, self-reported analysis should replace difference-of-differences as the preferred approach to program attribution.	X	X	X	

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Prahl, Ralph, Miriam Goldberg, David Sumi, Tom Talerico, Bobbi Tannenbaum, Bryan Ward, Rick Winch. "Integrating Supply-Side Results with End-User Net-to-Gross Self-Reports. Madison, WI: Public Service Commission of Wisconsin. July 2, 2008.	Lays out considerations concerning cases in which it may be appropriate to use the results of supply side research to alter net-to-gross ratios based on the results of self-reports from customer surveys. Circumstances where such an approach would be warranted include program effects that constrain selection to purchase inefficient options; broadens the range of efficient options available, changes in prices, or change in vendor business strategy. Alterations to self-report methods can take place in question sequence, estimation algorithm, or post-hoc.				x
Quantec, Inc. Statewide Codes and Standards: Market Adoption and Compliance Rates. Rosemead, CA: Southern California Edison. 2007.	Uses expert-estimated market shares: initial, maximum, and inflections in Bass-type diffusion curves. Estimated with and without program in place. Energy savings estimated based on secondary data on market size and unit energy savings. Interesting application of Delphi judging using net-accessible graphic interface.`		X	X	
Michael W. Rufo, *Evaluation of the 1998 Nonresidential Standard Performance Contract Program*, report prepared for California Board of Energy Efficiency, June 18, 1999	This report uses a variety of methods to assess the market effects of a program to promote energy performance contracting. Notable for use of a wide range of sources on market structure, operations, and program response, and for explicit consideration of the quality of data sources and evidence used in assessment of market effects.		X	X	
KEMA, Inc. *Focus on Energy Evaluation, Business Programs: Channel Studies – Fiscal Year 2008.* Madison, WI: Wisconsin Public Service Commission. January, 2009.	This report uses data on market of efficient high bay lighting, high-efficiency commercial air conditioners, and variable speed drives developed from vendor and customer surveys in Wisconsin and Illinois (a non-program area) to conduct a cross-sectional analysis of market effects. Significant differences in reported market share were found for high bay lighting but not for the other subject technologies.		X	X	

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Winch, Rick and Tom Talerico, 2008. *Second Annual Comprehensive CFL Market Effects Study.* Madison, WI: Wisconsin Focus on Energy.	This study analyzes the effect of CFL promotions on the pace of adoption. Evaluators collected CFL sales data from stores in Wisconsin and Michigan, with the latter used as a comparison/baseline area. Shows that a large increase in CFL sales in Wisconsin from 2006 to 2007 was nearly matched by an increase in Michigan, a non-program state. Used CFL sales per household in the two states and program sales per household in Wisconsin to calculate a net-to-gross sales ratio.		X	X	

Market and Technology Studies

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Mauldin, Thomas, Angela Li, Lynn Hoefgen, Thomas Ledyard, Betty Tolkin, and Shel Feldman, 2005. "Are Retailers Gaming the System? Availability and Pricing of ENERGY STAR Room Air Conditioners." In *Proceedings of the 2005 International Energy Program Evaluation Conference*. Brooklyn, New York: August 2005.	Analyzes sales of ENERGY STAR room air conditioners (RAC) and considers hypothesis that higher third quarter sales of ENERGY STAR RAC stems from consumers selecting cheaper, non-ENERGY STAR models at beginning of summer and more expensive ENERGY STAR models toward end of summer when non-Energy Star models are sold out. Compared prices and features of ENERGY STAR and non-ENERGY STAR RAC, collected in retail pricing survey. Used regression analysis of price and feature information on models available in MA in May and August 2004. Used results to develop recommendations regarding incentive levels.		X	X	X
Oman, Susan, Lynn Hoefgen, Angela Li, and Ralph Prahl. "Blinded by the Light: Why Are We in the Dark about How Many CFLs are Out There?" In *Proceedings of the 2007 International Energy Program Evaluation Conference*. Chicago: August 2007.	In this paper, we present evidence that commonly used estimates for national sales of CFLs are no longer accurate, explores how the national CFL market is changing, and examines why a nationally coordinated data collection effort is prudent. Calculates baseline CFL sales and net-to-gross (NTG) estimates for selected states and regions. Shows how program effects can be extend beyond incentivized sales when reliable, documented estimates of retail sales data are available.		X	X	

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Blake, William R., Shel Feldman and Dorothy Conant. "Dressing the Priestess: Preparation for and Results of a Delphi Study for a Residential New Construction Program." Proceedings of the 2003 International Energy Program Evaluation Conference, Seattle, August 2003. pp. 863 – 874.	To meet regulatory needs, the Massachusetts utilities sponsoring the ENERGY STAR® homes program required a ten-year forecast of the market penetration of qualifying units. A Delphi analysis was conducted, with a panel comprising nine experts, including a representative of the state's building community, an economist who deals with the housing market, a state codes expert, and national experts on the ENERGY STAR program, as well as a program implementation contractor, and members of the program management committee. The expert panel forecasted market share of ENERGY STAR homes under three program scenarios, including a baseline scenario of program termination.		X	X	
Urge-Vorsatz, Diana, and Jochen Hauff. "Drivers of Market Transformation: Analysis of the Hungarian Lighting Success Story." Energy Policy 29 (2001): 801-810.	Useful for modeling market penetration for prospective benefits. Details methods of developing market forces as: end-user survey, small end-user interviews and focus groups, supplier surveys and interviews, meetings with lighting experts, NGOs, other non-supplier groups. First two methods used for understanding market barriers/drivers; latter two for understanding dynamics of Hungarian CFL market. Identifies sets of market drivers and sets of market barriers. Identifies primary drivers as vendor competition, marketing/advertising, increases in nominal electricity rates, and to a lesser extent, sexiness and environmental considerations. Primary barrier is lack of information relating to understanding real economic benefits of CFLs. Strong correlation between high income and high penetration.	X	X	X	

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Jones, Donald, W., Bjornstad, David, J., Greer, Lee, A., 2002. "Energy Efficiency, Building Productivity, and the Commercial Buildings Market" *Prepared for the US Department of Energy,* May 8, 2002	The energy-efficiency gap literature suggests that building buyers are often shortsighted in their failure to apply life-cycle costing principles to energy efficient building technologies, with the result that under-investment in these advanced technology occurs. This study examines the reasons this behavior may occur, by analyzing the pressures that market forces place on purchasers of buildings. The basic conclusion is that the fundamental manner in which the buildings sector does business creates pressures to reduce initial capital outlays and to hedge against a variety of risks, including the ability of building owners to capture benefits from energy efficiency. Starting from the position that building buyers' willingness to pay drives choices over building attributes, the authors examine basic market principles; the structure of the buildings market, including the role of lenders; and policies that promote penetration of energy efficient technologies. The report concludes that greater attention to buyers, and to the incentives and constraints they face, would promote a better understanding of building investment choices and contribute to better policies to promote the penetration of these technologies into markets.	***X***			***X***
Sebold, Frederick, Alan Fields, Susan Bortstein, Phong Vu, Rachel Weber, Richard Pulliam, and Rick Ridge, 2001. "Tracking Market Shares of High Efficiency Measures in California's Residential Sector." In *Proceedings of the 2001 International Energy Program Evaluation Conference*. Salt Lake City.	Presents early results of state-level and national market share tracking efforts for residential products		**X**		

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Research Into Action, Inc. *Commercial Sector Initiative Baseline Study: Architects, Market Baseline Evaluation Report*. Report prepared for the Northwest Energy Efficiency Alliance, November 4, 2004.	This report is a 2003 baseline study of architects in the Pacific Northwest, examining the architects' role in design decisions relevant to the energy-efficiency of the finished building, the extent to which they consider energy-use implications when making relevant design decisions, and the extent to which they are aware of and report using various specific energy-efficiency technologies and resources. Uses results of in-depth phone interviews with commercial architects to establish baseline values regarding architectural trends and practices. Surveys covered items including square footage, business norms, program awareness, market barriers, and decision-making processes.		X	X	
Ecos Consulting, 2002. *Energy Efficient Lighting in New Construction,* Portland, OR: Northwest Energy Efficiency Alliance.	This Report summarizes the background research for the design and development of a Residential New Construction Program. The research was focused in three main categories: residential construction, residential lighting energy use, and barriers to market transformation. The most important finding for residential construction is the fact that energy efficient lighting fixtures commonly cost 1.5 – 2.5 times that for conventional ones. This fact confirms the need for a designed energy-efficient lighting system, which may reduce the number of fixtures required, rather than a one-to-one exchange of fixtures. Barriers to market transformation include price differentials of energy-efficient fixtures; parties involved in design or specification of lighting, as well as electrical distributors, home improvement centers, and lighting showrooms have little lighting design expertise; and, most new residential construction energy efficiency programs have not addressed optimal selection of light	X	X		

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
	sources and enhanced architecture for day lighting.				
Four Winds Alliance D&R International, 2000. "Opportunities for New Appliance Market Transformation Programs in the Pacific Northwest" *Prepared for The Northwest Energy Efficiency Alliance*. July 2000	This report takes a detailed look at the marketing and distribution trends for household appliances. To determine future market transformation program opportunities for refrigerators, freezers, clothes washers, clothes dryers, and dishwashers, existing reports were examined. Research was further gathered from interviews with manufacturers, national retailers, independent retailers, contractors, multi-family builders and property managers, public housing agencies, and regional and national market transformation stakeholders..	X	X		

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
U.S Environmental Protection Agency, ENERGY STAR Program. *Report to Congress on Server and Data Center Energy Efficiency.* Washington, D. C. August 2, 2007.	The United States (U.S.) Environmental Protection Agency (EPA) developed this report in response to the request from Congress stated in Public Law 109-431. This report assesses current trends in energy use and energy costs of data centers and servers in the U.S. and outlines existing and emerging opportunities for improved energy efficiency. It provides particular information on the costs of data centers and servers to the federal government and opportunities for reducing those costs through improved efficiency. It also makes recommendations for pursuing these energy-efficiency opportunities broadly across the country through the use of information and incentive-based programs.	X	X		X

Policy Analysis

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Sandahl, L.J., T.L. Gilbride, M.R. Ledbetter, H.E. Steward, and C. Calwell. *Compact Fluorescent Lighting in America: Lessons Learned on the Way to Market.* Prepared by the Pacific Northwest National Laboratory for the U.S. Department of Energy under Contract DE-AC05-76RLO 1830. June 2006.	This report reviews efforts to increase market acceptance and barriers of CFL's. The lessons learned are presented in three categories: those pertaining to technology, to marketing, and to program design. Also includes lessons learned from recent interviews PNNL conducted with CFL manufacturers regarding how their experiences would apply to the market introduction of LEDs or other new lighting technologies. Traces history of CFL market adoption through programs, technological advancements, policy and regulatory initiatives, and other influences. Identifies barriers to increased market acceptance and solutions Includes specific recommendations for program administrators, manufacturers, energy-efficiency groups and others for CFL programs, but these recommendations can be extended to other technologies, particularly in the lighting market.	X			X
Skumatz, Lisa A., and Charles Bicknell. "Comparing Award Mechanisms - What Works?" Paper presented at the International Energy Program Evaluation Conference, New York, New York, August 17-19, 2005.	Assesses "progress indicator" (market transformation) award mechanisms, including verification indicators and data needs. Pros and cons of progress indicator award mechanisms are considered in terms of both performance incentives and evaluation/verification. One notable disadvantage is the difficulty in determining "reasonable efforts" toward goals.				X

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Feldman, Shel, Marc Hoffman, Jane Peters, Mitchell Rosenberg. "Evaluating a Poster Child: Contributions of the Consortium for Energy Efficiency to the Clothes Washer Initiative." Paper presented at the 2001 International Energy Program Evaluation Conference. Chicago, 2001.	Short version of the evaluation of CEE's role in the development of the market for resource-efficient clothes washers. Good example of the use of historical tracing methods.	X	X	X	
Suozzo, Margaret, and Jennifer Thorne. *Market Transformation Initiatives: Making Steady Progress*. Report prepared for the American Council for an Energy-Efficient Economy, May, 1999.	Surveys nine residential and nonresidential market transformation initiatives across the country. Argues that market transformation programs involving high non-energy benefits, low incremental costs, and simple market structures are most successful	X			X
Nadel, Steven, and Howard Geller. *Market Transformation Programs: Past Results and New Initiatives*. Report prepared for the American Council for an Energy-Efficient Economy, 1996.	Concludes that the preferred market transformation strategy varies from product to product, and that codes and standards can play a critical role in achieving transformation.	X			
Barnes, Harley H. "Market Transformation: Half a Decade of Results from a Supply-Side Intervention." Paper presented at the International Energy Program Evaluation Conference, New York, New York, August 17-19, 2005.	Offers detailed description of NYSERDA's ENERGY STAR Products and Marketing Programs. Identifies key drivers of the Program using results of consumer surveys, information on stocking and display proportions, and market share data to track market changes.		.		

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Nadel, Steven, Jennifer Thorne, Harvey Sachs, Bill Prindle, and R. Neal Elliott. *Market Transformation: Substantial Progress from a Decade of Work*. Report prepared for the American Council for an Energy-Efficient Economy, April, 2003.	Surveys 28 major market transformation initiatives for residential, commercial, and industrial customers Rates each initiative on two dimensions: level of effort is scored on a three-point scale, and progress toward market transformation is scored on a five-point scale. Scores are subjective judgments by the authors. Offers extensive list of lessons learned.	X			
Schiller, Steve, 2007. "Survey of Energy Efficiency Evaluation Measurement and Verification (EM&V) Guidelines and Protocols. An Initial Review of Practices and Gaps and Needs" *Prepared for California Public Utilities Commission and The California Evaluation Outreach Initiative,* May 2007	*Survey to identify best practices in EM&V. Finds that a wide range of (non-statistically significant) indicators identified which my contribute to market effects - lack of leadership in identifying acceptable methods appears to be a common theme*	X			X
Horowitz, Marvin J., 2003. "An era of Energy Efficiency in the Commercial Sector: Investigation and Findings". In *Proceedings of the 2003 International Energy Program Evaluation Conference*. New York: August 2003.	*Describes specification and estimation of Houtthakker Taylor flow adjustment model to analyze electricity use in the US Commercial Sector from 1989 – 2000. The paper uses the results of this analysis to compare changes in energy intensity in states that have hosted extensive energy efficiency programs versus those that have not.*	X	X	X	

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Mahone, Douglas, Marian Brown, Nick Hall, Ken Keating, Lori Megdal, and Rick Ridge. "Highly Cost-Effective Savings: Appliance Efficiency Standards and Utility Programs." Paper presented at the International Energy Program Evaluation Conference, New York, New York, August 17-19, 2005.	Develops concept of net effects lifetime associated with C&S programs, and proposes savings estimation method to calculate it for purposes of program attribution. Notes cost-effectiveness of codes and standards as instrument of market transformation	X			X
Friedmann, Rafael, Bradley, Kris, and Torok, Christie, 2005. "Justifying the Audit Program Expense: A Study of California's Nonresidential Retrofit Programs". In Proceedings of the 2005 International Energy Program Evaluation Conference. New York: August 2005.	Uses review of qualitative data from past surveys to assess the role of energy audits in encouraging energy efficiency actions.	X	X		

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Hewitt, D.C., 2000. "The Elements of Sustainability." In *Proceedings for the 2000 Summer Study on Energy Efficiency in Buildings.* Asilmomar, CA: August 2000.	Examines six case studies to identify elements to be examined to determine the extent of transformation of a market, and whether it is sustainable on its own without program intervention: 1) Is someone making money by offering it? 2) Has a private market developed to continue the facilitation? 3) Has the profession or trade adopted it as a standard practice? 4) Would it be difficult or costly to revert to earlier equipment or practices? 5) Are end-users requesting or demanding it? 6) Have the risks to private market actors been reduced or removed? 7) Are purchasers satisfied with it?	X	X		
Hoefgen, Lynn, Angela Li, and Shel Feldman, 2006. "Asking the Tough Questions: Assessing the Transformation of Appliance Markets." In *Proceedings of the 2006 Summer Study on Energy Efficiency in Buildings. Asilmomar, CA: August 2006.*	Uses Hewitt's elements of sustainability (see above) to examine the sustainability of the market for efficient appliances in Massachusetts. Examines the remaining technical savings potential to help identify for which appliance types additional program investments may be warranted.	X	X		X

Theory

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
York, Dan with Bentham Paulos. *A Discussion and Critique of Market Transformation: Challenges and Perspectives*. Madison, WI: Energy Center of Wisconsin, 1999.	This review addresses the issue of "market transformation" by exploring the various theories and practices associated with this new model for energy efficiency programs. Despite its rapid acceptance, market transformation is vaguely defined. The intent of this report is to increase the understanding of market transformation in its various forms so that program developers and policymakers can design effective programs and have realistic expectations. Included are a number of different viewpoints from experts in the field and recommendations for further work needed to create a consistent and useful basis of understanding. Basically makes point that, as of writing, theoretical underpinnings of MT are weak. Not really an economic concept, more of a marketing concept.	X			
Duke, Richard and Daniel Kammen, "The Economics of Energy Market Transformation Programs," *The Energy Journal*, 20 (4): 15 - 64, 1999.	Presents a formal microeconomic model of market transformation based on the learning curve theory and empirical estimation of progress ratios for three products that have been the subject of MT programs. This model is placed in a formal welfare economic model in which public support to increase market acceptance of clean technology reduces deadweight loss associated with environmental externalities. The model specifies a feedback loop: increased sales due to the MT Program --> lower prices --> greater sales increases. Analysis estimates the price decrease associated with increases in sales directly attributable to the program, then estimates the secondary effect by applying an elasticity factor, also estimated	X	X	X	X

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
	empirically. Analysis indicates that markets with the following characteristics most appropriate targets for MT: strong demand once subsidy ends; rapid cost reductions (high progress ratio, low cumulative production v. potential market), elastic demand, high externalities, availability of sales and price data.				
Hall, Nick, Carmen Best, Johna Roth, Pete Jacobs, and Loren Lutzenhiser. "Assessing Markets to Design Programs That More Fully Attack Key Market Barriers and Take Advantage of Market Opportunities - Why Do We Continue to Miss So Many Opportunities?" Paper presented at the International Energy Program Evaluation Conference, New York, New York, August 17-19, 2005.	In 2004, the California Energy Commission (CEC) launched a project to identify key barriers not adequately addressed by California's programs. In this paper, the barrier classification approach used by the CEC and the AB-549 research team is presented as well as a discussion of the specific barriers that were classified. Develops market barrier classification framework, incorporating product, participant, market, purchase, and provider barriers. Framework is coupled to Rogers' technology diffusion model to create comprehensive program design and evaluation tool encompassing different adoption processes, trigger points, and intervention strategies.	X			X

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Mauldin, Tom, Tom Franks, and Margaret Cush Grasso, 2003. "Assessing Residential Market Transformation Programs Through Retail Sales Analysis." In *Proceedings of the 2003 International Energy Program Evaluation Conference*. Seattle: August 2003.	This paper discusses recent efforts to collect and analyze appliance and lighting sales records from stores in the northeastern U.S. This analysis provides insight on the impact of programs on the rebated and un-rebated sales of qualified products at retail stores. Compares retail appliance and lighting sales in program areas to non-program areas. Compares volume of incentives with sales of qualifying products to assess extent of qualifying products sold without incentives. Assesses trends over time, comparing pre-program to post-program sales.	X	X	X	
Talerico, Tom, Lark Lee, Kimberly Bakalars, and Barbara Smith, 2003. "Are Education and Training Programs Producing Knowledge and Behavioral Effects in Wisconsin?" In *Proceedings of the 2003 International Energy Program Evaluation Conference.* Seattle: August 2003.	The Wisconsin Department of Administration's (DOA) Public Benefits program, Focus on Energy (Focus), provides a variety of education and training (E&T) programs to the business and residential sectors as part of its overall efforts to achieve long-term market transformation. The primary research is whether or not the Focus E&T programs are affecting the knowledge and behavior of attendees such that they are more likely to implement energy efficiency practices. Evaluation documents changes in self-reported behavior of workshop attendees. Data collected post-training via depth-interviews with ratings		X	X	
Goldberg, Miriam L. "Does Talking About Barriers Just Get in the Way?" Paper presented at the International Energy Program Evaluation Conference, Seattle, Washington, August 20-22, 2003.	The identification of market transformation barriers by Eto, Prahl & Schlegel's Scoping Study (1996) established an economic justification for continued public funding of energy-efficiency programs, and offered a strategy for transitioning away from the need for such funding. This paper reconceives of market barriers as factors that reduce demand for energy efficiency by increasing costs or decreasing benefits perceived by end-users				

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Goldberg, Miriam L., G. Kennedy Agnew, Lori Boekler. *Focus on Energy Public Benefits Evaluation, Business Programs: Market Effects Proforma Estimates.* Middletown, WI: PA Consultants. February 6, 2003.	This report presents a procedure for projecting energy savings due to market effects of the Focus on Energy Business Programs and offers preliminary projections using that procedure.. The analysis projects adoptions of energy efficiency measures (outside the program) with and without Focus over a 25-year time frame. Market effects leading to increased energy efficiency adoption are modeled separately for end users and suppliers. The end-user methodology is based on a diffusion model of energy efficiency adoption with and without Focus. The supplier market effects are modeled in terms of increased sales by program allies only. This report attempts to estimate long term market effects of programs up to and beyond their termination. It thereby addresses the issue of sustainability of market effects and the measurement of that phenomenon. The programs under evaluation do not promote specific measures, rather a broad based approach to increasing energy efficiency in C&I facilities. This raises the measurement issues in regard to estimating energy savings.	X		X	X
Saxonis, William P. "Free Ridership and Spillover: A Regulatory Dilemma." Paper presented at the International Energy Program Evaluation Conference, New York, New York, August 17 - 19, 2005.	This paper critically examines recent free rider and spillover results from energy efficiency programs administered by the New York State Energy Research and Development Authority (NYSERDA) The paper collects the results of free ridership and spillover estimates developed through self-reported surveys using similar methods. It finds large differences in estimated spillover and free ridership rates among evaluations of similar programs conducted during the same period	X		X	X

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Reed, John H., Gretchen Jordan, and Edward Vine. *Impact Evaluation Framework for Technology Deployment Programs. Washington D. C.:* U. S. Department of Energy, 2007.	This report describes a framework for evaluating the retrospective impact of technology deployment programs. Program managers and evaluators in Federal, state, and local governments and in public entities and institutions are increasingly accountable for delivering and demonstrating results of their programs. Presents market transformation largely in terms diffusion of innovation. The general model also incorporates a number of concepts from recent studies of innovation, including analysis of adoption processes among consumers and producers, considerations of social networks, the effect of product attributes such as complexity and trialability on customer acceptance, and program/process modeling	X	X	X	
Ledyard, Thomas A, Ann Clark, Ralph Prahl, Todd Romano, and Eric Belliveau. "LIPA's Commercial Construction Program: Demonstrating Initiative Influence Along the Road to Transformation." Paper presented at the International Energy Program Evaluation Conference, New York, New York, August 17-19, 2005.	Uses self-reports to determine level of program attribution. Results are presented in terms of stages in the standard adoption curve, and in terms of the mechanisms by which actors came into contact with the program.		X	X	

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Barnes, Harley H. "Market Effects Momentum: Are We Giving Market Effects Their Full Due." Paper presented at the International Energy Program Evaluation Conference, Chicago, 2007.	This paper describes the “market-effects momentum” concept, reviews three recent evaluations that address it, and examines its implications for free-ridership, cost effectiveness, forward capacity markets, and cap and trade programs for greenhouse gas. Posits the existence of 'market momentum' generated by programs, defined operationally as the adoption rate of efficient goods or services due to a program under evaluation in years after the evaluated year. These effects are most clearly observable after a program has been terminated	**X**	**X**		
Dyson, Christopher, and Goldberg, Miriam, 2007. "The Gift That Keeps Giving: A Structured Approach for Measuring Participant Spillover". In *Proceedings of the 2007 International Energy Program Evaluation Conference.* Chicago: August 2007	This paper describes a structured approach for measuring participant spillover. It describes how the authors approached the various challenges of a self-report participant spillover methodology and summarizes the levels of participant spillover savings and other market effects that we found. Finally the paper discusses both the advantages and disadvantages of this approach..		***X***	***X***	
Barnes, Harley, Jon Maxwell, and William Steiglemann, "Is One Model of Market Transformation Enough for Public Benefit Market-transformation Programs?" In Proceedings of the 2003 International Energy Program Evaluation Conference. Seattle: August 2003.	The market in market transformation is interpreted to mean segments of the entire market. The authors use innovation-diffusion theory to divide the entire market into diffusion segments. They use payback to illustrate mapping of market-transformation initiatives to specific diffusion segments. Diffusion theory is also used to illustrate how market-transformation policy can, in principle, promote transformation of the entire market segment-by-segment. Finally, the paper shows that it is practical to measure market potential and market-transformation progress within diffusion segments.	**X**			

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Chappell, Catherine, Douglas Mahone, Marian Brown, Kenneth Keating, and Lori Megdal. "Net Savings in Nonresidential New Construction: Is a Market Based Approach the Answer?" Paper presented at the International Energy Program Evaluation Conference, New York, New York, August 17-19, 2005.	The goal of this paper is to review the past methodologies for estimating the net impact of the California nonresidential new construction (NRNC) program Savings by Design (SBD) and to provide recommendations for improving the evaluation of the nonresidential new construction market in California. Develops a market approach to NTG calculation in the nonresidential new construction sector, as distinct from participant-centered approaches such as self-reports, DOD, and econometrics. The market approach rests on the proposition that net program impacts are equivalent to changed consumption intensity in the market beyond the forecast baseline. This approach considers the whole market of new buildings, and can be supplemented with the Delphi method and a comprehensive energy use intensity method.	X		X	
Hall, Nick and John Reed, 2001. "Merging Program-theory and Market Theory In the Evaluation Planning Process," *In Proceedings of the 2001 International Energy Program Evaluation Conference. Salt Lake City: August 2001.*	This paper discusses concepts for planning evaluations of market preparation, market transformation and market effects programs. Advocates integrating market theory and program theory into evaluation planning, so that, in market effects programs, evaluations are more likely to focus on market events that are responsible for market changes.	X			X

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Eto, Joseph, Ralph Prahl, and Jeff Schegel, 1996. *A Scoping Study on Energy-Efficiency Market Transformation by California Utility DSM Programs.* Berkeley, CA: Energy and Environment Division, Earnest Orlando Lawrence Berkeley National Laboratory.	This paper's definition of market transformation is widely used: "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." Also defines market effect: "a change in the structure of a market or the behavior of participants in a market that is reflective of an increase in the adoption of energy-efficiency products, services, or practices and is causally related to market interventions.	**X**	**X**	**X**	**X**
Tiedemann, Ken, 2003. "Using Regression Discontinuity Models to Understand Market Transformation." In *Proceedings of the 2003 International Energy Program Evaluation Conference.* Seattle: August 2003.	China Green Lights program targeted lighting market by addressing 4 barriers: (1) increasing consumer awareness; (2) developing market-based demand-side mechanisms; (3) developing quality control and performance standards; (4) developing market-based supply-side financing mechanisms. Evaluation compares sales of incandescents to CFLs over 10 years to document drop in incandescents compared to CFLs and resulting market share pre- and post-program period. Notes that approach is promising for evaluating market transformation programs where conventional pre-post difference with a comparison evaluation model is not applicable. But notes that methodology is vulnerable to omitted variable bias and cannot necessarily attribute program impacts on basis of regression analysis.		X	X	

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Herman, Patricia, Shel Feldman, Shahana Samiullah, and Kirsten Stacey Mounzih. "Measuring Market Transformation: First You Need a Story ...." Paper presented at the International Energy Program Evaluation Conference, Chicago, Illinois, August 27-29, 1997.	Develops market characterization tool, which provides a comprehensive "story" about market structure. Market characterizations describe market actors, their decisions, influences on these decisions, and market barriers. This permits the selection of appropriate market effects for measurement. Characterizations utilize an "up-stream" approach to identifying market barriers.	X	X	X	
Prahl, Ralph, and Scott Pigg. "Do the Market Effects of Utility Energy Efficiency Programs Last? Evidence from Wisconsin." Paper presented at the International Energy Program Evaluation Conference, Chicago, Illinois, August 27-29, 1997.	Review of a variety of programs offered by Wisconsin utilities. Emphasizes the importance of efficient market share, or the ratio of number of efficient units purchased to total number of units purchased, as a key market indicator. Concludes that rebate programs can have persistent, sustainable market effects. Persistence varies depending on the mechanism by which programs cause change, with changes in awareness likely to produce the most persistent market effects	X	X	X	.
Reid, John H., and Oh, Andrew D., 2003. "Examining Networks of Building Professionals, Developers, Owners and Contractors in the Commercial Building Sector" In *Proceedings of the 2003 International Energy Program Evaluation Conference.* Seattle: August 2003.	Discusses using the power of social and semi-formal business networks to stimulate energy efficiency programs. Develops data on interconnections within a cluster of related and complementary companies, then uses packaged network analysis programs to assess the strength of networks.				

Bibliographic Citation	Summary	Mechanisms & Models	Indicators	Attribution Analysis	Regula-tory
Megdal, Lori, 2005. "Am I Wearing the Wrong Paradigm for my Program Goals". In *Proceedings of the 2005 International Energy Program Evaluation Conference*. New York: August 2005.	Market transformation (MT) programs often use the diffusion of innovation model for both program planning and program evaluation. This provides a great deal of valuable insight and a rich field of research literature that can prove helpful. Examines the applicability of a number of diffusion analysis approaches to understanding MT programs.	X	x		
Friedmann, Rafael, and James, Kenneth, 2005. "Optimal Design, Implementation, and Evaluation of an Energy Efficiency Portfolio". In *Proceedings of the 2005 International Energy Program Evaluation Conference.* New York: August 2005.	The optimal design, definition, implementation, and evaluation of energy efficiency portfolios and programs requires clear understanding of the current and future context in which portfolio offerings operate, identification of opportunities and definition of short, medium and long-term goals. Discusses using the power of social and semi-formal business networks to stimulate energy efficiency programs	X			
Jako, P. *Learning and Diffusion for Wind and Solar Power Technologies.* Petten, NL: Energy Centre of the Netherlands. 2002	This paper examines the effects of national tax regimes on levels of on-shore wind development, using trends in installed capacity and progress ratios (ratio of changes in unit price of installed capacity to changes in cumulative capacity installed) as measures of market advance. The underlying theory for this paper is based on the effects of learning on costs of production, with feedback to higher levels of technology adoption. The paper gathers data on trends in installed capacity, unit costs of major wind power components, and national policies in support of wind development from a large number of countries to examine these relationships. Uses cross-sectional comparison of trends in different countries and world regions to assess market effects	X	X	X	x

Appendix 2: List of Interviews

Anne Bishop, Vermont Public Service Board
Oscar Bloch, Wisconsin Public Service Commission
Eric Brateng, Puget Sound Energy
Phil Degens, Energy Trust of Oregon
Tom Eckman, Northwest Power and Conservation Council
Fred Gordon, Energy Trust of Oregon
Jeff Harris, Northwest Energy Efficiency Alliance
Kathy Kuntz, Wisconsin Energy Conservation Corporation
Jennifer Meissner, New York State Energy Research and Development Authority
Mike Sherman, Massachusetts Department of Energy Resources
William Saxonis, New York Public Service Commission
Iris Sulyma, BC Hydro
Carol White, National Grid