A Framework for Planning and Assessing Publicly Funded Energy Efficiency

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Table of Contents

Executive Summary

ES-1 Overview

The primary objective of this report is to discuss the assessment of the cost-effectiveness of market transformation interventions. To a great extent, the recent emphasis on market transformation strategies is strongly linked to cost-effectiveness. There are often opportunities to spend public funds strategically in ways that transform markets. In those instances, such strategies can provide a bigger payoff than the traditional resource acquisition rebate-style interventions. The idea behind market transformation is that these opportunities should be taken when they are available. However, the cost-effectiveness analysis can clearly be more complicated than with traditional resource acquisition interventions. Regulation, monitoring, and incenting implementers for good performance is also somewhat more difficult for market transformation strategies than for traditional rebate-style resource acquisition interventions.

The effects of market transformation interventions can be estimated. However, the time horizon of these effects may be considerably longer than for traditional rebate-style resource acquisition interventions. Also, the impacts may be more diffuse and therefore more complicated to trace. Nonetheless, measurement methods can be developed to aid in the tracking and measurement of the effectiveness of market transformation interventions, and the purpose of this report is to discuss the methods for doing so.

The development of the report was funded by proceeds from California's Public Goods Charge (PGC). As a result, it has a California orientation. However, the material contained in the report should be equally pertinent to policymakers, program planners, and analysts in other states and countries.

The project team was managed by Chris Ann Dickerson of PG&E. Regional Economic Research, Inc. (RER) served as prime contractor, and the RER team was directed by Fred Sebold and managed by Alan Fields. Lisa Skumatz of Skumatz Economic Research Associates, Inc. (SERA) acted as a subcontractor. In the course of the project, several other experts were added to the team, including (in alphabetical order) Shel Feldman (Shel Feldman Management Consulting), Miriam Goldberg (Xenergy, Inc.), Ken Keating, and Jane Peters (Research Into Action, Inc.).[1] These individuals took responsibility for writing several sections of this report and for reviewing each other's sections. The team met twice to discuss

[1] We would like to acknowledge Valy Goepfrich of Xenergy, who contributed significantly to Section 2 of the report.

issues relating to market transformation cost-effectiveness analysis and interacted extensively during the course of the project.

As a first step in the project, a detailed review of the existing literature was prepared and distributed to the team together with a list of questions for them to answer. The questions covered a number of issues where there seemed to be disagreement or lack of clarity in the existing literature on the measurement of market effects. Next, the team met to discuss the literature review, to develop the team's answers to the questions about measurement, and to plan the next steps for the development of new methods to assess the cost-effectiveness of market transformation interventions.

The team found that the existing literature has yet to evolve a common methodology. Rather there were multiple contradictory statements and provisos regarding the overall goals of market transformation, the role of market transformation interventions in a portfolio of activities designed to increase energy efficiency, and the features that distinguish market transformation-style interventions from other energy efficiency activities. This situation is likely attributable to several factors including the relatively recent expansion of market transformation as a concept in energy efficiency, the fact that people writing about market transformation have been working in many different areas of the country and have different underlying assumptions about terminology, and the underlying regulatory and policy contexts in which the market transformation interventions are being implemented.

To evaluate the effectiveness of an intervention in meeting its goals, it is first necessary to have a clear understanding of those goals. Thus, for the team to propose methods for measuring the cost-effectiveness of market transformation interventions, it was critical to establish a clear framework for understanding the goal(s) of those interventions, to describe the interventions using consistent terminology, and make the team's assumptions about underlying regulatory and policy contexts explicit. The first three sections of this report focus on these issues and set the stage for the discussion of evaluation methods in the final four sections.

ES-2 Policy Background

During the mid 1990s, the focus of energy efficiency efforts shifted from resource acquisition, or demand-side management (DSM), to market transformation. Market transformation denotes a permanent change in the operation of the market for energy efficiency, or at least one that lasts beyond the life of energy efficiency market interventions. It has been defined as "a reduction in market barriers resulting from market intervention, as evidenced by a set of market effects, that lasts after the intervention has been withdrawn, reduced or changed" (Eto, Prahl, and Schlegel 1998).

Market transformation differs from resource acquisition in two important respects (Megdal et al. 1999):

- The primary purpose is to change the operation of a market, rather than to acquire energy savings more directly, and
- Interventions are designed to stimulate impacts that will continue to occur beyond the lifetime of these interventions.

Although the philosophy of market transformation dates to the early 1990s (Keating et al. 1998), the widespread adoption of the philosophy is more recent. Many reasons can be given for the emergence of market transformation as a paradigm of energy efficiency. There are two reasons to think of it at least partly as a response to (or perhaps a corollary to) the deregulation of the electricity industry:

- First, the philosophy of resource acquisition was initially developed for a vertically integrated utility industry concerned with minimizing the cost of resource acquisitions. In this context, resource acquisition was considered an alternative to supply resources in an overall integrated resource planning (IRP) process. As industry restructuring began and generation assets were sold, IRP was abandoned in many areas. This called for an alternative focus for efficiency, and market transformation provided that focus.
- Second, the movement toward deregulation of electricity and natural gas markets was reflective of a general philosophical shift toward reliance on private markets. It could be argued that this shift was accompanied by a desire to end or diminish public interventions in energy efficiency markets, and market transformation provided some hope for the achievement of this objective. In D.97-02-014, for instance, the CPUC indicated that "our focus for energy efficiency programs has changed from trying to influence utility decision makers, as monopoly providers of generation services, to trying to transform the market so that individual customers and suppliers in the future, competitive generation market will be making rational energy choices."

The emphasis on market transformation as an energy efficiency strategy has differed somewhat across regions. In California, the shift to a market transformation focus has been relatively strong. This shift was initially signaled by the California Public Utilities Commission (CPUC) Decision 95-12-063, which calls for public spending to shift towards activities that will transform the energy market, and has been reinforced by a number of other decisions issued over the past five years. The initial strategies of market transformation were strongly influenced by the California Board for Energy Efficiency (CBEE), an advisory board to the CPUC.

While market transformation is not generally the sole focus of energy efficiency in other areas of the country, it has been accepted as a viable policy strategy in most areas with active energy efficiency public policies. Market transformation activities in the Northeast have been spearheaded by the Northeast Energy Efficiency Partnerships, Inc. (NEEP), while programs in the Northwest have been sponsored by the Northwest Energy Efficiency Alliance (NW Alliance). National efforts are promoted by the ENERGY STAR® program, as well as by the activities of the Institute for Market Transformation, the American Council for an Energy-Efficient Economy (ACEEE), and the Consortium for Energy Efficiency (CEE).

ES-3 Key Questions Relating to Market Transformation

This report addresses several key questions relating to market transformation. The following discusses how and in which sections of the report these questions are addressed.

What is the Economic Rationale for Energy Efficiency Policy?

Prior to dealing with the assessment of cost-effectiveness of publicly supported market interventions, it is useful to review the economic rationale for the interventions in question. The primary rationales for publicly funded energy efficiency policy relate to a wide range of failures in private markets for both energy and energy efficiency products and services. By understanding the nature of these failures and their effects on social welfare, a proper framework can be constructed for assessing the benefits and costs of improvements in market performance.

Section 2, written primarily by Miriam Goldberg,[2] discusses market transformation strategies in the broader context of the economic rationale for using energy efficiency policies to improve the allocation of resources. In particular, the section begins by reviewing intervention goals in terms of the economics of social welfare. Casting the intervention objectives in these terms provides a natural basis for considering both design and evaluation. Some general implications for design and evaluation are discussed and developed further in subsequent sections. Then, the economic principles and their implications are summarized. Details are provided for those who would like to understand these arguments better. Market intervention in a competitive retail supply environment is compared with corresponding DSM programs under regulated supply. With this background, the fundamental reasons for market transformation programs are then discussed.

[2] Again, we would like to acknowledge Valy Goepfrich of Xenergy, who contributed significantly to Section 2 of the report.

What is the Proper Role of Market Transformation in Energy Efficiency Policy?

As noted above, views on the relative importance of market transformation vary across regions as well as individuals. In California, at least until the events surrounding spikes in market prices,[3] market transformation has been the dominant theme of energy efficiency policy. Market transformation interventions are aimed to correct problems (barriers) in the markets for energy efficient products and services. They do not directly mitigate problems in energy markets, however, and may not constitute a comprehensive energy efficiency policy strategy. At least three issues suggest the use of a broader portfolio of policy intervention strategies. As discussed above, recent events in California's deregulated energy market have raised questions about the need for policies that can contribute to long-term capacity planning as well as short-term contingencies. Moreover, the persistence of environmental externalities associated with the generation of energy will continue to cause misallocation of resources to the production of energy regardless of the performance of markets for energy efficiency products and services. Finally, market transformation interventions may not be as effective as other types of interventions in obtaining socially optimal levels of energy efficiency, and therefore might need to be complemented by other policy strategies.

Section 3, written primarily by Ken Keating, lays out the terminology that is used in subsequent sections. As pointed out, several options are available when public policy supports market interventions on behalf of improved energy efficiency levels (beyond what the markets are producing by themselves). Complementary strategic approaches are possible. These include resource acquisition, market transformation, infrastructure support, and the support of research and development and equity investments. This section argues for recognizing the similarities in goals and the ways the initiatives can be analyzed, while keeping the distinctions clear in the strategies chosen. As with all of the sections in this report, this section emphasizes the connections of the team's approach to prior energy efficiency efforts and the current policy environment in California, while still learning from other jurisdictions.

How Can We Design Market Transformation Initiatives Most Effectively?

Interventions and the evaluations of their effects do not occur in a void. There is no single standard of program excellence or a one-size-fits-all evaluation paradigm. Rather,

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[3] In Summer 2000, San Diego Gas & Electric (SDG&E) retail customers who had chosen to stay with SDG&E as an energy provider (as well as most who had opted to purchase energy from alternative providers) were faced with rates that varied directly with market prices. Unsurprisingly, market prices spiked under summer weather conditions. However, both the general rise in market prices and the impacts of hot weather were exacerbated by the inadequacy of generation reserves. Moreover, extreme weather conditions caused a number of supply shortages, as evidenced by curtailments and brownouts. While the presence of high prices does not in itself constitute a rationale for public interventions in energy efficiency markets, these recent events have raised several issues relating to market transformation as an energy efficiency strategy.

intervention objectives must fit specific needs and evaluations should be matched to the intervention objectives and designs they address. Evaluations are most useful if they provide information on whether the market is functioning as the program designers assume and whether the interventions undertaken are having the intended effects. To focus on these information needs, the evaluation must have a clear roadmap as to the designers' expectations about the market, the key actors, their interactions, and the reasons behind the interventions.

Without a clear story line, program staff may not focus their efforts on the market relationships of greatest value to the program. Similarly, evaluators may not assess the areas of performance most crucial to program success. In short, the program may not use the PGC in the most responsible manner.

Section 4, written primarily by Shel Feldman, discusses and illustrates the need for elucidating the story line when designing effective programs, both for program staff and evaluators. This section is centered on the proposition that articulation of intervention logic models helps program designers focus their resources effectively. Furthermore, intervention logic models direct evaluators toward measurement of the crucial factors in intervention impact and success. Finally, review of relevant logic models forces evaluators and policymakers to confront the question of the use of PGCs at a conceptual level as well as at the practical level.

Throughout this section, considerable attention is paid to the importance of articulating the rationale for the intervention selected, including the choice of strategy (especially resource acquisition or market transformation), the target audience, and the tactics. This is shown to be particularly important for market transformation interventions, since they appear to be open to a greater variety of design options than most resource acquisition interventions. Thus, it is incumbent on program planners to review the logic of different design options perhaps in conjunction with the forecasting tools discussed in Section 7. Program planners should strive to select the option most likely to achieve the desired objectives in a cost-effective manner.

What Role Does Evaluation Play in Market Transformation?

The goals of an energy efficiency intervention evaluation are to determine the following:

1) How much energy has been saved by the energy efficiency intervention?
2) Were public or ratepayer funds spent wisely?
3) How can we improve the effectiveness of the intervention?

These goals apply to all five energy efficiency interventions, whether resource acquisition, market transformation, research and development, infrastructure, or equity. The interventions, however, because of the specific objectives and activities, may require different methods and strategies for determining how well the intervention achieved its goals.

The initial assumption is that at some point during the intervention's implementation, an evaluation will be conducted. However, determining when to do an evaluation, what to focus on, and how the evaluation should be conducted depends upon a number of factors. These include the type of intervention, the requirements for reporting, the observable progress of the intervention, the need for information to make decisions about the intervention, and available resources to conduct the evaluation.

Section 5, written primarily by Jane Peters, is designed to help policymakers and evaluators make these decisions by discussing the purposes of evaluations, the various issues regarding responsibility for conducting evaluations, the different evaluation approaches available, and how these might be applied to the five types of energy efficiency interventions.[4] Included in this section is a discussion of the principles of evaluation and measurement as they apply to energy efficiency interventions. The premise of this section is that evaluation and measurement activities should test the logic of the intervention to determine whether the logic makes sense and whether the results of the intervention are consistent with the intervention logic. Given that the primary goal of an energy efficiency intervention is energy savings, the evaluation must test this logic and determine what savings have occurred and whether public funds were well spent in the process of achieving those savings.

How Can We Evaluate the Market Effects Associated with Market Transformation Initiatives?

The State of California has implemented an array of initiatives aimed at increasing energy efficiency in equipment and design/installation practices. These efforts include various programs sponsored by utilities, third parties, and other initiatives. Some of these programs have attempted to increase the acceptance and installation of more efficient measures and practices through incentives for purchase or installation (rebates and financing), outreach, education, training or certification efforts, research and development incentives, and other interventions. More recently, the objective has been modified from a focus on delivery of services and measures to customers toward interventions that help reduce barriers to efficiency and improve acceptance and demand for efficiency in the marketplace.

Section 6, written primarily by Lisa Skumatz, discusses the process involved in evaluating market transformation interventions and highlights differences in approaches and implementation compared to traditional resource acquisition intervention. Included is an

[4] See Section 3 for a definition of the five types of energy efficiency interventions.

examination of the process involved in conducting market assessment and evaluation for a range of market transformation interventions, including information/advertising tactics, upstream incentives, and training interventions. In addition, the section walks through the steps involved in evaluating market transformation interventions and highlights differences in the traditional DSM direct-install/rebate environment. Throughout the section, particular attention is given to discussing the changes in the methods for measuring ultimate impacts and cost-effectiveness. Further, there is an emphasis on the need to assess a broader array of effects that reflect interim points in the process of changing the market and adoption of more efficient technologies—interim points that are consistent with the intervention's underlying logic.

How Can We Capture the Dynamics of Market Transformation in the Assessment of Market Effects?

The entire process of market assessment and evaluation needs to be based on a clear understanding of the dynamics of the marketplace. Baselines change over time in response to natural market conditions and the effects of interventions go beyond the period in which these interventions are applied. Market dynamics can be represented by dynamic models, which are simply algebraic relationships linking interventions with ultimate effects on adoptions of energy efficiency measures. These models tell the story underlying the intervention design, and can provide a frame of reference that can be used to organize market assessment and evaluation activities. Those activities would be focused on the development of information that would be used to calibrate the model and its key parameters. The refined model would then be used to develop estimates of market effects. These estimates are at least partly forecasts, in the sense that they cover some effects that have not yet occurred. This is clearly true in the case of prospective analysis, and is probably true for retrospective analysis as well. While retrospective analysis takes place after interventions have been applied, it is likely to cover some effects that are yet to occur. In either event, the estimates of market effects that can be derived from these dynamic models are designed to be incorporated directly into the assessment of cost effectiveness.

Section 7, written primarily by Fred Sebold and Alan Fields, focuses on the importance of recognizing market dynamics and the means of developing estimates of market effects. The section discusses market dynamics and the use of dynamic models to estimate market effects. The discussion highlights the need to recognize the baselines for market effects as dynamic phenomena. Baselines change over time and are influenced by past intervention activity. Developing a baseline involves specifying and estimating the relationships that determine the market characteristic for which a baseline is being determined.

The section also discusses some of the options for forecasting market effects, including Delphi approaches, analyses of time series market data such as diffusion models and market share models, and adoption process models. As indicated, each approach offers considerable promise for the estimation of market effects, although each has distinct limitations.

The core of the section is the development and illustration of a general dynamic modeling framework that can serve as a basis for estimating long-term market effects. The approach has some of the spirit of an adoption process model in that it explicitly incorporates awareness formation, willingness determination, and availability. It can also be modified to incorporate some of the flavor of diffusion models through the inclusion of demonstration effects in the determination of awareness, willingness, and availability. The model can be specified to incorporate both direct and indirect effects of various interventions. Some selected model results are used to illustrate the application of the framework to the estimation of market effects.

Furthermore, methods of parameterizing the model and calibrating it to observed behavior are discussed. It is argued that an eclectic approach involving a variety of techniques may generally be necessary to fully parameterize the model. This need derives from the difficulties in developing the kinds of data that would support the use of a single technique like the econometric analysis of time series data.

How Can We Assess the Cost-Effectiveness of Market Transformation Initiatives?

Given that market transformation initiatives are typically operated with public funds, fiscal prudence requires the assessment of their cost-effectiveness from the public perspective. In California, the design and assessment of market transformation initiatives is governed by a set of policy rules developed by the CBEE and subsequently adopted by the CPUC. Section 8, written primarily by Fred Sebold and Alan Fields, discusses assessment of the cost-effectiveness of energy efficiency interventions. The section begins by reviewing the historical context of cost-effectiveness analysis in California and outlines the current policy rules under which California's utilities operate. This is followed by a description of the Public Purpose Test's (PPT) structure. The PPT is the primary framework mandated for use in assessing market transformation portfolios and programs. As noted in Section 8, the PPT is a societal cost-effectiveness model designed explicitly to take into account the dynamics of market transformation. This section also discusses the consistency of the PPT with the policy analysis presented in Section 2. It was found that the PPT is generally consistent with this analysis. The section also discusses a variety of policy issues associated with implementing the PPT, including problems in isolating the effects of multiple programs targeting the same markets, questions relating to the appropriate level of application of the PPT, the appropriateness of applying the PPT to other intervention strategies, the use of the framework in assessing the impacts of multiple year interventions—the proper timing of cost-effectiveness analysis, differences in the retrospective and prospective applications of the model, and the difficulties in applying the PPT to a broader range of market effects than is typically considered. It also discusses ways of dealing with the greater levels of uncertainty that may characterize the assessment of market transformation interventions. The section concludes with a discussion of two concepts currently raised in a recent decision of the California Public Utilities Commission: net-to-gross ratios and market effects multipliers.

ES-4 Conclusions and Recommendations

A number of conclusions and recommendation are identified throughout the report. The following is a summary of the most important conclusions and recommendations organized into the following topics:

- The economic rationale for energy efficiency policy,
- The role of market transformation in energy efficiency policy,
- The design of market interventions,
- The evaluation of the effects of energy efficiency interventions,
- The incorporation of market dynamics in the evaluation of market effects, and
- The application of cost-effectiveness tests to energy efficiency interventions.

The Economic Rationale for Energy Efficiency Policy

- A theoretical justification for public policy to promote energy efficiency relies on a mix of market failures. This includes externalities in energy markets as well as a series of failures in markets for energy efficiency products markets, including lack of information, consumer discount rates effectively higher than societal discount rates, and public goods issues associated with technology research and development.
- Even if there is no failure in the energy efficiency market, it may be worthwhile to intervene in the market to reduce externality costs in the energy market. Moreover, the problem of environmental externalities in energy production is never solved by changing the market for energy efficient products, even if these changes are completely sustainable. As long as the externality remains in the energy market and is not addressed directly through taxes or some other means of internalization, there will be a need for continuing intervention in the energy efficient products markets.
- Assessing the cost effectiveness of public interventions relating to energy efficiency entails quantifying the economic improvement in the market for efficient products and services, as well as valuing the avoided externality in the energy market.

The Role of Market Transformation in Energy Efficiency Policy

- Effective energy efficiency policy requires a balanced portfolio of intervention strategies. These strategies should include market transformation, resource acquisition, infrastructure, research and development, and equity interventions. These strategies all have a place in ensuring a more efficient allocation of energy resources.
- Market transformation interventions may be an effective strategy if significant market failures are evident in the market for energy efficient products and services. However, this strategy should be used in conjunction with other strategies in order to optimize the overall mix of the energy efficiency portfolio.
- Interventions designed to promote a particular technology, practice, or service may be phased out as adoptions of that technology, practice, or service reach a targeted and self-sustaining level in that market. However, as long as there are externalities associated with energy production or usage, there will be a continuing need for interventions to develop and promote the next generation of technologies, better practices, and improved services to enable the more efficient use of energy.
- If there are no failures in the efficiency market that can be practically addressed through market transformation efforts, ongoing resource acquisition programs may be the most effective strategy. Moreover, infrastructure and research and development contribute strategically to the overall goals of a mixed portfolio and need to be given appropriate levels of support within the mix.
- As is the case with any portfolio, the appropriate mix of energy efficiency strategies may vary across markets and over time. Designers should consider the most effective combination of strategies for a particular market at a particular time. For instance, extreme market conditions, like the price spikes currently being experienced in California, may affect the benefits of interventions and may influence the choice of specific strategies.

The Design of Market Interventions

- The use of an energy efficiency initiative should be focused by articulating the logic of the initiative, whether that initiative is in the form of a research and development, infrastructure, resource acquisition, or market transformation directed effort. In each case, the logic should trace the effects of the initiative through to the final expected goal of the intervention.
- If the intervention strategy is either resource acquisition or market transformation, prospective cost-effectiveness analysis should include the levels and timing of expected energy savings under various assumptions. In the event that the intervention strategy is intended to evolve over time, the appropriate transition strategy should be discussed, as well as the point at which it is to be employed.
- While the ultimate goal of infrastructure and research and development interventions is to reduce energy consumption, it may be extremely difficult to isolate the impacts of these interventions on consumption.

The Evaluation of the Effects of Energy Efficiency Interventions

- A comprehensive evaluation design should integrate summative approaches designed to estimate the savings of a given intervention design and formative approaches designed to develop recommendations for the improvement of interventions.
- Both types of evaluations should test the logic underlying the design of the intervention. The results of summative evaluations should be used to refine the estimates of market effects, and the results of formative evaluations should be used to refine the design of the intervention.
- Summative evaluations should focus on impacts on adoptions of energy efficiency measures and the associated energy savings, as well as on indicators of other market effects leading to these impacts.
- Most of the attention in recent assessments of market transformation interventions has been on near-term market effects. It is important to extend the scope of these assessments to deal more formally with effects on ultimate market indicators such as impacts on adoptions and the associated energy and demand impacts.
- Evaluation approaches can include performance data tracking, structure and function studies (which traditionally include process and market evaluation and market assessments), and benefit studies (which include cost-effectiveness analysis, impact evaluation and engineering analysis). Though the specific application varies, there is a role for all three approaches in most evaluations of energy efficiency interventions.

The Incorporation of Market Dynamics in the Evaluation of Market Effects

- Especially for market transformation interventions, the estimation of ultimate market effects should be viewed as a forecasting exercise. To the extent that the effects of interventions last beyond the duration of the intervention, these effects should be derived from forecasts of adoptions and energy savings with and without the intervention in question.
- Planners and evaluators should consider the use of formal dynamic models to represent the dynamic process through which interventions affect adoptions and savings. Dynamic models are simply descriptions (typically algebraic) of the path via which interventions are expected to affect adoptions of energy efficiency measures and consumption of energy. These models can be used to forecast market effects in both prospective and retrospective applications, and can support both program planning and evaluation.
- The design and implementation of reasonable dynamic models is not a new process, but rather one that simply formalizes the program logic. Because it is not a traditional means of expressing program logic, it will take some time to implement. Nonetheless, the long-term benefits of this approach could be substantial. The process of constructing this type of model will force planners to

make specific assumptions about the impacts of program interventions. These assumptions relate to the paths of influence of interventions, as well as to the values of the parameters of the model. Moreover, the formal simulation model provides an overall framework for integrating the results of program evaluations, as well as for developing and testing alternative program strategies.

The Assessment of Cost Effectiveness

- Cost-effectiveness of energy efficiency interventions is best determined at the market level. This follows from the fact that a variety of overlapping interventions may be aimed at a specific market and their effects may be difficult to disentangle. Nonetheless, it also will generally be useful to attempt to assess the contributions of specific interventions to overall cost-effectiveness in order to support the process of program design and refinement.
- Because the focus of cost-effectiveness analysis is at the market level, almost all interventions used for that market should be assessed using the same cost-effectiveness model. The sole possible exception to this practice could be for equity programs, which are designed to affect distribution of income as well as efficiency in resource acquisition.
- The PPT is a reasonable framework for assessing the cost-effectiveness of energy efficiency interventions other than equity programs. It is consistent with the policy analysis presented in Section 2 and is designed to take into account the dynamic impacts of market transformation interventions as well as the full range of costs and benefits underlying the basic rationale for public intervention in energy efficiency markets. More specifically, the PPT is designed to include environmental benefits/costs as well as a variety of non-energy benefits and costs that influence the optimal level of energy efficiency. Other tests like the TRC are not consistent with the policy analysis for a variety of reasons, the most important being that they ignore environmental costs and benefits.
- The PPT should be used in both prospective and retrospective assessments. The primary differences in retrospective and prospective applications of the PPT involve the means of developing assumptions. In prospective applications, these assumptions may be based on informed judgments, while in the retrospective applications they should be based on evidence gathered from the marketplace during the course of market assessment and evaluation activities.

1

Introduction

1.1 Overview

This report discusses a variety of issues relating to contemporary energy efficiency policy. Its primary focus is the assessment of the cost-effectiveness of market transformation interventions. However, it also addresses several broader questions including the rationale for public intervention in energy markets, the design and continual refinement of energy efficiency portfolios, and the similarities and differences between the assessment of market transformation interventions and the evaluation of traditional resource acquisition intervention. Its development was funded by proceeds from California's Public Goods Charge (PGC). As a result, it has a California orientation. However, the material contained in the report should be equally pertinent to policymakers, program planners, and analysts in other states and countries.

1.2 Policy Background

1.2.1 The Emergence of the Market Transformation Paradigm

During the last several years, there has been a shift in the paradigm of energy efficiency from resource acquisition to market transformation. Market transformation denotes a permanent change in the operation of the market for energy efficiency, or at least one that lasts beyond the life of energy efficiency intervention. It has been defined as "a reduction in market barriers resulting from market intervention, as evidenced by a set of market effects, that lasts after the intervention has been withdrawn, reduced or changed" (Eto et al. 1998).

Market transformation differs from resource acquisition in two important respects (Megdal, et al. 1999):

- The primary purpose is to change the operation of a market, rather than to acquire energy savings more directly, and
- Interventions are designed to stimulate impacts that will continue to occur beyond the lifetime of these interventions.

1.2.2 Deregulation and Market Transformation

Although the philosophy of market transformations dates to the early 1990s (Keating et al. 1998), the widespread adoption of the philosophy is more recent. Many reasons can be given for the emergence of market transformation as a paradigm of energy efficiency. There are two reasons to think of it at least partly as a response to (or perhaps a corollary to) the deregulation of the electricity industry:

- First, the philosophy of resource acquisition was initially developed for a vertically integrated utility industry concerned with minimizing the cost of resource acquisitions. In this context, resource acquisition was considered an alternative to supply resources in an overall integrated resource planning (IRP) process. As industry restructuring began and generation assets were sold, IRP was abandoned in many areas. This called for an alternative focus for efficiency, and market transformation provided that focus.
- Second, the movement toward deregulation of electricity and natural gas markets was reflective of a general philosophical shift toward reliance on private markets. It could be argued that this shift was accompanied by a desire to end or diminish public interventions in energy efficiency markets, and market transformation provided some hope for the achievement of this objective. In D.97-02-014, for instance, the California Public Utilities Commission (CPUC) indicated that "our focus for energy efficiency programs has changed from trying to influence utility decision makers, as monopoly providers of generation services, to trying to transform the market so that individual customers and suppliers in the future, competitive generation market will be making rational energy choices."

1.2.3 Regional Differences in the Reliance on Market Transformation

The emphasis on market transformation as an energy efficiency strategy has differed somewhat across regions. In California, the shift to a market transformation focus has been relatively strong. This shift was initially signaled by CPUC Decision 95-12-063, which calls for public spending to shift towards activities that will transform the energy market, and has been reinforced by a number of other decisions issued over the past five years. The initial strategies of market transformation were strongly influenced by the California Board for Energy Efficiency (CBEE), an advisory board to the CPUC.

While market transformation is not generally the sole focus of energy efficiency in other areas of the country, it has been accepted as a viable policy strategy in most areas with active energy efficiency public policies. Market transformation activities in the Northeast have been spearheaded by the Northeast Energy Efficiency Partnerships, Inc. (NEEP), while programs in the Northwest have been sponsored by the Northwest Energy Efficiency Alliance (the Alliance). National efforts are promoted by the ENERGY STAR® program as well as the activities of the Institute for Market Transformation, the American Council for an Energy-Efficient Economy (ACEEE), and the Consortium for Energy Efficiency (CEE).

1.2.4 Recent Developments and the Role of Market Transformation

Recent events in deregulated markets have raised questions about the proper role of market transformation strategies in the overall context of energy efficiency policy. As part of the transition to deregulation, California's AB 1890 provided for retail rate caps at discounted levels while distribution utilities were completing the recovery of stranded costs. The costs were recovered through the collection of Competitive Transition Charges (CTCs) levied on all ratepayers. With the suspension of the CTC and the removal of rate caps in the San Diego Gas & Electric (SDG&E) service area, retail customers who had chosen to stay with SDG&E as an energy provider (as well as most of those who had opted to purchase energy from alternative providers) have been faced with rates that vary directly with market prices. Unsurprisingly, market prices spiked under summer weather conditions. However, both the general rise in market prices and the impacts of hot weather were exacerbated by the inadequacy of generation reserves. Moreover, extreme weather conditions have caused a number of supply shortages, as evidenced by curtailments and brownouts. These recent events have raised several issues relating to market transformation as an energy efficiency strategy.

First, it is unclear whether low reserve margins will be reversed through the construction of new generation facilities, or if generation shortages will be a common characteristic of deregulated markets. It is premature to tell if private markets will provide the appropriate amounts of capacity (with cyclical swings caused by the long gestation period for construction), or if entry barriers will cause chronic capacity shortages and supernormal prices and profits. Correspondingly, it is unclear that the deregulation of generation avoids the need for long-range capacity planning. If a public planning process is needed, this raises an important question: What role should energy efficiency interventions play in this process? Perhaps more pointedly, how appropriate are market transformation strategies to any long-term resource planning role that may be defined for energy efficiency?

Second, flexible strategies may be needed to mitigate short-term supply problems like those associated with extreme weather or unplanned outages. The CPUC recently instructed California's independently owned utilities (IOUs) to develop plans for clipping peak demand. This instruction renewed interest in a variety of interventions that do not neatly fit under the rubric of market transformation. This suggests that there is a clear place in the energy efficiency portfolio for interventions capable of obtaining quick and relatively certain reductions in energy usage.

1.3 Report Background and Objectives

1.3.1 Project Background and Objectives

The primary objective of this report is to provide a useful discussion of the assessment of the cost-effectiveness of market transformation. In a way, the movement toward/interest in market transformation strategies is strongly linked to cost-effectiveness. There are often opportunities to spend money strategically in ways that leverage markets. In these instances, these expenditures can provide a bigger payoff than the traditional resource acquisition rebate-style interventions. The idea behind market transformation is that these opportunities should be taken when they are available. However, the cost-effectiveness analysis can clearly be more complicated than with traditional resource acquisition interventions. Regulation, monitoring, and incenting implementers for good performance may also be somewhat more difficult for market transformation strategies than for traditional rebate-style resource acquisition interventions. This is partly because savings from market transformation interventions may be inherently more difficult to estimate, and there is some discomfort with the tying incentives to indicators measured with less precision. It may also be partly because of the lack of a well developed regulatory mechanism for structuring incentives.

The effects of market transformation interventions can be estimated. However, the time horizon of these effects may be considerably longer than for traditional rebate-style resource acquisition interventions, and the impacts may be more diffuse and therefore more complicated to trace. Nevertheless, measurement methods can be developed to aid in the tracking and measurement of the effectiveness of market transformation interventions, and the purpose of this report is to discuss the methods for doing so.

1.3.2 Organization of the Project Team

The project team was managed by Chris Ann Dickerson of PG&E. Regional Economic Research, Inc. (RER) served as prime contractor. The RER team was directed by Fred Sebold and managed by Alan Fields. Lisa Skumatz of Skumatz Economic Research Associates, Inc. (SERA) acted as a subcontractor. In the course of the project, several other experts were added to the team, including (in alphabetical order) Shel Feldman (Shel Feldman Management Consulting), Miriam Goldberg (Xenergy, Inc.), Ken Keating, and Jane Peters (Research Into Action, Inc.).[1] These individuals were responsible for writing several sections of this report and for reviewing each other's sections. The team met twice to discuss issues relating to market transformation cost-effectiveness analysis and interacted extensively during the course of the project.

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[1] We would like to acknowledge Valy Goepfrich of Xenergy, who contributed significantly to Section 2 of the report.

1.3.3 Caveats

Three caveats should be offered to readers of this report:

- While the team made many attempts to resolve issues relating to energy efficiency policy, intervention design, market assessment, evaluation, and cost-effectiveness analysis, some differences in perspective are likely to show through the individual sections. This may lead to some confusion, but it reflects the current state of the profession and is considered a healthy aspect of the report.
- Although we have attempted to adopt a common set of terms, there may still be some differences in the terms used to describe specific phenomena.
- The recommendations advanced in this report are based on the collective judgments of the team members. They reflect some input from other members of the energy efficiency community, but have not yet been exposed to broad review. We anticipate that these recommendations may be refined after such review takes place.

1.4 Key Questions Relating to Market Transformation

This report addresses several key questions relating to market transformation. These questions are summarized below:

1.4.1 What is the Economic Rationale for Energy Efficiency Policy?

The primary rationales for publicly funded energy efficiency policy relate to a wide range of failures in private markets for both energy and energy efficiency products and services. By understanding the nature of these failures and their effects on social welfare, we can construct a proper framework for assessing the benefits and costs of improvements in market performance. The report begins by focusing on the rationale for energy efficiency policy, using a economic welfare theory framework.

1.4.2 What is the Proper Role of Market Transformation in Energy Efficiency Policy?

Market transformation interventions are aimed to correct problems (barriers) in the markets for energy efficiency products and services. However, they do not directly mitigate problems in energy markets and may not constitute a comprehensive energy efficiency policy strategy. One of the issues confronted in this report, then, is the proper role of market transformation in the context of such a comprehensive strategy.

1.4.3 How Can We Design Market Transformation Interventions Most Effectively?

Given the legitimate role of market transformation interventions in the overall portfolio of intervention strategies, the next issue relates to the proper design of effective interventions. Clear designs are important both to ensure the effectiveness of the interventions as well as to provide a framework for the evaluation of these interventions. Throughout the report, the means of formalizing the logic or "story" underlying market transformation interventions is discussed.

1.4.4 What Role Does Evaluation Play in Market Transformation?

Evaluation plays multiple roles for market transformation interventions as well as other kinds of intervention strategies. It must accomplish the objectives of formative evaluation, which is designed to provide feedback that can be used in the refinement of the intervention, or summative evaluation, which supports the estimation of market effects and the assessment of cost-effectiveness. The report discusses these two types of evaluations and explains their application to market transformation interventions and other energy efficiency strategies.

1.4.5 How Can We Evaluate the Market Effects Associated with Market Transformation Interventions?

Market transformation strategies aim to mitigate a variety of market failures in the energy efficiency products and services markets. Because these interventions target a variety of market actors and decisions, their effects are likely to be more difficult to assess than the effects of more direct resource acquisition interventions. The report discusses differences in the evaluation of resource acquisition and market transformation interventions, and describes the techniques that can be used to estimate market effects.

1.4.6 How Can We Capture the Dynamics of Market Transformation in the Assessment of Market Effects?

The entire process of market assessment and evaluation needs to be based on a clear understanding of the dynamics of the marketplace. Baselines for market transformation interventions change over time in response to natural market conditions, and the effects of interventions go beyond the period in which they are applied. This report discusses the need to recognize market dynamics and offers methods for doing so.

1.4.7 How Can We Assess the Cost-Effectiveness of Market Transformation Interventions?

Given that market transformation interventions are typically operated with public funds, fiscal prudence requires the assessment of their cost-effectiveness. In California, the design and assessment of market transformation interventions is governed by a set of policy rules developed by the CBEE and subsequently adopted by the CPUC. The means of assessing cost-effectiveness is discussed throughout the report.

1.5 Report Organization

The remainder of the report includes the sections described above and a concluding section that summarizes the report and lists some conclusions and recommendations. The sections are organized as follows:

- Section 2, written by Miriam Goldberg, discusses market transformation strategies in the broader context of the economic rationale for using energy efficiency policies to improve the allocation of resources.
- Section 3, prepared by Ken Keating, reinforces this theme by describing the various strategic options that are available when public policy supports market interventions on behalf of improved energy efficiency levels: resource acquisition, market transformation, infrastructure support, the support of research and development, and equity investments.
- Section 4, written by Shel Feldman, discusses and illustrates the need for elucidating the story line when designing effective market transformation interventions, both for program staff and evaluators.
- Section 5, written by Jane Peters, discusses the purposes of evaluations, the various issues regarding the responsibility for conducting evaluations, the different evaluation approaches available, and how these might be applied to the five types of energy efficiency interventions.
- Section 6, written by Lisa Skumatz, discusses the process involved in evaluating market transformation interventions and highlights differences in approaches and implementation compared to traditional resource acquisition interventions.
- Section 7, written by Fred Sebold and Alan Fields, discusses market dynamics and the use of dynamic models to estimate market effects of market transformation interventions.
- Section 8, written by Fred Sebold and Alan Fields, discusses the assessment of cost-effectiveness of market transformation interventions as well as other types of energy efficiency initiatives.
- Section 9 provides a comprehensive set of recommendations relating to the role of market transformation as a component of an overall energy efficiency strategy, the design and evaluation of market transformation interventions, and the assessment of cost-effectiveness.

2

Policy Framework

2.1 Overview

The goal of this report is to identify program evaluation methods to ensure that public funds spent on market transformation programs are spent prudently. To determine if funds have been well spent, the following questions must be addressed:

- What problems are market transformation programs designed to solve?
- What is the rationale for public intervention in energy efficiency markets?
- What types of social benefits result from the public intervention that would not otherwise have occurred?
- How can these benefits be quantified?
- What social costs are incurred that otherwise would not have been incurred?
- How should these costs be quantified?
- What is the most meaningful way to assess and compare programs in terms of costs and benefits?

This section lays out a framework for addressing these questions as an application of classic economic theory.

2.2 Introduction

This subsection begins by reviewing program goals in terms of the economics of social welfare. Casting the program objectives in these terms provides a natural basis for considering both program design and program evaluation. Some general implications for design and evaluation are discussed and developed further in subsequent sections.

Then, the economic principles and their implications are summarized. Details are provided for those who would like to understand these arguments better. Market intervention in a competitive retail supply environment is compared with corresponding energy efficiency programs under regulated supply. With this background, the fundamental reasons for market transformation interventions are discussed. Implications for market transformation program design and evaluation are then described.

2.2.1 Framework Summary

The goals and potential effects of market transformation programs are framed in terms of standard economic theory. It is useful to return to these principles to understand how the programs may affect markets and how to value those effects. The basic framework and its implications are summarized here.

Market transformation is one of several intervention strategies that may be used to intervene in energy efficiency markets. Section 3 describes a range of strategies, including resource acquisition, infrastructure, and research and development. The policy framework described here is not specific to market transformation, but applies more broadly to any set of interventions designed to mitigate failures in the energy efficiency market and reduce externalities in the energy market.

Goals of Market Intervention. A market transformation program, or other strategy as described in Section 3, is an intervention in an existing market. The rationale for this intervention is that there is some type of market failure. In broad terms, a market can fail in four ways:

- Externalities,
- Imperfect information,
- Public goods, and
- Imperfect competition.

Most markets have imperfect information and imperfect competition to some degree, and many also have some form of public goods. Yet, most markets do not have publicly funded efforts to improve the level of information, overcome high consumer discount rates, or support basic technology development. A motivation for intervening in the energy efficient products market is externalities in the energy market, such as environmental damage. For political reasons, these externalities are not addressed more directly in the energy market. Nonetheless, if we acknowledge externalities as a motivation for publicly funded efficiency programs, the quantified benefits of interventions should include both the benefit of moving the efficient products market closer to its socially optimal level (ameliorating the above failures) and the benefit of reducing the externalities in the energy market. Section 8 shows how the resulting approach to measuring program benefits ties directly to the components of the Public Purpose Test (PPT), which has been established in California as the basis for assessing market transformation programs.

How Should Benefits Be Measured? Intervening to reduce a failure in a market means shifting a demand or supply curve in that market. For example, if lack of energy efficient product information has resulted in under-consumption of these products, providing better information will shift the product demand curve in the direction of higher consumption at each price. The societal value of shifting the demand curve from its current sub-optimal position closer to the optimal fully informed level, or of a shift in the supply curve if that was at a sub-optimal position, is measured by the reduction in deadweight loss in the products market.

The concept of deadweight loss is somewhat abstract. However, the reduction in deadweight loss due to mitigating a failure in the efficient products market can be measured concretely as:

- The market value of energy savings due to increased purchase of efficient products,
- Plus the non-energy benefits to consumers due to these products,
- Minus the non-energy disbenefits to consumers due to these products,
- Minus the cost of the additional efficiency purchased due to the intervention.

Thus, the components counted in determining the benefits of an intervention are the same as those in other benefit/cost tests described in Section 8, including the PPT, which is currently required for benefit/cost analysis in California. These components are as follows:

- The market value of energy savings,
- The non-energy consumer benefits,
- The non-energy consumer costs,
- The measure costs, and
- Energy or other externalities.

One difference between this framework and these tests is that measure costs are subtracted from the benefits side rather than being counted on the cost side. The other differences are primarily in emphasis. We stress the importance of recognizing externalities in energy production as a motivation for intervention. We also stress the importance of identifying non-energy costs.

What Costs Should Be Considered? Traditional tests that count avoided production costs as a benefit have counted the costs of efficiency measures as a cost, along with program administrative costs. In this approach, only program costs (excluding rebates or transfer payments) and not measure costs are counted. Rather, measure costs are subtracted from the value of the additional efficiency products to determine the net societal benefit of these products, or deadweight loss reduction. Section 8 describes the relationship between this approach and more familiar benefit/cost tests more fully.

2.2.2 Design Considerations

The economic framework described in this section suggests that market transformation programs are motivated by externalities in the energy market, but work on transforming the market for efficient products to ameliorate the externalities in the energy market as well as to reduce deadweight loss in the market for energy efficient products. This perspective suggests certain considerations for program design.

- Even if there is no failure in the energy efficiency market, it may be worthwhile to intervene in that market to reduce the externality costs in the energy market. However, intervening in a market where there is no failure risks creating new societal costs due to the intervention.
- Even if imperfect information is demonstrated to exist in the efficient products market, improving the level of information will not necessarily increase the demand for efficient products if information is not the reason that demand is at a lower level than might be considered desirable.
- Market transformation efforts are generally defined to mean interventions that will move the markets (shift supply or demand curves) in ways that will be sustained after the particular intervention is ended. However, the externality in the energy market will never be eliminated by changing the efficient products market, and continued intervention may be warranted.

2.2.3 Implications for Analysis

Given this general framework, the following chain of analysis can be used. For planning purposes, these steps are based on projections of the magnitudes of component effects. Retrospective evaluation revises these projections based on empirical information. Further details are discussed in Sections 5 and 6.

- ***Determine how much increase in demand/supply for efficient products is attributable to the intervention.*** This step involves asking a critical attribution question: "What changes in consumption and production of efficient products have been caused by the intervention?" In principle, this involves estimating the demand and supply curves with and without the intervention. However, other approaches may be taken that do not involve explicit estimation of these curves.
- ***Measure the value of avoided externalities due to energy savings attributable to the intervention.*** This step entails translating incremental efficiency measure adoption into the quantity of energy saved over time, and translating the energy savings into the value of the avoided externality.

- ***Quantify the deadweight loss reduction in the efficient products market.*** Deadweight loss reduction can be quantified directly by estimating the demand and supply curves with and without the intervention, as well as the socially optimal levels. Calculating net consumer benefits is an alternative approach. This approach entails calculating avoided market costs of energy as well as non-energy benefits, and subtracting measure costs and non-energy costs. The latter approach is more consistent with traditional evaluation methods and with the PPT.

The remainder of this section develops the economic framework in more detail.

2.3 The Public Purpose of Energy Efficiency Programs

2.3.1 Competitive Versus Regulated Energy Markets

The difference between regulated and competitive supply has consequences for market transformation program evaluation, or other interventions in energy efficiency markets. Under regulated electricity supply, resource acquisition programs—or more recently market transformation programs in a still regulated supply environment—were generally viewed as an alternative to building new power plants or otherwise generating additional supply. In these cases, program costs were compared with the benefits of avoiding new power plant construction, or other supply costs. This framework made good sense in a world where the decision to invest in supply was not made by the market.

In the competitive supply world, however, the decision to build a new power plant is handled by the market. Therefore, the cost-effectiveness framework of efficiency programs under regulated markets no longer applies.

The electricity supply market in California is not perfectly competitive. Market power is concentrated in a small number of generating companies and regulatory controls continue. Nevertheless, as long as competition continues, even with varying levels of control, assessing costs and benefits in terms of the economic value to a competitive market is appropriate.

In evaluating the cost-effectiveness of interventions in a competitive market, clearly the costs of the intervention continue to be included among the costs, as in the case of fully regulated supply. However, what are the benefits? If the intervention is to alleviate a market failure, the benefits must be measured in terms of the societal value of alleviating this failure. The economic framework for calculating such benefits is reviewed below.

2.3.2 Why Spend Public Funds on Market Intervention?

From a societal perspective, the primary reason to intervene is that the market is not functioning optimally on its own. For this to be the case there must be some failure in the market. Therefore, the fundamental reason to intervene in the energy efficient products market is to address a failure in the energy efficiency and/or energy markets. Eto, Prahl, and Schlegal (1996, p. 8) also identify market failure as the rationale for intervention.

> *"...if there is an intervention that is net beneficial (enhances societal welfare) for a specific market barrier, then this market barrier is a market failure and we have justification to intervene."*

At the same time, it is widely recognized that intervening in a market may worsen the market's performance. Thus, even if there is identifiable market failure, intervention is not necessarily called for. Indeed, most markets are imperfect to some extent, but do not trigger intervention.

2.3.3 What is a Market Failure?

In classic economic terms, a market is said to fail if the interaction of demand and supply does not result in the socially optimal quantity of the good or service (good or service) being consumed and produced (Stiglitz 1993). Fundamentally, markets can fail for four reasons:

- Externalities,
- Imperfect information,
- The good or service is a public good, and
- Imperfect competition.

Some sources use other classifications, but essentially all market failures can be grouped into one of these categories. The application of these failures to energy and energy efficient products markets is discussed below.

- ***Externalities.*** There is an externality associated with a good or service if the consumption or production of the good or service results in costs incurred or benefits received by consumers or firms not directly involved in the consumption/production of the good or service. For example, if the production of electricity results in environmental damage not reflected in the electricity price, then environmental damage is an externality associated with electricity. In the energy efficiency market, the difference between societal and private discount rates can also be viewed as an externality. In other words, because the societal discount rate is lower than the private rate, the societal value to the efficiency investment is greater than the value to the consumer.
- ***Imperfect Information.*** Imperfection information is often cited as a source of market failure in the energy efficiency market. This imperfect information may result from the newness of the technologies,
- ***Public Goods.*** A public good has two characteristics:

  - It is impossible or very costly to limit the benefits of the good or service only to persons purchasing the good or service, and
  - The additional cost of providing the good or service to an additional person is zero or very small.

  The value of the learning/experience curve for producing energy efficient goods can be viewed as a public good. Thus, research and development is an intervention strategy to mitigate this market failure.

- ***Imperfect Competition.*** The level of competition in a market is a function of three market characteristics: the number of firms in the market, the ease of entry into and exit from the industry, and the homogeneity of the good or service, as perceived by consumers. A market is likely to be more competitive:
  - The larger the number of firms in the market,
  - The easier it is to enter and exit the industry, and
  - The more homogenous the good or service.

  The lack of supply, or too few firms in the market, is occasionally mentioned as a source of market failure in the energy efficiency market. However, this failure is generally not a rationale for intervention through energy efficiency programs.

2.3.4 Other Rationales for Intervention

Maximizing economic efficiency in the classical sense of total social welfare is not the only standard by which a market may be measured. Likewise, mitigating market failures to move closer to the classically optimal levels of production/consumption is not the only rationale for intervening in a market. Ensuring adequate supply, maintaining consumer price stability, and promoting greater equity with respect to energy cost burdens are all motivations for promoting energy efficiency, particularly in the face of rising market prices and shortages in the competitive electric market.

Even when an intervention is driven by equity or other policy considerations, it is still important for the public funds to be spent as cost-effectively as possible. Essential to any assessment of cost-effectiveness will be quantification of energy savings, translation of these savings into avoided costs, and accounting for non-energy benefits and costs including mitigated externalities. Depending on the policy objectives, different values might be assigned to different components of savings to different market segments.

We rely on the classical economic theory as providing the most comprehensive and systematic framework for assigning value to the effects of market interventions. This framework also provides guidance for thinking about what strategies may be effective in particular contexts. At the same time, we recognize that other perspectives may need to be considered in an overall assessment of the effectiveness of a set of interventions.

2.4 How Market Interventions Work

An intervention in the energy efficient products market attempts to alleviate market failure in the energy efficiency and/or energy markets. To alleviate market failure, an intervention must shift the demand curve or the supply curve in the market. It is the demand for and supply of a good or service that determines the quantity of the good or service consumed/produced. If there is a failure in the market, the quantity of the good or service consumed/produced is not socially optimal. The goal of the intervention is to shift one or both of the curves so that the quantity consumed/produced will be closer to optimal.

Market transformation interventions attempt to alleviate market failures in ways that will persist after the intervention has ended. We intend for this definition of a market transformation intervention to be generally consistent with the definitions found in Eto, Prahl, and Schlegal and related literature.[1] Although it is unclear that all barriers listed in Eto, Prahl, and Schlegal are market failures in a technical sense. The concept "market failure" is used rather than "market barrier" to be consistent with standard economic terminology. Market transformation strategies may work on either the demand or supply side.

Resource acquisition strategies, by contrast, work directly on the demand side by subsidizing efficiency measures. While the subsidy and resulting increase in purchases of efficient products may have longer lasting effects (market transformation effects), the goal of the strategy is to directly shift the demand curve by changing the effective price to consumers. Resource acquisition and market transformation strategies, as well as infrastructure and research and development, may have a place in a portfolio of interventions for a particular market. Likewise, a particular tactic such as a subsidy may support both an immediate resource acquisition strategy and a longer term market transformation strategy.

2.4.1 Changing Demand and Supply

The factors affecting the demand for and supply of a good or service are well known. A consumer's demand for a good or service is determined by several factors:

- The price of the good or service,
- The consumer's income and access to credit,

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1 Eto, Prahl, and Schlegel (1996) provide a long list of market barriers that market transformation programs are designed to overcome. Some can be viewed as problems of imperfect information (failure #2). For example, the split incentive problem of builders making efficiency decisions for new construction can be viewed as a problem of consumers not understanding the value of higher efficiency equipment. Other barriers in the Eto, et. al. taxonomy are not market failures in the formal sense, but are simply costs of doing business. That is, the presence of such problems by themselves does not suggest a need for intervention in the market. However, once a decision is made to intervene, mitigating these barriers may be part of a market transformation strategy.

- The price of a substitute and complementary good or service,
- The consumer's tastes,
- How informed the consumer is regarding the good or service, and
- The consumer's expectations.

In addition, the market demand for a good or service, which is simply the summation of the consumer demands for the good or service, is a function of the number of consumers in the market.

Several factors determine a firm's supply of a good or service:

- The price of the good or service,
- The prices of inputs,
- Technology,
- The price of an alternative good or service,
- The firm's expectations, and
- The firm's access to credit.

In addition, the market supply of a good or service, which is the summation of the firm supplies of the good or service, is a function of the number of firms in the market.

To evaluate a market intervention, the connection between the program and the determinant(s) of demand and/or supply that the program is attempting to affect need to be clear. This issue goes to program design.

2.4.2 Designing a Market Intervention

For an intervention strategy to have a chance at shifting the market, it is necessary to:

- Clearly identify and provide evidence of the market failure(s) the program is designed to alleviate, and
- Clearly indicate how the program is expected to alleviate the market failure and thereby result in a more socially optimal quantity of energy efficiency and/or energy produced/consumed.

The second step indicates how the intervention strategy is expected to alleviate market failure, and thereby result in a more socially optimal quantity produced/consumed.

- Clearly identify the various components, that is, market interventions, of the program,

- Clearly identify the determinant(s) of demand and/or supply that each component is attempting to affect and how demand and/or supply will be affected (shift or movement along the curve, increase or decrease), and
- Specify the consequences for the quantity consumed/produced.

Additionally, to aid in the intervention's evaluation, the programs or related efforts must identify and collect data on market effects caused by its intervention(s) into the market, where the connection between the intervention and the hypothesized effect is clear.

The chain of events from intervention to changes in the amount of efficient products produced/consumed and the resulting energy savings is referred to as the program logic (Herman et al. 1997). Designing and assessing programs according to this sequence of events is also known as theory-based evaluation (Rufo et al. 1999; Rufo et al. 2000). Using program logic or theory-based evaluation in program design and evaluation is discussed further in Sections 3 and 4.

In the case of energy efficiency, a motivation for promoting efficiency measures is not so much the failures in the efficiency market as the externalities associated with energy production. Hence, interventions in the efficiency market could be designed not to ameliorate a failure in that market, but to mitigate energy externalities. While such interventions may have the desired effect in terms of reducing energy use and associated externalities, they may cause disruptions to an otherwise well functioning market, which could have additional societal costs.

Thus, while the compelling reason to intervene in the efficiency market may be externalities in the energy market, the intervention is likely to be most effective and least risky if there are failures to overcome in the efficiency market. By themselves, these failures would not be a reason to intervene in the market. In the presence of the energy externalities, however, the efficiency market failures can provide opportunities for effective intervention.

2.4.3 Examples of Market Interventions

Three broad types of interventions are considered:

- A consumer subsidy or rebate,
- Consumer information,
- Supply-side support, such as information, training, or research and development to reduce supply costs.

Rebates may be seen as a resource acquisition intervention, but may also have market transformation (that is, sustained) effects as a goal. Providing consumer information is a market transformation strategy if the goal is to inform consumers in ways that will be sustained in long-term buying habits. However, it is often necessary to provide information on an ongoing basis (for example, to inform purchasers of infrequently purchased goods, such as furnaces). Hence, many types of information interventions serve as infrastructure. Likewise, supply-side programs may be seen as market transformation to the extent that a particular set of interventions will have lasting effects on the supply curve, but may also be part of an ongoing research and development strategy. These strategies are discussed further in Section 3.

The following are market failures that interventions may be designed to alleviate:

- The existence of negative externalities in the production of electricity, primarily damage to the environment,
- Consumers being imperfectly informed regarding energy efficient products,
- Private or consumer discount rates being higher than societal discount rates, and
- The disincentive to innovation by efficient product suppliers due to limitations on suppliers' ability to appropriate the learning/experience benefits.

Externalities in Energy Production. Because of negative externalities in electricity production, the quantity of electricity produced/consumed is not socially optimal. That is, too much electricity is consumed/produced.

Imperfect Consumer Information. In the energy efficiency market, it is expected that if consumers were better informed, the demand for these products would increase. Therefore, because of imperfect information, the quantity of energy efficient products consumed/produced is not socially optimal. That is, too few energy efficient products are consumed.

Consumers may have imperfect information in a market, but if the information they lack does not affect their decision to purchase the good or service, there is very little to gain by making consumers better informed. Although information is imperfect, close to the socially optimal quantity of the good or service is already being consumed/produced. Therefore, key considerations in developing an intervention strategy to improve the information level include not only the extent to which information is imperfect, but also the extent to which improving the level of information will shift demand for efficient products.

The gap between the demand for efficient products and the value of these products in terms of life cycle energy savings may be seen as evidence of a lack of information about the product benefits. However, that gap may reflect other factors, including consumer tastes, product attributes apart from energy savings benefits, consumers' valuation of their time, and time horizons.

Differential Societal Versus Consumer Discount Rates. There is a body of literature suggesting that private discount rates (i.e., that is the rate implicitly used by consumers in making investments in long-lived products) are much higher than societal rates. In essence, society takes a longer run view than individual consumers. If society values energy efficiency based on a long-run energy savings stream using a lower discount rate than that used by individual consumers, the effect is that of an externality in the efficiency market. That is, the natural demand curve for efficient products is lower than if it reflected the societal value of the products, which is potentially substantially higher than the private valuation.

The difference between societal and consumer discount rates needs to be viewed with some caution. First, as is true for other failures in the efficiency market, public intervention is not justified based on this issue alone. The problem exists for any market for goods that last more than one or two years. However, there are no government programs to encourage people to buy longer lasting clothes washers, shoes, or stereos.

More importantly, estimates of implied consumer discount rates can overstate the gap between consumer and societal rates. Low measure adoption rates, compared to what would be seen if consumers acted in their own best interests and used societal discount rates, may stem from many factors.

- Consumers may not believe in the expected savings. This may result from imperfect information. If so, the effect should not be counted additionally as a discount rate problem. The lack of faith in the savings may be realistic, and may not be accounted for in the simple calculation of apparent savings.
- Consumers may not expect to keep the item for as long as it could in fact last and be useful. In other words, it is not the discount rate that is different, but the period of the savings stream.
- Consumers may accept different risk levels on average than society. This is because, at the societal level, the law of averages protects in ways it does not for the individual. Thus, society may not care if some measures are lemons, as long as the benefit is high enough averaged over lemon and non-lemon units. However, the risk would discourage an individual purchaser.
- Consumers may consider other attributes of the measures, which are ignored by economic analysis based solely on measure costs and energy savings. These other attributes and consumers' responses to them are appropriately reflected in the demand curve. The fact that the technology is risky or unproven may be one of these attributes.

Indeed, Eto, Prahl, and Schlegal (1996) do not include differential discount rates in their list of market barriers. Rather, they suggest that a difference between the societal and implicit consumer discount rates may indicate a market failure such as imperfect information.

To the extent that consumer discount rates are in fact higher than societal rates, there is little that a market transformation program can do in terms of creating a self-sustaining shift. Only ongoing resource acquisition or subsidies can solve this problem.

Disincentive to Innovation. Supply-side disincentives to innovation are discussed extensively by Duke and Kammen (1999). Learning and experience will lower production costs in the long run. However, learning moves between firms as employees move around and knowledge is exchanged. As a result, in a competitive market, firms underproduce:

> *"When the benefits of learning are not appropriable, learning becomes a positive externality and firms fail to produce enough in each period to maximize efficiency over the entire production period."*

Research and development strategies are designed to alleviate this disincentive. Since the disincentive is always present, an ongoing intervention strategy is called for, though each successful research and development effort will itself produce lasting market effects.

Reliability and Equity. As discussed in Section 1, recent concerns over reliability have added a new momentum to publicly funded energy efficiency. From the standpoint of economic efficiency, reliability problems, or supply shortages, in restructuring markets do not represent another type of failure that requires intervention. Rather, the shortage is the result of continuing regulation in the form of regulated rates to consumers in some service territories, combined with price caps in the wholesale market. In the absence of these retail and wholesale price controls, the quantity demanded would be reduced in response to high prices, and there would be no shortage. That is, supply would be economically "rationed" to those willing and able to pay the high prices.

The rationale for public intervention to mitigate these high prices is not economic efficiency—the functioning of the competitive market to produce the greatest societal welfare—but equity, that is, the distribution of the societal welfare. The value placed on equity is not determined by the market, but is a matter of public values. Efforts to increase equity will often lead to different results from what strict economic efficiency would dictate. In particular, price caps to prevent economic rationing and windfall profits to suppliers with large market shares can result in a quantity demanded in excess of the quantity supplied, or shortages. Promoting energy efficiency to alleviate these shortages is a means of supporting the equity measures. That is, energy efficiency can make it possible to keep consumer prices stable without risking supply shortages.

Equity is commonly recognized as a reason for public funding of low income programs for energy efficiency. While such programs should be operated as cost-effectively as possible, they are typically not required to pass cost-benefit tests based on pure economic efficiency or the economic value to society of the energy saved. In Section 3, equity is described as a distinct strategy of efficiency. The strategy of equity-oriented interventions is different because the goal is different.

Energy efficiency efforts designed to address capacity shortages may similarly be valued at least in part based on their contribution to equity in the form of allowing price caps to operate without inducing blackouts. While we recognize equity or consumer price stability as an additional rationale for intervention, we do not attempt to formalize how such considerations should be valued.

From the perspective of economic efficiency alone, as noted, reliability is not a separate type of market failure justifying intervention. However, the high prices associated with short supply increase the economic value of interventions. At higher electricity prices, energy efficiency has a greater consumer value. To the extent that lack of consumer information is a reason for under-consumption of efficient products, the value of improving information is increased. Likewise, the societal value of innovations in efficient products is increased when electricity prices are higher.

As noted in Section 1, the immediacy of the price spikes in the next year or two suggests a need for fast-response interventions, which drives toward resource acquisition strategies rather than longer acting market transformation. Reliability concerns also suggest a need for more time-specific valuation of electricity savings, and possibly more extensive consideration of costs of ancillary services and congestion pricing in establishing avoided market costs.

2.4.4 Near-Term and Ultimate Market Effects

Near-term market effects are the most direct effects of interventions, and typically consist of reductions in market failures and changes in behavior of market actors influencing customer energy efficiency decisions. These effects are often tracked via variables called proximate indicators. Ultimate market effects are less directly influenced by interventions, and usually take the form of changes in adoptions (market shares, sales) of energy efficiency measures and the attendant energy and demand savings. Variables representing these market features are often called ultimate indicators. This analysis focuses on the effects of public interventions on two ultimate indicators: changes in sales of energy efficient products, and changes in energy usage.

2.5 Quantifying Costs and Benefits

What is included in the costs? In the context of resource acquisition programs conducted by regulated utilities, most cost/benefit tests include costs of efficiency measures on the cost side. This accounting is appropriate when a single entity (the utility, or the regulator on behalf of ratepayers) must make the choice between spending to reduce demand and spending to increase supply. Thus, costs to reduce demand, program costs, and measure costs are weighed against the corresponding costs of supply.

In the competitive market, however, the market makes these choices. Public choice is whether and how much to spend to intervene in the markets. In this case, the only public cost is the cost of the program itself (for administration and delivery). As in the regulated societal test, transfer payments (rebates) are not counted as a societal cost since one party benefits at the expense of another with no net societal gain or loss. Thus, in the competitive market, the only component counted on the cost side is the cost of operating the program, excluding any rebate costs. Measure costs are not counted.

What is included in the benefit? In a competitive market, the benefit of public intervention is the societal benefit of alleviating the market failures that motivated the intervention. First, the motivation for market transformation interventions is presented, along with the types of changes they are attempting to make in the marketplace. Given this framework, what are appropriately considered the costs and benefits of such interventions are identified. A broad schematic of the kinds of analyses that can quantify the benefits concludes this discussion.

Consider the markets for electricity and energy efficient products in the absence of any intervention—Figure 2-1 and Figure 2-2, respectively. In each market, in the absence of any intervention, the quantity of the good or service consumed/produced is Q_0^* and the socially optimal quantity is $Q_{SO_0}^*$ or Q_{SO}^*. In the electricity market, the socially optimal supply curve S_{SO} includes the cost of the negative externality, primarily environmental damage, whereas the supply curve S_0 does not.

In the energy efficiency market, the socially optimal demand curve D_{SO} reflects perfect information regarding energy efficient products, whereas the demand curve D_0 does not. If there is a difference between societal and private discount rates, the socially optimal demand curve is based on valuing energy at the societal discount rate. One could also assume that the socially optimal demand curve for efficiency products is based on valuing energy including the externalities. To keep things simpler and avoid double counting, the externality is represented only in the energy market where it occurs. In the efficient products market, the difference between the current demand curve D_0 and the socially optimally demand curve D_{SO} reflects only the failures that occur in that market.

The cost of not consuming the socially optimal quantity of the good or service is referred to as deadweight loss. It is the triangular area denoted by the points A, B, and C in Figure 2-1 and Figure 2-2.

Figure 2-1: Market for Electricity – No Intervention

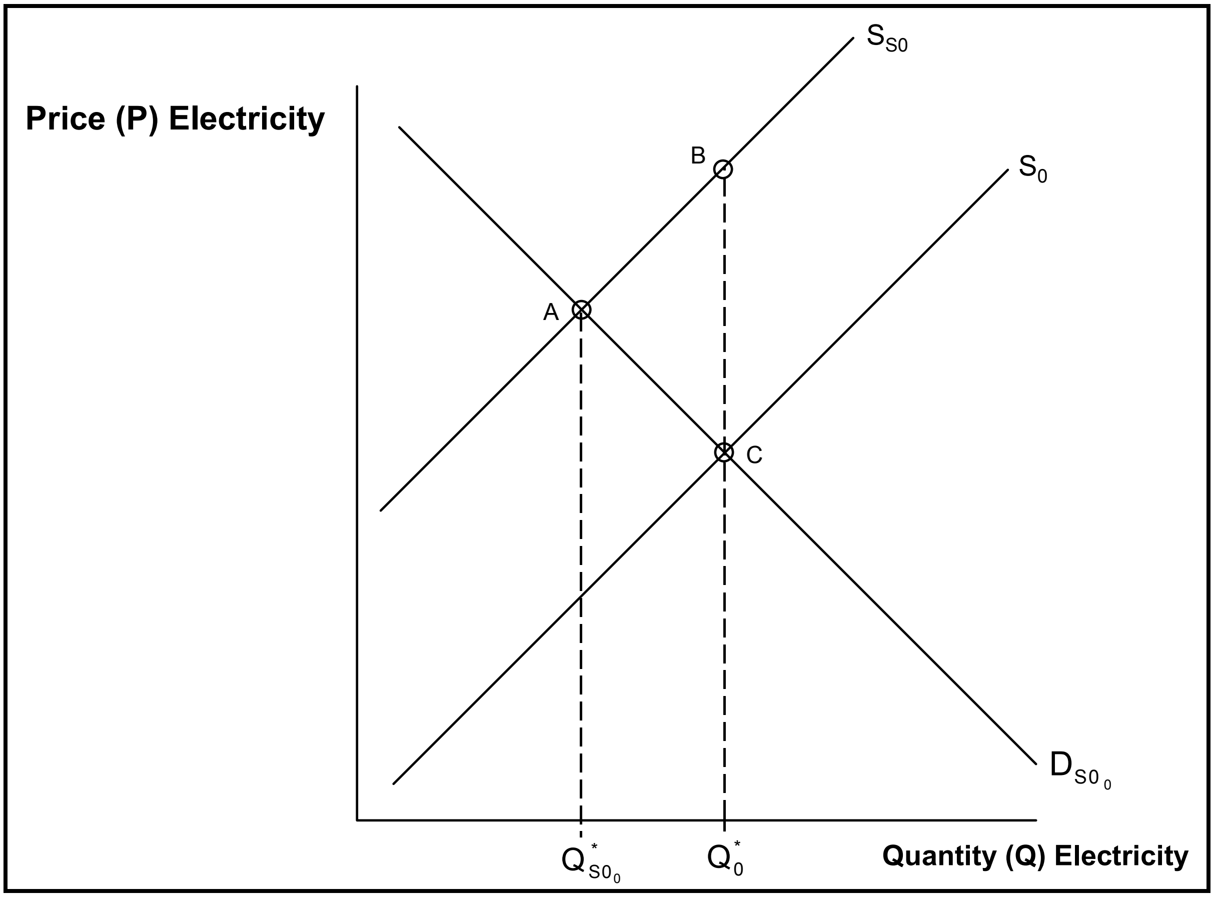
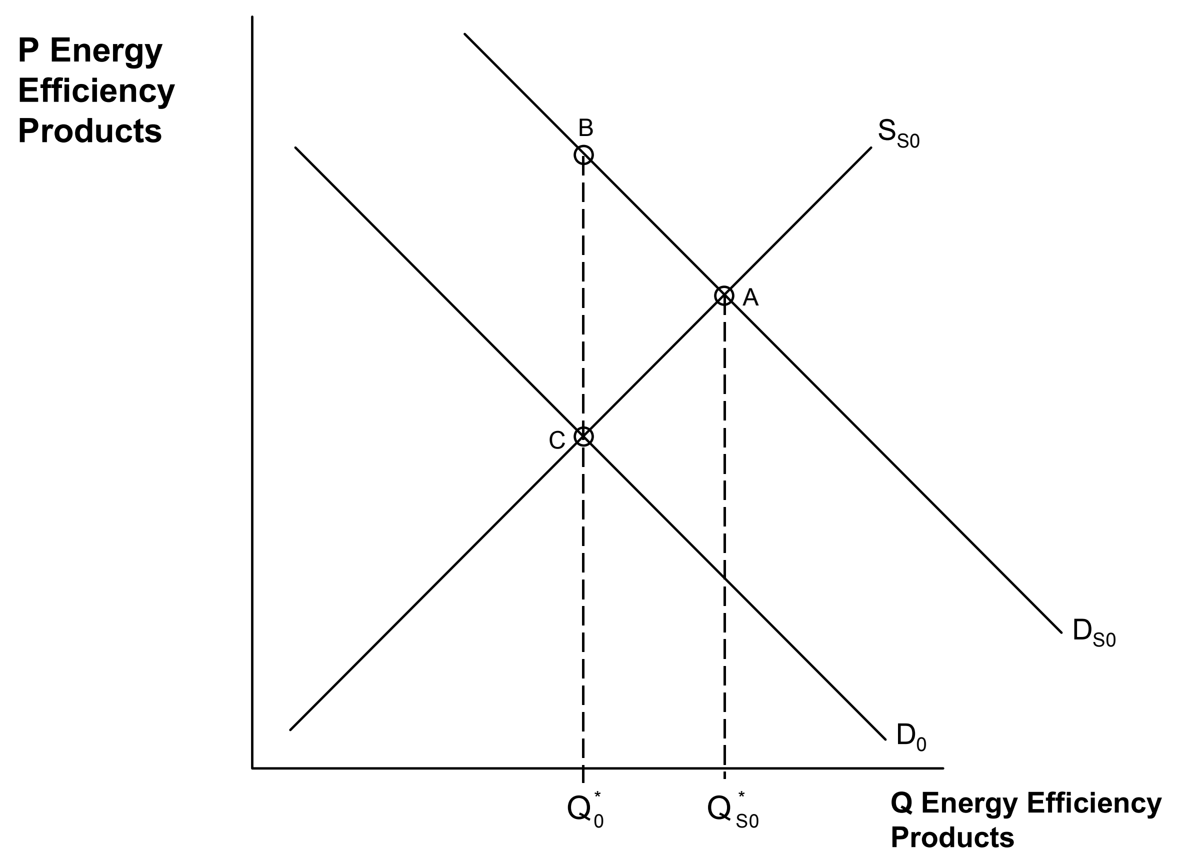


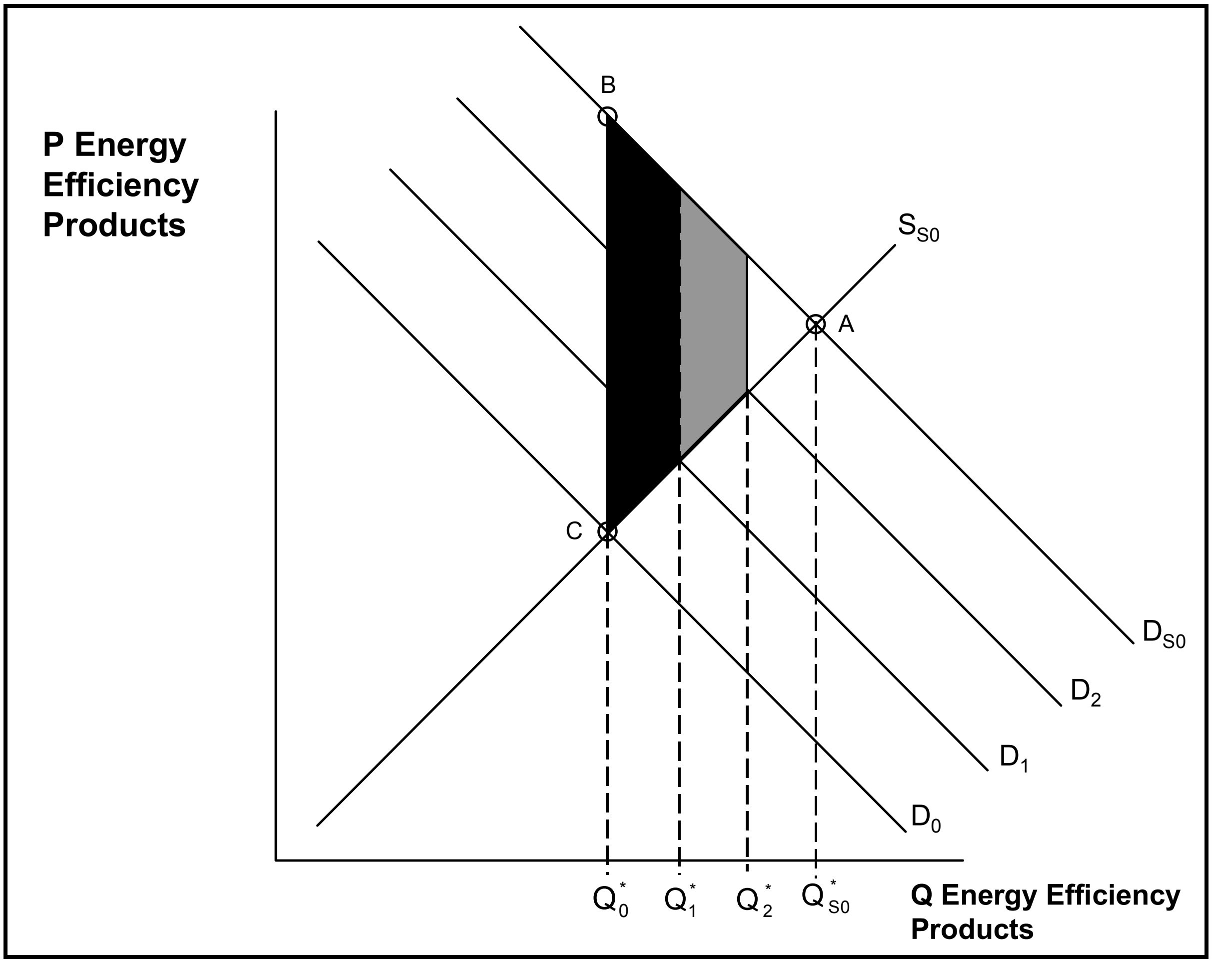
Figure 2-2: Market for Energy Efficient Products – No Intervention



Next, consider the effect of each intervention on the markets for electricity and energy efficient products.

Consumer Rebate. A consumer rebate lowers the effective price of the energy efficient product and may increase consumers' awareness of the product. First, focus on the potential informational effect of a consumer rebate. Suppose during each year a consumer rebate is offered and for some time thereafter, the intervention increases the demand for energy efficient products because consumers become better informed regarding these products. In Figure 2-3, the demand for energy efficient products increases from D_0 to D_1 at some point in time because consumers are better informed about these products as a result of the intervention. Therefore, by alleviating the failure of imperfect information in the energy efficient products market, the consumer rebate results in a quantity of these products consumed/produced Q_1^* that is closer to the socially optimal quantity. The benefit of consuming/producing a quantity closer to the socially optimal quantity is the decrease in deadweight loss. This decrease is shown by the dark shaded area in Figure 2-3.

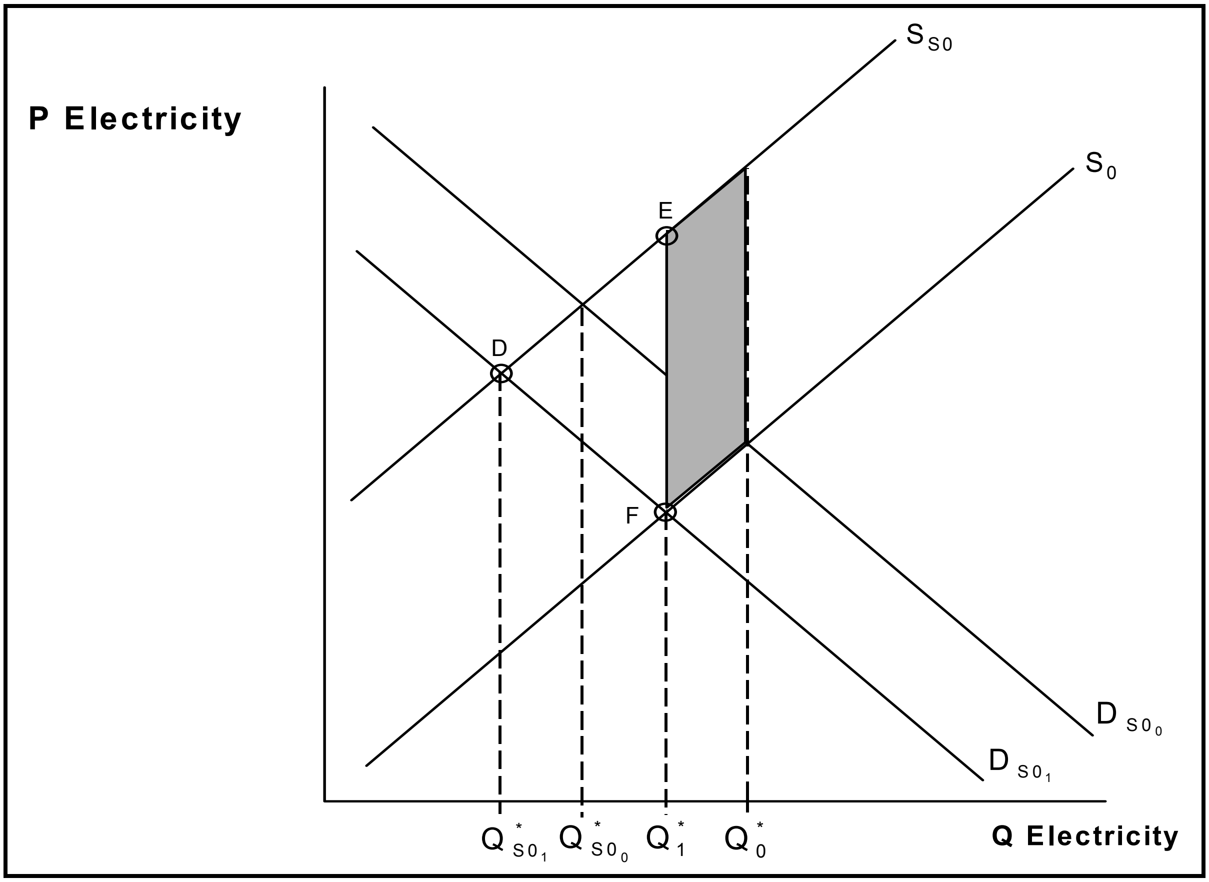
Figure 2-3: Market for Energy Efficient Products Effect of Consumer Program



During each year of the consumer rebate, the demand for energy efficient products will further increase to D_2 because of the decrease in the effective price. However, unlike the increase in demand for energy efficient products due to consumers' becoming better informed, this increase in demand will continue only as long as the rebate continues. The lightly shaded area between the lines at Q_1^* and Q_2^* shows this temporary, nonsustained decrease in deadweight loss due to the direct effect of the rebate.

The benefit of increased energy efficient product demand is the resulting decrease in electricity demand. This decrease in electricity demand, at some point after the rebate has started having effects, is shown as D_{SO_1} in Figure 2-4. The benefit of this decreased electricity demand is the cost of the externality that is no longer incurred, shown as the shaded area in Figure 2-4.

Figure 2-4: Market for Electricity Effect of Intervention



If the rebate no longer existed, its effect on electricity demand would reflect only the increased energy efficient product demand caused by consumers becoming better informed. It would no longer reflect the increase in the demand for these products caused by the decrease in effective price. Consequently, after the consumer rebate has ended, the benefit of decreased electricity demand attributable to the consumer rebate will only be a portion of the shaded area in Figure 2-4.

The consumer rebate decreases electricity demand. Therefore, the externality costs associated with the no-longer-consumed/produced quantity of electricity are no longer incurred. However, the externality costs remain identical for the quantity of electricity that continues to be consumed/produced. Too much electricity continues to be consumed/produced. The deadweight loss associated with this over consumption/production of electricity is the triangular area denoted by the points D, E, and F in Figure 2-4. While the triangle's position has shifted compared to the situation before the intervention (triangle ABC in Figure 2-1), the area of the triangle (i.e., the magnitude of the deadweight loss) has not been reduced.

Consumer Information. Analysis of a direct consumer information intervention is equivalent to the analysis of the consumer rebate, without the effect of the decrease in the effective price of energy efficient products. In Figure 2-3, energy efficient product demand increases from D_0 to D_1 at some point because consumers are better informed regarding these products because of the intervention. The benefit of consuming/producing a quantity closer to the socially optimal quantity is decreased deadweight loss, shown as the shaded area in Figure 2-3.

Another benefit to increased energy efficient product demand caused by better consumer information is the resulting decrease in electricity demand. If this decrease in electricity demand was shown in Figure 2-4, a demand curve would be inserted somewhere between D_{SO_0} and D_{SO_1}. The curve D_{SO_1} reflects the increase in energy efficient product demand caused by better-informed consumers and the decrease in the effective price because of the rebate. When compared with the consumer rebate, the benefit of decreased electricity demand attributable to consumer information will be only a portion of the shaded area in Figure 2-4, which is the cost of the externality no longer incurred.

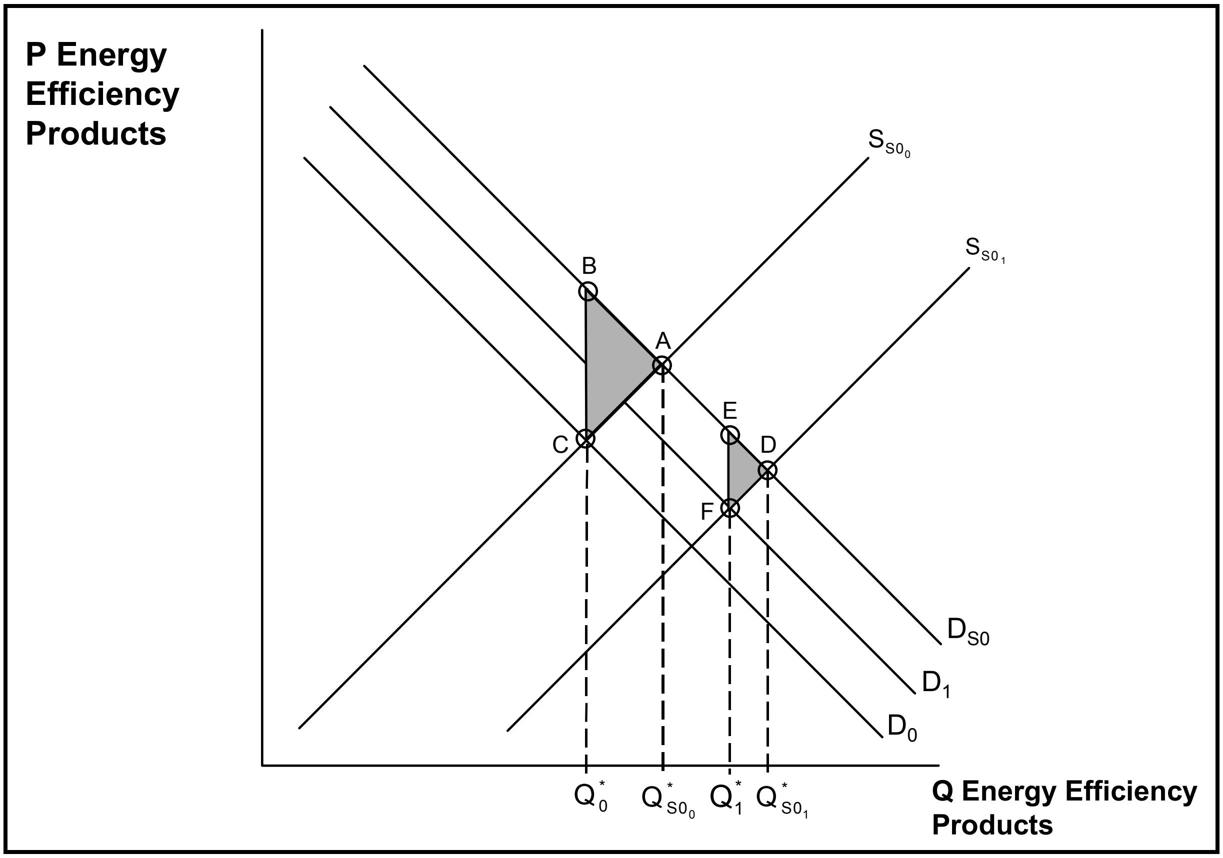
If electricity prices rise, the value of energy efficiency products becomes greater. As a result, the deadweight loss reduction associated with improved consumer information is potentially greater. That is, a given shift in the quantity demanded corresponds to a greater deadweight loss reduction, because the value of each unit is greater. In Section 8, the relationship between electricity costs and the benefits of increased adoption of energy efficiency measures is made explicit.

Supplier (Upstream) Interventions. Suppose during each year of the supplier (upstream) intervention and for some time thereafter, the intervention does the following:

- It increases the supply of energy efficient products by decreasing the price of an input, training, or development,
- It increases the demand for energy efficient products by causing consumers to become better informed regarding these products.

Increased energy efficient product supply and demand, resulting from the supplier intervention, at some point are reflected in S_{SO_1} and D_1, respectively, in Figure 2-5.

Figure 2-5: Market for Energy Efficient Products Effect of Supplier Program



The benefit of alleviating the imperfect information failure in the energy efficient products market is a decrease in the deadweight loss associated with the under consumption/production of these products. This decrease is the difference between the triangular area denoted by the points A, B, and C and the triangular area denoted by the points D, E, and F in Figure 2-5.

The benefit of increased energy efficient product supply, and a further benefit of increased energy efficient product demand, is the resulting decrease in electricity demand. This decrease in electricity demand is shown as D_{SO_1} in Figure 2-4. The benefit of decreased electricity demand is the cost of the externality that is no longer incurred, shown as the shaded area in Figure 2-4.

Figure 2-5 does not show any reduction in deadweight loss due to the shifting of the supply curve. That is, the figure assumes that the original supply curve was itself optimal. The program moved the supply curve as a means of reducing externalities in the energy market, not alleviating a supply-side failure in the efficient products market. The decrease in deadweight loss (the difference between the areas of triangles ABC and DEF) is due not to the shift in the supply curve from S_{SO0} to S_{SO1}, but to the shift in the demand curve from D_0 to

D_1. This shift in demand due to improved consumer information is, however, the result of the supply-side market intervention.

If the supplier intervention does not cause consumers to become better informed regarding energy efficient products, the program will not decrease the deadweight loss associated with the under consumption/production of these products. Demand will stay at D_0 and the deadweight loss triangle will move from the line S_{SO0} to the line S_{SO1}, but will have the same area as triangle ABC.

Even if there are no benefits in the efficiency market, the supplier intervention will still produce benefits in the form of avoided externality of energy production. As long as the intervention increases the supply of energy efficient products, it will decrease the price of these products and demand will increase. Therefore, if the supplier intervention does not cause consumers to become better informed regarding energy efficient products, electricity demand will still decrease from D_{SO_0}, but not as far as D_{SO_1} in Figure 2-4. Decreased electricity demand will reflect only the increase in energy efficient product demand caused by price decrease. It will not reflect increased demand for these products caused by better-informed consumers. If electricity demand attributable to the supplier program does not decrease as far as D_{SO_1}, then the corresponding benefit will only be a portion of the shaded area in Figure 2-4.

If there is a supply-side failure in the efficiency market (i.e., the disincentive to innovation) that is improved by the program, the starting point supply curve S_0 is not socially optimal and the efficiency market is moved to a supply curve that is closer to socially optimal. In this case, the initial deadweight loss in this market would reflect lack of optimality in supply and demand. The deadweight loss after the program has moved the market would be less than the initial deadweight loss due to both demand and supply shifts. Duke and Kammen (1999) provide a more complete accounting of the effects of research and development strategies.

As in the cases of consumer rebates and direct consumer information interventions, the supplier intervention decreases electricity demand and the externality costs associated with the no-longer-consumed/produced quantity of electricity are no longer incurred. However, the externality costs remain the same on the quantity of electricity that continues to be consumed/produced. Additionally, there is still a deadweight loss associated with the over consumption/production of electricity (the triangular area denoted by the points D, E, and F in Figure 2-4).

Transaction Costs. An argument can be made that reducing the transaction costs associated with acquiring energy efficient products results in a societal benefit, even if the transaction costs are not associated with any market failure. It is true that, all else being equal, a real reduction in the effective cost to consumers results in additional consumer surplus, equal to the cost reduction times the quantity consumed. The challenge lies in accurately valuing the transaction cost reduction. This issue is complex and is not addressed in this report.

2.6 Summary

2.6.1 Economic Framework

Market transformation is one of several strategies for intervening in energy efficiency markets. From an economic perspective, the rationale for intervening in a market is to ameliorate a market failure. Common failures in energy efficiency markets targeted by energy efficiency programs include the following:

- Lack of consumer information on the benefits of efficiency measures (imperfect information in the efficiency market),
- A disparity between consumer and societal discount rates resulting in consumers valuing energy savings less than society at large (an externality in the efficiency market), and
- Supply-side disincentives to develop efficient products because of suppliers' inability to "appropriate" the learning/experience curve production efficiency improvements (innovation as a public good in the efficiency market).

However, these problems exist in most markets without motivating public intervention. An overriding concern in energy efficiency markets is the externalities associated with energy production, a failure in the energy market.

From this perspective, the following are benefits of intervention in the efficient products market:

- The societal value of moving the efficiency market closer to its socially optimal level, and
- The societal value of avoided externality associated with the resulting energy savings.

The societal value of moving the efficiency market closer to socially optimal is the reduction in economic deadweight loss. This reduction is the difference between the societal value of additional energy efficient products purchased and the cost of production. The societal value of the additional products includes the avoided cost of the saved energy, as well as the net consumer non-energy benefits of the products, accounting for both positive and negative features of the products.

However, if there is no failure in the efficiency market, the intervention may move the supply and/or demand curves but produces no benefits in that market. In this case, the only benefit of the intervention is the avoided externality associated with the saved energy. Moreover, if there is no failure in the efficiency market, the intervention may in fact make that market worse, creating a societal cost.[2]

2.6.2 Implications for Program Design

The perspective taken in this section suggests certain considerations for program design.

- Even if there is no failure in the energy efficiency market, it may be worthwhile to intervene in that market to reduce the externality costs in the energy market. In particular, even if there is little indication of supply-side failures in the efficiency market, supply-side interventions (such as supporting developments to lower efficient equipment costs) may be justified. However, intervening in a market where there is no failure risks creating disbenefits due to the intervention.
- Even if imperfect information is demonstrated to exist in the efficient products market, improving the level of information will not necessarily increase the demand for efficient products. Imperfect information is not necessarily the reason that demand is at a lower level than might be considered desirable. Thus, information-oriented programs will not necessarily solve the problem.
- Market transformation efforts are generally defined to mean interventions that will move the markets (shift supply or demand curves) in ways that will be sustained after the particular intervention is ended. However, the externality in the energy market will never be eliminated by changing the efficient products market. Other than imposing a tax to capture externalities in the cost of energy, the most direct way to reduce the energy externality is to subsidize the cost of efficient products. Since the externality will never be eliminated, neither would the need for this subsidy. For some markets, this type of ongoing subsidy may be more cost-effective than alternative programs. Thus, ongoing subsidies or resource acquisitions should be considered in the portfolio of programs addressing a market, even if such subsidy programs are not considered market transformation. Such subsidy programs should be included in the overall benefits/cost test applied to the market's portfolio of interventions.

2.6.3 Implications for Cost-Effectiveness Assessment

Assessing program benefits means quantifying the economic improvement in the efficient products market, as well as quantifying the avoided externality in the energy market. The value of the avoided externality is a translation of the energy saved. The value of improving the energy efficient products market can be quantified one of two ways. The first way

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[2] For example, the reason consumers are not purchasing a measure whose energy savings are worth more than the cost of the measure may be that the measure has negative attributes that make it worth less than its cost. Aggressive promotion of the measure might increase purchases, but the net benefit might be negligible.

involves determining supply and demand curves with and without the intervention. The second approach, more consistent with common evaluation practice, involves quantifying the market value of the energy savings, consumer non-energy benefits, consumer non-energy costs, and measure costs. Procedures for measuring these quantities are discussed in Sections 5 and 6. Benefit/cost measures using these quantities are discussed in Section 8.

3

Market Intervention Strategies

3.1 Overview

This section begins by assuming the economic arguments presented in Section 2 offer several valid justifications for spending public money to increase energy efficiency in the market. This section lays out the terminology that will be used and the fundamental constructs behind the analysis found in subsequent sections. That is, this section provides distinctions and clarifications that will be drawn upon in later discussions of program planning (Section 4), evaluation design and implementation (Sections 5 and 6), the development of dynamic modeling approaches (Section 7), and cost-effectiveness analysis (Section 8). As with all of the sections in this report, this section will emphasize the linkage to prior energy efficiency activities and the current policy environment in California, while still learning from other jurisdictions.

3.2 Introduction

Legislative intent, social responsibility, and macroeconomic theories are complementary justifications for spending public money on energy efficiency. Once the justification and need for market intervention to support energy efficiency is established, policymakers have many ways to pursue that intervention. In the last 25 years, policymakers and utilities in the U.S. have garnered an enormous amount of experience in attempting to make government, homes, businesses, and industries more energy efficient. Now they can build on that experience and the well-developed approaches to implementation and evaluation that they have witnessed.

The oil embargo and the subsequent price signals of the 1970s were combined with public appeals in order to raise awareness of solutions for avoidable and unavoidable energy problems facing the U.S. At first, the only tools were price signals, which were temporary, and public appeals for the "moral equivalent of war." The earliest strategic efforts were based on the idea that if people had all the information needed, they would make investments in energy efficiency. Mandated Residential Conservation Service audits, information without incentives, became the rule, but were found to be generally ineffective in stimulating new investments in energy efficiency (Hirst and Hu 1983; Hirst et al. 1983). Not only were externalities such as environmental costs still excluded from the price of energy, but the consumer remained insulated from the increases in the cost of new energy supplies because new costs were averaged in with the older, less costly sources of energy. Utilities, however, understood the cost of the new energy sources such as nuclear plants. They also dealt directly with the regulators who were beginning to understand the costs of the externalities and the potential for less costly demand-side management (DSM).

Electric utilities, in particular, were exhorted, required, and eventually rewarded to undertake investments in efficiency on behalf of society. Utilities engaged in audits, demonstrations, information campaigns, rebates, complex incentive schedules, giveaways, rates penalizing higher consumption, labeling strategies, and intervention in the establishment of energy codes. They targeted low income programs, often refining strict economic cost-effectiveness guidelines in order to justify serving these customers. Utilities and policymakers learned to value replacement, renovation, and new construction programs that built energy efficiency into normal purchase decisions instead of later replacing operating equipment. The utilities and their regulators began to understand that it was less expensive to build something right the first time than to go back and fix it later. They supported the development of independent private businesses as valuable allies in accomplishing efficiency improvements. Finally, utilities and others recognized the potential of working with other partners in the market, each with its own motivations, to accomplish a common goal (Eckman et al. 1992). This strategic approach to achieving lasting energy efficiency has been named market transformation and, thanks in part to varying interpretations of what it was, has become the dominant force in energy efficiency programs over the last few years (York 1999; Suozzo and Thorne 1999). This over-emphasis on what was *one* promising strategic approach has resulted in the survival of energy efficiency programs during confusing regulatory times. However, it has also created a narrow vision of how to accomplish the continuing public benefit goal of creating a more energy efficient society.

It is essential to acknowledge that the goal of the intervention strategies listed above is to seek an increase in energy efficiency in our society. The listed activities simply represent a multiplicity of *tactics* within a set of far fewer logical *strategies*.

3.3 Complementary Strategic Approaches

To keep the discussion of the next several sections focused and consistent, terminology needs to be firmly established. Almost all energy efficiency activities over the last two decades have been derivatives of four basic strategies to accomplish the same end goal. The authors refer to these strategies as resource acquisition, market transformation, infrastructure support and development, and research and development. A fifth strategy is sometimes identified. The equity or low income approach to energy efficiency is an intervention in the market that includes energy efficiency as a goal. These equity programs are justified for many policy reasons, but their issues are distinct from those discussed in this paper and will not be discussed further.

The effects of these strategic interventions are complementary, and their operation is synergistic. However, it is important for clarity of discussion to make the definitions as distinct as possible. Infrastructure and research and development are two strategic approaches to increasing energy efficiency in the market, and this report will explain how expenditures of funds collected for public goods are very legitimately targeted for these two approaches. However, most of the discussion in this section will focus on the more controversial and misunderstood strategic interventions: resource acquisition and market transformation.

Throughout this report, the word "program" will be used sparingly. The team of authors agreed that it has become too imprecise a term to support the types of distinctions that the authors are discussing. A market transformation "program" could mean an overall approach to the market, or it could mean any one of the group of initiatives within a strategic intervention, or it could mean the whole strategic intervention. Lastly, it can be used to describe any facet of an initiative, such as the ENERGY STAR® "advertising program." Generally, the programmatic hierarchy within this report is strategic approach, intervention, initiative, and facet, effort, or component of an initiative. The objective is not to change the way professionals speak of "programs," but to allow as much clarity as possible within the text of this report.

Resource Acquisition. Resource acquisition is the basic approach of using trackable (to the individual program participant and measure), measurable, cost-effective investments in energy efficiency to replace generation energy, transmission, and distribution capacity. This is the approach underlying traditional utility Least Cost Planning and Integrated Resource Planning. These frameworks, which were the crucial regulatory foundations of the energy efficiency programs in the '80s and '90s, treated energy efficiency resources as a viable alternative to new generation (Gellings and Chamberlin 1988). For a regulated utility with an obligation to provide electricity to everyone in their territory, offering energy efficiency programs could often be cost-effective and, if combined with regulatory incentives, even profitable. With the advent of the fears of competition and the reduced obligation to serve *all* customers and *all* their power needs, utilities reduced their investments in all long-term resources, not just energy efficiency. However, while the private sector snapped up divested generating resources, there was no natural market to supply energy efficiency as a resource. Policymakers have stepped into this void with Public Goods Charges (PGC) to fund energy efficiency activities. The basic social and economic justification for market intervention on behalf of energy efficiency remains strong, and resource acquisition remains an effective strategic approach in accomplishing the goals of energy efficiency.

The strategic approach of resource acquisition allows the utility to match investments to identified needs in terms of location, timing, size, and speed of the acquisition. Resource acquisition is a powerful tool that treats energy efficiency as an investment that can be targeted. For example, the California Public Utilities Commission (CPUC) is approving the energy efficiency filings of the California investor-owned utilities for 2000. In these decisions, the regulators ordered the utilities to use PGC funds to target DSM activities that would increase the reliability of the electric system (CPUC 99-09-049 and 050). Acquisition is the clearest alternative for programmatic responses to the regulators. When the megawatts absolutely, positively must be there on schedule, the best way to obtain the resources will be to buy them—one kilowatt at a time if necessary.

The strengths of resource acquisition as a strategic approach is that it provides for control of timing, location, budgets, sizing, and effect size. After years of experience with planning, implementation, measurement, and evaluation, policymakers can feel secure in the reliability, cost-effectiveness, persistence, and forecasting accuracy of an intervention built around a resource acquisition strategy. Regulators have become generally comfortable with the amount of causality that can be roughly ascribed to acquisition accomplishments. Further, the controls afforded allow targeting programs for many policy and resource motivations, such as rate class equity, under-served populations, and highly leveraged transactions (i.e., chain stores). In the end, the most dependable way to induce energy efficiency into the market may be to use resource acquisition interventions to override the market failures.

The most common error is to confuse resource acquisition, which is a strategic approach to achieving energy efficiency, with rebates and incentives, which are tactical tools. There is a temptation to call resource acquisition strategies “subsidy programs,” but that is too narrow a description. Resource acquisition often involves more than an income transfer—education, working with trade allies, advertising, and other strategic actions are combined with incentives. The term “acquisition” describes the general purpose of the activity, whereas “subsidy” defines one method of attaining that goal. Continuous and ongoing incentive programs will have the effect of subsidizing the production, sales, or purchases of energy efficient measures or services in a market with continuing externalities. However, a strategic approach to resource acquisition will involve modifying the incentive structure and size to meet market conditions and the program administrator’s needs. In addition, terms like retrofit, replacement, and lost/market-driven opportunities do not define resource acquisition, but are descriptions of market events in which intervention can be targeted, using tools like education and incentives. They are market events that can also serve as targets in market transformation strategies.

The weaknesses of resource acquisition as a strategy include the following:

- Very high apparent costs—if administrators spend almost the cost of avoided generation, how much market efficiency is actually gained?
- Buying megawatts one kilowatt at a time can involve very high transaction costs.
- Paying large incentives may provide the wrong social message and market signals about energy efficiency.
- Probably the most difficult weakness, from the perspective of the ultimate goal of making energy efficiency the norm, is that sometimes the investment buys only the impact of the single transaction and the market for the technology or service may decline when the subsidies disappear. Resource acquisition programs impact only a sliver of the market in any year.

Other weaknesses ascribed to resource acquisition strategies are actually the impact of the way utility sponsorship of acquisition activities have been regulated and rewarded. They are not intrinsic problems of resource acquisition. These criticisms include the focus on only influencing "participants" in order to avoid the impression that the whole market is changing independent of the participant-focused program.[1] Some initiatives are more cumbersome and counter-productive because of constraints to avoid "leakage" of saving outside the service territory. In addition, resource acquisition initiatives can result from policies that discourage the most cost-efficient and cost-effective savings opportunities in favor of more expensive initiatives for the sake of equity among rate classes. These are not problems due to a resource acquisition approach to energy efficiency, but to the public policy arena in which it operates.

The current Pacific Gas & Electric Company (PG&E) Motors Replacement program is an excellent example of the strengths and weaknesses of a resource acquisition strategy. It is strategically conceived to provide incentives upstream of the consumer where they may be more impressive. It targets a market event hopefully influenced by the upstream market players (the dealers). Each transaction is tracked to the location of the plant or business. The energy and demand savings are very well established given any given hours of operation and motor loading. The sizes of motors targeted can be changed, with higher incentives provided to replace crucial sizes that might otherwise be re-wound. The load impacts are traceable, reliable, creditable to the utility, and the pace of the intervention can be controlled by the utility.

On the other hand, by the time the costs of administration and "bonus" incentives, which doubled the incentive costs, are calculated, the program can be expensive per kWh. The program directly influences only a few percentage points of all the motors sold. The sales

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[1] This is sometimes described as the fear of spillover being credited to free ridership.

are still one-on-one transactions. Moreover, a small program in one utility's service territory will not change the manufacturers' procedures and product mix, because their markets are worldwide (Barbour et al. 2000).

Market Transformation. Market transformation is a strategic effort "by utility and other organizations to intervene in the market, causing beneficial, lasting changes in the structure or function of the market, and/or practices, leading to increases in the adoption of energy efficient products, services, and/or practices, and with the changes in the market being *lasting* changes, meaning that the changes last beyond any revision to or discontinuation of the intervention" (Schlegel et al. 1997). According to Keating et al. (1998), market transformation is identified by the presence and relative strength of several characteristics of the intervention: a focus on energy efficiency, a strategic approach to understanding and working with the market (market-based), a focus on opportunities for synergism with other market actors resulting in leverage, with the overall result being a self-sustaining or lasting effect. An operational definition could be "An initiative can be recognized as more or less likely to be a strategy-level market transformation program to the extent that it focuses on energy efficiency, involves a logical strategy for working in the market, and includes available market leverage so that it produces potentially lasting effects."[2]

Including the concept of "focus on energy efficiency" may seem unnecessary, but in fact, even today many economists think of market transformation as a generalized end/transition-state in all markets (DeCotis et al. 2000), rather than a term of art in energy policy. For our purposes, market transformation is a specific energy efficiency term that connotes a strategic approach to intervening in the market to achieve lasting energy efficiency.

A strategic market transformation intervention would be more likely to succeed if it involves:

- An understanding of the market, market actors, and market channels,
- An understanding of the attributes of the measure or practice and how the measure fits into the market,
- Sufficient energy benefits to warrant the risk and cost of intervention,
- Sufficient private benefits available to interest private sector collaborators,
- The ability to leverage other actors in the market who, in pursuing their own goals, will help administrators achieve theirs, and
- A reasonable logic that ties together these elements into a defensible projection of long-term sustainability of the market impact.

[2] This is not to the exclusion of the nuances and insights provided in other definitions. Expressions such as "structural or behavioral changes" and "penetration of the eligible market" are complementary aspects of the criteria-based definition.

The advantages of a market transformation strategy include the fact that even small changes in an entire market can have enormous energy efficiency impacts. A change in a code, standard, or standard operating procedure may seem small, but its effect is magnified over the vast number of transactions influenced by the change. While the immediate cost is not negligible, the ultimate cost to the implementing entity per kWh can be dramatically lower than resource acquisition costs. It approaches markets in a more unified and congruent fashion than resource acquisition, which may be aimed at rate class segments instead of market segments. It leverages not only private sector investment and innovation, but can run in combination with other regions to create more leveraged changes upstream of the consumer. The national clothes washer initiative, supported by the Consortium for Energy Efficiency (CEE), was a great deal more successful in confronting and motivating the manufacturers than any regional program could have been (Feldman 2000). It can also open up opportunities for continuous improvements in efficiency by creating changes in the values of market players and adding new market players.

The risks of a market transformation approach are the reverse of many of the strengths of resource acquisition.

- Because an administrator of a market transformation intervention is involved in markets over which it has limited control, the timing, location, and size of the impact are not controlled.
- Without the long-term experience of resource acquisition efforts, the level of confidence in the approach and the causality involved in market transformation is lower among policymakers.
- Because it is focused on a dynamic market, as opposed to program participants, the administrators are less able to track the impact and bring the results to regulators in a neat package.
- In addition, market transformation requires a longer time horizon than is customary and practical for resource acquisition programs.
- It is also important to realize that the *risk of failure* is not only higher, but that, unlike resource acquisition programs, the ultimate outcome may provide little quantifiable benefits when and if market transformation fails. When resource acquisition initiatives fail to be cost-effective or fail to reach their potential, they still always capture some measurable resources.

Sometimes market transformation strategies are confused with “information programs.” Information initiatives are one part of a strategic intervention, but only a piece of the effort. The belief that providing information will transform markets is based on a simple view of markets. Going back to the late 1970s, policymakers thought that giving people the full information about energy efficiency would lead them to change their buying behavior. This logic falls down when analysts recognize that sometimes, even with complete information, energy efficiency will not be the obvious choice to a consumer. There are other factors involved in such decisions, and sometimes energy efficient options are objectively riskier. Information initiatives are actually best categorized as infrastructure, as discussed below (i.e., they are necessary to support a variety of activities that more directly lead to energy savings). The cost of the effort is shared among many initiatives and accounted for in the cost-effectiveness of the overall portfolio.

A good example is the national ENERGY STAR® program. By itself, it is neither a market transformation initiative nor a resource acquisition initiative. It is a labeling and information effort that can support either market transformation or resource acquisition initiatives. The market transformation initiative for Resource Efficient Clothes Washers uses ENERGY STAR as an important tool, but the strategy depends on combining several strategic efforts of utilities and market transformation organizations to market, incentivize, and lobby for standards. The ENERGY STAR label (and the work behind it with manufacturers) provides a good tool for market transformation, but it also can be used as a simplified approach to qualifying appliances, lighting, services, and buildings for resource acquisition purposes. Because it supports many projects, none of which could individually justify and support the ENERGY STAR effort, it is best seen as a shared infrastructure strategy (see below).

Information efforts are distinguished here from “marketing efforts,” which are more directly linked to either a specific market transformation initiative or a resource acquisition initiative. In these cases, the marketing or advertising is still a component of an initiative, not a stand-alone initiative or infrastructure.

In California, there are regulatory definitions of market transformation that are more restrictive, actually focusing on one alternative strategy for success with market transformation—the privatization of energy efficiency efforts. This assumes that the basis and need for public policy intervention in this market will have been obviated. Assembly Bill 1890 set the stage in California for delimiting the definition of market transformation, with the call for completing the role of DSM with public money in four years. Policymakers further refined (confined) the definition:

> *“The ‘market transformation’ approach reduces market barriers to the purchase of energy efficient products and services so that all customers will eventually have the knowledge and skills to purchase appropriate products and services on their own, without the need for ongoing publicly-funded programs.”* (CEC 1997)
>
> *“The mission of market transformation is to ultimately privatize the provision of cost-effective energy efficiency services so that customers seek and obtain these services in the private, competitive market.”* (CPUC 1997)

In 1999, the CPUC adopted Policy Rules for Energy Efficiency Activities (CPUC 1999), in which it defined 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. In the terms in this section, Market Transformation is a reduction in Market Barriers resulting from Market Intervention, as evidenced by a set of Market Effects, that lasts long after the intervention has been withdrawn, reduced, or changed.*"

Further, the policies emphasize the privatization of energy efficiency:

> *"The mission of PGC-funded programs is to transform markets and ultimately privatize the provision of cost-effective energy-efficient products and services so that customers seek and obtain these products and services in the private, competitive market. (II-3)"*

The concept of privatizing energy efficiency, which is one way for a market for efficiency to be self-sustaining and eliminate the need for publicly funded intervention in a particular market niche, is not central to the concept of market transformation or sustainability (Hewitt 2000). Privatization is a panacea with strong political support, but it is a one-hammer solution to a world of screws and nails. Not only is restricting the definition of market transformation to privatizing the energy efficiency markets an awkward theoretical constraint, but it has ramifications for programmatic implementation. The strength of the appeal for getting utilities and government out of the business of supporting energy efficiency spills over to a desire to design every intervention, even the least promising ones, as a market transformation strategy. While standard performance contract (SPC)[3] initiatives may be effective as a resource acquisition strategy, they have only a veneer of market transformation.[4] Similarly, forcing an infrastructure initiative like the Pacific Energy Center

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3 SPCs involve offering a standard price for savings from specific end uses. Savings providers could be third parties or the owners of the project sites.

4 A key indicator of the actual intent or goal of an initiative is how its success is measured. If the SPC programs were believed to be an interim step toward producing self-sufficient, profitable, private energy efficiency businesses that would take over the role currently filled by publicly funded programs, then the evaluations would focus on the market transformation indicators instead of energy savings. These indicators would be progress toward operating without public subsidies, the targeting of profitable niches, the emergence of competing, non-subsidized firms (instead of the paradox that those without public funding are pushed out of the market by the lower prices offered by SPC firms), and the production of business plans that show how the SPC contractors will be able to succeed without public funds. What is measured is done, and with SPC, these indicators are not being measured.

or a research and development operation like the Food Service Technology Center through the filter of market transformation is needlessly distracting.

As noted below, other jurisdictions have recognized the need for using all programmatic strategies, not only market transformation. Market transformation cannot work well in many markets, such as low income efforts, markets with high transaction cost, evolving technologies, and site-specific industrial process markets. The reasons justifying market intervention, such as the failure of externalities, remain in force even for energy efficiency that might otherwise fall through the cracks. Infrastructure will always need to be supported for public benefits, and without research and development the pipeline for new technologies and services will dry up, starving both market transformation and resource acquisition. Equity programs will always be part of the policy arena, regardless of (or because of) the marketplace for energy. Further, the chimera of ending public purposes funding through successful market transformation ignores the continuing development of new efficiency opportunities.

Infrastructure for Energy Efficiency. Infrastructure for energy efficiency is an additional strategic use of PGC funds in the overall effort of justified intervention in the markets. Infrastructure can be defined as the organizational and structural support necessary for energy efficiency to succeed, although it will not produce direct energy load impact by itself. Infrastructure is typically a shared resource that underlies both acquisition initiatives and market transformation initiatives. Toll-free hotlines, audit services, the Pacific Energy Center, and some would argue the ENERGY STAR initiatives are examples of the types of infrastructure typically included in a balanced portfolio. Infrastructure consists of activities that do not produce sufficient private benefit to entice or justify an investment by private sector actors.

For example, there are businesses that can make money as weather forecasters in a for-profit entity, but they depend on a vast federal National Oceanic and Atmospheric Association (NOAA) infrastructure for the most basic data to perform their job. However, they do not receive sufficient private benefit from NOAA to pay for it directly. Similarly, consumers depend on an information infrastructure for energy efficiency (whether hotlines, demonstration or advertising programs, or specialized facilities like the Pacific Energy Center) that is important to their achievement of energy efficiency, but which does not provide sufficient individual benefit (profits) to be privatized. At the Northwest Energy Efficiency Alliance (the Alliance), about 6% of the market transformation budget goes to supporting the infrastructure that is useful or essential to support the market transformation programs. Similar investments in infrastructure are commonplace to support acquisition programs. These can include lighting centers, national and regional information centers, training classes, hotlines, and technical support contractors. Whether a publicly funded program has a portfolio of acquisition initiatives, market transformation initiatives, or a mix of both, infrastructure will be needed and should be included in the calculation for cost-effectiveness of the portfolio.[5]

Research and Development. Research and development is another complementary strategic intervention in the market to achieve energy efficiency. Businesses do most of the research and development in this country, but often research and development for energy efficiency does not have sufficient prospects for a competitive return on investment to justify private investments. As with infrastructure, a single firm or group of firms could not recoup its investment in research and development through profitable activities before competitors would gain access to the information and technologies in the publicly funded programs. As noted in Section 2, "disincentive to innovate" in a competitive market is a supply-side market failure. A public goods portfolio that is justified overall may find that a continuing level of investment in providing the demonstration and proof-of-concept research is essential to maintain a constant improvement in potential societal energy efficiency. Research and development in the electric utility market has fallen on hard times because cost-recovery cannot be ensured. Additionally, the low prospects for a reasonable rate of return in these uncertain regulatory times has dampened enthusiasm for risking money on keeping the pipeline full of new ideas. Whether the portfolio emphasizes acquisition or market transformation,[6] a small investment in research and development would be justified for the same reason as the rest of the public intervention in the market. Research and development does have dry holes, but problems avoided as a result of research and development outcomes are often as valuable as confirmed innovations. Currently, about 6% of the budget of the Alliance is earmarked for research and development.[7] The cost of research and development can almost only be appropriately accounted for when cost-effectiveness is done at a portfolio level.

Balanced Portfolios Predominate in U.S. Other parts of the country have dealt with public benefits charges and how to allocate the resources in terms of energy efficiency. The Pacific Northwest as a whole, the states of Oregon and Montana individually, and Massachusetts, Rhode Island, Connecticut, New York, Texas, and Wisconsin have wrestled with the issues.

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5 For some purposes, it may be necessary to split out the fraction of the cost of infrastructure support that assists a specific initiative, but this is not an insurmountable problem.

6 The THELMA research that preceded the Resource Efficient Clothes Washer market transformation initiative was essential to the eventual project, and the basic metering and research data from that project helped secure the recently announced national efficiency standards for clothes washers.

7 It is important to realize that for both infrastructure and research and development, the Alliance budget was established by policymakers to represent about 15% of the regional investment in energy efficiency, therefore, much of the entire region's budget for the research and development component is closer to 6% of 15%, or less than a tenth of a percent of the energy efficiency budget.

The four northwestern states convened a yearlong study of energy issues in the face of evolving competitive markets for electricity. The resolution was that 3% of retail revenue was the targeted funding level for public benefits, with 15% of those funds targeted to market transformation efforts on a regional basis and 66% set aside for local conservation, including low income efforts—traditional resource acquisition initiatives. The balance was targeted for local and regional investments in renewables (Comprehensive Regional Review 1997).

Oregon is still working through the rules for the administration of the publicly funded programs that will take effect on October 1, 2001, but the indications are that market transformation will remain only a minority effort in a mixed portfolio of strategies. In Montana, a statewide board makes decisions on how to allocate the funding. To date, they have agreed to fund their proportional share of the Alliance (the northwest regional market transformation organization), but are spending most of the money on traditional resource acquisition programs. In both states, large customers are allowed to self-direct some or all of their PGC share, with most of the money anticipated to be spent on resource acquisition-type, site-specific measures. Also, there are large dedicated funds set aside for equity programs, including $3 million/year in Oregon for the construction of low income housing (it *is* called "public purpose funding," not "energy efficiency funding").

Massachusetts and Rhode Island were among the first states to direct the expenditure of public funds. Massachusetts defined market transformation very broadly as:

> *"…strategic efforts to offset market failures and to induce lasting structural or behavioral changes that result in increases in the adoption or penetration of energy efficient technologies or practices."* (Mass. Dept. of Public Utilities 1997)

Whereas Massachusetts' regulators expressed a preference for programs that moved toward self-sustaining market transformation interventions, they have guided a portfolio of strategies that includes retrofit and lost opportunity acquisition initiatives as well as supporting regional and national market transformation efforts, which are based on support for continuing research (Dept. of Telecommunications and Energy 2000). The support for research sometimes falters when the needs of meeting program metrics predominate. In Rhode Island, concerns about equity issues have created a difficult environment for market transformation. Both states included dedicated equity funding.

New York, with its small public budget for energy efficiency, directed most of the market transformation money through the New York State Energy Research and Development Authority (NYSERDA), but included some DSM bidding or standard offer efforts as part of the overall market transformation effort. Texas chose a mix of standard offer contracts and market transformation for its energy efficiency portfolio. Wisconsin policymakers see market transformation as the goal of most programs, but have distinguished some efforts as clearly designed to change the whole market from those that support site-specific resource acquisition. Low income programs are well supported in Wisconsin.

The public expenditures for energy efficiency in Connecticut are guided by a board representing low income ratepayer advocates, industrial and commercial ratepayers, and environmental advocates, as well as the state's two electric utilities. Approved programs include regional and national market transformation efforts and continuing acquisition programs, research and development, low income equity programs, and some limited information infrastructure.

In general, most public expenditures for energy efficiency are directed at a mix of strategic interventions, including market transformation, equity, and resource acquisition, but often include research and development and infrastructure. The allocations are not always expressed ahead of time, but regulatory or legislative preferences are included and some flexibility to create a balanced portfolio seems to exist everywhere.

3.3.1 Complementary, but Distinct

Every strategic approach in a portfolio aims to accomplish the same goals of energy efficiency, and the basic analysis that underlies prospective, interim, and ultimate cost-effectiveness is essentially the same. Nevertheless, it is very important to understand and respect differences among approaches. In some ways, the strategic decision to be made is whether to treat the symptom or the underlying problem.[8] Whether the intervention approaches the market as a fundamental problem to be changed or uses the tools of resource acquisition to mitigate the symptoms of the market failures, the logic of the approach is consistent. At the same time, the intervention will lose focus if the administrators do not know which approach they are pursuing. From planning through implementation, measurement, and evaluation to eventual decisions on continuing interventions and regulatory incentives, it is important to keep the approaches conceptually distinct.

In all cases, the ultimate goal is cost-effective energy efficiency improvements, not the reduction of barriers or dissemination of information. Cost-effectiveness can be judged using the same Public Purpose Test (PPT) or any other test for both strategies, as long as the periods are appropriate for the strategy. Table 3-1 illustrates the parallelism in the approach to cost-effectiveness. In both resource acquisition and market transformation, prospective cost-effectiveness is determined based on a series of assumptions about costs and benefits. In order for the cost-effectiveness goals or exact benefit/cost ratio to be supported, the assumptions must be borne out in the field for both resource acquisition and market transformation. While the period for determining whether a resource acquisition initiative is cost-effective has traditionally been annual, there is no internally logical reason that

[8] Sebold, F. Personal communication. 2000

evaluators could not be asked to check the assumptions every 75 days or every 33 months. Annual reporting is a regulatory construct. Because the period is arbitrary, the fact that market transformation may best be measured after several years does not make the evaluation any less rigorous.

Table 3-1: Congruency of Approach to Cost-Effectiveness between Resource Acquisition and Market Transformation

Assumptions/Forecasts	Resource Acquisition	Market Transformation
Cost to run program	Administrative cost	Administrative cost
Measure cost	Utility and consumer $	Utility and consumer $
Savings per widget	kWh and kW	kWh and kW
Number of widgets	Net participant purchases	Net measure penetration

Each assumption in Table 3-1 is reflected in both the prospective and retrospective cost-effectiveness analyses. The assumptions are used in prospective cost-effectiveness analyses, tested and tracked in interim market progress reports, and confirmed in the evaluation of the ultimate indicators for market transformation.

The ultimate penetration of a product or service is part of the logic model or story behind the market transformation intervention, and depends on many market factors. It will be a forecast with the uncertainty that forecasting in the absence of historical experience entails. The penetration within the given period is an essential assumption, however, for any prospective cost-effectiveness projection for a resource acquisition or market transformation program. Other important assumptions include the savings per widget, the speed of the up-take, the projected sustainable level, the estimated costs, and the forecast of the value of the avoided externalities.

Costs of infrastructure and research and development strategies are included in the overall portfolio cost-effectiveness, as the benefits are assumed to be dependent on the roles they play. If they had no role in supporting either resource acquisition or market transformation, public funding would be questioned. It is important to understand that the infrastructure and research and development strategies need to be strategies, and not holding/hiding categories for "good" activity that some people like to see. They should be selected and planned as carefully as the interventions of the resource acquisition and market transformation strategies. They can meet joint objectives within a mixed portfolio, such as a resource and referral service for an acquisition program, as well as a specific link to change agents in a market transformation strategy. The Pacific Energy Center provides this function. In other cases, infrastructure may be designed to meet only one primary function, such as market transformation's focus on policy changes, and the "education of political leaders" served by contracts with state and local government associations in the Northwest (Northwest Energy Efficiency Alliance 1999).

3.4 Distinctions Matter

It is very important for program administrators to be clear about what they expect from an intervention. The problem with mixing research and development with acquisition in planning and implementing programs should be evident. However, it may not always be apparent from the start why market transformation and resource acquisition interventions need to be distinct in the minds of planners, implementers, evaluators, and regulators. There is, of course, a danger in overemphasizing distinctions when many of the characteristics are actually points of emphasis on a continuum, rather than an either/or situation (Keating et al. 1998).

The first important distinction is targeting. Resource acquisition programs target individual participants within a population. Market transformation initiatives target whole markets. Markets are often difficult to delimit, but they are usually broader than a participant pool, yet more targeted than a whole population.[9] Good acquisition initiatives also involve market channel actors in program delivery, but the emphasis is on identifying and motivating end-use consumers. Market transformation initiatives relinquish control of when and where the activities are targeted in order to gain influence, leverage, and partners in the market.

Targeting establishes what will be measured. In the planning stage, that means determining how the baseline will be established. For example, if an administrator is designing a resource acquisition initiative for medium-sized motors, he may be interested in forecasting how many rebates are likely to be taken in the given period (one year) based on prior experience. The administrator designing a market transformation initiative will be interested in the distribution of efficiency levels of motors sold in the market and the overall number of motors or horsepower in order to have a basis for forecasting the market share.

The strategic interventions that are designed will depend on the identified target for the strategy. There are barriers to be overcome for each approach. For market transformation, the barriers to be identified and targeted are market barriers or imperfections. For an acquisition initiative, the barriers will be programmatic, such as customer relations and

9 Classically, markets are defined as an economic exchange among willing participants, but in market transformation markets can be broadly described as a set of consumers, distributors, and suppliers interacting to provide a good or service. See Section 4 for more discussion of the essence of energy efficiency markets.

attractiveness of the program to participants regarding such issues as the time needed to process rebates.

The target and the strategy chosen have profound effects on how a program is run. With resource acquisition, administrators are buying a kilowatt-hour and they set the standards for what they buy, e.g., high power factor in light bulbs or horizontal axis clothes washers. With market transformation initiatives, technical compromises are made to adapt to the needs of other market actors. Once they become part of the market, effective players need "to go along to get along." Bulb standards may be relaxed to entice more manufacturers to compete; the higher efficiency for motors may need to be reduced a little in order to be accepted and supported by trade associations. The pay-off is large for successful compromises, but requires an acknowledgment that, unlike resource acquisition, administrators do not control the market.

Lack of control extends to the geographic scope of the market impact. Resource acquisition interventions are best designed with eligibility controls to ensure the investment produces the intended benefits on the targeted system. Market transformation interventions are best designed to address markets that cross utility and political boundaries. Other parts of the state or country will participate in the market created by a market transformation initiative. Geographic and other targeting may actually make an initiative less effective and antagonize other market actors who do not live and die by artificial market boundaries.

The distinction among strategies is also crucial in what is tracked, measured, evaluated, and rewarded, as well as the timing of these activities. Resource acquisition initiatives involve participant-focused evaluations. Market transformation requires market-focused evaluations ("market progress reports" instead of "program evaluations"). Market penetration, not the number of net rebates, is tracked. Measurements for both strategic interventions are still based on the relationship between what happened with and what would have happened without the intervention. For participant-focused evaluations, the issues are usually categorized as problems in determining free ridership and spillover and, in almost all cases, trying to determine this based on the motivations and characteristics of the participants. For market transformation initiatives, the effect of the intervention is determined by the actual penetration in the marketplace "with the program," and the baseline penetration expected "without the program."

As noted above, the timing of measurement and cycles of reporting are arbitrary. Measuring the impacts of acquisition on an annual basis, although cumbersome, was possible. Each program cycle could be judged separately for effectiveness. Market transformation interventions can be tracked annually, but doing so does not fit well with the longer cycles needed to observe market changes. Often there is little information to be gained on an annual cycle and, at other times, more frequent market progress reports are needed. Clearly, making the distinction between the strategies being employed is important when setting expectations for measurement cycles.

Similarly, reward structures should vary appropriately between a resource acquisition and a market transformation intervention. In one case, the investments are annual, the activities and results are under the administrator's control, and the rewards need not be postponed. In market transformation, however, rewards can be set up artificially based on activities or outputs, but, in reality, the investments are long term and it may take several years to see the ultimate indicators of success.

At the most fundamental level, the distinctions between intervention strategies are important because running an initiative without recognizing the target leads to poorly conceived efforts whose end result may undermine the stated ultimate objective.

3.5 How Can the Best Strategic Intervention be Chosen?

Four main strategies to accomplish energy efficiency benefits using PGC funds have been identified. Keeping them conceptually distinct is important. However, how does one decide which strategy is best for a given market, technology, efficiency measure, or public purpose?

3.5.1 Infrastructure and Research and Development – When Are They Supported?

The Alliance (1997) provides a good basis for determining when it is appropriate to fund infrastructure.

- Does the investment support information development and/or dissemination that addresses a high priority market?
- Is the investment focused on a clearly identified market barrier(s) that is best addressed by either a) the development of new information, and/or b) the dissemination of information to one or more participants in the market?
- Is the investment needed because the private sector cannot or will not support the activity due either to the distribution of private cost compared to private benefits or because the private sector cannot readily "capture" the profits from the enterprise?
- Is the investment needed to ensure that the information developed is publicly available?[10]

[10] The last two criteria can be seen as focusing on two conflicting goals of market transformation: private profit to make transformation in the interest of the private sector, and the desire to provide key information to as many competing actors as possible to increase competition and the likelihood of a stronger market.

The same criteria should apply for research and development as for infrastructure requiring public support if research and development will not be conducted by the private sector or, that, in the absence of public investment, the results will not be easily available in the market. Research and development fills an essential role in the total programmatic effort (Parti and Parti 2000).[11]

3.5.2 When is Market Transformation the Preferred Strategy?

Although energy efficiency program implementers have had less experience with selecting, designing, implementing, and evaluating market transformation initiatives, there are logically consistent criteria for deciding when to follow a market transformation strategy.

- The target market must be large enough to assure that, if the intervention is successful or partially successful, the benefits will be large enough to provide a good pay-off for the risk involved. Market transformation is a very risky approach to obtaining energy efficiency. Even a poor resource acquisition effort always produced some benefits that could be counted. A bad market transformation initiative could spend money and years of effort, but could be completely the wrong approach, gain nothing, and possibly make things worse. That is why, from day one, the Alliance referred to market transformation initiatives as “ventures.” Large savings opportunities are better targets for market transformation because these potentially large benefits can justify the intrinsic risk.
- When the scope of the market that is targeted is very broad (the expression “wide but shallow” seems to apply), a market transformation approach may be the only way to reduce the likelihood of disproportionate transaction costs.
- The presence of substantial non-energy benefits associated with the measure or service is a good indicator of a likely target for market transformation. Market transformation depends on leveraging a great deal of consumer interest and investment. This is more likely to occur if there are more than simple energy savings returns on their investment. The more varied the consumer value, the greater the chance the market will support the measure or service after the intervention is ended, modified, or reduced. In addition, the sustainability of a technology or service will depend on its being pushed by private sector actors for profit. The more angles or benefits to sell the product, the better the chances of its success in the market. The Consortium for Energy Efficiency (CEE) Resource Efficient Clothes Washer Initiative is a product that produced large water benefits, thereby attracting municipalities and their political clout to the program. These municipal water utilities provided additional legitimization and sometimes even their own rebates (Feldman 2000). Further, the manufacturers of qualifying machines were eager and effective partners because they could distinguish their

[11] Parti and Parti (2000) argue for an analytic model that optimizes the investment in research and development versus expenditures in initiatives within the same market transformation intervention—basically balancing the risk of insufficient knowledge to run an initiative effectively against the decreased level of accomplishment if administrators stop to gain more confidence.

products and brand names and could make large profits by selling into a market that was growing swiftly.

- Chances for success as a market transformation initiative will be enhanced if there are opportunities to piggyback on the efforts of powerful actors in the marketplace. Finding opportunities (such as working with Home Depot to reduce their potential fire-hazard liability for torchieres, or working with the National Electrical Manufacturers Association (NEMA) to have the dry transformer standards they developed endorsed by ENERGY STAR) are opportunities for making a difference in the market. Understanding barriers and targeting them are reasonable ways to analyze a market, but market transformation programs will succeed by capitalizing on opportunities—pick the best opportunities, not the biggest barriers.
- Market transformation initiatives are best addressed to markets that are better understood. This is a difficult proposition. Pilot projects or small acquisition efforts may be needed to provide entrée and experience.
- It is better to choose market transformation targets that the administrator is organizationally prepared to deal with and has the resources with which to finish the job. Effective market actors have multiple contacts amidst the market channels, and market transformation requires a long-term commitment.
- Lastly, the only appropriate market transformation targets should be those for which a clear and convincing story can be developed about how intervention will occur, with what effects, and on which schedule (Herman et al. 1997). These factors must be based on an extensive knowledge of the current market and some idea of where it is going on its own.

3.5.3 When is Resource Acquisition the Preferred Strategy?

Clearly, not all markets, technologies, and services are good candidates for market transformation initiatives. When knowledge, opportunities, and market leverage are present, the impact of these programs can be enormous and very cost-effective. With fewer poorly targeted market transformation initiatives in a portfolio, the likelihood of a very cost-effective portfolio is increased dramatically. However, market transformation is not the only way to attain the societal goals of increased energy efficiency, and it is often not the best way to expend resources.

- If a market has more barriers than opportunities (i.e., small commercial sector customers where leverage is small, the problems with split incentives extremely hard to overcome, and transaction costs likely to bankrupt private sector service providers), a resource acquisition may be the only reasonable strategy.
- If there is a need to control the speed, quality, timing, location, or other aspects of the energy efficiency results (i.e., when peak load or distribution feeder impacts are desired), resource acquisition is clearly a better strategy. Resource acquisition, with its potential disregard for markets, is a particularly effective method to use

when it is necessary to work across market divisions to address specific geographic issues.

- When rate-class/sector equity is an issue, resource acquisition provides a sharp instrument that can be targeted and tracked. Rate classes are not particularly congruent with markets, and designing resource acquisition initiatives to deal with these policy issues is a more direct way to address the priority than trying to configure market transformation initiatives awkwardly to achieve the policy goals.
- When measures or services are so marginally cost-effective that very high confidence in the measured results is needed to ensure prudent investments, an acquisition initiative, with its ability to track participants and long experience with measurement and evaluation, is a better option than market transformation with its diffused and delayed impacts.
- When there are insufficient non-energy benefits or insufficient profit opportunity for an initiative to become self-sustaining, acquisition might be a preferred answer. This is frequently the case with residential weatherization, refrigerator recycling programs, and many site-specific industrial efficiency improvements.
- Acquisition may be preferable for site-specific industrial process measures. In line with the discussion in Section 7, the direct benefits of the initiative could be overwhelming but the discrete nature of the applications make the indirect effects, which are important for market transformation, difficult to develop.

Although market transformation presents an inviting vision of highly leveraged market interventions to produce a self-sustaining force for energy efficiency, exceptional market transformation targets that meet all criteria are difficult to find. Many times, societal energy efficiency and externality-reduction goals are best approached through resource acquisition initiatives designed to override market failures.

3.6 Summary

There are several options available when public policy supports market interventions on behalf of improved energy efficiency levels (beyond what the markets are producing by themselves). Complementary strategic approaches are possible. These include resource acquisition, market transformation, infrastructure support, and the support of research and development and equity investments. This section has argued for recognizing the similarities in goals and the ways the programs can be analyzed, while keeping the distinctions clear in the strategies chosen.

It has been argued that public funds can be spent on any strategy, but that most jurisdictions have sought energy efficiency with a balanced portfolio of strategic options. Some suggestions have been provided for when market transformation or resource acquisition is the better choice, as well as recognizing the reasons for funding infrastructure and research and development. One should neither depend on a single strategic approach too much, nor avoid another. The strategies all have a place in ensuring a more receptive market for energy efficiency.

3.7 Recommendations

- Establish and maintain a balanced portfolio that includes all the strategic methods to intervene in the market. No one approach can work optimally for all markets.
- Infrastructure, research, and development contribute strategically to the overall goals of a mixed portfolio and need public benefit funding support.
- Approach planning for either market transformation or resource acquisition in a strategic and parallel fashion. The underlying logic for cost-effectiveness, whether prospective or retrospective, is the same.
- Judge cost-effectiveness at the portfolio level, but pay attention to ways for improving the individual initiatives.
- Use the goals, barriers, and opportunities in the market to help determine which strategic approach(es) to use.

4

Program Design and Prospective Cost-Effectiveness Analysis

4.1 Overview

The preceding sections described the rationale for energy efficiency programs and discussed interventions appropriate to meeting societal needs in an era of deregulation and independent generating plants. This section initiates the discussion that is at the core of this monograph. How can the professionals who develop and conduct these interventions ensure that the public funds involved will be spent as wisely as possible? How can evaluators best focus their efforts to provide feedback to program managers and to assess program effects on behalf of those responsible for the public funds involved?

Subsequent sections address specific issues of evaluation perspectives and methods, as well as forecasting approaches. This section takes a macro-level view, concentrating on the need to explicate the logic that underlies the development, implementation, and evaluation of programs.

4.1.1 The Purpose of this Section

Programs and program evaluations do not occur in a void. There is neither a single standard of program excellence, nor a one-size-fits-all evaluation paradigm. Rather, program objectives must fit specific needs and program evaluations should be matched to the objectives and designs they address. Evaluations are most useful if they provide information on whether the market is functioning as the program designers assume and whether the interventions undertaken are having the intended effects. To focus on these information needs, the evaluation must have a clear roadmap as to the designers' expectations about the market, the key actors, their interactions, and the reasons behind the interventions selected—the "story" of the intervention (Herman et al. 1997).

Without a clear story line, program staff may not focus their efforts on the market relationships of greatest value to the program. Similarly, evaluators may not assess the areas of performance most crucial to program success. In short, the program may not use the public goods charges in the most responsible (cost-effective) manner. Thus, the purpose of this section is to discuss and illustrate the need for elucidating the story line when designing effective programs, for the benefit of both program staff and evaluators.

4.1.2 The Structure of this Section

Subsection 4.2 discusses the reasons that program designers and implementers should articulate the logic of their approach and why doing so is particularly important for market transformation programs. Subsection 4.3 suggests and elaborates on the major components to be included in a program logic document: descriptions of the current market, the expected effects of the intervention, the intervention program rationale, and the resources to be applied. Subsection 4.4 reviews how the program logic may be used in developing both prospective and retrospective cost-effectiveness analyses. Subsection 4.5 offers a brief summary of the section, along with selected recommendations.

4.2 Articulating the Logic of the Program

This section begins by illustrating the importance of articulating the logic of an energy efficiency program. This is followed by a discussion on why this issue is of considerable importance in the planning and evaluation of market transformation programs.

4.2.1 Why it is Important to Articulate the Program Logic

Whether implicit or explicit, a specific logic drives every energy efficiency program. That logic specifies the priorities among program activities and the areas in which investment will be heaviest. It also determines the issues that will be targeted for more detailed examination in the program evaluation.

Articulating the program logic ensures that the activities, resource investments, and evaluation efforts fit with and focus on the core assumptions and causal hypotheses of the planners and policymakers. The following example illustrates the value of setting forth the program logic.

Consider the Residential Clothes Washer Initiative (RCWI) mentioned in Section 3. The RCWI was led by the Consortium for Energy Efficiency (CEE) and built on earlier efforts by the Western Utility Consortium and a project (THELMA) designed to assess the energy savings and market potential for resource efficient clothes washers. CEE oversaw the development of consistent qualifying levels for washers, for use by all regional and local programs that joined in the Initiative. In addition, CEE helped recruit participants in the intervention, provided a forum and a clearinghouse for the exchange of design and marketing information, and acted as a liaison to manufacturers and national appliance retailers. Partly as a result of the RCWI, manufacturers signed a historic agreement in May 2000 that established voluntary increases in the efficiency levels required for the sale of clothes washers in the U.S. market (in 2004 and again in 2007). In addition, manufacturers agreed to continue the development, production, and sale of washers that would exceed the standards and thus qualify for designation as ENERGY STAR® models.

These results fitted directly with the program logic for the RCWI. The intervention was motivated by the paucity of resource efficient washers in the market in the early 1990s and the concern that some manufacturers might use the low market shares of those (mostly foreign) models as a rationale for opposing the raising of standards. Accordingly, the RCWI focused its attention on finding ways to increase the supply of resource efficient clothes washers in the North American market and helping to ensure reasonable penetration levels for those washers. With a clearly articulated program logic, the RCWI was able to concentrate its own resources on the upstream market actors and the recruiting and support of local and regional participants. In turn, the evaluators (Feldman et al. 2001) were able to direct their attention to the responses and perceptions of participants in the intervention and those of the upstream market actors.

This example also illustrates an important principle that will be addressed more fully later in this section. Specifically, a strategic intervention such as the RCWI is likely to entail a mix of activities and should be judged in that context when cost-effectiveness is at issue. Other aspects of the activities mix include the following:

- The research and development effort of the THELMA project, which helped establish the value of the product and the feasibility of the intervention
- The infrastructure developed by the ENERGY STAR program, which helped create advertising and promotional materials as well as awareness on the part of other market actors
- The resource acquisition efforts of scores of local utilities as well as regional market transformation organizations, which helped to increase the early penetration of resource efficient washers and gain sustained notice by retailers and manufacturers

To return to the larger theme for a moment, it may be noted that a failure to articulate the program logic of the RCWI could have resulted in misallocation of resources. For example, CEE might have added its resources and staff support to the resource acquisition activities conducted by the local and regional participants. While this may have resulted in additional early gains in resource acquisition, the evaluation suggests that it may not have helped achieve the broader objectives of the intervention. At the same time, the program logic helped guide the evaluation of the RCWI[1] to testing the validity of the assumptions and causal mechanisms that had been hypothesized, rather than devoting effort to the measurement of penetration levels achieved in the early phases of the intervention.

4.2.2 Why Program Logic Appears to be Particularly Important for Market Transformation Programs

Articulating the logic of an energy efficiency program becomes particularly important with the advent of market transformation programs. This is not because market transformation programs are different in kind from resource acquisition programs, but because the relevant rationale is often more complex and involves more steps. For these reasons, market transformation programs seem more vulnerable than resource acquisition programs to the misapplication of public resources through faulty understanding of intended outcomes and the causal hypotheses that underlie the selected interventions. Thus, market transformation programs motivate a greater concern with program logic. The following prototypical examples of a resource acquisition program and a market transformation program illustrate this point.

A ballast replacement rebate program offers an example of a classic resource acquisition program logic. Utility planners identify the replacement of magnetic ballasts with electronic ballasts in commercial facilities as offering considerable reductions in energy use. Market research indicates that most commercial customers recognize the long-term benefits of this retrofit, but are concerned with the initial costs involved. The planners believe that reducing the first cost of the electronic ballasts will increase the willingness of customers to purchase the product, leading to increased sales and installations, and resulting in long-term energy savings. Accordingly, planners offer customer rebates and promote awareness of those rebates through direct mail, point-of-purchase materials, and advertising in business publications.

The program logic is straightforward. Customers do not perceive sufficient value in a given energy efficient technology to pay the price demanded by other market actors. By applying resources to lower that price and making the price reduction widely known, program planners can change the customers' value equation and increase sales of the technology, thus increasing energy savings.

Other characteristics of the example are also worth noting. First, the connection between the intervening agent and the intervention target is clear and uncomplicated. The utility is

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[1] It is important to distinguish the purpose of the evaluation as well as the purpose of a particular strategy. The evaluation of the overall set of interventions in the clothes washer market will necessarily assess the penetration of resource efficient washers in the short run and as projected for the longer term. Similarly, the relevant cost-effectiveness analysis will include the costs of the RCWI as well as those of the other activities involved.

offering a rebate directly to a customer who makes decisions about the purchase of electronic ballasts. Second, the means of influence are fully within the grasp of the utility. It has direct control over the payment of the rebate, which is assumed to be the critical intervention. Third, the indicator of program success relates directly to the intervention. The number of sales is broadly reflective of the number of rebates.[2] Finally, as discussed in Section 3, the location of the equipment can be tracked and the associated energy and demand can be measured directly, if desired.

Given the lack of complexity in the logic of such programs, program staff members are normally able to focus their resources and activities appropriately. Of course, allocation problems exist (e.g., determining the optimal tradeoff between advertising expenditures and financial incentives). However, these problems tend not to involve many variables and thus seem well suited to relatively uncomplicated modeling and forecasting methods.[3] Finally, evaluators face relatively little difficulty in determining what assumptions to test and what outcomes to assess.

Residential new construction (RNC) programs provide an example of a market transformation program logic. Here, utility planners begin by reviewing evaluations of earlier RNC efforts, conducted within a resource acquisition framework. Those programs, based on financial incentives to builders for the inclusion of energy efficient features (such as high insulation levels and high efficiency HVAC equipment) tend to have few lasting effects on the RNC market. Although those who buy homes during the program period obtain homes that are quite energy efficient, ongoing demand is not greatly affected, so few builders modify their practices to include the improvements once the financial incentives are withdrawn.

Several recent RNC programs have therefore been designed to intervene simultaneously at several points in the market, based on the theory that changes in demand and supply must be mutually supporting if they are to be sustainable. Thus, these programs include extensive promotion of energy efficient homes at the same time that both technical and sales training programs are provided to builders and craft subcontractors. Furthermore, these programs often provide certification services and work with architects, builder sales offices, realtors, and mortgage lenders to ensure broad awareness and support of energy efficient homes by other market influencers.

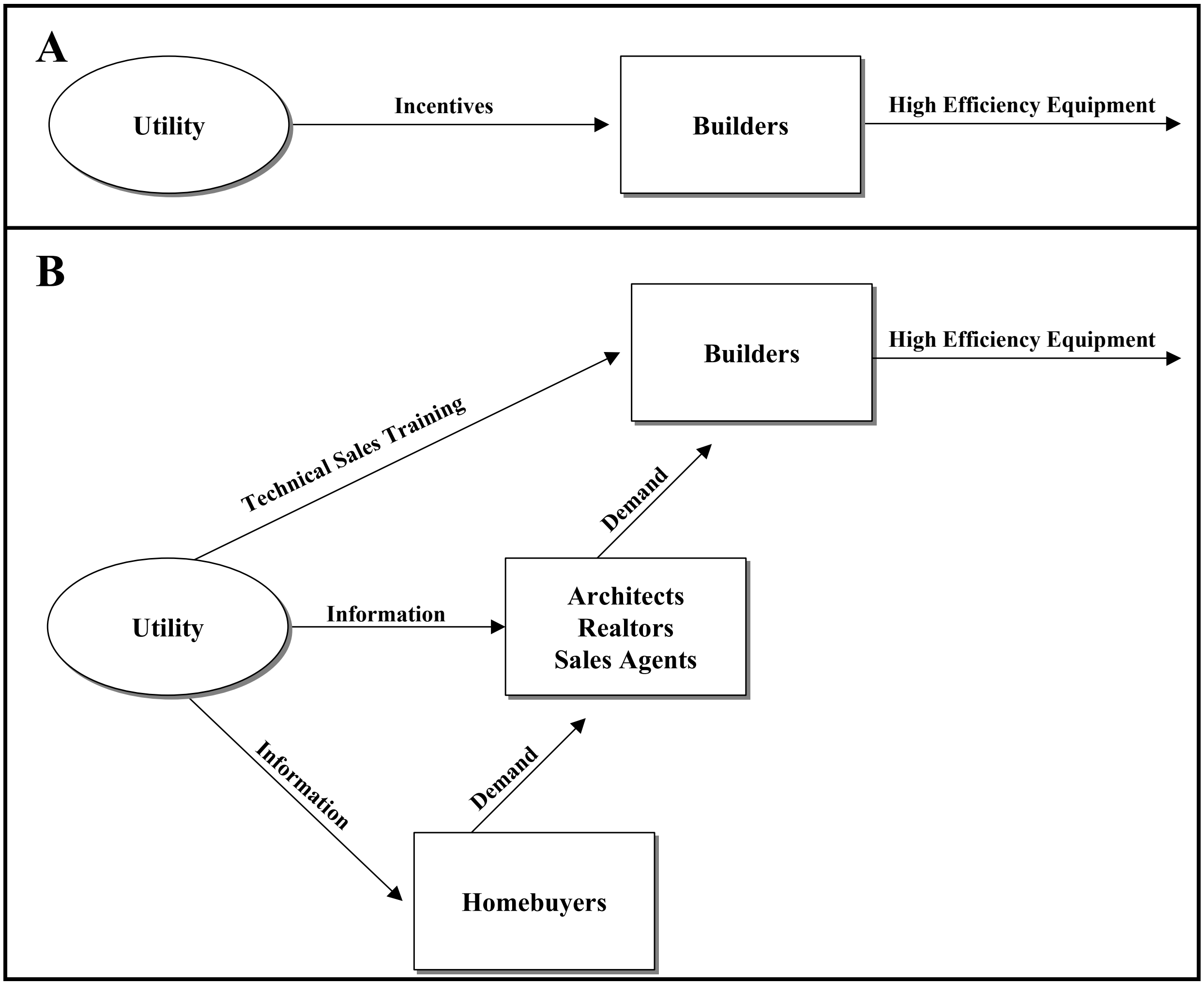
2 The relationship is not perfect, of course. The occurrence of free ridership means that the number of incremental sales of the energy efficient technology is less than the number of rebates paid. At the same time, the presence of free drivers (including breakage—failure to collect rebates for sales simulated by the rebate offer), biases the relevant numbers in the opposite direction.

3 See Section 7 for a more thorough treatment of these issues.

At the broadest level, the program logic is still straightforward. If builders and their subcontractors are to modify their practices to increase the energy efficiency of RNC over the long run, they must see demand for qualifying features and have confidence that the demand is sustainable. Conversely, if homebuyers are to be directed toward energy efficient homes, a reasonable and reliable supply of those homes must be available. In addition, other market actors must facilitate the relevant transactions. Sales agents and realtors must be able to identify energy efficient homes and guide buyers to them, while mortgage lenders must value such homes.

However, the program logic no longer allows for direct connections between the intervention and the real target of the program, as shown in Figure 4-1. To increase energy efficiency in new homes, resource acquisition and market transformation programs have changes in the practices and energy-consuming equipment in those homes as their desired mid-term outcome. The resource acquisition program logic (Panel A) linked the payment of financial incentives directly to these desired effects. The success of the market transformation programs requires that the influence of the program reverberate through several linkages in the value chain for the RNC market (Panel B). Thus, success is far less under the direct control of the intervener. Moreover, the likelihood of success is highly dependent on the validity of the market analysis by the program planners, who must have accurately identified the important market actors and understood the flows of influence and other transactions among them. Finally, the complexity of the story requires that the critic—the evaluator—attend to the various market actors and their relationships when providing feedback about potential improvements in the allocation of resources and activities.

Figure 4-1: Direct and Indirect Paths to Energy Savings in the Residential New Construction Market



An important consequence of the complexity of a program like the RNC effort described is that allocation decisions appear less tractable than they do within the resource acquisition context. How much effort and what resources should go to training builders and their subcontractors, as opposed to promoting energy efficient homes? At what point in the program period should realtor outreach be stressed? To what degree is investment in home performance certification necessary to develop or broaden confidence among mortgage lenders or homebuyers? How great an increase in energy efficiency can be expected, over what length of time? The relevant decisions, when properly articulated, will guide not only the efforts of program staff, but also those of evaluators seeking to provide useful feedback and, at the proper time, assess the outcomes achieved.

It is as if program planners have moved from a world of basic algebra, solving one equation in one unknown or two simultaneous equations in two unknowns, to the world of chaos theory.

Conducting market transformation programs in a rational and cost-effective manner presents planners with far more unknowns than well-specified equations. Both planners and evaluators are highly dependent on having a clearly articulated program theory.

4.3 Program Design Elements and Program Logic

What, then, are the crucial steps in designing a program and laying out its logic? This section first suggests several features that should be identified in any program design. It then discusses issues that often seem to be omitted or addressed less fully than may be appropriate in program design discussions.

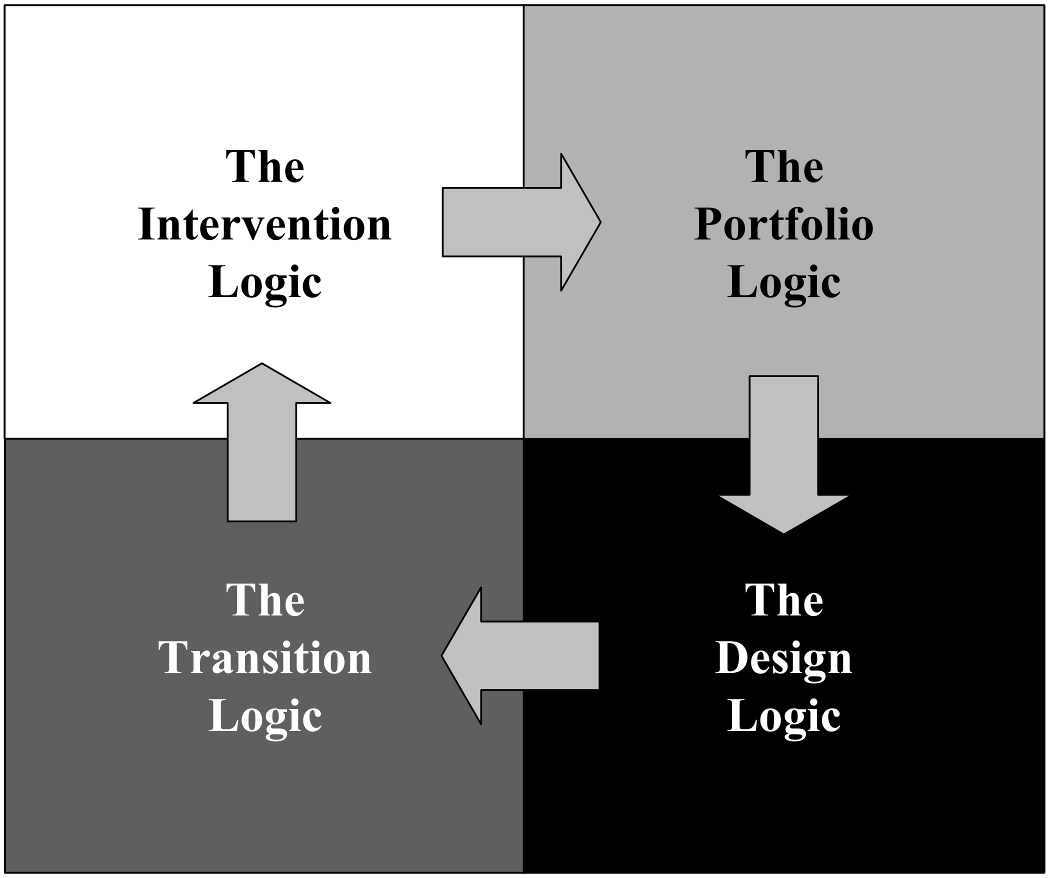
4.3.1 Overview

What do we mean when we say that an energy efficiency program should have an explicit logic—a story line? Simply this: program planners must be able to describe the market landscape at the time the program begins and must have a clear idea as to how that landscape should have changed by the program's end. Moreover, program staff should have a clear perspective as to the key actors in the plot and their relationships with one another.

In describing market actors and their relationships, program planners should be able to identify the problems that motivate intervention to increase the role of energy efficiency. Planners should also be able to describe the details of the intervention, including who will be involved, what they will be doing, and with what support. Finally, staff should be able to show that the particular intervention selected is among the most reasonable available for achieving the desired changes.

Indeed, it may be more accurate to suggest that there is not one story, but rather four stories that should be told. As shown in Figure 4-2, it is first necessary to lay out the rationale for the intervention itself.

Figure 4-2: The "Story" as Four Interlocking Logics



This would include an explanation as to how the current market is working. It would also describe the level of energy efficiency that results, the opportunities for additional efficiency, and the reasons that the market is not expected to provide additional efficiency on its own. Specific points include the following:

- ***The current market.*** Who are the market actors? What are their interrelationships? Which of those relationships are inhibiting the production, promotion, purchase, or application of energy efficient products and services? To what extent does the product mix include energy efficient options? What portion of manufacturers is producing how many models that are energy efficient? Is the distribution of the energy efficient options comparable to that for standard options? What is the overall penetration of the energy efficient options? Is the penetration of the energy efficient options skewed toward particular customer segments?
- ***The intervention program rationale.*** What market actors and what relationships is the program targeting? What is the program designed to change? How will the expected market effects enhance the production, promotion, purchase, or application of the energy efficient product or service involved? Why

is market intervention required (rather than trusting to the "natural" evolution of the market)? Is the effort designed to affect the market as a whole or a specific niche or market segment? Over what period?

- ***The expected effects of the intervention.*** What changes in the market should be expected as a result of the program? Are these changes in the number of energy efficient models or the number of producers? In the distribution of energy efficient options? In the penetration of these options? How large are the effects expected to be? How much energy will be saved, over what length of time? When will these effects become evident? Why was the particular outcome selected as the program objective? If the intervention program is successful in achieving market changes, will other upstream or downstream market inefficiencies come into play? Has the next stage of the program been considered (including such possibilities as enacting standards or simply leaving the market)? Has a transition point been identified for moving from the current program to the next step or another design?

The second story involves a description of the strategies to be implemented. It will also include a description of the expected effects of each, as well as the complementary effects that are expected. A sampling of relevant questions follows.

- ***The portfolio strategy and its components.*** Given the current state of the market, what mix of strategies is needed or would be most effective in achieving greater energy efficiency? How quickly are resources needed? Is additional research and development needed? For what specific products or product features? What is the likelihood of success? When will improved products be ready for market? What increases in energy efficiency or market share can be expected? Is additional infrastructure development required? What is the rationale for the mix of strategies suggested? How should resources be allocated among these strategies? What is the appropriate timing of these investments relative to one another?

The third story is that of the design logic for each strategy, whether resource acquisition, market transformation, or other. This is what is most commonly thought of as *the* program logic, but as may be seen from this discussion, it is best embedded in a broader set of considerations regarding the intervention and the strategy portfolio. Some specific questions that may be asked about the design logic for a market transformation strategy include:

- ***The strategy design logic.*** What are the specific market effects that are to be achieved? What specific activities will constitute the market intervention? Why have those specific activities been selected? Specifically, what is the expected causal linkage between the chosen activities and the anticipated market effects? How will these market effects lead to increases in energy efficiency? At what level? Over what length of time should this occur?

- ***The resources to be applied.*** What resources are required to intervene effectively in the manner anticipated? What tradeoffs of activities and investments are involved? Why were those tradeoffs selected? What infrastructure is necessary to support the effort on the part of the intervening organization?[4] What resources are needed for development and maintenance of this infrastructure?

The final story required is that of the endgame. What logic will guide the intervening organization to modify its approach to the pertinent market? Relevant issues include the following:

- ***The transition logic.*** Under what conditions should the intervention be modified? When should the intervention be curtailed as having failed? When should investments be increased? What would signal success of the intervention? Over what period should this be assessed? If the intervention is successful, how should the investments and activities involved be redirected? What would signal the need for continued investment in the pertinent market?[5]

4.3.2 Additional Discussion

The remainder of this subsection addresses several of these issues more fully. The issues covered include the need for a complete description of the market actors and their relationships, as well as the importance of distinguishing between program outputs and program outcomes. Other issues are the value of considering the context in which market actors are operating and the need to describe infrastructure requirements and organizational issues.

Describing the Current Market

The elements of a market description include the goods or services that are to be exchanged in that market, the relevant market actors and their relationships (whether buyers, sellers, or facilitators), and the rules that govern the exchanges involved (Feldman 1994). Without a full description of all these elements, planners may fail to recognize important influences on the availability/sale/use of energy efficient products/services and thus ignore critical leverage points.

For example, most RNC descriptions will include such market actors as architects, builders, subcontractors, suppliers, inspectors, realtors, mortgage lenders, and homebuyers. More recent papers indicate that these descriptions are incomplete, however (GDS Associates et al. 2000; Woods 2000). Specifically, these papers argue that previous market descriptions ignore the influence of the secondary mortgage market as a key determinant of what primary lenders attend to, including (or more accurately, excluding) energy efficiency.

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4 Note that this does not refer to infrastructure activities in the market as a whole.

5 As indicated in Section 3, program strategies may differ considerably on this issue.

A market description should also discuss the transactions among the market actors, including not only those that are financial but also those involved in the exchange of information. A detailed analysis of the relationships among market actors will provide planners with a guide as to which market nodes offer the greatest leverage and, thus, how potential interventions will reverberate in the market.

There is value to identifying what Eto, Prahl, and Schlegel (1996) describe as market barriers. However, greater analytic power comes from understanding the flow of goods and influence that dictate the production/distribution/promotion/sales of energy efficient products and services. For example, recognizing that builders and homebuyers in the RNC market have split incentives provides little program direction for ameliorating that condition. In contrast, understanding that tract builders must complete projects and sell units as rapidly as possible to limit their interest payments may suggest useful market interventions (e.g., increasing the ready availability of energy efficient equipment to builders) that will better align builder practices with homeowner demand for such equipment.

The Expected Effects of Intervention

As noted earlier, the desired outcomes of many resource acquisition programs were the direct consequences of utility interventions and were under their direct control. If the program staff directed its resources well and cost-effectively, the program would achieve its objectives. For example, if a ballast rebate program was administered well and the awareness campaign was conducted effectively, it was a relatively sure bet that more electronic ballasts would be sold and installed.[6] It seems quite reasonable to suppose that promoting rebates through direct mail, breakfast meetings, and account executive calls will increase customer awareness and use of the rebate/purchases opportunities.

By analogy, some targets for market transformation programs are defined in terms of what can be accomplished directly through intervention activities, and some evaluations are focused on assessing those results. For example, the prototypical RNC program described earlier includes training programs for builders and subcontractors. The better the program staff administers the program and the more effective it is in reaching and motivating potential trainees, the more workshops it can conduct and the more builders and subcontractors it will reach. It is reasonable to include these program *outputs* among the process objectives of the program and to assess them as part of the program evaluation. However, the authors maintain that it is incorrect to confuse them with program *outcomes*.

[6] This is not to say that important evaluation issues are absent. The precipitating market research could be inaccurate or the causal hypotheses relating to the reduction of first costs could be incorrect. Moreover, the rebate level chosen could be ineffective or could generate an overabundance of free riders. However, the desired outcome and the relevant indicators (sales, installations) are obvious.

It may be helpful at this point to suggest a framework for describing the elements of what has been labeled a program outcome model (United Way of America 1996) and is widely used by evaluators in many different fields.[7] The elements of this model include Inputs, Activities, Outputs, and Outcomes (Initial, Longer term). Definitions of each of these are provided here, together with examples from energy efficiency programs.[8]

- ***Inputs.*** Resources dedicated to or consumed by the program:
  - Money (rebates, spiffs,[9] advertising costs, educational brochure costs)
  - Staff time (program designers, managers, account execs, "circuit riders")
  - Equipment and supplies (brochures, rebate forms, promotional or educational tapes)
- ***Activities.*** What the program does with the inputs to fulfill its mission:
  - Provide workshops
  - Create promotional materials
  - Visit and work with retailers
- ***Outputs.*** The direct products of program activities:
  - Number of training sessions held
  - Participant satisfaction
  - Number of customers or market actors participating in workshops
  - Number of advertising impressions achieved
  - Number of promotions placed
  - Number of store visits by circuit riders
- ***Outcomes.*** Benefits for participants [and society] during and after program activities [bracket added]:[10]
  - Increased awareness
  - New knowledge or skills
  - Modified behavior
  - Energy savings
  - Demand savings

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7 The evaluation literature includes numerous other schemes for formalizing program descriptions, as well as variations on the one offered here. The interested reader may wish to consult publications of the American Evaluation Association or monitor *evaltalk*, a listserv that contains frequent discussion of these issues.

8 The definitions are taken from United Way (1996), p. 3.

9 Literally, the term refers to "special incentive(s) from factory." It is generally used to refer to any incentives for salespersons, regardless of their source.

10 Depending on the program design and implementation, some outcomes may be relatively short-term, such as increased awareness or skills, while other may be more long-term, such as reduced pollution.

- Reduced pollution
- Other non-energy benefits

The reader may note that outcomes constitute the last of the areas singled out for articulation in this framework. Furthermore, the reader should note that outcomes refer to the effects themselves, not to the indicators of those effects. It is important for the evaluator to operationalize the outcomes so they can be measured in a sensitive and reliable fashion. Particular attention should be given to developing estimates of the energy savings that will be achieved and the methods that can be used to assess the validity of those estimates as the intervention proceeds.[11]

In these efforts, the evaluator is likely to find that discussions with program staff will help identify variables that are appropriate and useful indicators of the expected outcomes. However, the indicator specification step itself is more appropriate to the measurement enterprise than to the development and assessment of the program logic.

The Intervention Program Rationale

Resources are limited. Accordingly, selecting a particular market for program intervention must be justified with respect to foregoing other market opportunities. Nonetheless, program logic often fails to discuss why the particular market was chosen—whether it is critical to the economy of a particular region or service territory, whether it is particularly ripe for a new energy efficient technology that is unlikely to proliferate without an initial boost, or whether it is one that is likely to have useful spillover effects into related markets. Explicating this part of the story and understanding its import can help program staff, evaluators, and policymakers focus on relevant activities and identify generalizable lessons from specific interventions.

The Residential Clothes Washer Initiative (RCWI) offers a case in point. As noted earlier, the underlying problem of the clothes washer market, planners believed, was that energy efficient units were not widely available in the North American market. Accordingly, their objective was to obtain commitments by domestic manufacturers to produce, distribute, and promote a sufficient number of brands and models, thus creating widespread public notice and make energy efficient units a viable market choice.

In brief, the RCWI was extraordinarily successful in stimulating the production of resource efficient clothes washers and increasing their penetration. How did the cooperation and agreement come about and why has it not occurred with other technologies? What lessons can be drawn?

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[11] See Section 5 for more detail on this issue.

Some elements of the market context for clothes washers at the beginning of program development (the early 1990s) may enhance understanding of the program results. The most important may have been the following:

- The Department of Energy was preparing to review efficiency standards for clothes washers under congressional mandate. Such reviews focus on the technical feasibility of efficiency improvements and the anticipated willingness of end users to purchase the units at a fair price.
- The North American clothes washer market is dominated by a handful of manufacturers who are engaged in strong head-to-head competition for market share. Resource efficient washers were already being produced for sale in other markets by competing manufacturers as well as subsidiaries of U.S. manufacturers. Moreover, these new models incorporated important non-energy benefits, such as being less noisy and gentler on clothes than standard washers.

The context suggests that clothes washer manufacturers of were motivated to consider introducing new models, both for competitive reasons and for dealing with the standards issue. At the same time, most manufacturers appeared reticent to commit heavily to resource efficient models because they were uncertain of customer demand. In addition, most manufacturers were cautious about intervention programs intended to increase the sales of resource efficient models because such programs had been highly sporadic and had often required different standards in different regions.

As noted, the RCWI established a program, based on consistent product qualification requirements, that would help to build and demonstrate the necessary demand. Sponsors promoted resource efficient clothes washers to residential customers, trained retail sales staff on the benefits of these washers, made certain that qualifying models were properly labeled, and (in many areas) provided rebates to purchasers. Program staff and sponsors also met with other market actors to explore their concerns and needs. Moreover, program staff kept other market actors informed of program implementation activities and modifications.

These efforts were effective in helping garner manufacturer and retailer cooperation precisely because the program activities were matched to the context, and because they fit with the resulting needs and wants of those market actors. Thus, an important lesson learned may not be that the specific activities of the RCWI program can be repeated and similar success achieved with another technology. Rather, it may be that the process of identifying the context and the related needs and wants of other market actors is key to success.

The Resources to be Applied

The program design should include relevant assessments of available resources as well as those that need to be developed, and not simply a financial budget. Among the relevant issues are infrastructure requirements, such as those discussed in the previous section. For example, the RNC program described earlier presumes the availability of respected professionals who can train builders and their subcontractors. If such professionals are not readily available, resources may be required to identify potential trainers, to develop the training program itself, and perhaps, to train the trainers.

Other resource issues that might be discussed include the use of different types of program administrators. Lively discussions have developed regarding the motivations and independence of private and public program administrators (Eto, Goldman, and Kito 1996; Schultz 1996). However, little information is presently available regarding the cost-effectiveness of different approaches. Some programs may be best administered through utilities while others may be best administered through third parties and still others, through state agencies. Factors affecting the pertinent recommendations are likely to include the specific experience of potential program staff. Relevant factors may also include the degree to which the attention of the potential staff is spread over other projects and the fit between the organization's culture and the recommended program activities. It seems unlikely that a single model will be appropriate in all cases. However, program design documents (and evaluators) do not appear to have grappled fully with these issues, despite the likelihood that they may have important consequences for the wise allocation of public goods charges.

4.4 The Uses of Program Logic

As indicated at the outset of this section, an explicit program logic provides direction for the investments and activities of program staff as well as those of program evaluators. In so doing, the program logic becomes a valuable tool for helping to assess the cost-effectiveness of the program both prospectively and retrospectively. Each of these uses is discussed below.

4.4.1 Program Logic and Prospective Cost-Effectiveness Analysis

Planners can optimize the cost-effectiveness of a program prospectively by reviewing all aspects of its logic carefully before its implementation, beginning with the anticipated feasibility of the intervention. The following elements are among those that will be covered.

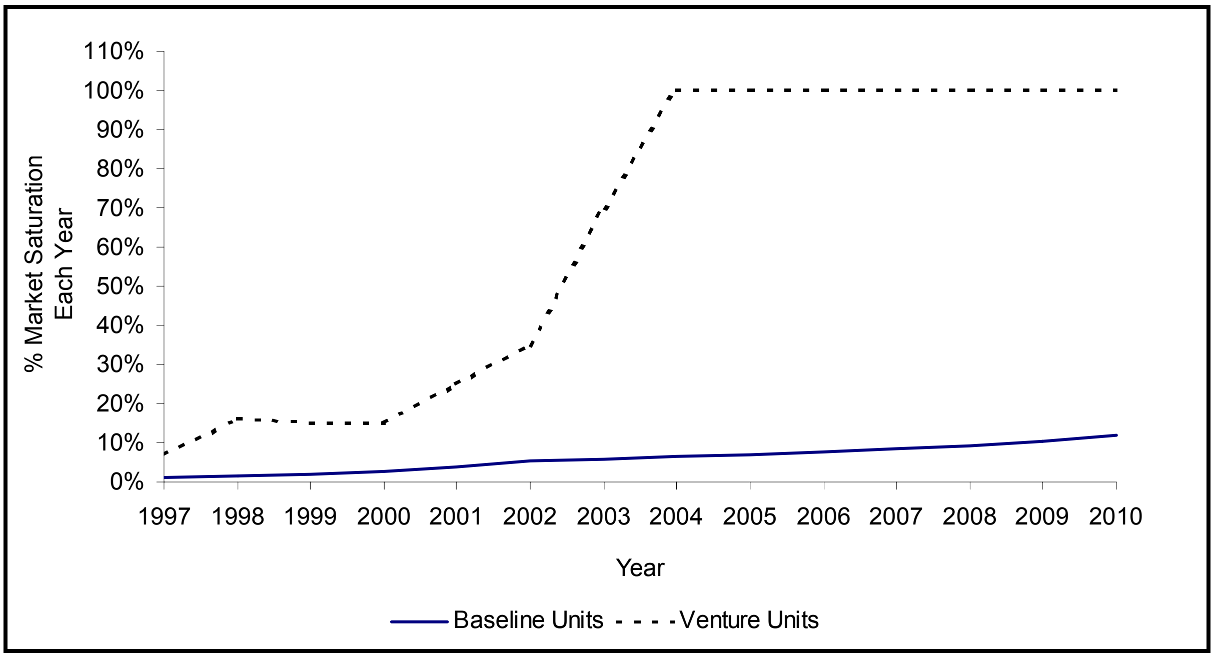
- What will be required to mobilize the necessary financial resources, the administrative and implementation skills to conduct the program, and the requisite organizational commitment?
- What are likely threats to program development, implementation, and success? How probable are they? How readily might they be overcome?

Once a decision has been made that the intervention appears feasible, the expected effects should be made part of the story. Standard questions such as the following must be addressed.

- What is the technical potential for the market that has been selected? (How much energy or demand can be saved per unit? How many incremental units must a successful program generate?)
- What is the economic potential for this market? (What level of investment appears to be available? What net benefits or benefit-cost ratio is required?)

As described in Section 7, an important part of this exercise is an estimation of "naturally occurring conservation" (i.e., the market penetration that might be expected for an energy-saving technology in the absence of any market intervention). This should then be compared with the level of penetration projected to result with the intervention proposed. Figure 4-3 shows the projected cumulative results under both of these scenarios for the penetration of resource-efficient clothes washers in the region served by the Northwest Energy Efficiency Alliance (the Alliance). The steep incremental effect of the Alliance's intervention (initially here to last only through 1999) provides a strong *a priori* case for the sustainability of the market changes and for the likelihood that the intervention will be cost-effective.

Figure 4-3: Projected Penetration of ENERGY STAR® Clothes Washers, With and Without Intervention by Northwest Energy Efficiency Alliance



From Cost Effectiveness Summary for ENERGY STAR Resource Efficient Clothes Washers (with permission).

In addition, the story should describe the reasons for supporting infrastructure development, funding, or conducting research and development, increasing equity, or selecting resource acquisition or market transformation strategies. As discussed in Section 3, for example, "a need to control the speed, quality, timing [or] location … of the energy efficiency results" suggests the use of resource acquisition. Another indication for a resource acquisition strategy is that "insufficient non-energy benefits or insufficient profit opportunity" are available to motivate sustained private-sector support. In contrast, market transformation is favored when the target market is large, substantial non-energy benefits are apparent, and opportunities exist "to piggyback on the efforts of powerful actors in the market place." Underlying the discussion of these decision factors is the point that planners must have a clear concept of the current market and their objectives when selecting their strategy. The corollary point is that the reasons for the strategy selection must be made part of the story.

Furthermore, consideration should be given to both the near-term outcomes, including expected energy savings, and the longer-term outcomes, including sustainable market changes. The distinction between resource acquisition programs and market transformation programs is useful for many topics covered in this monograph. Nonetheless, in practice the distinction is one of emphasis, rather than one between completely different program activities, outputs, or outcomes.

Various examples demonstrate that the investments and activities required for market transformation programs do not differ in kind from those used in resource acquisition programs. The clearest example is the use of rebates, which some early discussions suggested as inappropriate to market transformation programs. As shown in such programs as the RCWI, however, financial incentives to end users may be necessary to help build awareness among consumers. Moreover, careful application of that resource may help show other market actors the value of partnering. The two types of programs may lead to similar outcomes as well.

- Resource acquisition programs focus on capturing energy savings within the program period and, generally, from a defined population of end users or facilities. However, they may also affect the market in the longer term or create conditions that prepare the market for broader types of change. For example, commercial lighting programs that offered rebates for the purchase and installation of electronic ballasts and T-8 lamps saved substantial amounts of energy in New England (Easton 1997) and in California (Xenergy 1998). These programs also appear to have created awareness of energy-saving technologies and levels of demand, along with lower costs to manufacturers, which led to sustained changes in the market (Peters et al. 1998).
- In a parallel fashion, market transformation programs generally achieve savings in the near term, although they are primarily designed to change markets in sustainable ways. For example, the RCWI focused on enlisting manufacturers in

> producing, distributing, and promoting resource efficient clothes washers. However, one near-term outcome necessary to the success of the RCWI's mid-term objectives was to increase the penetration of these washers in a substantial way. As a result, a considerable level of energy savings was achieved over the initial program period.

In other words, both resource acquisition and market transformation outcomes may result from a specific program. Indeed, this possibility may be an opportunity to increase the cost-effectiveness of certain programs, so long as it does not divert the resources necessary to achieve the selected strategic objectives.

The difference between resource acquisition and market transformation programs in the targets addressed suggests the importance of discussing the boundaries of the market that is to be affected as part of the prospective design discussion. One of the hallmarks of market transformation programs is that they are intended to have effects beyond the specific targets initially addressed. The assessment and treatment of effects beyond a particular service territory or region are one important issue that emerges as a result. The prospective cost-effectiveness analysis must take into account the benefits and costs of program coordination with other interveners where such efforts are integral to the program, as with the RCWI. Among the difficult issues that must be considered is the allocation of net spillover effects among different intervening agencies.

The issue of the affected population should be faced at a more fine-grained level as well. Most resource acquisition programs are rather specifically targeted. Since sustainable market effects are not highly relevant, little attention need be paid to their breadth, with occasional exceptions for equity concerns.[12] Given the longer period in which market transformation effects are expected to emerge and spread, it is important for planners to describe their expectations as to the diffusion process and its results. Which potential agents of diffusion were targeted and why? What are the factors expected to motivate the diffusion by these agents? What length of time will be required? What final level of saturation will be achieved?[13]

For example, consider again the market transformation-based RNC program design. Should this program be directed toward builders of tract homes or builders of custom homes? Based on the argument that gaining acceptance in the high-end market will lead to copying efforts by other builders, planners with long-term energy savings objectives may wish to focus on

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[12] This is not to say that market segmentation is irrelevant for resource acquisition programs. However, the precipitating factor is usually the cost-effectiveness of trying to reach an entire population (e.g., all residential customers) vs. that of trying to reach specific segments (e.g., homeowners or married couples with children). It is not the prospective cost-effectiveness of the underlying tactical plan.

[13] The classic discussion of the diffusion of innovation may be found in Rogers 1995; a more recent popular treatment, which incorporates additional perspectives, is provided by Gladwell, 2000

the custom builder segment. But such an argument would also recognize that the diffusion may require considerable time, so that planners with nearer term energy savings objectives might wish to focus on tract builders instead. Whatever the decision, it is important that the issue be considered and the rationale for the selected target articulated.

Another area in which resource acquisition programs and market transformation programs differ considerably—in degree, if not in kind—is with regard to the variety of program designs that may be relevant to achieving the selected objectives. Careful development and examination of the program logic can further the cause of optimizing cost-effectiveness here as well.

As previously argued, resource acquisition programs tend to feature relatively direct relationships between program objectives and interventions. In the electronic ballast example, rebates are intended to reduce initial costs, thus stimulating more purchases, resulting ultimately in greater energy savings. In the resource acquisition-based RNC programs, financial incentives are intended to compensate builders for including higher levels of insulation or HVAC equipment efficiency, leading to more installations and greater energy savings. Similarly, where information about energy efficiency or its benefits is considered to be lacking, the usual intervention program is to provide that information directly through advertising, promotional materials, or training efforts. The information is expected to induce greater purchase or use of the energy efficient product or service.

A major characteristic of these interventions is their directness in the choice of specific activities and in the choice of targets. In most cases, the target of a resource acquisition program is the end user—an individual or agent who will benefit directly from the energy savings that will be achieved.[14] For this reason, resource acquisition program designs do not appear to lend themselves to the consideration of a variety of scenarios.

In contrast, given the different market actors and relationships generally involved in a market transformation program, a variety of scenarios should be considered.[15] It is as if the beginning and end of the story are fixed, but a variety of actions is available to connect one to the other—just as a myriad of plots can occur on the way from "boy meets girl" to "and they lived happily ever after." The current market and the desired changes in the market may be givens, but various program designs may be possible. The problem is to find the story line

[14] Accordingly, a "split incentives" problem arises when those controlling the purchase or use of energy-saving equipment are not the end users who must pay for that use. It is particularly in such cases that resource acquisition programs address other market actors, as in the offer of financial incentives to RNC builders.

[15] As noted in the previous section, it may not be wise to consider a market transformation program unless the planner has some confidence in the initial assessment of the current market actors and their interrelationships.

that best connects (is most effective; uses resources most efficiently) a particular market with a future state in which energy efficient products and services are better utilized.

This point may be illustrated by reconsidering the logic for a commercial lighting ballast program. In the example used earlier, an important objective was to achieve energy savings quickly. Thus, the selected strategy was to offer direct incentives to commercial decision makers.

If, however, the strategic objective was to develop the market for electronic ballasts over time, other activities and program targets might be more appropriate or more cost-effective. For example, the planners might consider a program of financial incentives intended to reduce the market risk perceived by manufacturers, thus inducing them to increase production and promotion and to lower the cost premium to purchasers. Similarly, program developers might target architects or electrical contractors with incentives or workshops (or both) to increase their awareness of the technology and its benefits and to help them market the energy-saving technologies to their clients. Another option would be to lobby heavily for more stringent building codes and their enforcement, while offering training programs for inspectors.

Any or all of these activities might have been included as adjuncts to a resource acquisition program, but—given expectations as to when most energy savings would materialize—they are more likely to be appropriate for a market transformation effort. What is not readily apparent, however, is which of these activities, or what combination of these activities, is most likely to achieve the desired effects in the most cost-effective manner.

Similarly, planners might consider a variety of RNC program targets and activities. For example, the intervention might include workshops to provide builders and their subcontractors with the knowledge and skills required to build qualifying homes. These workshops could also help builders improve their ability to promote and market such homes and implementers could participate in co-operative advertising with builders. The intervention could also contribute to the development of home rating systems and fund the training of inspectors or work with builders' sales agents, independent realtors, and mortgage lenders.

A case can be made that any or all of these activities are likely to increase the long-run sales of energy efficient homes. However, this does not mean that all these activities are equally likely to induce market changes or that the cost-effectiveness ratios of each are likely to be the same. Thus, the complexities of the story underlying a market transformation program require the designer to confront the issue as to where resources can be best applied, both to achieve the desired outcomes and to do so in a highly cost-effective manner.

As discussed in Section 7, modeling, scenario analysis, the informed use of expert opinion, or other systematic analyses of prospective benefits and costs would be valuable. These approaches are also amenable to sensitivity analyses in which the relative importance of different input assumptions and process hypotheses can be tested.

Thus, to the extent that the program logic is clear, such analyses can be used to estimate the incremental effects (e.g., penetration levels) to be expected from incremental investments in the targeted activities. The first step, however, is to develop qualitative assessments of the value of the targeted activities themselves. Planners should articulate the program logic for each candidate approach and assess the potential strengths and weaknesses of each. Figure 4-4 illustrates this approach for selected commercial ballast program options.

Figure 4-4: Sample Intervention Activity Selection Matrix (Energy Efficient Ballasts, Commercial Sector)

Program Target	Selected Intervention Activities	Expected Outputs	Anticipated Spillover Effects	Time Frame	Strengths	Weaknesses
Commercial customers	Financial incentives	Immediate increase in sales of energy-efficient ballasts (EEBs)	Increase in ordering and stocking of EEBs	Immediate	Captures immediate savngs; some customers likely to stay with EE technology	Not particularly sustainable
Commercial customers	Promotion; education	Increased awareness of EEBs and their benfits	Increased demand for EEBs	Slow	Builds sustainable demand	Requires time and long-term investment; may not provide clear signal to increase supply at time required
Manufacturers	Financial incentives	Lower prices to the market	Increase in ordering and sales of EEBs	Immediate	Captures immediate savngs; some customers likely to stay with EE technology	Not particularly sustainable
ESCOs	Promotion; education	Increased awareness of EEBs and their benefits	Increased credibility of EEBs	Slow	Enlists other market actors, particularly those who often have carte blance in designing and selecting layouts and equipment	Likely that most ESCOs have already been exposed to EEBs and use them regularly
Lighting designers	Promotion; education	Increased awareness of EEBs and their benfits, as well as appropriate and attractive applications	Increased credibility of EEBs	Moderate for affected customer segments	Enlists other market actors; builds sustainable demand	Limited to certain customer segments; effects on others likely to be nil or very long-term
Electrical contractors	Promotion; education	Increased awareness of EEBs and their benefits	Increased credibility of EEBs	Moderate	Enlists other market actors; builds sustainable demand	Benefit to contractors not clear; may require financial incentives as well

Based on prospective analyses of this type, planners can select a preferred set of market transformation tactics. Furthermore, in providing support for selected tactics, they can estimate, at least qualitatively, the expected cost-effectiveness of the program. Furthermore, they can use this information as a rough benchmark for designing and conducting retrospective evaluation results.

4.4.2 Program Logic and Evaluation Design

A carefully articulated program logic, together with the program outcome model, will serve as a valuable guide for retrospective cost-effectiveness analysis. It will provide evaluators with a clear roadmap as to what should be evaluated and direct them to questions that should be addressed.

Although many of the questions raised will be appropriate for both resource acquisition and market transformation programs, others will be specific for one type of program but not the other. Table 4-1 provides examples of each type.

Table 4-1: Applicability of Selected Evaluation Issues to Resource Acquisition and Market Transformation Programs

Issue	Applicability/Comments
Was the market description guiding the program design accurate, or might it have missed certain crucial market actors? Did the program identify important relationships among market actors that inhibit energy efficiency? Was the program design reviewed and enhanced as additional information from the field became available? Was the program design responsive to signals that activities should be increased, modified, or reduced?	✓ Issues of program modification may be less relevant to resource acquisition programs, because they are often of shorter duration. ✓ Comprehensive description of market actors and their relationships more critical to successful market transformation program design.
Were sufficient resources requested and allocated? Were they allocated according to the priorities identified in the program logic?	✓ Equally applicable to both program types.
Were the activities selected appropriate to the program logic? Did they target the opportunities and leverage points identified in the program logic? Were they consistent with the time over which the program design was meant to operate?	✓ Equally applicable to both program types, for the most part. ✓ However, the leverage points issue will probably be more pertinent to market transformation programs. ✓ Attention to the time frame issue important for reviewing the appropriateness of the strategy selection (resource acquisition vs. market transformation).
How did actual activities vary from those initially planned? Was the program overly rigid or overly loose with regard to such modifications? Was the process of review and modification systematic while being responsive to opportunities and problems?	✓ Again, the issue of program modification may be less relevant to resource acquisition programs
Did the program inputs and activities result in the outputs anticipated or promised? Was information regarding outputs monitored and used for quality control and internal process improvement? Were activities modified or improved over time in response to such feedback?	✓ Equally applicable to both program types, for the most part. ✓ Again, however, the issue of program modification may be less relevant to resource acquisition programs, except as the are continued over several years with ample time for the use of feedback.
Did the intervention achieve the effects anticipated? To what degree did the program theory predict changes over time? Were the expected near-term outcomes achieved? What is the evidence that these effects are attributable to program activities? Were reverberations through the market system as described in the program logic? How widespread are the market effects observed?	✓ Program outputs, near-term outcomes and longer-term outcomes will relate to one another quite directly in many resource acquisition programs. ✓ However, the reverberations issue will generally be more relevant to market transformation programs.
Are anticipated energy savings developing at the level anticipated in the program logic? Are these effects greater than those seen in comparison areas (if identifiable)? How widespread are those savings?	✓ Over short periods, this question will be less relevant to market transformation programs.
Is there reason to believe the effects are sustainable? Based on what evidence?	✓ Applicability will generally be limited to market transformation programs.
What confidence attaches to the findings and conclusions?	✓ Because of the complex interrelationships and time scale involved, evaluations of market transformation programs may be subject to more uncertainty.

Generally speaking, all of the issues described in Table 4-1 are applicable to both resource acquisition and market transformation programs. However, for the purpose of exposition, several comments in the table highlight differences in the relevance of these issues to the two program types. Specifically, a review of the issues considered suggests an important practical difference between the use of program logic descriptions in resource acquisition programs and their use in market transformation programs. For the most part, even if they are renewed over several years, resource acquisition programs are normally intended to secure energy savings over a relatively short period. In contrast, market transformation programs are expected to last over several years if they are to prepare and transform markets in a sustainable fashion.

Historically, resource acquisition programs were evaluated at the end of a fixed calendar period. The evaluation results were often unavailable during the time that the program could be enhanced or before decisions were made to re-authorize or eliminate the program in future years. Moreover, regulatory practice tied to yearly authorizations tended to preclude changes in investments or activities within a given program. Thus, even if resource acquisition programs ran for several years, the benefits of obtaining and responding to evaluative feedback were not often realized as fully as they might have been.

As suggested in the earlier discussion and highlighted in Table 4-1, the complexity of market transformation programs appears to increase the importance of properly describing the market and tying program activities to an explicit change logic. Given the time market transformation programs are expected to be in the field, many opportunities will arise for obtaining feedback regarding the validity and reliability of the initial market description and the logic supporting the expectations of near-term outcomes.

In general, it would be inappropriate to assess a market transformation program on longer term energy savings over short periods. However, it would seem equally inappropriate to squander opportunities to collect information that tests the program logic. Moreover, it would be extremely wasteful not to use this information to modify the program logic as necessary and thus improve the program and its cost-effectiveness in an iterative fashion.

As illustrated in an ongoing market transformation program designed to increase the availability of ENERGY STAR qualified products in Wisconsin,[16] the information may be developed internally or an independent evaluator may provide it. It may be part of a systematic data collection effort or it may be arise from less predictable events.

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16 This program is designed to change the Wisconsin appliance market. It leverages off of the infrastructure elements of the national Energy Star program and has used financial incentives to customers to gain a foothold in the market. However, its program logic focuses on direct interventions with retailers in the state and crucial evaluation elements have included inventory differences between participating and nonparticipating retailers, mystery shopper assessments of salesperson knowledge, and shopper reports of salesperson promotions.

The initial program design included spiffs for salespersons based on their sales of ENERGY STAR products. Program staff interviews indicated that this external incentive would be inconsistent with the compensation plans of many dealers. The idea of a sales incentive was dropped, but other incentive mechanisms are now under consideration.

The program was highly successful with respect to increasing the penetration of ENERGY STAR appliances in its first year. An independent evaluation found, however, that customers who received the rebates were often unaware of the source of the funds or the broader program involved. Customers were thus unlikely to seek out other qualifying appliances and would not be expected to provide the demand that would drive continued retailer interest in promoting energy efficient appliances if program investments declined. The program manager therefore increased efforts to identify the rebate checks with the ENERGY STAR label and developed follow-up mailings that cross-promoted other ENERGY STAR qualified products.

Of critical importance is that the program logic or the activities be reviewed and, if necessary, modified to incorporate or respond to the improved information base.

4.5 Summary

This section is centered on the proposition that articulation of program logic models helps program designers focus their resources effectively. Furthermore, program logic models direct evaluators toward measurement of the crucial factors in program impact and success. Finally, review of relevant logic models forces evaluators and policymakers to confront the question of the use of public goods charges at a conceptual level as well as at the practical level.

Subsection 4.2 showed why it is critical to explicate the logic of a program, particularly for market transformation efforts. An example demonstrated that two different rationales might underlie a particular set of program activities. Without a clear understanding of the preferred logic, implementers might proceed in the wrong direction over time and evaluators might focus on the wrong outcomes. Because market transformation programs are generally more complex and involve more steps than those focused on resource acquisition, program logic is of greater concern.

Crucial components of program logic were identified in Subsection 4.3 as being descriptions of the current market, the expected effects of the intervention, the rationale for the intervention, and the resources to be applied. Each topic was expanded in more detail. Among the points discussed were the importance of fully identifying the set of actors influencing a particular market, as well as their financial and informational interactions. In considering the expected effects of intervention, a framework was offered for laying out a program development model. Moreover, the distinction between program outputs and outcomes was stressed. Additional consideration was given to the need to identify the context that helps justify the intervention selected and to reviewing personnel and organizational resources, as well as financial support requirements.

Subsection 4.4 discussed the uses of program logic for both prospective and retrospective cost-effectiveness analyses. Considerable attention was paid to the importance of articulating the rationale for the intervention selected, including the choice of strategy (especially resource acquisition or market transformation), the target audience, and the tactics. This was shown to be particularly important for market transformation programs, since they appear to be open to a greater variety of design options than do most resource acquisition programs. Thus, it is incumbent on program planners to review the logic of different design options, perhaps in conjunction with the forecasting tools discussed in Section 7. Program planners should strive to select the option most likely to achieve the desired objectives in a cost-effective manner. Consideration was also given to ways in which program logic relates to retrospective program evaluation and critical questions were suggested. Several of these questions were shown to be applicable to both resource acquisition and market transformation programs, while others were identified as more appropriate to one or the other. Particular attention was paid to the opportunities for using evaluation to improve the cost-effectiveness of market transformation programs through ongoing feedback.

Based on this discussion, the following recommendations are appropriate.

The use of program resources should be focused by articulating the logic of the initiative, whether that initiative is in the form of a research and development, infrastructure, increased equity, resource acquisition-directed, or market transformation-directed effort. This will enable designers, policymakers, and evaluators to review the premises critically, coordinate implementation activities, and identify the issues and outcomes most relevant to evaluation and cost-effectiveness analysis.

- A comprehensive story should be developed regarding the rationale for the initiative and the reasons it is expected to be effective.
  - The specific market actors and interactions targeted should be identified, as well as the reasons for those choices.
  - The market context should be described and a detailed assessment should be provided for the current market, the market actors, and the interactions normally observed in the target market.
  - All resources required should be specified, including organizational capabilities and time, as well as financial support.

  - The time required to achieve each phase of the anticipated effects should be estimated.

- Prospective analyses should be conducted regarding the initiative's cost-effectiveness.
  - The reasons that the market is not expected to perform efficiently in the absence of the proposed intervention should be clarified.
  - The rationale should be considered for including the particular initiative as part of the overall intervention portfolio, including an analysis of the opportunity costs of that choice.
  - The expected outcomes of the particular resource commitments and activities should be reviewed. These should then be compared to the outcomes of reasonable alternative tactics.

- The logic of the initiative should be refined and relevant activities modified as information becomes available to assess the validity of ht initial assumptions and the causal hypotheses.
  - Formative and summative analyses should be identified, as discussed in Section 5.
  - Retrospective analyses should be conducted often enough to provide feedback as to the value of specific activities in helping achieve longer-term outcomes. Evaluations focused on longer-term outcomes should be scheduled for when those outcomes (e.g., achieved savings) can reasonably be expected.

- The outcomes expected to result from the intervention should be distinguished from the outputs of activities directly under the control of the intervener.

  The concept of cost-effectiveness—the wisest application of resources—is relevant to both, of course. Nonetheless, intervention outputs should be recognized as being of value only insofar as they lead to the desired outcomes. (Hence, far more weight should be placed on the latter than on the former, particularly during later stages of the intervention.)
  - Consideration should be given to the strategic and practical shifts that are to follow on the success of the intervention (or its failure) and these should be made explicit as part of the overall program logic. So, too, should the indicators as to when the shift(s) are to occur.

5

Evaluation and Measurement

5.1 Overview

This section discusses the principles of evaluation and measurement as they apply to energy efficiency interventions. The first three sections laid out a general strategy for thinking about energy efficiency interventions in a policy and program planning context. Section 4 described how to design an intervention by developing a logic model and a story for what is expected as a result of the intervention. Taking a logic model based approach also informs the process of designing the evaluation, as well as helping define how the intervention should be implemented.

This section takes the next step describing the approach in designing an evaluation. Evaluation and measurement activities should test the logic of the intervention to determine whether the logic makes sense in practice and whether the results of the intervention are consistent with the logic.[1] Given that the primary goal of an energy efficiency intervention is energy savings, the evaluation must test this logic and determine that savings have occurred and that public funds were well spent in the process of achieving those savings. More detail is provided below on the implementation of the evaluation, the measurement of cost-effectiveness, and the value of forecasting.

5.2 Introduction

The two goals of an energy efficiency intervention evaluation are to determine the following:

1) How much energy has been saved by the energy efficiency intervention?
2) Were public or ratepayer funds spent wisely?

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[1] This approach is similar to the concept of theory-based program design and evaluation as discussed by Rufo, Goldstone, and Wilson (2000). Within the broad field of evaluation, the idea of theory-driven evaluation is attributed to Peter Rossi (see Shaddish et al. 1991). Rossi's notion of theory-driven evaluation posits that a dynamic model can be used to assess program effects and that the model should be based in social science theory. He further posits that this evaluation approach should be used on innovative theory-driven program designs based on social science theory. A recent review of program theory and theory-driven evaluations issues is available in Rogers et al. (2000).

These two goals apply to all five types of energy efficiency interventions, whether resource acquisition, market transformation, research and development, infrastructure, or equity. The interventions, however, because of the specific objectives and activities, may require different methods and strategies for determining how well it achieved its goals.

There are three essential decisions to be made in planning and designing an evaluation (Shadish et al. 1991):

- Whether an evaluation should be done,
- The purpose of the evaluation, and
- What role the evaluator should play.

The initial assumption in this document is that at some point during the implementation of the intervention, an evaluation will be done. However, determining when to do an evaluation, what to focus on, and how the evaluation should be conducted vary with different factors that drive the evaluation. These include the type of intervention, the requirements for reporting, the observable progress of the intervention, the need for information to make decisions, and available resources to conduct the evaluation.

This section will help policymakers and evaluators make these decisions by discussing the purposes of evaluations, the various issues regarding responsibility for conducting evaluations, the different types of evaluation approaches available, and how these might be applied to the five types of energy efficiency interventions.[2] This section concludes by reviewing some thorny issues that evaluations must be prepared to address.

5.3 The Purpose of Evaluation

It is important to begin by examining the purpose of evaluation. As noted previously, the two goals or purposes of energy efficiency intervention evaluation are to determine whether energy has been saved by the energy efficiency intervention and whether public or ratepayer funds were spent wisely.

Within the broader evaluation community, there are two general reasons or purposes for evaluation: “to improve something (formative evaluation) and to make various practical decisions about something (summative evaluation)” (Scriven 1991; Shadish et al. 1991). Determining whether energy has been saved best fits the summative category, while determining whether public or ratepayer funds were spent wisely tends to fit the formative category.

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[2] See Section 3 for a definition of the five types of energy efficiency interventions.

Though formative and summative evaluations appear to be distinct, in practice the differences are less clear and lie primarily in their purpose rather than in their methods or even their eventual use. An impact evaluation using load impact studies to assess whether an intervention has saved energy tends to be summative. However, the information in such an evaluation can also be used to improve the intervention. Similarly, process and market evaluations tend to be viewed primarily as formative, but the information provided by such evaluations can be the basis for decisions to cancel or expand interventions, which are summative decisions.[3]

In resource acquisition program evaluations, there was a tendency to focus on the determination of savings—a summative purpose. Policymakers relied strongly on cost-effectiveness and load impact assessments to make decisions about whether to continue programs and, specifically, the value of shareholder incentives. A focus on summative purposes is also expressed in the draft policy rules by the emphasis on assessing sustainability and intervention success (CPUC 1999):

> *"The primary purpose of market assessment and evaluation is to document changes in the structure and functioning of markets and assess the sustainability of these changes in the market and to evaluate the success of programs. These efforts should focus on measuring the market effects caused by programs and testing the assumptions and explanations that underlie them."*

Though the focus of this document is toward cost-effectiveness evaluation. Cost-effectiveness is a summative, not a formative, activity. Nonetheless, as will be quite evident in the following discussion, there are important formative evaluation activities that are critical to ensure that interventions are as cost-effective as possible and that success is facilitated and even enhanced (essentially, that the public funds are being spent wisely) (Peters et al. 1995; Walton 1986; Senge 1990; Faruqui 2000).[4] Some key issues to consider in terms of timing and conduct of evaluations are explored below.

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3 In the early days of the Bonneville Residential Weatherization Program, load impact evaluation led to changes in measure packages in order to improve program delivery and savings assessment. Similarly, the process evaluations led to decisions to change the program implementation. In the case of the Bonneville Street and Area Lighting Evaluation (an early market tracking evaluation), the results of the tracking study lead to the cancellation of the program based on a decision that the market had been transformed.

4 Increased reliance on both summative and formative analysis is seen today in best business practices. A quick review of business literature will inevitably lead the reader to the terms "process improvement," "total quality management," and "a learning environment." These strategies are formative approaches to business management. Consider the "Deming Chain Reaction" discussed in Walton's biography of Edward Deming: "improved quality leads to cost decreases because of less rework, etc., which leads to productivity improvement, which leads to capture of the market with better quality and lower price, which leads to staying in business and to more jobs."

The premise of these more comprehensive business strategies is that improved performance leads to profitability, in contrast to notions of "lean and mean" or "shrinking your way to greatness," which have been common approaches used by utilities during the recent restructuring period.

5.4 Evaluation Timing and Responsibilities

Evaluations of interventions that emerge from the five types of energy efficiency strategies will differ although the primary goal does not. The differences in the evaluations arise primarily because the objectives and activities used for each intervention differ. Since objectives and activities are driven by the logic of an intervention, the evaluations must reflect these differences in order to be consistent with the intervention and useful to stakeholders. This subsection discusses some issues that surface when conducting evaluations of different types of energy efficiency interventions.

Section 3 introduced the premise that each type of energy efficiency intervention has a specific role to fill in achieving the long-term societal goal of making government, homes, businesses, and industries more energy efficient. Just as policymakers have recognized value in using both building codes and energy efficiency interventions in achieving this long-term societal goal, an effective portfolio of energy efficiency interventions using public purpose funds will include a mix of market transformation, resource acquisition, infrastructure, research and development, and equity interventions. An evaluation plan for such a portfolio must look at the portfolio as a whole and determine the timing and evaluation approach to take in order to answer intervention-specific and portfolio-based questions. Such a portfolio approach and evaluation plan has been recently developed for New York by the New York State Research and Development Authority (DeCotis et al. 2000).

5.4.1. Portfolio and Intervention Specific Evaluation

Portfolio-based evaluation questions are developed by setting the framework for the portfolio. Perhaps the portfolio has equity, geographic, or sector considerations. Section 3 suggested that market transformation interventions should be considered riskier than resource acquisition interventions. Consequently, an entire portfolio will likely recognize the risk component in allocating energy efficiency dollars and evaluation resources. Similarly, infrastructure—because it offers a foundation for other interventions to succeed—needs to be aligned with the overall portfolio, as do research and development activities. Resource acquisition interventions may require special evaluation attention to ensure that the resource is in place and operational at the required times. Equity interventions may have specific targets for operational efficiency that need to be met.

Evaluations, as noted above, can have one of two primary purposes: to inform a decision (summative) or to inform a process for modifying or changing an intervention (formative). In establishing the portfolio, the decision points for each intervention should be made explicit so that summative evaluations can be targeted to inform these decisions. So that formative evaluations can also be targeted to inform this process, a process should be developed for reviewing the interventions and deciding if they need to be reviewed for possible modification.

This approach to evaluation, and implicitly the planning and designing of the interventions, is not a one-time event. It should be considered a fundamental component of the ongoing strategic planning process of the organization(s) involved in spending and overseeing the public purpose funds. As such, it requires review and modification throughout the period in which funding is available, both to ensure that the evaluations are informative to the audience and that they are responsive to the manner in which the interventions are functioning. Also critical to this type of approach is that it be established early in the intervention cycle, essentially planning the evaluation prior to portfolio and intervention launch.

This last point cannot be stated too often. Evaluations should be planned prior to launch of the intervention to ensure that the intervention can be evaluated, and that the data required to effectively evaluate the intervention are identified and collected at the appropriate time. Perhaps the most glaring failure of the ’80s and ’90s, from an evaluator’s point of view, is the lack of baseline data to address such issues as free ridership and long-term market change.

5.4.2. The Evaluation Audience

There are potentially up to seven audience types or stakeholders for any evaluation.

- Regulatory decision makers,
- Legislative decision makers,
- Management decision makers,
- Intervention managers and implementers,
- Trade allies,
- Public interest groups, and
- Energy end users.

While some groups traditionally have not been involved in the design and review of energy efficiency evaluations, all parties have a potential stake in the conduct and outcome of the evaluation of activities funded by public or ratepayer money.

It is important that the evaluation design recognize the audiences who will actually use the evaluation and that the essential issues of these audiences are addressed. To facilitate this, it is useful for representatives of these audiences to be involved in setting the evaluation agenda. In thinking through this concept, it is helpful to think broadly about use. One party might consist of regulators or legislators who will review the report. Ensuring that representatives familiar with regulatory or legislative party needs are involved in the initial stages of evaluation design can avoid unexpected questions and potential controversy once the evaluation is concluded.

Ideally, this will occur during the strategic planning process. In the case of resource acquisition programs, it has been common to focus on the interests of regulatory, utility, and program manager audiences. Though trade allies sometimes have expressed concerns about implementation issues, public interest groups or energy end users tend not to become involved. Because market transformation activities are specifically targeted to influence the market, trade allies, public interest groups, and energy end users are more likely to see their own interests as potentially affected by the intervention. Additionally, legislative decision makers have increasingly become the source of funds for energy efficiency interventions and may wish to be more involved in the evaluation process. Efforts to ensure representation from all interested parties are important to ensure that the evaluation provides information that will satisfy the questions raised by each interested group.

The larger evaluation community today also has an expanded definition of stakeholders and their role in evaluation. At one end of the spectrum is participatory evaluation, which follows an action research model. Audience members are included in the design and evaluation implementation process. Not all evaluations are moving to this model, but it has been effective with certain target groups, although it is uncommon in energy efficiency evaluations. However, this type of evaluation strategy might be effective when the audience is directly affected by the evaluation results or implementation (e.g., evaluations of equity interventions or interventions targeted at markets with few members). In these cases, the members may have strong views about the intervention and their involvement could improve the evaluation.[5]

5.4.3. Who Should be the Evaluator?

Determining who should conduct the evaluation is an important issue to be addressed at the design stage. Evaluations can be conducted by internal staff or by outside contractors. Portfolio evaluations can be conducted by a single master contractor or by many contractors, each with their own projects. The sponsoring organization can place the evaluation function in the program area, the financial area, or in a research area. There are always trade-offs to be made and no single answer is best for all situations. What is important is that everyone be aware of the trade-offs that have been made and that these are understood when reviewing the results of the evaluation process.

There are, however, some thoughts that warrant consideration.

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5 For a listing of links to participatory action research sources published by the Cornell Participatory Action Network, see http://www.goshen.edu/soan/soan96p.htm.

If the evaluation function is organizationally distant from the intervention function, the value of formative evaluations will be diminished. On the other hand, being too close to intervention functions can potentially lead to a conflict of interest and a reluctance to know the full story of the intervention. Organizations in other fields have a long history of conducting evaluations in which the evaluation and intervention functions are closely linked. Typically, the problems of being closely linked tend to be overshadowed by the benefits of being able to use evaluations to inform decision making in a timely fashion.

Using internal staff to manage evaluations tends to be more resource efficient than having the internal staff conduct all evaluations. If a baseload amount of evaluation can be determined, it may make sense for the internal staff to conduct that baseload. However, this role for internal staff might lead to a conflict of interest for summative evaluations. Though many organizations successfully conduct evaluations through their internal audit capabilities, using contractors can help by both minimizing the risk of conflict of interest and evening out resource requirements. Another solution to conflict of interest for internal evaluation efforts is to use an external evaluator to audit and conduct verification of internal staff evaluation efforts.

Using a master contract to conduct evaluations tends to be administratively more efficient than separate contracts for each evaluation. There is also the opportunity for evaluation lessons learned in one effort to inform other evaluation efforts and for the organization promoting the intervention to obtain consistency in evaluation reporting. However, other considerations suggest a different tact. While a master contractor can offer cost savings over multiple contractors, it is unlikely that the savings will be substantial. Secondly, there are drawbacks to the consistency of a master contractor. When multiple contractors use varied approaches, the client organization has the opportunity to explore different theories of change and different methodologies in the evaluation analysis.

Whatever organizational approach is pursued, there are often risks to conflict of interest, access to data, trust, quality, and cost. Members of the evaluation community should subscribe to the principles and ethical guidelines of their professions so stakeholders can have confidence that the evaluation community will minimize the risks of these trade-offs. Within the broader evaluation community, the American Evaluation Association has established a set of guiding principles for evaluation.[6] Ethical principles of the social science and engineering disciplines also provide stakeholders with assurances that association members will conduct research in an ethical manner. Stakeholders should expect evaluators to be familiar with and abide by these principles.

6 See http://www.eval.org/EvaluationDocuments/aeaprin6.html.

5.4.4. Evaluation Management

Evaluation management has many important facets. Certainly, the technical issues need to be overseen. Those involved in planning and designing evaluations should understand and be familiar with the available methodologies, the general requirements for good research, the intervention, and the program logic model underlying the intervention.

Evaluation also seems to function best when operating in an environment that motivates and empowers those who manage and implement interventions. In the ’80s and early ’90s, evaluations were often viewed as “report cards” of the utility by the regulators and public interest groups, or of the program manager and implementation staff by the utility. An argument can be made that this made those resource acquisition evaluations less productive. Such an approach is doubly unproductive when dealing with market transformation, infrastructure, research and development, and equity interventions. Dealing with the riskier, less certain methods for improving energy efficiency requires that evaluations be part of a learning process to improve and enhance the interventions.

The marketplace is dynamic and cannot be fully understood from any one point of view. Businesses worldwide are familiar with believing they have things figured out, only to be blindsided by a new product or a catchier advertisement, or even a surprise in the availability of raw materials, forcing them to change strategy immediately or risk failure. Flexibility and responsiveness are keys to success. Energy efficiency interventions, especially market transformation approaches, must have similar levels of flexibility. Evaluations must be structured to enhance and inform the flexibility, not impede it.

Flexibility means that the evaluation changes as the intervention changes. The authors’ view is that evaluation flexibility is accomplished with smaller scale evaluation efforts conducted more frequently, so that changes in the intervention can be commented on and monitored. Flexibility also means that the overall view of the intervention’s success does not necessarily hang on any single report, but rather on the trend that emerges over the course of the entire evaluation. Flexibility may result in decisions being made earlier or later than anticipated in the planning stage, when information in the evaluation indicates a trend that needs to be addressed.

Along with building in flexibility, it is important that evaluation information be made available in a timely fashion.[7] Evaluations need not be retrospective. They can be conducted in real time for all five types of interventions. Tools for doing this include ongoing data tracking and spot surveying across the market, as well as targeted interviews and analyses at appropriate intervals. With these tools, it is possible to obtain snapshots of intervention

[7] The reader should note that by evaluation information the authors are referring to all types of information, not just measures of cost-effectiveness or ultimate success in achieving market effects.

progress as often as every two or three months, though six-month intervals or longer are more likely to be satisfactory.

No matter how the results are reported officially, it is important that they are made available to those who can use them as early as possible. Thus, it is important to include intervention staff in the review of draft reports so that important information can be gleaned from the reports before official publication. It is also important to incorporate decision makers' timelines into the evaluation schedule to ensure that decision makers have the needed information at the time decisions are made. These schedule requirements can easily be incorporated when evaluations are planned before intervention launch.

5.5 Reporting and Evaluation Utilization

Reporting can, and should, translate evaluation data into information that is useful and actionable. The types of reporting discussed here are resource acquisition intervention evaluation reports, market progress evaluation reports, market research and interim reports, briefs and white papers, cost-effectiveness analyses, and integrated evaluation reports.

Resource Acquisition Intervention Evaluation Reports. Evaluation reports for resource acquisition interventions tend to be post-intervention reviews. Typically, these types of reports have focused on conducting process and impact evaluations. The retrospective nature of these reports frequently leads program managers to tell process evaluators "I already knew that." The focus often shifts to the impact evaluations as the critical last piece of information needed for conducting the cost-effectiveness analysis or determining the appropriate shareholder incentives. By doing so, the report card view of evaluation is underscored, missing the opportunity for the evaluation process to be much more.

In California, evaluation reports have typically been conducted on an annual basis to assess results following a year's activity. In some states, however, resource acquisition evaluation reporting has not occurred on an annual basis. Some utilities in Wisconsin and Massachusetts conduct their impact and process evaluations on an "as-needed basis" in order to improve and enhance the intervention or to adjust and fine tune the algorithms used to estimate the shareholder incentives.[8] The utility evaluation staff assesses the value of the types of information that can be collected and then determines when it is most appropriate to collect and report it, given the participation rates and the cost of acquiring the information.

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[8] Utility companies in Massachusetts and Wisconsin have used a value of information based approach for setting their evaluation schedules since the mid 1990s. For instance, Wisconsin Electric negotiates with the regulatory commission as to when program results will be reported. National Grid USA Companies in Massachusetts reports annual program savings to their regulatory commission with updates to the algorithms based on scheduled evaluation findings.

Typically, the evaluation staff negotiates with the regulatory staff to set a final schedule that meets both groups' needs.

Market Progress Evaluation Reports. Market progress evaluation reports (MPERs) are used by the Northwest Energy Efficiency Alliance (the Alliance) and other market transformation groups to track the progress of interventions over time. MPERs are conducted as often as every six months, or as infrequently as every 12 or 18 months, depending on the intervention, the resources available, and the criticality of the information for decision making.

MPERs contain a variety of information and do not neatly fall into the process, cost-effectiveness, or impact categories common to resource acquisition evaluations. Each MPER for a given venture[9] is likely to contain common tracking information, but each will also include information unique to that reporting period based on the market stage of the intervention and the decisions that are pending. Because the reports track market progress, they focus on timely and relevant information for intervention managers and decision makers.

In the case of the Alliance, each MPER includes a review of findings, conclusions, and recommendations from previous MPERs, provides a description of the current progress of the intervention relative to the Alliance criteria for success and progress indicators, compares market penetration to baseline, reviews cost-effectiveness assumptions, provides a best estimate of energy impacts, and provides a statement of attribution.

Market Research Reports, Interim Reports, Briefs, and White Papers. This category concerns the variety of special reports that can be produced to focus on a specific question or topic of concern for any type of intervention. Typically, such a report is needed for a decision, to help identify or respond to a specific need, or to provide an update in between or instead of scheduled reports. There are no specific guidelines for such reports. In Section 6, the use of the term performance indicator report describes a type of report that would focus on performance indicators for a particular intervention.

Cost-Effectiveness Analysis. A cost-effectiveness analysis can be a stand-alone report or document or be a part of a report. In some earlier resource acquisition evaluations, cost-effectiveness analyses were typically conducted retrospectively as part of an impact evaluation. For market transformation interventions, the assumptions of the prospective cost-effectiveness analysis are reviewed and tested periodically and included in the market progress evaluation reports.

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9 The Alliance uses the term venture for their program. The term is used intentionally to recognize the riskiness of the investment.

The assumptions of the prospective cost-effectiveness analysis are typically explained up front. Not all cost-effectiveness assumptions include the same level of risk nor is the risk located in the same component. In a resource acquisition intervention, the level of risk lies primarily in whether the kWh savings per participant are reliable. The analysis, therefore, often focuses on savings and what would have been achieved with and without the intervention. In a market transformation intervention, the risk lies primarily in whether the market will respond at the anticipated level and in the expected time period. Thus, the cost-effectiveness analysis often focuses on testing market assumptions.

In infrastructure, research and development, and equity approaches, the risk is often associated with the logic suggesting that the intervention will make a difference. The risk associated with assumptions of the logic can be identified and examined. Risk for information center infrastructure activities like the Pacific Energy Center or the Seattle Lighting Design Lab might be in the degree to which word of mouth is facilitated and accelerates the uptake of the promulgated information. Risk for a research and development intervention might revolve around whether it results in products that provide greater efficiency at lower cost and are desired in the market. Risk in equity interventions, such as low income conservation programs, might revolve around the cost to bring the home up to sufficient habitability for weatherization measures to be effective, or there might be risk in the political support and economic analysis that drive the equity intervention.

In addressing cost-effectiveness issues for market transformation, infrastructure, and research and development interventions, the evaluation team collects data to assess whether the prospective cost-effectiveness assumptions hold or need to be revised. These energy efficiency strategies often assume 10-20 years for the ultimate indicators. Therefore, a final cost-effectiveness analysis cannot be conducted for a long time. Relying on an approach to test assumptions provides an interim method for deciding if the intervention is meeting cost-effectiveness expectations.

Integrated Evaluations. In the ’80s and ’90s, many evaluators noted that integrated evaluations using process and impact data were preferred for evaluating resource acquisition interventions. Many examples have surfaced over the years that demonstrate this principle. However, an integrated approach was not the norm, owing to the timing of demand-side management program evaluations, budgetary limitations, and the dominance of impact evaluations. MPERs, as described above, typically are integrated and include impact, process, and market components appropriate to the period covered by the MPER. This team strongly supports integrated evaluation or at least integrated evaluation design for all types of energy efficiency interventions.

5.6 Evaluation Approaches

This subsection addresses evaluation approaches that can be used for all types of energy efficiency interventions. Three broadly defined evaluation approaches can be used to address the two goals in evaluating energy efficiency interventions. These approaches are performance data tracking, structure and function studies, and benefits and costs studies.

5.6.1. Performance Data Tracking

Performance data tracking is important for all types of energy efficiency interventions. It is a fundamental component of performance measurement in industry, and within the commercial sector it is the cornerstone to understanding company success. It is also the most basic level of evaluation for energy efficiency interventions, though there are many options as to what to track and how frequently tracking should be conducted. Output and outcome tracking are reviewed below.

Output Tracking. The program logic model framework described in Section 4 considers outputs the direct products of the program activities (United Way 1996). Tracking and reporting outputs allows the observer to determine whether activities occurred, how often they occurred, where they occurred, and whether anyone took part in the activities other than the program providers. Essentially, outputs measure the volume of work accomplished, not the value or quality of the work.

These data should be tracked throughout the course of an intervention to permit comparison over time against the plan. Measurement of the baseline or pre-intervention condition is important to ensure that the conditions at the outset of the intervention are known and the effect of the intervention can be measured.

Data on the implementation process are typically directly observable from program records, if records are kept. In a review of California utility programs in the ’80s (White et al. 1984), state utilities were faulted for not conducting rigorous evaluations. Looking at the critique in light of the program logic model framework, it is evident that most evaluations consisted primarily of output measures—how many rebates, how many audits, how many efficiency measures installed, etc. These output measures are important for all five energy efficiency interventions, but only as indicators of implementation. They do not provide sufficient information to evaluate program effectiveness.

Market output data often are not directly collected by the implementation staff, and thus must be tracked using external data collection activities, surveys, observation, and the like. Market outputs concern those things the intervention directly sought to influence. For instance, target audience satisfaction is usually considered an output since most interventions seek to directly influence their target audience. Interventions that directly seek to influence the amount of product stocked on retailer or distributor shelves should consider product tracking an output, not an outcome. However, if satisfaction or product stocking is not directly addressed by intervention activities, they may be short-term outcomes of the intervention.

Examples of output data include the following:

- The number and locations of ads placed,
- The number of website visitors, unique URLs, frequency of visits, etc.,
- The number of rebates taken, amount, estimated value of savings,
- Number of calls to call center on intervention, number of complaints,
- Number of students who participated in education intervention, number of teachers trained,
- Number of forms returned,
- Target market satisfaction with intervention activities,
- Number of market actors contacted,
- Target market recognition/awareness of the logo, materials, etc., and
- Number of dealers handling product or service.

Outcome Tracking. Outcomes in the program logic model framework are the changes or benefits that occur during or after participating in an intervention. They are evaluative data for use in assessing effectiveness. Outcomes include changes in behavior, skills, knowledge, attitudes, values, conditions, status, or other attributes that are targeted by the intervention. For instance, resource acquisition interventions often seek to enhance customer satisfaction directly—thus, satisfaction is an output. Conversely, in market transformation interventions, market channel satisfaction is likely to be the target of an intervention, with consumer satisfaction the outcome of successful activities with market channel members.

As with outputs, outcome data should be tracked over time. Baseline or pre-intervention measurement is very important for outcome data, since the conditions the intervention hopes to affect are generally pre-existing. Dynamic modeling of different outcome measures, as described in Section 7, can be very useful to forecast the moving baseline for analysis of program market effects. Not surprisingly, outcomes can also be categorized as short term, middle term, or long term with different expectations and targets for each period. These short- and middle-term outcomes have also been termed “proximate indicators” (Feldman 1995). These outcomes help assess whether the ultimate indicators of energy savings and increased market share are occurring. Because the data are tracked over time, intervention managers, planners, and policymakers can determine if outcomes are changing in the expected and desired directions. These data, therefore, are the indicators of whether the overall goal will be achieved.

Outcomes are important to all five types of interventions. The key to identifying outcomes is to understand the logic of the intervention: what are the specific activities expected to accomplish and how are they likely to influence other market actors and actions? For each anticipated effect, the evaluator should assess which outcomes can and should be tracked in order to understand if the anticipated effect is occurring and the extent of its occurrence.

Some of the outcome data that might be tracked include the following:

- Target audience's knowledge of location of energy efficiency product/service information,
- Target audience's intentions to use energy efficiency product/service,
- Non-targeted consumer's/businesses awareness of, or satisfaction with, intervention,
- Prices of product or service,
- Retooling plans by manufacturers,
- Standards process and views of various market participants,
- Changes in infrastructure supporting product or service,
- Number of new market entrants,
- Number of new models, and
- Reordering practices by distributors/retailers.

5.6.2. Structure and Function Studies

Evaluation activities that address the structure and function of interventions include market assessment, market evaluation, and process evaluation.[10] These types of evaluations tend to be formative in nature and help guide changes and modifications in the intervention design and implementation process and improve the response by consumers and businesses.

As noted previously, these structure and function issues can also be pertinent to summative evaluation purposes. As an example, the first MPER for the Alliance electric motors venture included a market analysis of the market conditions at the time implementation began. The analysis suggested that the venture as designed could never accomplish its objectives and goals since the market structure had changed since the venture was first conceived. Consequently, the Alliance used the MPER process to conduct additional research and redesign the venture. The first MPER, therefore, led to a summative conclusion that a new venture design was needed largely based on a structural and functional analysis of the market.[11]

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[10] The use of the term market assessment here may be more narrowly defined than in the CPUC policy rules.

[11] The Alliance electric motors venture south to use point of purchase rebates to facilitate the adoption of energy efficient motors. The evaluation found that stocking practices had shifted to "just-in-time" practices, which made the point of purchase approach less viable. (See Stout et al. 2000.)

There are many examples of resource acquisition interventions that have been improved using process evaluations. The PG&E Retrofit Express program, which was responsible for a large percentage of PG&E's commercial lighting kWh, used process evaluations and market studies to refine the program design during the early and middle 1990s. The effectiveness of these improvements led to the sustainable transformation of the commercial lighting market for T-8s and electronic ballasts (Xenergy and Easton 1998).

Formative evaluation strategies have worked for resource acquisition interventions to which they have been applied and are a major component of evaluation of market transformation, infrastructure, research and development, and equity interventions. Market transformation interventions, by definition, must be market driven to be effective. In a comparative study of the Alliance and the Northeast Energy Efficiency Partnership, this point was clearly made by both organizations. Both organizations view evaluation as a tool for management and integration with the planning process (Raab and Peters 1998).

These structure and function approaches are also important for infrastructure and research and development efforts. Since such efforts often lack the opportunity to observe market effects, structure and function evaluation approaches may be the most effective tools to address how well the efforts are working. An example is the evaluation of the Pacific Energy Center (TecMARKT 1998). A diffusion of innovation framework was used to assess market effects. The evaluation focused on changes across communication channels that resulted from use of the Pacific Energy Center by building owners, designers, and building professionals. Another example is the organizational structural analysis and the process evaluation conducted for the Seattle Lighting Design Lab by the Alliance (Hein 2000; Peters 1998).

Examining the structure and function of interventions has long been the purview of process and market evaluations and market assessments. These types of evaluations, in their most common form, report primarily on program events from multiple points of view. They are enhanced when theoretical frameworks guide the evaluation. Such theoretical frameworks should be grounded in social science theories of change. Some theories have been particularly useful, including diffusion of innovation (Rogers 1983; Moore 1991; Moore 1995), the notion of a tipping point (Gladwell 2000), business decision-making models (Peters et al 1996; Cebon 1992), and Kirkpatrick's training model (Kirkpatrick 1996; Alliger and Janak 1989). As noted in Section 4, an intervention and evaluation should be grounded in a logical framework. If the evaluation is also grounded in a theoretical framework (not necessarily the same as the program theory), the evaluation can bring new insights to the intervention design, planning, and implementation process.

Examples of what market assessment, market evaluation, and process evaluation approaches might include are noted below. However, the reader is cautioned not to necessarily split evaluation activities into these parts. It is sometimes appropriate to conduct a special study that focuses on process, market, or cost-effectiveness issues. In planning and designing evaluation and measurement for a portfolio, however, it is best to take a more integrated view as described above. Such an integrated approach would include performance tracking, various structure and function studies, and various benefit and cost study approaches as appropriate to create a comprehensive or overall evaluation of an intervention.

Market Assessment. Market assessment is a good fit for the assessment of market transformation interventions. Yet, market assessments also have value for other energy efficiency interventions. This term suggests evaluation and measurement activities that can be conducted to understand the market for energy products and services and to assess progress in the market.

Several activities are equally useful at the planning stage as well as at the evaluation stage, yet they often occur at the evaluation stage for one of two reasons. First, planners and intervention designers often do not perceive a need for market research. For instance, they may feel certain that a particular intervention will work because it worked somewhere else. The second reason occurs even when some market research has been conducted at the planning stage. Once an intervention design is determined, the intervention may move in directions that were not conceptualized prior to the implementation, as such ongoing market assessment research may be required to measure the intervention's effects.

The following research activities can be conducted under the term market assessment:

- Market characterization and determination of market actors and market actor roles,
- Determination and identification of populations including segmentation,
- Market barrier identification, analysis, and tracking of changes,
- Baseline measurement of market output and outcomes tracking data, and
- Attribution issues.

Market Evaluation. Market evaluations have been conducted for resource acquisition, infrastructure, equity, and market transformation interventions. In the '80s and '90s, market evaluations were used for programs like Super Good Cents by the Bonneville Power Administration (Bonneville) and by California utilities to examine the effects of their appliance rebate programs. In a situation where many intervention types are included in a portfolio, market evaluation activities might be conducted to address overall market effects resulting from multiple interventions in a common market.

Given the broader focus of market evaluations, research and development interventions may seem difficult to fit into this box. However, where research and development efforts exist to stimulate larger changes in the market, such as Bonneville's Residential Standards

Demonstration Project (RSDP) and the Model Conservation Standards (MCS) Project, market evaluations might be appropriate. In these program efforts by Bonneville, research and demonstration activities were used as a means to demonstrate the viability of stricter building code requirements. The research and demonstration efforts addressed building code officials', builders', and consumers' responses to the code enhancements. Market assessments, as well as cost-effectiveness, energy load impact, and process-type studies, examined the long-term effects of these efforts.

Market evaluations imply looking backward to see the effect of an intervention, yet they require baseline measurements to be effective. Therefore, one must think of the market evaluation issues at the outset of the evaluation design phase. One of the ultimate indicators for market transformation interventions is market share estimation. This has often fallen under the category of market evaluation. Market share, however, has some problems as an ultimate indicator. Over time, market share changes. Knowing when a product is truly on an upward curve in the adoption cycle with stable or increasing market share is difficult to predict until years later. Thus, it can be difficult to know when it is time to implement a transition or exit strategy if market share is treated as the most important indicator.

Market evaluation can include the following types of activities:

- Market share estimation,
- Customer and trade ally market response, and
- Estimation of changes in awareness and effects of advertising and media campaigns.

Process Evaluation. Process evaluations have a long history in the broader evaluation community and for evaluating energy efficiency interventions. Process evaluations have been used primarily for the evaluation of resource acquisition and equity interventions (Charles River 1992).

As noted previously, however, process evaluation has also been important for some market transformation and infrastructure interventions where the goal of the evaluations has been to provide information to the intervention managers and the funding organization to ensure that the product or service meets consumer and business needs. Market transformation process work tends to focus on implementation and delivery issues and intervention response. Process evaluations have also been useful for research and development interventions. In these efforts, the focus is likely to be on implementation, administration, and organizational issues (Peters and Seratt 1992).

Some important issues addressed by process evaluations are noted below:

- Implementation and delivery issues,
- Response to intervention by target market and trade allies,
- Organizational issues,
- Administrative process, and
- Baseline measurement of intervention output performance tracking data.

5.6.3. Benefit and Cost Studies

Benefit and cost studies examine the relationship between the cost of implementing an intervention and the benefits derived from the intervention. These studies typically focus on ultimate indicators of energy savings and the costs to achieve those savings. Benefits typically include the energy saved because of the intervention, as well as the non-energy benefits that occur as a result of the effort. Costs range from implementing the intervention to those borne by the end user to invest in energy efficiency, both directly and indirectly. For a complete discussion of these issues, see EPRI's reports on impact evaluation (RCG/Hagler 1991; Xenergy 1995).

These benefits and costs are often part of the data recorded in performance tracking efforts or estimated by impact and market evaluations:

- Intervention costs,
- Incentives,
- Intervention staffing,
- Mailing, printing, advertising, etc.,
- Participant costs,
- Cost of measures not covered by incentives,
- Search and hassle costs,
- Costs incurred in learning to use new products or services,
- Administrative costs,
- Fulfillment house costs,
- Implementation contractor costs,
- Utility costs,
- Lost revenues,
- Regulatory costs,
- Nonparticipant costs,
- Increased rates, and
- Social costs.

Cost-Effectiveness Analysis. Benefits are grouped into either energy benefits or non-energy benefits. Energy benefits have been the focus of energy impact evaluations for many years. Energy benefits can be derived directly from engineering models or statistical/econometric models of billing or metered data. Engineering savings estimates are typically based on performance measurement using metering devices to measure the product's energy use. These can be laboratory bench tests or in-field performance measurement.

Non-energy benefits are all benefits experienced by the user or society that are not energy savings: increased comfort, increased productivity, improved health, improved financial capability, cleaner air, reduced greenhouse gas emissions, etc. The estimation of non-energy benefits is a relatively recent area of inquiry. Non-energy benefits can be tracked using a variety of data collection tools or can be estimated by statistical models for emissions and other environmental benefits (Skumatz and Dickerson 1999; Hill and Sarnow 1999; Vine and Sathaye 1999).

Impact Evaluation. Econometric models are used to estimate energy load impacts across a large number of applications in order to assess intervention-wide impacts. In its simplest application, a linear regression model is used to estimate load impacts based on energy billing and weather data. More complex econometric models can be developed using engineering and demographic data. Evaluators use these more complex models to correct for self-selection by participants, to account for free riders, free drivers and spillover, and to refine savings estimates on a measure-by-measure basis.

Engineering Analysis. Engineering methods to determine savings can also combine measurement, metering, and observation of installations. Such applications are often site specific and do not aggregate to intervention-wide savings. Engineering analysis can also be conducted for a statistical sample. These can then be expanded to intervention-level estimates.

Another savings verification approach, called "deeming," counts and verifies the measures installed and uses pre-specified savings estimates for each measure to estimate the savings. Some utilities use this to estimate intervention-wide savings during years when load impact evaluations are not conducted. The pre-specified savings per installation in these cases are the load impact estimates from previous years.

5.7 Key Methodological Issues

Several important methodological issues will surface when conducting evaluations to determine energy savings and whether public funds have been well spent. These are sub-issues to the fundamental question addressed by the evaluation: given what happened after the intervention, what would have happened in the absence of the intervention? Reliability and validity affect the evaluation of these differences. These are discussed in great depth in

Cook and Campbell's (1979) seminal work on quasi-experimental design. This section focuses on issues that have emerged as a concern in evaluating energy efficiency interventions. The terminology for these issues has evolved solely within the energy efficiency community and does not reflect the terminology used by Cook and Campbell or by other disciplines.

Baseline Measurement. The optimum for good research design is to have pre and post measurement of a treatment group and a comparison group,[12] preferably with random assignment of individuals to various conditions. In field settings, such as evaluation of energy efficiency interventions, the researcher has little control over some aspects of the design, for instance participation cannot be assigned and it is generally the result of self-selection. However, conducting pre and post measurement is generally easy to accomplish.

Baseline measurement requires that the research be designed at the outset or before the intervention is implemented. The variables that are considered most likely to be indicators of progress are measured before the intervention is implemented or as early as possible. These variables are re-measured during the intervention for comparison to the baseline condition.

Baselines are not static. As the intervention is implemented, the baseline shifts as a result of the intervention's effects. Subsequent intervention effects must be assessed relative to this shifting baseline. These issues are addressed in Section 7.

Comparison Area. As previously noted, a comparison group is preferred for good research design for any energy efficiency intervention. However, in most situations, the researcher cannot randomly assign some consumers to receive the intervention and some to not receive the intervention. An alternative approach has been to identify similar areas that are geographically isolated from the intervention area and study consumers there as a comparison group.

This use of comparison areas can be difficult to implement primarily because it is difficult to define what is similar or comparable. First, the differences in demographic, firmographic, or climatic characteristics between two geographic areas of the United States are often substantial and may affect the rate of adoption of energy efficiency measures. Second, while regulatory driven interventions can be localized, interventions that seek to influence the market tend to be less localized and thus more likely to contaminate other geographical areas. Nevertheless, several studies have successfully used a comparison area to improve the evaluation research design. Seven such studies were reviewed in the Summary Study for California Demand Management Advisory Committee (CADMAC). The use of comparison

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12 Treatment group in the case of energy efficiency interventions refers to consumers or businesses exposed to the intervention. Comparison group refers to consumers or business not exposed to the intervention.

areas, especially when combined with cross-sectional research design, was quite robust (Peters et al. 1998).

Assessing Market Barriers. This report has argued at its outset in Section 2 that the term "market barriers," as used by Eto, Prahl, and Schlegel (1998), is not accurate. However, since their list of market barriers is often used in designing and evaluating market transformation interventions, the authors feel it is important to address how their list of market barriers should be used in evaluations. The market barriers they list might more accurately be termed barriers to implementation or barriers to adoption of energy efficiency products and services, since they generally refer to factors that impede the process of implementation or adoption.

Eto et al. suggest that once barriers are identified, interventions can be designed to eliminate or reduce these barriers, resulting in increased adoption of energy efficiency measures and increased energy savings. This approach, if used in developing an intervention, can be revisited during the evaluation. However, finding that barriers have been reduced or eliminated still will not prove that energy efficiency measures have been adopted or that energy has been saved.

Furthermore, the types of issues that Eto et al. label as market barriers are important issues for evaluators to follow in evaluating all energy efficiency interventions. The evaluator should be familiar with the list of barriers and should explore with consumers and trade allies to assess the existence of these barriers, look for barriers that might not have been previously identified, and explore whether the intervention has effectively reduced or eliminated the barriers.

Attribution of Impacts to Intervention Efforts. A fundamental research question for the evaluation of energy efficiency interventions is whether the effects observed after the intervention occurs can be attributed to the intervention. As noted previously, part of the determination can be addressed by the research design. Use of pre- and post-measurement and comparison areas can improve the ability to answer this question. Yet, this alone may not answer the question. As noted in Meberg et al. (1977), the real problem to be addressed is causality and whether any other factors could account for the observed changes. Both quantitative and qualitative techniques can be used to judge these issues. Quantitative models that specify other potential influences can be quite effective. Qualitative analysis of reports from multiple perspectives also can be quite effective.

These approaches can be used even if the intervention is complex, with multiple parties contributing components to the intervention. There are many examples of this. The U.S. Environmental Protection Agency's ENERGY STAR® campaign includes multiple components at the federal level and is supported by state, regional, and local utility efforts. The resource efficient clothes washing machine effort also had multiple components, from the standards setting process to local utility, regional, and state efforts, as well as national efforts by the Consortium for Energy Efficiency and manufacturers' self interests in gaining access to niche markets.

The logic of the intervention needs to be explicated to have any hope of addressing this issue. Multiple data sources will likely be required to explore the various effects of different components. The option always exists, especially in complex programs, to examine ultimate indicators and then to allocate them based on resource contribution. However, even if this later solution is adopted, the measurement of ultimate indicators must include a full understanding of the overall logic of the intervention components and the other potential influences.[13]

Sustainability. Sustainability is a crucial issue for market transformation interventions, but could be pertinent to some infrastructure and research and development interventions also. In all of these interventions, the sustainability question is whether the market will be able to deliver energy efficiency capability after the intervention has been terminated. In equity and resource acquisition interventions, there is no expectation of market sustainability, though they might in fact demonstrate sustainability in some cases.

Sustainability requires that the energy efficiency product or service is financially viable so that market actors can earn a profit and end users are aware, willing, and able to purchase and use the product or service. A full assessment of the market structure surrounding the product or service is critical in determining if these conditions are in place. Hopefully, the logic of the intervention has addressed these conditions so that sustainability is more likely.

Persistence. An issue of importance for all energy efficiency interventions is persistence. Persistence has two faces: measure persistence and savings persistence.[14] Measure persistence refers to the continued presence and use of an energy efficiency product or service or its replacement by a more energy efficient product or service. Savings persistence refers to the continued energy saving performance of an energy efficient product or service or its replacement by a more energy efficient product or service.

Persistence has been of particular concern for resource acquisition and equity interventions. In most cases, the results of persistence studies for products and services delivered through resource acquisition and equity interventions may suffice for estimates of persistence in market transformation interventions. However, as market transformation interventions may

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[13] An evaluation that addressed these issues directly is the evaluation of the national efforts to promote resource efficient clothes washers (Feldman et al. 2000).

[14] In some ways, sustainability could be viewed as a third face of persistence and might be called market persistence.

explore different products and services, the issues of persistence must be examined and reconsidered.

Free Riders, Free Drivers, Spillover. It would make life a lot easier for the evaluation and regulatory community if one could say the issues of free riders, free drivers, and spillover are non-issues in some categories of interventions, but that would not be true. There are, however, certain intervention designs—especially for market transformation and research and development—that use free riders and free drivers to accelerate market adoption. In these situations, the benefits of accelerating the market are part of the intervention logic and attempts to estimate free-rider or free-driver impacts probably does not make sense.

However, in other cases, free riders, free drivers, and spillover are a concern because the purpose of evaluation is to determine what would have happened in the absence of the intervention. Here are some brief definitions.

- Free riders are those who adopt an energy efficient product or service who would have adopted it without the intervention.
- Free drivers are those who adopt an energy efficient product or service because of the intervention, but are difficult to identify either because they do not collect an incentive or they do not remember or are not aware of exposure to the intervention.
- Spillover is the ongoing adoption of energy efficient products and services because of experience with or exposure to the intervention, but not specifically targeted by the intervention.

Despite the fact that a definition can be developed for each of these conditions, the evaluation design needs to determine what approach to take in estimating ultimate indicators. As noted above, the purpose of good research design for energy efficiency interventions is to be able to address the fundamental question of what would have happened in the absence of the intervention. Pre- and post-measurements of targeted effects using a comparison group are sufficient to provide an overall answer to this question. In some cases, especially where required by regulatory rules, it is necessary to develop net-to-gross savings ratios that specifically adjust impacts based on estimates of free riders, free drivers, and spillover.

5.8 Summary

This section discusses the principles of evaluation and measurement as they apply to energy efficiency interventions. The premise of this subsection is that evaluation and measurement activities should test the logic of the intervention to determine whether the logic makes sense and whether the results of the intervention are consistent with the logic. Given that the primary goal of an energy efficiency intervention is energy savings, the evaluation must test this logic and determine what savings have occurred and whether the public funds were well spent in the process of achieving those savings.

This section began by discussing the purposes for an energy efficiency intervention evaluation. Given that the goals of energy efficiency interventions are to save energy and to spend the public's money well in the process, the purposes of an evaluation can be to focus on the summative or the formative issues. While determining if energy has been saved by the intervention best fits the summative category, and whether public or ratepayer funds have been spent wisely best fits the formative category, in practice things are less clear cut. The authors, therefore, described at length how these two purposes can both be served by a variety of methods and how understanding the purposes of the evaluation are important in developing an appropriate research design.

Following a review of the purposes of energy efficiency intervention evaluations, the authors discussed some practical problems involved in evaluation design. The first issues to consider are the role of portfolio versus intervention-specific evaluation and designing evaluations at the outset of an intervention so that sufficient data are collected in a timely fashion. Other practical issues revolve around targeting the evaluation to the appropriate audiences and including representatives from these audiences in the evaluation planning process. Designing evaluations in this manner can minimize surprises at the time results are reported.

In the design stage, it is also important to consider if evaluations should be done internally or by an external contractor, and where the management function for evaluations should be housed by the organization sponsoring the interventions. Clearly, there are trade-offs to be made in almost any choice, but recognizing these trade-offs and addressing them can improve the quality of the evaluations. Finally, various methods of reporting were reviewed. How reports are timed and what they include affects how well they are used by the various audiences for the evaluation. In general, our bias is that the evaluation design should be comprehensive and integrate summative and formative approaches. Since these approaches may result in a variety of reporting strategies, the audience for the evaluation should be clear as to what information is needed and when the information is needed.

Three broad evaluation approaches were identified that can be used for all five energy efficiency interventions. These evaluation approaches include performance data tracking of both output and outcome data, structure and function studies (which traditionally include process and market evaluation and market assessments), and benefit studies (which include cost-effectiveness analysis, impact evaluation, and engineering analysis). Though the specific application varies, there is a role for all three approaches in most energy efficiency intervention evaluations. The logic of the intervention, as stated previously, will drive the questions that need to be addressed.

Addressed here are methodological issues that arise in the effort to conduct evaluations of interventions where the researcher cannot control who receives the intervention and how many other interventions may be occurring at the same time. These issues include baseline measurement, use of a control area, measuring market barriers, attribution of impacts to intervention efforts, sustainability, persistence, free riders, free drivers, and spillover. These methodological issues do not go away or surface depending on the type of energy efficiency intervention, but rather are inherent in the effort to measure the effects of real-world interventions and must be thoughtfully considered in almost all evaluations.

These last two paragraphs point to a range of technical issues in conducting energy efficiency intervention evaluations. Specific technical solutions to these issues were not proposed. The following sections, however, provide more detail about evaluation implementation, cost-effectiveness measurement, and forecasting. Some technical considerations are addressed in more detail.

6

Methods for Evaluating Market Effects

6.1 Overview

This section continues the general flow of thought begun in earlier sections and offers implications for later sections. The methods described in this section are designed to quantify the kinds of benefits and costs discussed in the policy analysis presented in Section 2 of this report. The primary focus is on two of the strategies encompassed by the overall energy efficiency portfolio discussed in Section 3: resource allocation and market transformation initiatives. As noted in Section 4, the development of clear program logic is necessary for the design of good evaluations; this section examines the ways in which the evaluation process can be focused explicitly on the assessment of program logic. Section 5 introduced the need and appropriate audiences for evaluation and describes the qualitative and quantitative evaluations that can be performed in association with market transformation programs. This section discusses the types of methods that can be used to evaluate the market effects of a variety of market transformation interventions, and highlights differences with the evaluation of the impacts of resource acquisition interventions. Section 7 takes these concepts considerably further, addressing issues of multi-period effects and the complexities involved in developing an understanding of evaluation and cost-effectiveness in a dynamic marketplace. Finally, Section 8 deals with the incorporation of the results of the evaluation process into the assessment of cost-effectiveness.

6.2 Introduction

6.2.1 Focus

This section discusses the evaluation of market transformation programs. In order to provide context for the discussion, the methods for performing these evaluations are compared with those used for a more familiar type of interventions strategy, resource acquisition. As will be shown, the evaluation of market transformation and resource acquisition interventions involves different emphases, techniques, analytical issues, and data.

The remainder of this section explores the methods of evaluating market transformation programs and contrasts them to methods of evaluating resource acquisition programs. It is organized as follows:

- The remainder of this subsection discusses basic concepts associated with the evaluation of resource acquisition and market transformation interventions.
- Subsection 6.3 discusses differences in process, or formative, evaluation between these types of interventions.
- Subsections 6.4 through 6.7 focus on summative evaluation, or the estimation of intervention impacts through market tracking and impact evaluation efforts.
  - Subsection 6.4 provides an overview of the tasks involved in summative evaluation under the two intervention approaches.
  - Subsection 6.5 discusses issues relating to the specification of baselines for the assessment of market effects.
  - Subsection 6.6 describes strategies available for examining the near-term and interim effects of market transformation interventions.
  - Subsection 6.7 discusses the estimation of ultimate effects on adoptions and energy/demand savings for resource acquisition and market transformation interventions.
- Subsection 6.8 introduces a variety of issues associated with the assessment of the cost-effectiveness of market transformation interventions.

6.2.2 Specific Types of Interventions

This section analyzes and compares approaches for several examples of resource acquisition and market transformation interventions. For resource acquisition interventions, the examples used will be primarily based on direct install and rebate interventions. These approaches have been common interventions over the past several years, and continue to be viable elements of the energy efficiency portfolio. Examples of market transformation interventions will include informational initiatives like awareness campaigns, cooperative advertising, and/or branding; upstream interventions like those designed to encourage manufacturers or dealers to design, make, stock, or sell more efficient models; and training interventions.

6.2.3 Resource Acquisition and Market Transformation Evaluation Goals

As discussed in Section 5, evaluation has two major goals: supporting improvements in the design of market interventions; and assessing the impacts of these interventions. These general goals are common across general intervention strategies. However, the specific designs of evaluations may differ appreciably for resource acquisition and market transformation.

Formative Evaluation (Process Evaluation). Evaluation plays an important role in providing the kind of feedback that can be used to refine the design of market interventions. In the terms used in Section 5, this is the formative function of evaluation. This role is equally important for resource acquisition and market transformation interventions, but arguably more complex for market transformation. In the context of resource acquisition, this type of evaluation—called process evaluation—entailed the assessment of the program delivery system, the evaluation of the influence of various factors on program participation, and the determination of participants' satisfaction with the design of the program. For market transformation strategies, formative evaluation is still concerned with the delivery of the intervention, but is likely to be less focused on program participation (which is very difficult to define for some interventions) and participant satisfaction. Most importantly, formative evaluation for market transformation entails the collection of information that can be used to refine the underlying program logic.

Summative Evaluation (Market Tracking and Impact Evaluation). For both resource acquisition and market transformation strategies, the general goal of summative evaluation is to measure the impacts of the intervention. However, the specific goals of summative evaluations may take very different forms under these two interventions strategies.

- ***Summative Evaluation under Resource Acquisition.*** Under resource acquisition, this type of evaluation is conceptually straightforward, given the relative simplicity of the intervention and its effect on energy usage. Typically, summative evaluation of resource acquisition programs—referred to as impact evaluation—entails estimating two effects: the impact of the intervention on the adoption of energy efficiency measures; and the impact of adoptions on energy usage. In some approaches, these steps are combined into a single analysis of the impact of participation on energy usage. In others, these steps are separated, with the first involving discrete choice analysis or efficiency choice analysis and the second entailing engineering analysis, billing analysis or a combination of the two. In many respects, resource acquisition impact evaluations focus on ultimate indicators of impacts.

Summative Evaluation under Market Transformation. For market transformation strategies, summative evaluation has considerably different specific goals. Given that the ultimate aim of market transformation programs is to increase the adoption of energy efficient technologies and practices, summative evaluation should still focus directly or indirectly on adoption impacts and the associated energy and demand savings. However, the assessment of market transformation interventions also needs to focus on the mechanism through which changes in adoptions and energy usage are ultimately induced. This means that considerable attention must be focused on other indicators of market effects to measure and reflect progress in the multiple prongs of the program's logic. Generally, considerably greater attention on market tracking is required under market transformation programs than under resource acquisition programs, which focused on clearly identified "participants." For the purposes of our discussion, the authors refer to *near-term market effects* as the direct effects of an intervention on market barriers, and *interim market effects* as effects that are indirectly induced through these near-term effects, but occur prior to changes in adoptions. The terms “near-term” and “interim” connote both closeness to the intervention in terms of the logic of the intervention as well as time sequence. Associated with these near-term and interim market effects are a variety of quantitative indicators, which will be called *near-term and interim indicators*. In contrast, the authurs will also refer to intervention-induced changes in adoptions and energy usage as “ultimate market effects,” and to the variables that represent them as “ultimate indicators.”

6.2.4 Resource Acquisition and Market Transformation Evaluation Methods

The methods used to evaluate resource acquisition and market transformation interventions may differ substantially. Evaluation principles suggest that metrics that are tracked and analyzed should link back to the intervention’s goals and overall logic. While both resource acquisition and market transformation interventions are ultimately aimed at reducing energy and demand, market transformation initiatives are based on a variety of intermediate objectives, principally altering attitudes, perceptions, and behaviors of both energy consumers and the market actors that influence their energy efficiency decisions. Although the logic of resource acquisition interventions is fairly straightforward, the logic of market transformation can be fairly complex.

Differences in methods used to evaluate market transformation and resource acquisition interventions stem from two key factors:

- The assessment of market transformation interventions examines the market-level effects of a mix of interventions. This is largely because interventions overlap and are not focused on traditional, identifiable participants and tend to be evolutionary and ongoing and/or have lasting effects beyond the time of the intervention.
- Evaluation of a range of points reflecting the chain in program logic is a key element for assessing the market effects of market transformation interventions. Near-term effects of interventions can and should be assessed by examining the progress and changes at various intervention points, not just at the “end” of the process (the ultimate change in efficient measures adopted, translated into energy savings). This involves assessing changes in attitudes, awareness, intentions to purchase (for purchasers), as well as changes in availability, stocking practices, and relative prices (reflecting manufacturer/distributor changes), and other interim steps that serve as precursors and important elements influencing market share and ultimate savings.

Assessing the logic underlying the design of the interventions helps to determine which steps in the delivery process are most fruitful to track in order to determine if the intervention (or set of interventions) is having the intended effect in the marketplace. Interim indicators related to reaching goals associated with various stages in the intervention logic can provide evidence of market progress and eventual ultimate impacts.

6.2.5 Timelines for Market Effects

Certainly, near-term market tracking efforts provide essential feedback on intermediary metrics of progress consistent with the program's logic and direct interventions. A key aspect of timing for market transformation evaluation is the concern that arises because market transformation effects are not all realized within the program period. In fact, the follow-on effects are a crucial and planned part of the program's impact. However, unlike many of the resource acquisition programs, the time horizon for many market transformation programs may be two, five, or even ten years before the energy savings effects of some interventions are realized. By that time, multiple interventions have also influenced these markets, complicating attribution of market effects and the estimation of underlying baselines. Understanding and estimating these follow-on influences is important in evaluation. The issues related to measuring multi-year impacts and dynamic baselines are discussed in detail in Section 7, and horizon issues related to public purpose tests are included in Section 8.

6.3 Formative Evaluations

6.3.1 Overview

Some of the same analytical issues and approaches previously associated with "process evaluations" are highly relevant in conducting formative evaluations of market transformation programs. These evaluations focus on aspects of program design and delivery, some measure of activity levels and progress toward goals, and, in some cases, satisfaction of staff, participants, and nonparticipants with delivery of the program. Many of these factors are presumably related to key steps in the logic of the design and delivery of the intervention. Whether the market transformation intervention entails an information/advertising intervention (like ENERGY STAR®), an upstream manufacturer or dealer incentive, or contractor training, the major steps involved in performing the process evaluations are nearly identical. For the most part, this type of evaluation is performed at the intervention level.

6.3.2 Intervention Documentation and Staff Interviews

Reviewing the intervention's associated documentation provides information on program logic and the program goals to identify key checkpoints for assessment. Information on program design and delivery, changes, and dates/timing issues, and the link to logic is examined. Interviewing program staff provides feedback for assessing the following:

- Program activities,

- Smoothness of delivery,
- Problems,
- Bottlenecks,
- Unexpected outcomes,
- Field experience,
- Suggested program improvements,
- Strengths/weaknesses,
- Staff perception of program performance and the connection with stages of the program's logic, and
- Staff satisfaction and dissatisfaction with specific aspects of the program.

6.3.3 Activities

Tracking program activities, dollars spent, other key counts directly associated with the intervention provides feedback on the level of actions that have been taken to try to move forward according to the program logic. Advertising/branding program activities might include dollars spent on message development and advertising placement, the number of ads developed, or similar measures. A manufacturer or dealer incentive program might include time to devise the message and incentive, contact a number of dealers, or other indicators. Contractor training programs might include counts of the number of contractors contacted about the training, the number of training sessions conducted or developed, or similar indicators. Under resource acquisition, this often included the number of customers contacted, calls made about the program, participants scheduled, installations completed, etc. The simple tracking items are not dissimilar and follow from the program logic, but the resource acquisition program tends to focus on participants and measures.

6.3.4 Participant/Nonparticipant Feedback

For some interventions that have identifiable participants (e.g., direct install or rebate initiatives, where consumers can be labeled as participants or nonparticipants, or contractor training programs, where other market actors can be so characterized), process evaluators interview a small sample of participants and nonparticipants to gather feedback on their satisfaction with the intervention, strengths/weaknesses, experience, outcomes, match with expectations, reasons for participating, activities undertaken, and suggestions for program improvements. Nonparticipants are also interviewed about their understanding of the program, program expectations, perceived strengths/weaknesses of program, and reasons for not participating. These interviews focus on program refinement, not necessarily to provide reliable quantitative feedback on aspects of the program. While this approach fits in an environment with clear participants and nonparticipants, it does not fit all types of market transformation programs. This approach can be applied to some manufacturer/dealer programs, and potentially to some contractor training programs, but it is less applicable to an information/advertising/branding program, which has a more general outreach. Feedback on an information or advertising campaign can be obtained not only from a small sample of the target audience, but through different methods, including focus groups and other approaches. Large-scale surveys can gather feedback from purchasers/non-purchasers (rather than participants/nonparticipants), but may be unable to trace their action to specific program influences. For this reason, these kinds of surveys are less relevant in conducting process evaluations of certain market transformation programs.

6.3.5 Summary and Differences

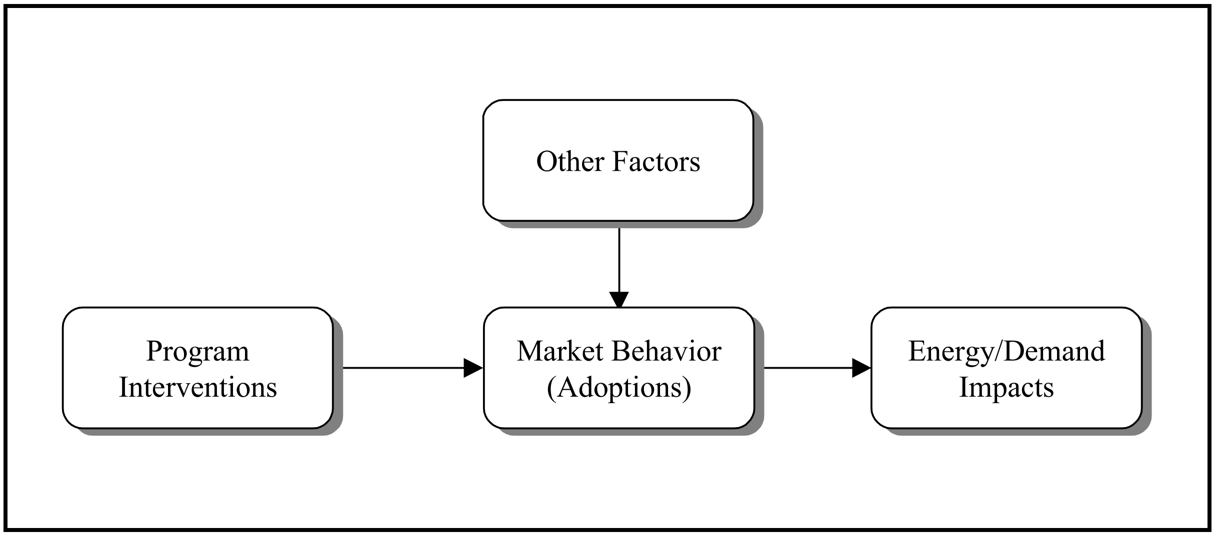
The objective of the process evaluation is to prepare a report that provides feedback to help improve program design and delivery. The reports commonly examine program design and administration, assess progress/fit of design and delivery toward reaching goals, compare actual costs to expected, review strengths and weaknesses of program elements, recommend changes to streamline delivery and improve satisfaction, and note changes associated with providing program refinements. Many stages of the evaluations are comparable for both market transformation and resource acquisition programs, including documentation review, staff interviews, and general program tracking activities.

Generally, under resource acquisition programs, these evaluations are often conducted too infrequently. Additionally, they are often not seriously integrated into program refinements and adjustments, possibly because they are not a focus of regulatory priorities. However, under market transformation, this report gains increased importance because it is needed to assess aspects of the early stages of the fit and effectiveness of the intervention with respect to the specific intervention's logic. Intervention reviews are very useful and provide input used to help evaluate progress, steps, and logic. Annual or more frequent reviews, in coordination with deadline tracking and ongoing market tracking or performance indicator assessments—market tracking activities—should take on an increasingly important role given the design of interventions under market transformation. Process evaluations and milestone deadlines are generally the main tracking efforts that can be linked to individual interventions, rather than the overall market transformation influences at the market level that are tracked and evaluated through market assessments and impact evaluations.

6.4 Overview of Summative Evaluation

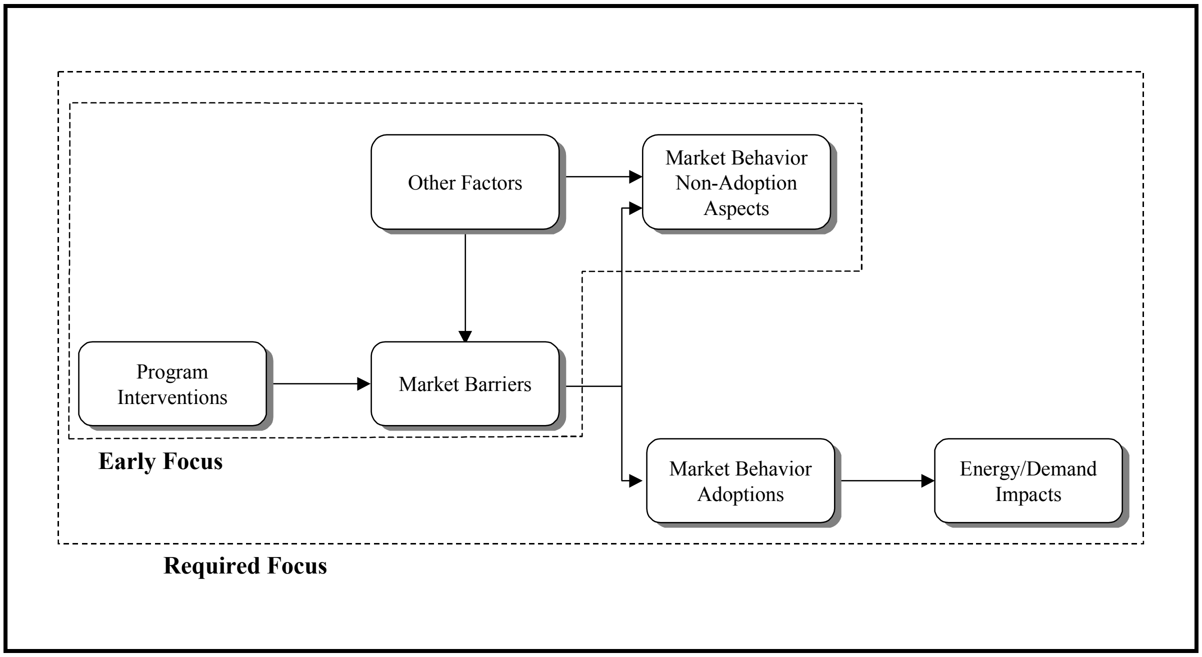
The next four subsections deal with summative evaluation of the impacts of energy efficiency interventions. For both resource acquisition and market transformation interventions, the objective of summative evaluation is to estimate impacts on adoptions and to develop energy savings estimates based on the changes in adoptions. Differences in evaluation design are primarily traceable to the complexity of the impacts of the interventions in question. Figure 6-1 depicts the focus of impact evaluations of resource acquisition interventions. As shown, program interventions affect adoptions fairly directly, and adoptions lead to energy and demand impacts. Impact evaluation focuses on quantifying these two steps in the process, as discussed later.

Figure 6-1: Focus of Evaluation of Resource Acquisition Programs



Under market transformation, the relationships transmitting the effects of interventions are considerably more complex and the focus of impact evaluation is considerably different. Figure 6-2 illustrates the logic of market transformation interventions. As shown, interventions are designed to affect specific identified market barriers. The corresponding changes in barriers induce changes in overall measure adoptions as well as other aspects of the marketplace. These effects take place over a period of time and involve a variety of market actors and relationships. Changes in adoptions lead to energy and demand impacts. It seems fair to say that the industry is undergoing an evolution in its approach to impact evaluation for market transformation. Understandably, early efforts focused on "near-term" or interim market effects, which are essentially the effects of interventions on market barriers. Ultimately, however, as has been emphasized throughout this report, the focus has to be broadened to encompass the impacts of changes in market barriers on adoptions and energy/demand savings.

Figure 6-2: Focus of Evaluation of Market Transformation Programs



The next three major subsections discuss topics associated with summative evaluation: issues relating to baselines, measurement of near-term and interim market effects, and estimation of ultimate market effects.

6.5 Baseline Issues in Summative Evaluation

Both resource acquisition and market transformation interventions are designed to influence the adoption of energy efficient technologies beyond the level that would have occurred naturally from the effects of market forces. For both types of strategies, then, the overall market baseline can be defined as the adoptions that would occur in the absence of the intervention in question. Effects are defined relative to this baseline, so assessing the cost-effectiveness of a set of interventions requires constructing best estimates of adoption, efficiency, and savings with and without the program. Therefore, understanding or estimating to what degree adoption would have occurred naturally is a key element of sorting out the effects of influences from both types of program interventions. However, the practical aspects of estimating this baseline differ across intervention strategies. Estimating a baseline is generally simpler for a resource acquisition intervention than for a market transformation intervention, for several reasons:

- ***Time Horizon.*** The time horizon of impacts is generally shorter for resource acquisition interventions. Because of their focus on direct inducement of consumer adoptions of energy efficiency products and services, the time frames for baselines and impacts are typically confined to the period of the intervention.

By their very nature, market transformation impacts are designed to last longer, and consequently baselines need to be projected for a longer period.

- ***Targeted Behavior.*** The market being targeted by a resource acquisition intervention tends to be fairly clear: a single product in a sector or sub-market, (e.g., residential hot water retrofits). Market transformation interventions, on the other hand, may be designed to affect a wide range of adoption decisions in a particular market (e.g., all decisions relating to energy efficiency in existing residential structures).
- ***Participant Focus.*** Resource acquisition interventions focus on directly affecting the behavior of adopters, some of whom can generally be classified as participants. Market transformation initiatives may focus on the behaviors of a wide range of market actors including manufacturers, distributors, contractors, retailers, and various decision influencers.
- ***Overlapping Interventions.*** The general nature of market transformation tends to foster the use of overlapping interventions in many markets. When many interventions are designed to affect the same markets, attribution of specific influences may be extremely difficult. Similarly, baselines are affected by these same overlapping interventions. The baseline for one intervention may need to be adjusted for the impacts of another. Further, when near-term and interim effects are assessed, baseline levels for these factors are also needed to assess progress from the intervention(s) consistent with the logic.

6.6 Estimating Near-Term and Interim Market Effects

6.6.1 Introduction

As discussed in detail in Section 3 and reiterated above in subsection 6.4, market transformation program logic is commonly more complex and multi-stage than resource acquisition logic. The impacts may be diffused across an entire market and intervene at several points and through several channels, and usually are expected to have lasting impacts, potentially beyond the length of the intervention. The time horizon for market transformation is often longer than for resource acquisition interventions, and it may take two, five, or ten years for the ultimate effects of some interventions to be realized. Evaluating the effects of market transformation interventions entails more than simply assessing ultimate impacts. The logic dictates that the intervention be designed to influence attitudes and behavior at several points along the way toward adoption. With market transformation interventions, it is imperative to examine the effects at interim stages to monitor whether the impacts of the strategies are tracking consistently with the program logic and setting the groundwork for the ultimate impacts expected.

Summative evaluation thus entails some focus on near-term and interim metrics—metrics that reflect steps in the program logic. These metrics provide not only a crucial evaluation "check" of the progress in important stages of program logic, but also early or nearer term feedback on program effects than might be provided by examining only the ultimate indictors. First, the ultimate impacts might not be measurable without some time delay. Second, the intervention's influence might not yet have worked through the various stages leading up to purchase or market share impacts. These interim measures are rarely examined in the evaluation of direct install interventions because these interventions focus directly on delivery of measures to a participant. However, they are important elements of evaluation in market transformation interventions. Some types of interim evaluations are discussed below.

6.6.2 Milestone Deadline Tracking

Milestone deadline tracking has become an important reporting procedure for market transformation programs. Some utilities face milestone deadlines and are required to demonstrate that they are making efforts in program areas and are being effective in the marketplace. These can and should be tied to specific steps in the underlying intervention/program logic to provide the most meaningful feedback.[1] The logic of market transformation activities can very widely from one intervention to another. The result has sometimes been forms and submittals that are not very useful in tracking the progress of the portfolio of interventions.

6.6.3 Near-Term and Interim Market Tracking and Market Assessments

This family of evaluations is similar in many ways to resource acquisition performance indicator evaluations. For resource acquisition interventions, ongoing data on a set of indicator program activities are summarized and reported on a monthly, quarterly, or similar frequency. Most data are focused on counts. For a direct-install/rebate program, these might include calls, participants, installation of specific measures, average wait times, incentives applied for and paid, installation costs, and other data. Many of the key indicators could serve as an efficient data tracking system for providing input to the program impact evaluation. The frequent ongoing performance indicator reports were instrumental in helping program administrators determine whether there were program bottlenecks or problems in a timely enough manner to address problems before they became insurmountable. The indicators are program, measure, and participant specific. However, despite their value, these reports are seldom set up and are often not part of regular utility program evaluations. Annual process evaluations are often the closest that utilities came to this assessment, substantially losing the value from timely feedback.

The parallel under market transformation is sometimes called near-term or interim market tracking or market assessments. This focus on the market is important because market

1 Sometimes, because milestone tracking has been associated with regulatory efforts, uniform "forms" have been developed that do not easily adapt to differences in program logic.

transformation programs no longer focus on attributable participants. Rather, the portfolio of interventions leads to changes in market conditions. These assessments track and assess changes in various near-term and interim market indicators relating to energy efficiency.

For market transformation interventions like advertising/outreach/branding efforts and contractor training, key near-term and interim indicators reflecting the program logic are likely related to points in the decision-making process. Examples of progress indicators would include advertising hits to the target audience, measured changes in attitudes toward the preferred products, or effectiveness of outreach or brands in influencing intentions to purchase. Additional training-related indictors may address changes in installation and testing practices. For market transformation interventions like dealer or manufacturer incentive or upstream programs, major indicators may include changes in availability, visibility, and relative prices. Availability and visibility increases put the product in the minds of purchasers. Decreases in relative premiums for efficient equipment improve paybacks and may improve sales. Each of these indicators can, again, likely reflect steps in the program's logic. Key steps and issues involved in tracking these factors are discussed below.

Visibility/Availability. One measure of market progress can be increased visibility or availability of desirable products in the relevant marketplace. This type of measure can, for instance, be a crucial link in assessing the progress of upstream manufacturer/dealer incentive programs or, indirectly, of information campaigns or contractor training programs (as these programs may lead to increased demand). Visibility in catalogs or advertising improves the likelihood that products would be known and potentially purchased/used. These items can be tracked, although it would be very expensive to maintain these metrics marketwide or separately for all models and manufacturers. Indicators from among the array of available items and advertisements (e.g., specific journals, advertising tracking data) could be tracked. Tracking the number of trade journal articles that address reliability and proven results in installations would also be useful. Data sources include surveys and in-store inspections at a well-selected sample of stores and distributors, perusal of catalogs and Internet listings, examination of a sample of trade journals, newspapers, and advertising tracking/hits estimates for radio/TV/print. Complications develop as models change and the market continues to mature. The definition of what is more efficient changes over time, complicating tracking. These measures are seldom the focus of resource acquisition program evaluations, but serve as crucial links in program logic for many types of market transformation interventions.

Stocking Practices. One step beyond visibility in catalogs is actual availability on the shelf (availability for purchase). This could be a link in the intervention logic for upstream manufacturer/dealer incentive interventions. Stocking practices, including shelf space designated for efficient models, displays for efficient equipment, and inventory practices, are useful to track to determine if desired models are increasing in practical availability to designers/installers/purchasers. Surveys and pre- and post-counts (and ongoing tracking) identify changes in the availability of energy efficient equipment in the market. Data sources include in-store (or possibly telephone) surveys at a sample of outlets and distributors. Practical problems in collecting these data include developing a sensible way to track stocking practices. These practices include steps to determine what is on the floor, on back room inventory sheets, on back order, etc. In addition, point in time is important because there are cycles in stocking practices. Pre- and post-counts are too simplistic because, for instance, window and air conditioner stocks increase in the summer.[2] While more direct metrics are available to track resource acquisition intervention influences, market transformation programs require a much deeper understanding of markets and how they work. This becomes an essential part of evaluation under market transformation.

Prices/Relative Prices, Premiums, and Specials. Assessing changes in prices and price premiums for more energy efficient models can reflect fundamental changes in markets for higher efficiency equipment. This could be an element of the program logic associated with upstream manufacturer/dealer incentive programs, as well as a result of greater demand influenced by advertisements and training programs. As the price disadvantages associated with higher efficiency equipment decrease, the likelihood that more energy efficient equipment will be purchased increases, thereby increasing relative market share and sales (reliability, design, operation, and other factors being equal). More favorable relative prices can result if the number of manufacturers of energy efficient equipment increases, or if increased production levels allow producers to take advantage of economies of scale, conditions that can result from a variety of market transformation program influences. Tracking incentives, sales, and special discounts for energy efficient models can reflect changing manufacturers, dealers, or store initiatives behind efficient models. Obtaining price data is generally complicated, but some information is available from catalogs, the Internet, in-store examinations, or surveys of prices for different models. However, obtaining reliable large-scale information may be difficult. Direct prices and model numbers are not always comparable and features vary beyond mere efficiency. Some work has been done using regression analysis to decompose price differentials for different features, including efficiency features.[3] An additional complexity arises because it is not always clear how to interpret changes in relative prices for efficient models. The programs may be successful even if the price differentials for energy efficient models increase (at least in the short run) because of supply shortages, etc. The direction for positive program indicators is not necessarily clear. Again, a deeper understanding of the markets is necessary to interpret

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2 Ignelzi, Patrice. Personal communication with Skumatz. July 2000.

3 Work in Skumatz (1999) used “hedonic price index” methods to examine and track the price differentials associated with efficiency ratings factors for windows.

results. Data collection alone can provide insufficient feedback on the market effects of the interventions.

Price information is evaluated for resource acquisition programs only under specialized circumstances. As an example, evaluators may try to discern how much of a rebate is passed on customers and how much is retained by contractors in the form of higher costs. While issues related to supply, stocking, and other practices may have arisen from process evaluations associated with resource acquisition programs, they would likely have been mentioned only if they were the source of program delays or missed deadlines. Under market transformation, metrics at specific points in the delivery chain emerge as key performance indicators that demonstrate progress in achieving steps in the program logic. To evaluate these interventions, it is critically important to understand the markets, identify changes at each specific logic point, and investigate changes and anomalies.

Barriers. Work for the California Demand Management Advisory Committee (CADMAC) (Eto, Prahl, and Schlegal 1996) identified a series of barriers that programs might be designed to alleviate. Those listed in the paper include high first cost, information and search costs, performance uncertainties, asymmetric information and opportunism, hassle or transaction costs, hidden costs, access to financing, bounded rationality, organization practices or custom, misplaced or split incentives, product or service unavailability, externalities, nonexternality mispricing, inseparability of product features, and irreversibility.[4] Monitoring progress in addressing barriers may be useful as interim measures or process evaluation issues.[5]

Summary and Differences. Tracking of near-term and interim indicators should be designed to reflect the goals of the program interventions and the logic or flow of the program's design. Market transformation interventions are designed to produce influences at

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[4] In addition, other barriers may be specified. One of the key questions might be posed as why firms do not make energy conservation investments that appear to be cost-effective. Several arguments have been made. Firms may have a blind spot with respect to conservation, or there may be improperly quantified management issues or hassle/disruption factors. These may explain why apparently cost-effective investments are not being made. Second, conservation entities may have been doing a poor job of identifying the capital decision-making process at the firms. Or there may be a third alternative: perhaps decisions to invest in apparently cost-effective conservation might be encouraged if some aspect of the capital market could be improved to make these investments more cost-effective or more attractive. Are there financial mechanisms or interventions that could be devised that could help transform investments in the conservation markets? Several articles (Dixit and Pindyck 1994) discuss the appropriate criteria for assessing the cost-effectiveness decision under certainty and uncertainty. Under uncertainty, the "real options" literature notes that factors affecting decision making may include issues like the relative capital intensity of the investment, factors that have not always been taken into account in the assessment of apparent cost-effectiveness. It may be that some capital and decision making barriers could be addressed through improving capital markets, making attractive financial products tuned to conservation, or better identifing the decision-making process.

[5] However, it should be noted that these traditional types of barriers characterize the situation for most economic decisions. In this market, policymakers have apparently determined that the imperfections affecting decision making are more important or can be influenced/corrected.

a variety of levels (end users, manufactures, in-between) and numerous end uses and sectors (residential, commercial, etc.). One difference in tracking market impacts as compared to resource acquisition interventions is the greater difficulty in identifying the cause of some of the tracked effects. For example, greater availability may have been driven by a combination of all three sample market transformation programs (contractor demand, consumer demand for brands, and upstream incentives). For that reason, even at this level of tracking, market transformation programs generally track these indicators for the portfolio of programs and at the market level. Traditional participants are not generally known and the direct link between intervention efforts and resulting actions is not clearly identified or separable by those for whom attitudes, behaviors, or decisions have been influenced.

6.6.4 Near-Term and Interim Market Assessment and Measurement: Examples

Many market transformation programs have included in their program logic the desire to influence decision making and behaviors related to energy efficient measures. Information and education programs (branding programs) are particular examples of market transformation interventions with this focus. However, even contractor training and upstream programs work to influence purchase decisions for their particular target audiences. For these types of interventions, a number of approaches can be used to examine these interim steps.

Evaluating Education and Outreach Efforts. Many studies have examined the energy impacts of education and outreach-type programs. Most studies conducted on energy education have relied on the same basic techniques: pre- and post-billing analysis, usually with a control group (other community) or a treatment group that did not receive education. The impacts from weatherization and education programs appear strong, but sample sizes are generally quite small and treatment/non-treatment assignment is not always consistent. Studies that attempted to measure the impacts of education-only programs had to use very intrusive measurement techniques that may have themselves affected the results.[6] In addition, a few studies used experimental designs with different communities as control groups, but identifying appropriate control groups is troublesome.

Advertising Efforts. Advertising evaluation efforts are focused differently. They use a variety of focus group and survey methods to examine success at points in the decision-making process, including recall, intention, etc. These programs focus on tracking quality of informational/advertising copy, and scores are weighted higher because they report a strong correlation between intention and purchase reported.

In an increasing number of cases, pre- and post-campaign scanner data are used, often controlled by data tracking agencies that purport to address baseline issues. More

6 Peters, Jane. Personal communication with Skumatz. September 1999.

complicated and quantitative techniques are available, including comparisons using special groups of communities that are randomly assigned different cable feeds, allowing the inclusion/exclusion of ads from groups within the same community. Households with cable feeds are then linked to specific shopping club cards (e.g., Safeway cards) and the influence on purchase behaviors can be linked to scanner data.

Near-term and interim measures that are useful for assessing the impacts of overall program efforts include tracking surveys of knowledge, attitudes, and behaviors, and comparisons with pre-program scores or non-treatment areas. These measures can be effective stages for checking the logic of a program or providing different feedback than the market assessment methods mentioned above. In fact, a number of appropriate methods have been used in advertising that may be useful or adapted to assess aspects of market transformation programs.

Advertising agencies focus on tracking numerics, such as advertising exposures in target markets and similar measures. This is one of the most cited measures for advertisers. Exposures to the target audience represent the crucial link in the chain from no knowledge to improvements in awareness, attitude, willingness to purchase, intention to purchase, and purchase or adoption. This is directly applicable to market transformation interventions (including outreach/branding programs and even upstream and contractor/training programs), with the target audience(s) defined by the program's logic. There are firms that track the number of exposures, and data could be obtained by market transformation program evaluators. However, the link from intention to purchase to actual purchase will need to be retested for these products. Other work shows that this link varies dramatically by type of product, longevity, cost, etc.

Pre-Testing of Messages and Materials. The advertising field tends to spend much more money testing ads up front to get maximum effect and little to nothing on tracking impacts after the fact. If there is a strong correlation between tested intentions and purchase behavior (which they report), spending money to refine the message up front may be most cost-effective. Similarly, the advertising field tracks numerous ongoing measures and conducts extensive focus group work appropriate for a variety of energy education program efforts.[7] The program logic in all three of the market transformation examples often specifies communication elements in the package. Using focus groups (with surveys of multi-point scales on recall, quality of communication, message received, actions warranted, and impacts on intentions to purchase) to test these materials can serve as near-term evaluations of market progress. By testing the attitudes and intentions of groups outside the treatment area, comparisons of impact can be made to monitor the progress of the portfolio of interventions.

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[7] Advertisers also track the number of times a message is heard in target audiences to link to intentions, cost-effectiveness of placing the ads, etc.

Surveys of Intentions. Advertisers regularly conduct surveys and focus groups that measure intentions to purchase products, and look for changes after advertising and marketing campaigns. These approaches rely on a link between intentions and purchasing behavior. This has been asserted regularly, has been shown to be the most important indicator, and has differential impacts between types of products (Kalwani and Silk 1982). This technique relies on multi-point scales of level of intention (5, 7, and 11 point scales, with the high representing "definitely will purchase" and the low meaning "definitely will not purchase"). Although intention can be identified as the most important variable, its size varies. Also, the coefficient varies in strength between generic durable goods compared to specific brands of packaged goods. This type of survey is particularly relevant to market transformation outreach and contractor training interventions. Over the next few years, a fair degree of attention should be placed on estimating or tailoring the degree of correlation between intention to purchase and actual purchase for key types of energy measures of interest. Since these relationships for packaged goods vary by type of product, estimates for energy measures may need to vary based on groupings like lighting equipment (cheaper, replaced often), HVAC (long term, difficult installation), refrigerators and appliances, etc. After some of these relationships are explored and estimated, the results may be able to be applied or adapted to programs beyond those used in the estimation.

There are several suggestions for expanding the reliability of evaluation of informational efforts in market transformation (Green and Skumatz 2000):

- Additional work using quasi-experimental designs with different communities as treatment and control groups,[8]
- Gathering cross-section information from the programs of multiple utilities and using regressions to control for differences in programs and educational methods (a method that may show promise for teasing out educational effects),
- More frequent use of softer advertising techniques, including focus group tests of intentions to purchase to test campaigns and educational materials for effectiveness up-front, and
- Evaluating several template programs and using their results across utility areas.

Summary. A number of techniques are available to assess the effectiveness of various components of the intervention strategies. The major focus should be on determining whether the interventions produce a package that helps achieve the program's goal and if the interventions support the program logic. Some judgment is needed to assess whether the portfolio of interventions is mutually supportive, whether there is too much overlap (potentially leading to higher than necessary costs to reach desired audiences), and whether

[8] Peters, Jane. Personal communication with Skumatz. September 1999.

all important components are included. These metrics can be used to gauge the progress of awareness and intentions to purchase. New research is needed to develop the ability to forecast from intention to purchase, but that research is not conceptually difficult.

6.7 Estimating Ultimate Market Effects

6.7.1 Introduction

In this subsection, we consider the estimation of *ultimate market effects*. As noted several times earlier, these effects include changes in adoptions (characterized as sales or market shares), coupled with the energy and demand savings associated with induced adoptions. Following the general approach used for other types of evaluation, we contrast the functions of estimating ultimate market effects under resource acquisition and market transformation environments.

6.7.2 Estimating Market Effects for Resource Acquisition Interventions

As shown above in Figure 6-1, the logic of resource acquisition interventions is fairly straightforward. In summative (impact) evaluation, virtually all attention has been placed on the analysis of ultimate indicators, chiefly adoptions and the consequent energy and demand effects. Methods of estimating these effects are summarized briefly below.

Estimating Adoption Impacts

For resource acquisition programs, direct inducements are offered to participants to adopt energy efficiency measures. As a result, impacts on adoptions are relatively straightforward. In general, the estimation of adoption impacts under resource acquisition entails starting with total adoptions by participants, then adjusting for free ridership and free drivership.

- ***Free Riders.*** Under resource acquisition, free riders are defined as program participants that receive the incentive or measures under the auspices of the intervention, but that would have installed the efficient measure without the intervention. In determining overall impacts, these participants are properly excluded from the benefits and savings attributed to the program. Free riders associated with resource acquisition interventions are typically estimated through self-reports or comparisons of participants and nonparticipants. Insofar as the latter kind of comparisons generally suffer from self-selection bias, various statistical means of correcting for this bias are often applied.

- ***Free Drivers/Spillover.*** This term refers to decision makers who were induced to adopt a measure outside the framework of the intervention, but indirectly because of the intervention. Examples might include businesses that installed non-incentivized conservation measures as a consequence of demonstration effects or improved availability of the measures in question. The methods used to measure free drivers vary depending on the type of program. However, most approaches entail the use of survey methods to elicit estimates of self-reported free drivership.

Under resource acquisition interventions, net to gross (NTG) ratios are developed for use in translating gross impacts into net impacts. Depending on program type, sector, and end uses, NTG ratios vary widely. The important thing to recognize about net-to-gross ratios constructed for resource acquisition interventions is that they are participant-focused. That is, they are centered on the savings enjoyed by participants, with adjustments made for free ridership and (at least some of the time) free drivership. Because the characterization of some decision makers as participants may not be conceptually straightforward under market transformation interventions, the types of net-to-gross ratios used for resource acquisition assessments often cease to be relevant.

Estimating Impacts of Program-Induced Adoptions on Energy and Demand

Because of the relative simplicity of resource acquisition impacts on adoptions, considerable effort is generally devoted to analyzing the second step of the impact: the effect of adoptions on energy savings. The process of estimating gross savings is fairly familiar to the evaluation profession, although the process is by no means free of biases and uncertainties. While it is an extremely important element of the evaluation of the ultimate impacts of all types of interventions, we offer only a high-level summary of the techniques used for this purpose.

Methods for estimating the impacts of intervention-induced adoptions on energy and demand include engineering approaches, statistical analyses of billing data, and a variety of hybrid approaches. Depending partly on the types of measures in question, engineering approaches may entail a wide range of techniques varying from the application of simple engineering algorithms to the use of complex building simulation models like DOE-2. Statistical billing analyses can take the form of simple applications of models like the Princeton Scorekeeping Method (PRISM), or relatively complex regression models. Regression models may be specified in various forms (levels vs. changes, or monthly vs. annual), but are generally designed to isolate the influence of the presence of one or more measures on energy usage. Various hybrid models may also be used to incorporate a maximum amount of information into the estimation process. For instance, several forms of statistically adjusted engineering (SAE) approaches are commonly used to reconcile engineering estimates of savings with actual changes in energy usage. These techniques are among the most commonly used for resource acquisition programs, although the results were, in some cases, sensitive to the analyst and modeling approach used. Variations on these techniques are also used for outreach/education programs or programs with education components (Green and Skumatz 2000). The gross savings estimates developed by one of more of these estimation techniques are generally modified through the use of the appropriate net-to-gross ratios, thus resulting in estimates of net savings.

Data collection in support of these estimation techniques is relatively straightforward, and generally involves the use of a mix of program data, survey data, and billing records. Program information may include information on participant adoptions and sometimes ex ante savings estimates for these measures. Survey data may encompass both participants and nonparticipants. For both of these groups, information on (changes in) conditions associated with energy usage may be collected. For nonparticipants, data on adoptions of energy efficiency measures may also be obtained. Billing records are extracted in the case where either billing analysis or a hybrid approach is to be used. For retrofit or replace-on-burnout measures, pre-and post-installation data are needed. For new construction, only post-installation data (by necessity) are used.

6.7.3 Estimating Market Effects for Market Transformation Interventions

As with resource acquisition interventions, the ultimate indicators of the market effects of a market transformation intervention are the induced changes in market share, sales, and installations of efficient equipment and the attendant changes in energy and demand. Again, we can decompose this process of estimating ultimate market effects into the analysis of impacts on adoptions and the estimation of energy and demand effects associated with the induced adoptions.

Estimating Adoption Effects

By design, market transformation programs often have influences at many levels (end users, manufactures, in-between), and the interventions cut across end uses and sectors (residential, commercial, etc.). At the market level, gross changes in adoptions can be tracked as discussed earlier. However, attributing changes in adoptions to specific interventions may be extremely difficult under market transformation. This is because program interventions are designed to affect the market, because interventions overlap, are ongoing, and because participants are generally unknown. Who received the incentives, who took the measures, who was influenced by interventions, etc., are unknowns. Impact, attribution, and net-to-gross issues are discussed below.

In assessing impacts, one crucial component involves developing a baseline of the anticipated market shares or sales that would have occurred in the absence of intervention. This permits assessment of the degree of changes in the observed overall market due to a set of program influences and efforts. Data and methods to support the determination of baseline include trend or other analysis based on tracking market share over a period before the interventions, discrete choice market share models, diffusion models, Delphi techniques, or other methods. These approaches are discussed in Section 7.

Unlike the resource acquisition environment, corrections for free riders, free drivers, etc., are generally inapplicable for market transformation evaluation. Free riders are not even defined unless the intervention somehow isolates participants. Free drivers are certainly not an issue, since a key objective is encouraging all the actors up and down the chain to produce, supply, sell, demand, and install more energy efficient equipment, so actions do not take place "outside the program." Because the focus switches from those participating from the program to overall market changes, the key correction is for expected baseline changes.

Correcting changes in gross adoptions to account for movements in the baseline over the impact period translates gross impacts into net impacts. Some judgment is needed to determine the level of impacts that will be attributed to market-level interventions. For example, some interventions, like general advertising, will tend to cut across high-level categories like commercial vs. residential, or end uses, complicating attribution at the residential or commercial level, much less traditional sectors like residential new construction. Suggestions for computing baselines were mentioned above (pre/post, control groups, trend analysis, models of adoption or growth based on historical time series or comparisons to trends in control areas).

Considering the three key types of market transformation interventions being considered, there are various measures that are appropriate to track, as well as data collection/analytical methods that are more appropriate. These are summarized in Table 6-1.

Table 6-1: Measures and Data Collection/Analytical Methods Appropriate for Tracking

Market Transformation Intervention Type	Ultimate Indicator/Impact	Other indicators	Methods in Addition to Tracking Samples
Advertising/outreach/ branding	Sales and market share changes for efficient measures	Awareness, attitudes, intention to purchase, number of items target audience is exposed to materials, etc.	Large scale surveys, Delphi techniques, focus groups for ad testing and/or changes in intention to purchase, etc.
Upstream vendor incentives	Sales and market share changes for efficient measures	Stocking behaviors, sales, availability, price, catalog space, etc.	Surveys, focus groups of vendors, on-site inspection, review of documents, etc.
Contractor training	Sales and market share changes for efficient measures	Surveys of practices Willingness to implement, change installation practices, purchases/installation/re-commendations of efficient equipment	Surveys, focus groups, choice surveys/modeling

Data Collection

There are various methods that can and have been used to gather the data needed to develop baseline and impact data for evaluating market transformation programs. Given that information on market shares and sales of products is the most important aspect of assessing market transformation efforts, the focus is on data collection methods that provide sales-related baseline and impact data.

- ***Counts/Sales.*** To measure market transformation program impacts, information must be gathered on sales for less and more efficient products or relative market share for more efficient products of interest. Sales data have been held confidential by manufacturers and distributors, but considerable efforts are underway to address this problem.[9] This accumulation of sales information by product, efficiency level, and geographic area is vital in developing gross quantitative estimates of program impacts. Tracking these items periodically will be useful in identifying gross market changes.

  If available, equipment sales, both efficient and less efficient, represent the single best measure of market progress. Data collection might occur from well-designed samples of manufacturers, distributors, or on-site inspections at stores. These data are difficult and expensive to obtain, although recent efforts are making progress in California and a few other states. These data are useful for measuring program impact, as well as inputs for examining the baseline. If these data are tracked for a period before the program intervention begins, models can be developed to project the path the "natural" market might have taken without the program. These might be simple trend models, fitted to incorporate S-curves or other adoption patterns, or the time-series data could be compared between the area receiving the intervention and a "control" area. Comparing the "pre-influence" periods can assess the suitability of the control area to serve as a baseline. Depending on the relative maturity of the market, or differences in climate or other factors, some adjustments may be needed before the series can be used as a proxy for a program-period baseline. The differences in the estimated energy use associated with sales after the program's influence, less the energy use that would have occurred with the estimated baseline sales of the equipment of interest, represent an estimate of the savings from the program.

- ***Surveys.*** Surveys are a much-used method for gathering information on a wide range of aspects of market progress. Repeated surveys can track progress over time. Surveys of retailers, manufacturers, or distributors can gather data on equipment sales, prices, promotions, attitudes, practices, and similar data. Surveys of the public can be used to assess exposure to advertisements, decision making and equipment purchase behaviors, and attitude tracking. Surveys of contractors can gather data necessary to analyze installation practices, attitudes, and acceptance of efficient models. Depending on the program logic, sector, and end use, surveys can be one of the most valuable sources of data to support program

[9] Current work by RER and SERA (as subconsultants), as well as efforts by ADM.

evaluation under market transformation (as it was under resource acquisition program evaluation). Telephone, mail, intercept, on-site, fax, e-mail, and a variety of newer net-based survey approaches are being used to gather data in support of market assessment and baseline measurements for market transformation programs. Pre- and post-intervention surveys are used to assess market changes and measure adoption. Surveys in areas not affected by the market transformation portfolio of interventions are used to provide a baseline, much as under resource acquisition programs. However, while surveys may provide information on actions, and purchasers (no longer "participants") can address aspects of their purchase, demographics, and attitudes, they are likely unable to attribute their purchase to a specific intervention from among the portfolio of interventions. This is unlike the resource acquisition program environment, where program records provided a link between program and participant. Because information is needed from purchasers (or anyone considering purchasing a particular piece of equipment) in order to evaluate the program or market effects under market transformation, screeners can be incorporated into large-scale sector surveys to identify purchases. This is more expensive than the "ready list" provided by program records.

- ***Choice or Ranking Surveys.*** Another technique for gathering data on market shares is discrete choice or ranking surveys that explain the market share of different models based on the characteristics of key equipment models. This survey may be administered to a variety of actors depending on the purchaser of interest (consumers, contractors, etc.) and the program's logic. A sample of the actors is asked to rank a limited number of cards on which key equipment attributes are summarized (including, potentially, possible program interventions). Respondents are asked to rank the cards in terms of their willingness to purchase the various products. Given the orthogonal design of the attributes described on the cards, current and future market shares can be estimated. Additionally, the market shares based on potential market interventions can also be estimated. Although first applied to estimating market shares of specific brands, this technique was used to estimate likely shares of different product designs in the telephone industry[10] and to estimate different market shares for efficient and less efficient air conditioning equipment (Mast et al. 1999).[11] These data provide a robust source of information on likely market shares given current and continuing market conditions (baseline). Moreover, the data allow the researcher to estimate the impacts of a range of potential market interventions that might be planned under a market transformation design. This approach can be used not only to develop an estimate of the near-term baseline, but also to develop an ongoing series useful for examining baselines over time to evaluate longer term market

[10] Perry, Donald, Ph.D., GTE, personal communication with Skumatz, June 2000.

[11] In this case, SERA estimated the baseline natural vs. traditional market shares and projected shares under various market transformation market intervention options using ordered logit techniques.

transformation programs and periods (see Section 7). These choice exercises can also be administered pre- and post-viewing of market transformation program advertising or outreach materials. This would allow the researcher to gauge the impact of the program materials on panelist rankings.

- ***Delphi Techniques, Focus Groups, and Other Techniques.*** Delphi surveys use information from a panel of experts to generate information on current or anticipated market shares and/or the influence of potential market interventions on sales or shares. The Delphi survey usually incorporates feedback loops. Information from the "first round" of responses regarding market shares of various technologies are provided back to the panel to allow the experts to "adjust" their projections based on the opinions of the other experts. These techniques have been used to estimate the current and future expected levels of remodeling and renovation in various sub-markets of the commercial sector (Skumatz and Hickman 1995) and have been used to derive estimates of market shares of alternative air conditioner technologies (Mast et al. 1999), and a variety of market share estimates for other technologies. Focus groups and similar approaches, while even one step less quantitative, can provide useful information on assessing market transformation program aspects. For example, focus groups can be used as a small-scale pre-test of outreach or advertising materials for a market transformation intervention. Adapting techniques from advertising research, attendees can be asked to complete surveys before and after viewing a proposed advertising spot. Thus, differences in their attitudes, acceptance, and likelihood of purchasing the more efficient equipment can be assessed. This is about as far as feedback during a focus group can go. This aspect of "intention to purchase" stops short of the program's ability to track the actual purchase. However, as described later, the advertising literature purports a strong link between increased intention to purchase and actual purchasing behavior—at least for package goods and some other categories of items—with variations based on size of purchase, frequency, and other characteristics. The strength of these links for purchase of energy efficient measures has not been well studied however, so the relationship between intention to purchase and actual purchases is not yet known.

- ***Other Techniques for Measuring Impacts.*** The advertising industry has developed tools that may be appropriate for measuring the impacts (and baseline) associated with some market transformation information/outreach/branding interventions like ENERGY STAR. Some geographic test markets have had split television cable systems installed, allowing the same community to see different advertisements (or potentially some vs. no advertisements).[12] For package products, these firms provide links to key stores in the affected area, and scanner or sales data can be linked. For energy efficiency equipment, scanner data will likely not be useful. However, surveys of the two groups (treated and non-treated

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[12] This technique is useful for measuring impacts of ads placed specifically on television. However, control groups in different communities would still be required for adverting via newspaper, radio, and other techniques.

households) could be used to examine differential impacts on attitudes, intentions, etc., and if a panel survey is established, links to purchases may be accomplished.

Although market-level sales information is not a key focus in evaluating resource acquisition programs, gathering quarterly (or other periodicity) sales by manufacturer, efficiency level, and location of sale provides a powerful indicator of progress in transforming markets for an array of market transformation interventions. Changes in market share and sales can be evaluated over time, and this can be translated into a direct measure of potential impacts on kWh saved (the ultimate focus). The energy use associated with the program-influenced sales of various efficiencies of equipment can be computed and compared with the estimated baseline sales to develop and estimate of energy savings from the program or portfolio of interventions. There are several difficulties associated with this measure.

- Sales information historically has been very difficult to obtain. At least two significant efforts to collect these data for California are currently underway. Consequently, future prospects in this area look more promising.
- The evaluator must recognize that sales and market share data almost certainly were influenced by a wide range of interventions, and that it is generally impossible to attribute portions of the effect to separate interventions.
- The data are generally available only with significant lags, making this a delayed indicator of effects.
- Sales information must be adjusted to pull out the progress in market share that would have occurred naturally without the program (baseline), a point discussed earlier.

The data sources for market share and sales information are manufacturers, dealers, and distributors. A number of practical problems have arisen regarding these data, including confidentiality concerns, market coverage, maintaining respondents, reporting, and cost. Complications ensue as equipment models (and/or model numbers) change and the market continues to mature. The definition of what is more efficient changes over time, complicating tracking. As mentioned, even when net impacts can be determined, attribution to specific interventions is an issue under market transformation evaluation. This is unlike resource acquisition programs, which linked the purchase or participation to a specific program influence and could provide net impacts associated with specific programs.

Estimating Energy and Demand Effects

As noted earlier, in the market transformation environment, the focus has shifted from concerns over measuring the savings attributable to the measures to identifying and estimating effects on adoption patterns. Nonetheless, in order to assess the cost-effectiveness of market transformation initiatives, estimates of energy and demand savings are still needed. The numerous impact evaluation studies that have been conducted for resource acquisition programs provide savings estimates for specific energy efficient measures that have proven useful in the evaluation of market transformation programs. As market transformation evaluation techniques mature, estimating measure-specific savings will become a higher priority because newer measures and models will become available for which savings estimates derived from impact evaluations are not available.

6.8 Implications for Cost-Effectiveness Evaluations

6.8.1 Introduction

Using the techniques described above, the evaluator can develop estimates of key indicators of market effects. For the purposes of cost-effectiveness analysis, these indicators will have to include estimates of the time path of energy and demand savings. These indicators can be integrated into the overall cost-effectiveness analysis using the Public Purpose Test or some other framework. Section 8 discusses the assessment of cost-effectiveness. The remainder of this section, however, discusses a series of specific issues associated with the incorporation of estimates of ultimate market effects into cost-effectiveness analysis.

6.8.2 Attribution to Specific Interventions

It should be noted that it may be very difficult to attribute market effects to a specific program or intervention. Therefore, cost-effectiveness evaluations may best be used to assess the cost-effectiveness of portfolios of interventions targeting a specific market. For instance, the mix of efficiencies of equipment sold (sales and market share information) with the set of interventions can be compared to the estimated baseline sales to assess the portfolio's impact on equipment efficiencies. These differences can be linked to kWh estimates by using estimates of savings associated with individual measures (either developed as part of the evaluation process or transferred from earlier studies of other interventions). Using this information, estimates of overall energy savings associated with the portfolio of interventions can be computed.

6.8.3 Valuing Energy and Demand Savings

Traditionally, the energy and demand effects of resource acquisition programs have been valued using forecasts of avoided costs. Given the perception of these programs as alternatives to resource supply, this approach is understandable. However, the analysis presented in Section 2 offered a theoretical framework for conceptualizing the benefits and costs of energy efficiency interventions, and this framework has implications for the means of valuing ultimate market effects. In this context, two issues are central to the assessment of cost-effectiveness: non-energy benefits (NEBs) and externalities. These issues are discussed below.

Non-Energy Benefits. A truer measure of program cost-effectiveness probably should include some or all of a series of NEBs that have been listed and quantified (Brown 1993; Magouirk 1995; Skumatz and Dickerson, 1997, 1998, 1999). Measuring the proper benefit is an important concern in cost-effectiveness. In the social accounting of benefits, the most appropriate measure is the quality of service involved. Traditionally, this has been difficult to measure, and measures of energy savings are often substituted in its place. Energy savings is an imperfect measure, however. A more efficient window may save energy, but the improved service of the comfort from less radiant heat transmission is not well valued using only energy savings. A second area of concern in NEB is to assure that benefits are not double-counted and that transfers are not included in the benefits. For example, counting both the increase in property value and the comfort and savings stream benefits would likely include double-counting. Counting employment benefits from increased insulation manufacturing would not be counted if this pulled production away from that of other useful goods and services.[13] The counting of transfer payment benefits needs to consider if there are unemployed resources that become employed.

However, viewed from a societal point of view, virtually all the NEBs valued in the recent literature could or should be included in the assessment of societal cost-effectiveness, regardless of the immediate beneficiary under which they have been categorized (for example, the categories of utility/ratepayer, societal, or participant used in Skumatz and Dickerson 1999; 2000). These include credit and bad debt savings, economic and environmental benefits, water and other non-utility savings, transfer payment benefits, transmission and distribution savings, service termination savings, and benefits from comfort, health, and other sources. These should, of course, be net benefits, extracting the value of non-benefits emanating from the program or intervention (Skumatz and Dickerson 2000).

Externalities. Traditionally, cost-effectiveness measures have focused on direct costs compared to energy savings, with less attention to environmental considerations and other externalities (health, etc.). These externalities are generally not priced directly in the marketplace, so decision makers do not incorporate these costs (or benefits) into their cost-effectiveness assessments. The literature on externalities suggests these values are best determined by identifying "willingness to pay" and opportunity cost methods (Tresch 1981). Health effects are measured using standard damage function approaches (i.e., linking how much of the pollutant is reduced, the link to the health effect, and the associated dollar value is computed (Cropper and Freeman 1991). However, this can require onerous computations.

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13 Another example of a proposed benefit that is more approximately considered a transfer was included in a paper reviewed for ACEEE that posited that increased sales in buildings within a retail chain that had daylighting should be counted as a benefit.

More recently, some of these benefits have had values attached. Because of the Clean Air Act and the penalties associated with non-attainment, values are now established for some pollutants. Credits for these pollutants can be traded, bought, and sold, and this trading has provided market prices for pollutants that can be used in valuing externalities.

Some of the NEB literature has attempted to incorporate values for some of these program benefits, including greenhouse gas emission changes and values and other environmental benefits (Galvin 1999; Skumatz and Dickerson 2000), as well as some of the health benefits. Although these valuation estimates have large ranges attached (Skumatz and Dickerson 2000), new work is underway to incorporate more rigor to these estimates.[14] Little to no work has been conducted in the NEB area valuing demand versus kWh. Valuing excluded externalities is an important component in the assessment of social cost-effectiveness, and further work to increase both the precision and accuracy of these valuations is needed. Formal work developing improved cost-effectiveness tests to incorporate these and other relevant benefits (and costs) is currently underway in California.[15]

6.9 Summary and Conclusions

Market transformation evaluation focuses on examining changes in markets at the market (not measure or sector) level. Given the difficulty of attributing effects from sales data and the associated energy savings estimates, a variety of interim near-term measures are crucial elements of evaluation under market transformation. The interim measures provide links to determining whether the program is leading to (desirable) market changes and whether the interventions have the potential to lead to the anticipated energy savings. In fact, the interim measures reflect key steps of the program's logic, and are more important under market transformation than under resource acquisition strategies. This section has pointed out some key differences in analysis technique and data options between resource acquisition interventions and market transformation initiatives. The analysis for market transformation impacts differs because, unlike the case for resource acquisition interventions:

- The participants are often unknown,
- The interventions aspire to cause changes at the market level, and
- The interventions tend to be longer lasting and take longer before the ultimate impacts and energy savings are realized.

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[14] Work underway for PG&E and the California utilities by Hall (TecMRKT Works) and Skumatz (SERA) is focused on improving environmental and other estimates. Similar work refining the NEB estimates is also underway for NU by SERA under contract to RER.

[15] This work, designed to develop an improved and more encompassing cost-effectiveness test incorporating appropriate NEBs is being conducted by TecMRKT Works and SERA.

Using a portfolio approach or focus, evaluation would not take place at the program level, but instead, would estimate the overall energy savings impacts from the portfolio. Interim and near-term tracking indicators and other methods gain importance dramatically in market transformation evaluation work and are used to check the success of the program mix in matching the program's logic and achieving interim goals that were derived from the logic.

The previous sections address issues associated with evaluation under market transformation. An important change as evaluation moves from resource acquisition to the market transformation environment is that, under the resource acquisition regime, structured sets of costs and benefits were estimated, corrections were made to attribute savings and to estimate net savings, and the cost-effectiveness of specific program interventions were computed. With the broader reach of market transformation programs, the focus is to move forward acquisition of energy efficient equipment in the marketplace. Market-level assessments became the focus, rather than attribution of impacts to specific program interventions. Very useful but different evaluations are appropriate under market transformation environments. However, these evaluations focus on measuring the impacts on market-level sales (market defined at sector, end use, or other appropriate levels, depending on the intervention portfolio).

Because market transformation interventions are being supported by public funds, concerns are raised about monitoring the cost-effectiveness of the program efforts. In some cases, it may be possible to attribute specific market effects to specific interventions in order to assess program performance. However, given the nature of market transformation interventions, this is unlikely to generate reliable results. The nature of many market transformation efforts is relatively broad-based, and it would be difficult or impossible for a survey respondent to attribute their change in behavior to a specific advertising campaign or other intervention. The program efforts are directed at end users, manufacturers, and many stages in between. The infrastructure for tracking changes, impacts, participants, and other program aspects is no longer relevant. Instead, it seems more sensible to track the sales levels or market shares at the market level, and to infer the impacts of packages of interventions using the types of models discussed in Section 7. A variety of interim and auxiliary metrics can also be tracked, which are designed to reflect aspects of the program design logic (e.g., surveys of changes in attitudes by distributors, etc.).

Under market transformation, program objectives have changed and cost-effectiveness is more appropriately addressed at the portfolio or market level. New tests of cost-effectiveness are needed, or their interpretations need to change. Finally, judgment, past experience, program logic, past performance of similar interventions, and interim metrics can be used to determine whether the mix of interventions designed to affect or transform a particular market is appropriate or effective. Under market transformation, significant effort should be placed on understanding the way the market works, so that changes in indicators can be interpreted correctly, and so that modifications to interventions can be designed to achieve program goals most effectively.

7

Market Dynamics and Estimating Market Effects

7.1 Overview

This section considers general means of recognizing market dynamics in the development of estimates of market effects. As recognized in Section 6, the entire process of market assessment and evaluation must be based on a clear understanding of the dynamics of the marketplace. Baselines change over time in response to natural market conditions, and the effects of interventions go beyond the period in which they are applied. In many respects, the dynamic models discussed in this section are meant to provide a frame of reference that can be used to organize the market assessment and evaluation (MA&E) activities discussed in Section 2. Those activities would be focused on developing information to be used to calibrate the model and its key parameters. The refined model would then be used to develop estimates of market effects. These estimates are, at least partly, forecasts in the sense that they cover some effects that have not yet occurred. This is clearly true in the case of prospective analysis, and is probably true for retrospective analysis as well. While retrospective analysis takes place after interventions have been applied, it is likely to cover some effects that are yet to occur. In either event, the estimates of market effects that can be derived from these dynamic models are designed to be incorporated directly into the assessment of cost-effectiveness. This application of the forecasts will be discussed at some length in Section 8.

7.2 Introduction

Assessing the cost-effectiveness of a market transformation interventions ultimately requires the development of estimates of their effects on the adoptions of energy efficiency measures and the resultant energy savings. Constructing these estimates is complicated by a number of conceptual and practical difficulties, most of which are related to the essential characteristic of market transformation interventions: *The effects of market transformation interventions last beyond the period in which they are implemented, so the estimation of market impacts has to recognize the dynamics of the market. In essence, the assessment of cost-effectiveness requires the development of dynamic frameworks capable of estimating the entire time path of adoptions (and the attendant savings) with and without the intervention in question.* This section focuses on the importance of recognizing market dynamics and the means of developing estimates of market effects. While this dynamic approach is necessitated by the dynamic nature of the market effects associated with market transformation, it is not limited to the assessment of market transformation interventions. As will be emphasized throughout this section, the approach is meant to be a comprehensive means of integrating the analysis of at least four of the intervention strategies discussed in Sections 2 and 3: market transformation, infrastructure, research and development, and resource acquisition.

The rest of this section is organized as follows:

- Subsection 7.3 discusses market dynamics, dynamic baselines, and the need to use a forecasting perspective in estimating market effects.
- Subsection 7.4 reviews the current literature on estimating the market effects of market transformation interventions.
- Subsection 7.5 describes a comprehensive framework that could be used to conceptualize and estimate impacts of interventions on adoptions and energy usage.
- Finally, Subsection 7.6 summarizes the advantages of using a formal dynamic model to analyze market effects and offers suggestions for future research.

7.3 Dynamic Baselines and Market Effects

Traditionally, the focus has been almost exclusively on program-period adoption effects of energy efficiency programs, even in those few cases where spillover was recognized and seriously assessed. However, to the extent that market transformation interventions affect behavior in a lasting way, this change in behavior will induce adoptions of energy efficiency measures in subsequent periods. Indeed, these subsequent effects are inherent in the nature of market transformation. Estimating these post-intervention effects constitutes a significant test of our ability to forecast behavior in a dynamic setting.

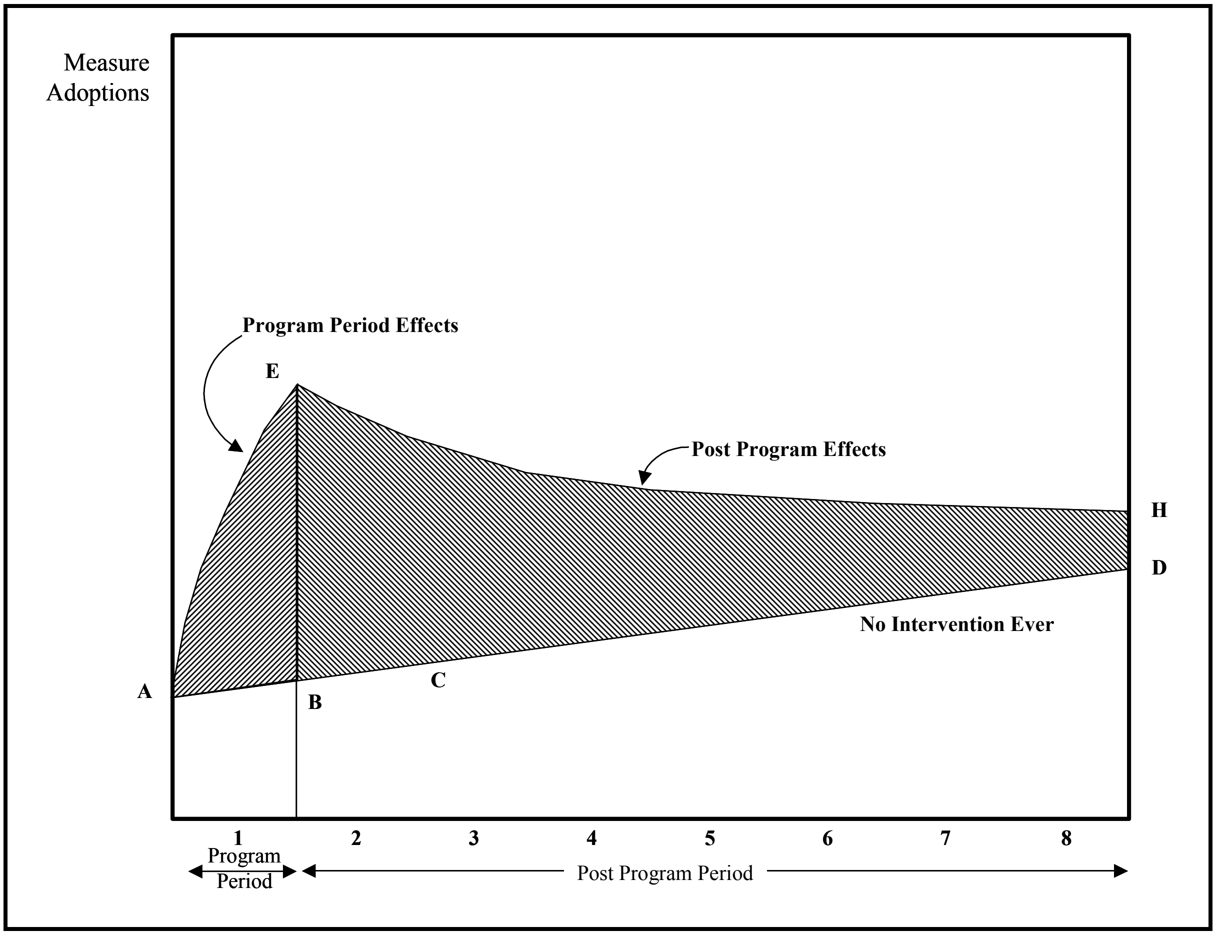
Under any energy efficiency paradigm, intervention impacts are generally defined with reference to a baseline. Because of the nature of market transformation initiatives, the notion of a baseline for market effects is somewhat more complex than under the old resource acquisition model. To accommodate the estimation of market effects, clearer baseline concepts must be developed and the ability to estimate these baselines must be improved.

Figure 7-1 illustrates the nature of the problem. Time is shown on the horizontal axis, and adoptions of a targeted energy efficiency measure are shown on the vertical axis. For the sake of the illustration, assume that an intervention is operated during a single program year,[1]

[1] We use the term “program year” or “program period” to refer to an administrative concept used for reporting purposes.

then discontinued. The current-period market effects of the intervention are indicated as the increment in adoptions relative to the baseline (which represents what adoptions would have been in the absence of the intervention). As shown, the net impact of the intervention during the intervention period is represented by the area AEB. However, suppose that adoptions stayed higher than the baseline in the period following the intervention, tracing out the path EH.[2] Then, the full impact of the intervention over its entire lifetime would also include incremental adoptions (relative to the baseline) in subsequent periods, as reflected by the area BEHD. In order to estimate this area, it is necessary to forecast the path of future adoptions (EH), as well as the path they would have followed had the intervention never existed (BD).

Figure 7-1: Subsequent Period Effects on Adoptions



Estimating market effects of multiple year interventions can be even more problematic. If program year effects are to be estimated, it is necessary to define and measure a baseline for the net changes associated with each year. In most general terms, such baselines are defined

2 The implicit assumption here is that the effects of the intervention are sustainable, although they are subject to gradual decay.

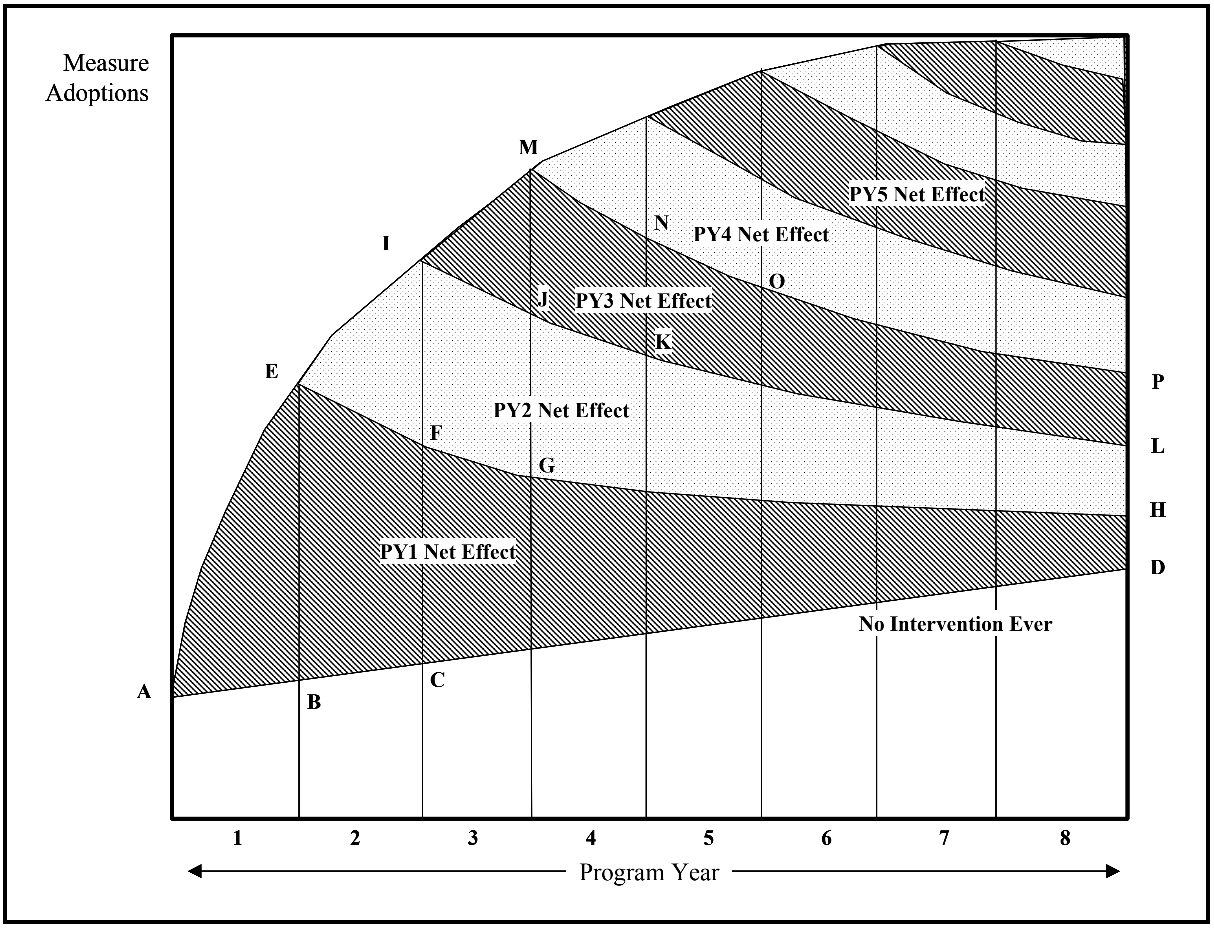
as the conditions that would have prevailed in the absence of the intervention being evaluated. However, the nature of a baseline is inherently more complex under the market transformation paradigm than under previous philosophies of energy efficiency. Again, this complexity stems from the fact that market transformation initiatives are designed to spawn market effects that last beyond a single program year. As a result, the baseline for an intervention for each program year may depend upon the effects of the interventions used in past program years.[3]

Figure 7-2 illustrates this issue. It builds on Figure 7-1 by representing the adoption paths for a specific energy efficiency measure targeted by a multiple-year market transformation intervention. As a result of the intervention in the first program year, adoptions rise from A to E during the program year. During the second year, adoptions rise to I, in the third year to M, and so on. Associated with this time path of adoptions are two conceptual baselines. The first is the "*no intervention ever" baseline*, which represents what adoptions would have been *if the intervention had never been offered*. The second represents what adoptions would have been *in the absence of the intervention implemented in the program year in question*. For lack of a better term, this is referred to as the *program year baseline*. For the first program year, this is just the "no intervention ever" baseline. For the second and subsequent program years, however, this program year baseline will be referenced to impacts of interventions in previous program years. For instance, for the second year, this baseline would be the adoption path EFGH, which by assumption would have been followed had the intervention been discontinued after the first year. Thus, the net impact of the second year intervention would be the area EHLI. For the third year, the program year baseline would be IJKL, and the net program year effect would be ILPM (and so on for subsequent years).

In practice, estimating baselines (and thus isolating net market effects) is a difficult process. It really needs to be part of an overall forecasting process. That is, frameworks (whether they be formal statistical models or more heuristic frameworks) need to be developed to forecast baselines as well as "with-intervention" market activity. Several recent attempts to develop such forecasts are reviewed in the next subsection.

3 Technically, this has always been the case, even under the resource acquisition paradigm, as long as interventions had any long-lasting effects. However, given the explicit design of market transformation interventions to stimulate sustainable impacts, it has become even more important to recognize the dynamics of baselines.

Figure 7-2: Dynamic Baseline



7.4 Alternative Approaches to Estimating Long-Term Market Effects

7.4.1. Overview

In order to capture the dynamics of market transformation, estimates of market effects must recognize time lags, feedback effects, and a complex set of interactions. Unfortunately, the ability to estimate long-term market effects is not particularly well developed. Indeed, the discussion of estimating approaches is really in its infancy. Several general types of forecasting options are described below, including the use of Delphi techniques, the analysis of time series market data, and adoption process models. In Section 4, a hybrid approach integrating some of the features of these other approaches is considered.

7.4.2. Delphi Techniques

One option is to use a judgmental approach to forecast market behavior under various scenarios. Judgmental methods for forecasting market penetration generally involve subjective estimates of the technology's performance. The Delphi method is one approach to judgmental forecasting. The Delphi method interrogates a panel of experts through sequential questionnaires. First, a group of experts in the field is asked individually to predict the future course of a technology. The results of this first survey are then distilled to produce a second survey summarizing the thoughts of the entire group. Thus, the Delphi approach is based on the intuition of experts, which is later refined using the results of the panel as a whole. Armstrong (1985) concludes that the feedback and iterative rounds may increase accuracy, though the gains are slight. Overall, this approach is more accurate than traditional meetings or interviews. The Delphi method is most effective when used to determine market potential or choice probabilities as it can, at best, only suggest ranges of adoption rates (Bolt 1972).

The application of the Delphi approach to market transformation analysis has been pioneered by Feldman (GDS 1999). In a recent study for Boston Electric and COM/Electric, Feldman used the technique to evaluate the impacts of interventions on both high efficiency clothes washers and premium efficiency motors. Using a panel of experts, Feldman generated forecasts under base case assumptions as well as various intervention scenarios. Differences in these forecasts were interpreted as market effects.

Depending upon the amount of formality, a judgmental approach like the Delphi method can be cost-effective, relatively easy to implement, and useful. It can be used to develop forecasts that take into account a wide range of market factors, including economic growth, natural diffusion of new technologies, changes in codes and standards, and other factors that influence adoption paths under various assumptions. The major drawback to this approach is that the estimates are subjective, so results might change depending upon the analyst, the individuals included as expert judges, or the assumed values of key variables. Additionally, judgmental approaches may not be suited for sensitivity analysis and are not designed to allow statistical hypothesis testing. Nonetheless, given the difficulties of conducting formal statistical analysis of adoption behavior, judgmental approaches like Delphi techniques can clearly play an important role in the analysis of key aspects of behavior.

7.4.3. Analysis of Time Series Market Data

Insofar as market effects are inherently changes in the marketplace over time, it stands to reason that these effects could be assessed through the analysis of time series data on market indicators. While relatively little formal time series modeling has been attempted in this area, evaluation professionals are starting to consider the application of various empirical approaches to the analysis of market effects. In considering this approach, most attention has been placed on modeling adoptions of energy efficient technologies. Several types of conceptual models could be applied to this end, including various forms of diffusion and discrete choice market share models.

Diffusion Models. Some evaluators have proposed the application of diffusion models to the estimation of market effects (Mast et al. 1999). Diffusion models are used to describe the process through which a new technology diffuses through (is accepted by) the market over time. In a fairly standard form of a diffusion model, the incremental adoptions of a technology per period are a function of time (the number of periods for which the technology has been available) and the current stock (cumulative adoptions) of the technology at the beginning of that period. One widely used diffusion model is offered by Bass (Bass 1969). In the Bass model, current adoptions are decomposed into those resulting directly from program messages and mass media (innovation effects) and those resulting indirectly from "imitation effects" associated with the experiences of friends and relatives.

In general, diffusion models offer some promise for forecasting market effects. However, they also suffer from a variety of limitations:

- Diffusion models are most appropriate to the analysis of new technologies. They are not particularly useful for analyzing the adoptions of mature technologies. They are also technically applicable only to technologies whose adoption cannot be rescinded or repeated (e.g., insulation) (Mahajan and Peterson 1985).
- In general, diffusion models tend to be simplistic with respect to the factors driving the rate of diffusion. While it is understood that the rates of diffusion depend upon product attributes and other factors (Rogers 1995), few attempts have been made to integrate these factors into the diffusion model. If diffusion models are to be used to model the impacts of interventions on adoptions, they will need to be refined in two respects: first, by explicitly incorporating variables representing market barriers and general product attributes (e.g., relative cost), and second, by augmenting them with analyses of the impacts of interventions on market barriers and product attributes. Some work has been done in these areas (Horsky and Simon 1983; Mahajan and Peterson 1978), but much more needs to be done if this type of framework is to be applied to the assessment of market effects.
- Like any other time series framework, the estimation of diffusion models will require time series data on the variables they contain. This is not a trivial requirement. Collecting sufficient market data to model adoptions of a technology in terms of various explanatory variables is an expensive and time-consuming task. In general, using diffusion models to estimate the impacts of market transformation interventions will probably require data on markets with and without these interventions, given that relevant time series data will probably not contain sufficient observations on behavior with and without the presence of the intervention. Additionally, for new technologies—those for which the diffusion model is conceptually most appropriate—such data may simply not exist.[4]

[4] Note, however, that an approach sometimes called "modeling by analogy" can be used in such cases. See Regional Economic Research, Inc. 1999.

Discrete Choice Market Share Models. Market share analysis explains the market share of a product in terms of the product's features and/or the characteristics of the consumers evaluating it. While the main driving force of these models has been to investigate the market shares of different brands, it can easily be extended to investigate the market share of different technologies. Several market share model specifications are available, including the familiar binary, multinomial, and nested logit models used frequently in technology-related choice analysis. Another common type of market share model that is less familiar in energy efficiency literature, but one that meets these conditions, is the multiplicative competitive interaction (MCI) model, or attraction model (Cooper and Nakanishi 1988).

The distinction between econometric, market share, and diffusion models is somewhat arbitrary. A market share model is an econometric model. In addition, a diffusion model that incorporates marketing data is not much different from a logistic time series model incorporating the same explanatory variables. There are only two essential differences between a diffusion model and a market share model. First, the diffusion model investigates cumulative sales, while the market share model investigates the technology's share of the market (i.e., sales over a given period). Depending upon the characteristics of the market (specifically market size and the decay/replacement rates), one can generally convert from diffusion to market share. Second, the diffusion model implicitly incorporates time within its framework, whereas the market share approach generally does not. Nonetheless, one can explicitly incorporate time within the market share model by including it as an independent variable.

The benefits of market share models in particular, and econometric models in general, are that they explicitly relate structural cause-effect relationships. This can help determine the role of various interventions (market transformation interventions as well as interventions falling into the other types defined in Sections 2 and 3) on the adoption of the subject technology. While market share models have the benefit of including explanatory variables representing market phenomena, thus allowing for sensitivity analysis, they have two significant drawbacks for this analysis. First, there are often no time dynamics implicit within market share models. That is, some models assume that market shares are in equilibrium, and that changes in market shares over time are due to changes in marketing efforts, prices, or other explanatory variables. There is often no assumption about how market shares will adjust to changes in their equilibrium values. Rather, one can incorporate time dynamics into the model by including time or lagged values of market shares explicitly as regressors. The second drawback to using this model is that it requires data to develop parameter estimates. As has been noted several times, these data are not always readily available.

As noted above, both diffusion models and market share models share the common problem of limited market data availability. It is difficult to overstate the seriousness of this limitation. While the evaluation community has assembled an enormous amount of information on the behavior of market actors, it is extremely difficult to identify more than one or two energy efficiency measures for which consistent market share data are available for a period of time adequate to support the estimation of these types of models. To some extent, the energy efficiency community in California is attempting to address this issue through the support of market share tracking initiatives. To the extent that similar tracking systems can be developed for other areas, techniques involving pooled cross-section/time series estimation may offer significant promise for the estimation of model parameters. However, it will take time before these initiatives generate enough data to support the estimation of these types of models for a wide range of energy efficiency measures.

7.4.4. Adoption Process Models

Adoption process models characterize adoptions as the result of a sequence of stages, usually beginning with unawareness and ending with either rejection or adoption. A variety of adoption process sequences can be found in the literature, depending on market and product type. A common sequence proposed by Rogers includes awareness, interest, evaluation, trial, and adoption/rejection (Rogers 1995).

Operational adoption process models can be structurally complex, with simulated parameters set up as functions of time and market-mix variables. They are typically simulation models mapping dynamic behavior of a real system. Operational simulation of adoption process models usually uses one of two forms: 1) micro-simulation, or 2) discrete simulation. Discrete simulation is a stronger option than micro-simulation (Research Triangle Institute 1991). Micro-simulation models simulate the behavior of individual consumers in a market. These models tend to be highly complex, since a dynamic system including structural models of individual choice, market interaction, and environmental parameters is required. Market forecasts are obtained by aggregating over the individual consumers in the model. Discrete simulation models simulate potential consumers passing from one stage to the next in a specified adoption sequence. The model produces a period-by-period forecast by recording when prospective consumers enter and leave each stage. Consumers are assumed to pass from one stage to the next according to a simulated time sequence. The time sequence in discrete simulated models may be specified using periodic transition probabilities or using transition functions.

The micro-simulation model allows rich details and realism within the system and is compatible with direct segment and sensitivity analysis. The discrete simulation model has a major advantage in modeling dynamic systems with variables that change abruptly at each stage of adoption sequence. The discrete simulation process also has the benefits of structural richness, and the effects of interventions can be included and controlled within the process.

The major disadvantage of the adoption process models is that the adoption process generally has many parameters to be calibrated, either judgmentally or using data-oriented methods. Empirical calibration requires extensive primary market research data, which can make adoption process modeling expensive. On the other hand, collecting such data may be more feasible than assembling sufficient amounts of time series data (as required by other approaches). As a result, these models offer significant potential for forecasting market effects.

7.4.5. Survey-Based Approaches

Although survey analyses are not generally considered forecasting approaches, it is probably fair to say that many recent attempts to forecast market effects have been based on the analysis of survey data. For instance, sustainability—a key element of the dynamics of market effects—has generally been assessed through a process in which market actors are queried on changes in behavior and the likelihood that these changes will be sustained. These analyses tend to be qualitative, in the sense that they focus on whether specific effects are generally sustainable. However, they can probably be restructured to yield more quantitative estimates of the parameters of dynamic models.

7.5 A Comprehensive Framework for Forecasting Market Effects

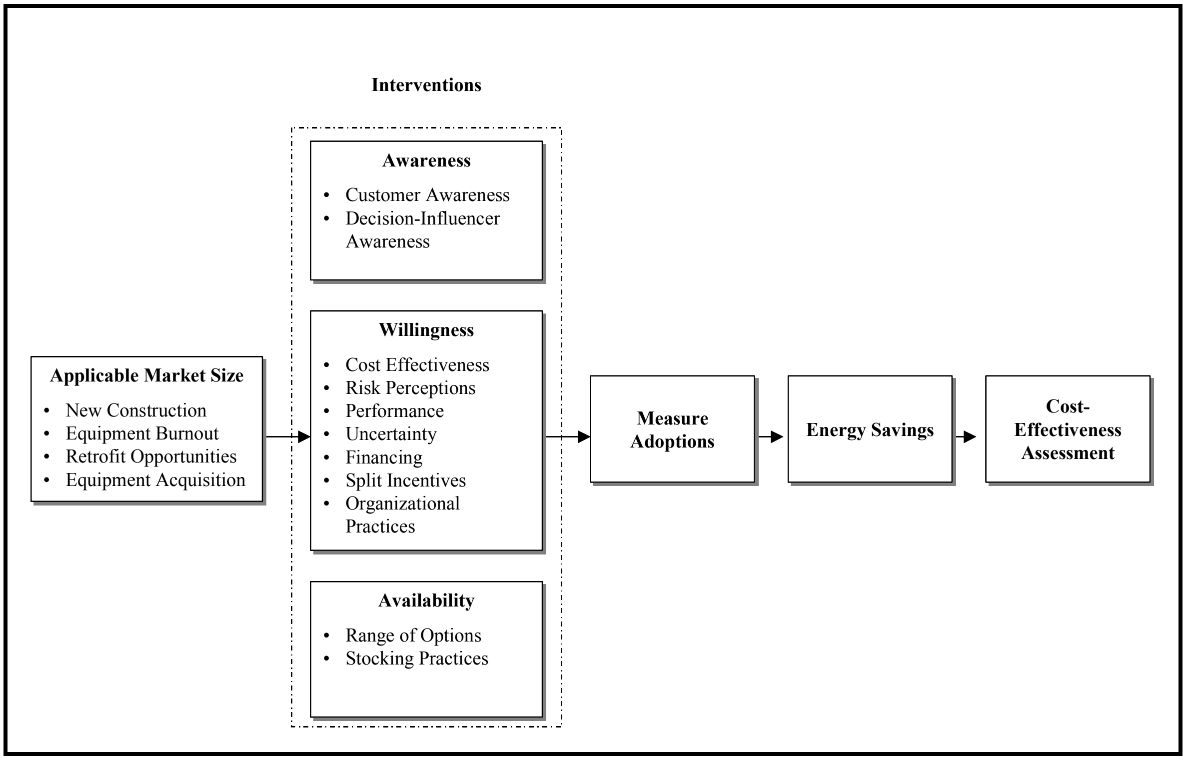
7.5.1. Introduction

This subsection proposes a simple yet comprehensive framework for conceptualizing and (ultimately) forecasting market effects. It is designed to integrate many of the best features of the forecasting approaches reviewed previously. It has the overall structure of an adoption process model and the dynamic logic of modified diffusion models. It can be parameterized by using survey information, Delphi studies, other judgmental approaches, or statistical analysis of time series data. Of course, like any analytical framework, it provides a simplified description of markets for energy efficiency measures. While its design is particularly critical to the assessment of market effects of market transformation interventions, it is intended to be applicable to the full range of interventions strategies, including market transformation initiatives, infrastructure provision, research and development, and even resource acquisition. Its application to a specific market would require the tailoring of the dynamic specifications to reflect the key features of all interventions and their theoretical effects. Nonetheless, the general model presented here should illustrate the use of dynamic specifications to generate forecasts of market effects. These forecasted market effects can be used in the assessment of cost-effectiveness of program portfolios and specific interventions. Another useful feature of the framework is that it can also be used to simulate the market effects of various intervention options.

7.5.2. Immediate Determinants of Adoptions

Figure 7-3 presents an overall conceptual framework for the analysis of the market effects of energy efficiency interventions. The framework characterizes the total adoptions of an energy efficiency measure (EEM) as depending most directly upon four key factors.

Figure 7-3: A General Conceptual Framework



- ***Applicable Market Size.*** The first determinant of adoptions is the applicable market size. This reflects the number of opportunities for which the measure is applicable. The characterization of applicable market size depends on the market event associated with adoptions. Typically, four market events are identified: new construction, replace-on-burnout, retrofit, and appliance acquisition.
- ***Awareness.*** In order for adoptions of an EEM to occur, decision makers and decision influencers must be aware of the measure and its basic properties. Awareness may be low because of lack of information and/or high information costs.
- ***Willingness.*** For decision makers faced with opportunities to install an EEM and aware of the measure, adoptions depend upon the willingness to install the measure. Willingness is dependent on a variety of factors, including the number of

competing technologies, the cost of the EEM, the energy savings from the measure (perhaps differentiated by time-of-use), the price of energy, and a host of non-price barriers.

- ***Availability.*** The lack of availability of a measure may restrict its adoption by potential adopters who are both aware and willing. Lack of availability may result from manufacturers' practices or problems in the distribution chain.

In most general terms, the adoption model can be characterized as a chain of these factors:

$$Adoptions = \begin{pmatrix} Applicable \\ MarketSize \end{pmatrix} \bullet Awareness \bullet Willingness \bullet Availability \qquad (1)$$

The model could also be expressed in terms of an *adoptions rate* as:

$$AdoptionsRate = Adoptions \Big/ \begin{pmatrix} Applicable \\ MarketSize \end{pmatrix} = Awareness \bullet Willingness \bullet Availability \qquad (2)$$

7.5.3. General Characterization of Impacts of Interventions

Energy efficiency interventions can have an impact on both program year adoptions and subsequent year adoptions. These impacts can be transmitted several ways in the context of this framework:

- Interventions can increase awareness using a variety of techniques, including consumer education, contractor training, and salesperson incentives. Some interventions that influence awareness may fall under the classification of market transformation, but others may best be classified as other interventions strategies. For instance, energy centers fall under the rubric of infrastructure, but clearly have the capability of affecting awareness of energy efficiency technologies. The same could be said for some technology demonstration initiatives, which are generally classified under research and development. As discussed later, these impacts on awareness may have various levels of sustainability depending upon turnover in decision-making roles, dissemination of information through private channels, and other key factors.
- Interventions can enhance willingness to adopt by improving the cost-effectiveness of adoptions (from the perspective of the customer). Cost-effectiveness can be improved though reductions in manufacturers' costs and by providing financial incentives to market actors and/or customers. Interventions can also affect willingness by mitigating some of the non-price barriers deterring adoptions: perceptions of risk, hassle costs, the unavailability of financing, concerns about performance, split incentives, and poor organizational practices. Again, it must be noted that interventions not typically associated with market transformation can

have influences on willingness. Rebate-focused resource acquisition clearly affects willingness through reductions in the participant's cost of purchasing the measure in question. Demonstration initiatives may influence willingness through changes in market actors' perceptions of risk and/or performance. Effects of willingness may be more or less sustainable, depending upon their exact nature.

- Interventions can enhance availability by encouraging product development, improving information for supply channel participants, improving business practices on the supply side of the market, etc. As is probably a tired story by now, availability may be affected by a variety of intervention strategies, some of which are generally considered market transformation options and some of which are not. For instance, publicly funded technology research may induce manufacturers to expand the range of technology options, and retailers may be exposed to various technologies through infrastructure initiatives like energy centers.

In what follows, we focus on ways in which these market effects on awareness, willingness, availability and—ultimately—adoptions can be estimated and incorporated into the overall adoptions framework. The emphasis is on illustrating the ways in which dynamic assumptions can be incorporated into a very simple simulation framework, then used to estimate market effects of various interventions. It should be noted that the analysis will focus on the long-term effects of interventions of specified lengths. For instance, we may use a model to analyze the effects of a two-year intervention. In adopting this approach, we do not imply that interventions are typically run for short periods (two years), but rather that cost-effectiveness analysis must be conducted for a set of interventions employed for a specific period.

7.5.4. Applicable Market Size

As noted in the previous section, applicable market size reflects the number of opportunities for which the measure is applicable. The characterization of applicable market size depends on the market event associated with adoptions. Typically, four market events are identified:

- ***New Construction.*** For new construction, total market size could be measured in terms of number of dwellings, number of buildings, square footage, number of units, or some other indicator. The applicable market would be that portion of the total market in which the qualifying equipment or configuration is present. For high efficiency chillers, for example, the applicable market could be defined in terms of the total number of new sites or total square footage with chillers, or the total number of chillers in new construction. For T-8s, the applicable market could be defined as the total number of four-foot fluorescent fixtures in new construction, the total square footage of new sites with four-foot fixtures, or the number of four-foot fluorescent lamps in new construction. For high efficiency gas water heaters, the applicable market could be characterized as the total number of new residential units with gas water heating.

- ***Replace on Burnout.*** This market event refers to the act of replacing a piece of equipment upon its burnout. The associated applicable market would be the total number of units of the equipment type being replaced in a given period.
- ***Retrofit.*** The retrofit market event typically refers to the modification or replacement of existing operational equipment or structures. It would include the acquisition of devices that change the overall performance of equipment (e.g., variable speed drives), the early replacement of equipment (e.g., lighting system change-outs), the disposal of energy-using equipment (e.g., refrigerator recycling), and the modification of structures (installation of insulation).
- ***Equipment Acquisition.*** This refers to the expansion of the equipment stock in existing construction. It could include the net acquisition of high efficiency central air conditioning as an alternative to new conventional equipment. The associated applicable market would be the total number of units of the equipment type being acquired (other than for replacement) in a given period.

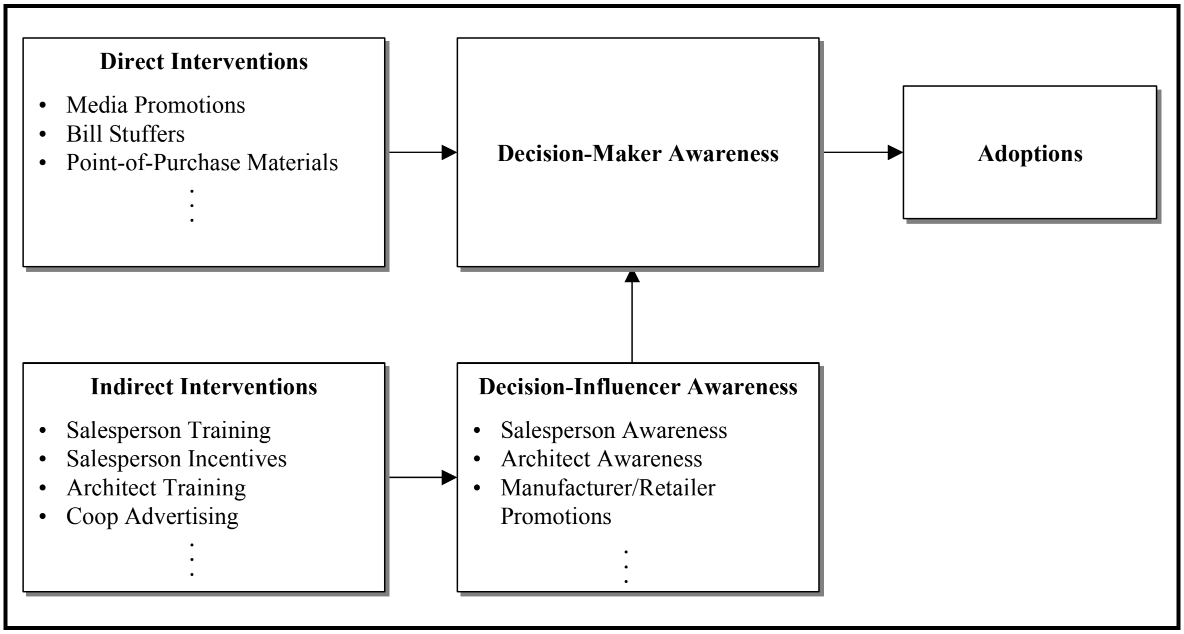
The applicable market size can be estimated for each period based on existing stocks of equipment and structures, new construction, total market sales of equipment, and other reasonably readily available types of market data. For this analysis, the size of the applicable market is assumed to be unaffected by interventions.

7.5.5. Awareness

Overview. In the context of the market effects modeling framework, awareness refers to decision-maker awareness of the EEM and its basic properties. In practical terms, it is assumed that complete unawareness will lead to no adoptions, and that increases in awareness will have more or less proportional impacts on adoptions, all other things given.

As illustrated in Figure 7-4, an intervention or a portfolio of interventions may have direct impact on the level of awareness of the potential adopter or an indirect influence through informing individuals who influence the decision maker. In assessing these effects, it should be kept in mind that awareness is a dynamic concept. Awareness changes over time, with or without interventions. It is influenced by the experiences of key market actors, migration/turnover of individuals with decision-making responsibilities, changes in market conditions, and other factors.

Figure 7-4: Intervention Effects on Awareness



Direct Intervention Effects on Awareness. To reflect the dynamic nature of *direct intervention* impacts on awareness, a very simple initial specification is employed:

$$Awareness_t = (\alpha_0 + \alpha_1 INT_t) Awareness_{t-1} + (\alpha_2 + \alpha_3 INT_t)(\alpha_4 - Awareness_{t-1}) \quad (3)$$

This formulation suggests that awareness in period *t* (e.g., this year) is related to awareness in the previous period (last year) in two ways. First, only some fraction ($\alpha_0+\alpha_1 INT_t$) of the decision makers who were aware in the previous year remain aware. This fraction consists of two components. The first, α_0, is the fraction remaining aware in the absence of any interventions. The second, $\alpha_1 INT_t$, is the fraction remaining aware as the result of some intervention, INT_t. The fraction α_0 can be considered an awareness sustainability rate, in the sense that it will determine the sustainability of awareness impacts after the intervention is discontinued (i.e., $INT_t=0$). Second, some portion ($\alpha_2+\alpha_3 INT_t$) of those previously unaware becomes aware in the current period. The parameter α_2 reflects the proportion that becomes aware as a result of factors other than interventions, while $\alpha_3 INT_t$ represents the impact of the intervention on those who were previously unaware. The parameter α_4 is the potential fraction of decision makers that can be made aware. For example, a value of 1.0 indicates that all decision makers can be made aware.

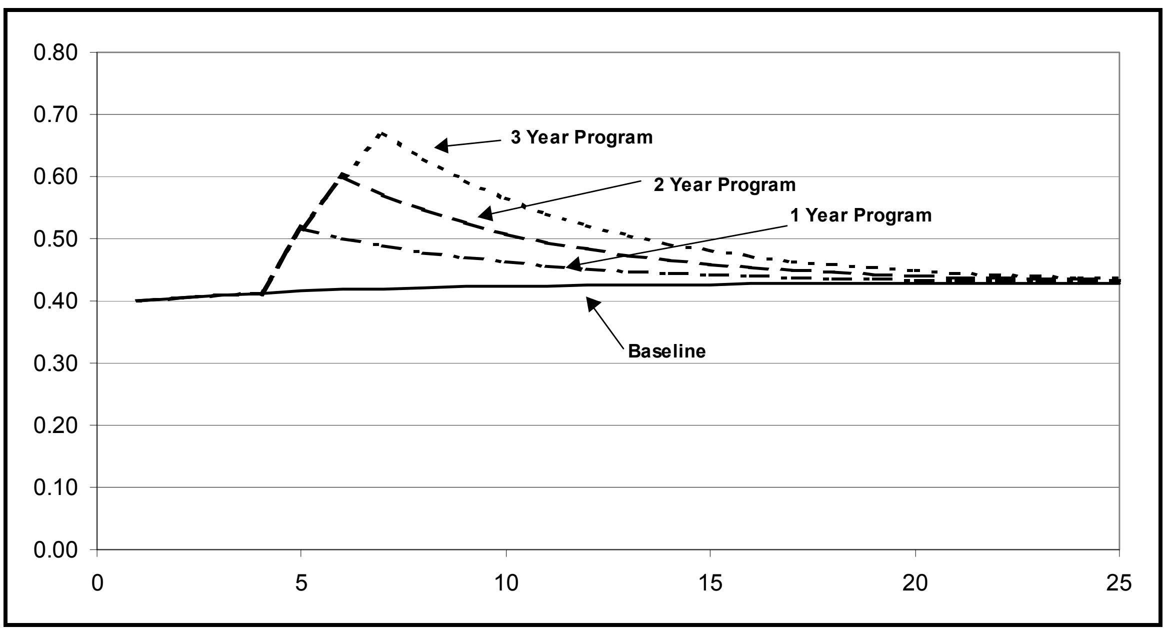
Note that in this formulation, the previous period's awareness level reflects the impacts of past interventions. Unless the awareness sustainability factor (α_0) is equal to zero, improvements in awareness will be sustained to some extent into the future beyond the life of the intervention. Note also that sustainability is not exclusive to market transformation. If resource acquisition, research and development activities, or infrastructure initiatives influence awareness in the current year, this impact may be sustained into future periods. While we could argue that market transformation interventions are designed explicitly to affect awareness in a more or less sustainable way, some sustainability in awareness may be associated with other types of interventions.

Figure 7-5 illustrates this point for one-year, two-year, and three-year intervention periods, using the following assumptions:

- Each year, the natural evolution of the market informs 8% of the previously unaware decision makers (α_2 =0.08).
- All decision makers can become aware (α_4 =1.0).
- The natural sustainability rate for awareness is 90% (α_0=0.9).
- The program administrator runs a program where the effect of one program year's offering is to inform 10% of those previously unaware of some EEM ($\alpha_3 INT_t$=0.1), as well as to increase the sustainability of awareness by 10 percentage points ($\alpha_1 INT_t$=0.1).

As shown in Figure 7-5, even with a large natural sustainability rate (90%), the impacts of the intervention on awareness wear off rapidly once the intervention is discontinued.

Figure 7-5: Impact of an Intervention Lasting One Year, Two Years, and Three Years



Of course, there may be several interventions aimed at increasing awareness. If so, the above expression can be generalized by relating λ_t to these interventions (call them $INT_{1t}, INT_{2t}, \ldots, INT_{Kt}$):

$$\lambda_t = \lambda_{1t} INT_{1t} + \lambda_{1t} INT_{2t} + \ldots + \lambda_{kt} INT_{Kt} \tag{4}$$

where each of the λ_{ik} represents the current period impact of intervention *k*. As an example, one of these parameters could reflect the effect of media exposure on awareness, where the associated intervention would be quantified as the number of media impressions. Another could reflect the impact of program-induced salesperson promotion of high efficiency equipment, and so on.

Indirect Effects on Awareness. Some interventions, like salesperson or architect training, may have indirect impacts on customer awareness. It should be recognized that the time paths of these impacts would depend upon the dynamics of the intervention's direct and indirect effects. Interestingly, some indirect interventions may have effects on awareness that do not immediately start to decline geometrically over time. It is relatively easy to revise the simple model above to reflect such indirect effects. For instance, customer awareness could be allowed to depend directly upon salesperson awareness of energy efficiency options, and a relationship could be incorporated indicating the effect of training on salesperson awareness. The awareness equation could be written as:

$$\begin{aligned} Awareness_t &= (\alpha_0 + \alpha_1 SPAware_t) Awareness_{t-1} \\ &+ (\alpha_2 + \alpha_3 SPAware_t)(\alpha_4 - Awareness_{t-1}) \end{aligned} \tag{5}$$

where $SPAware_t$ represents salesperson awareness in period *t*. The impact of the intervention (salesperson training) could be specified as:

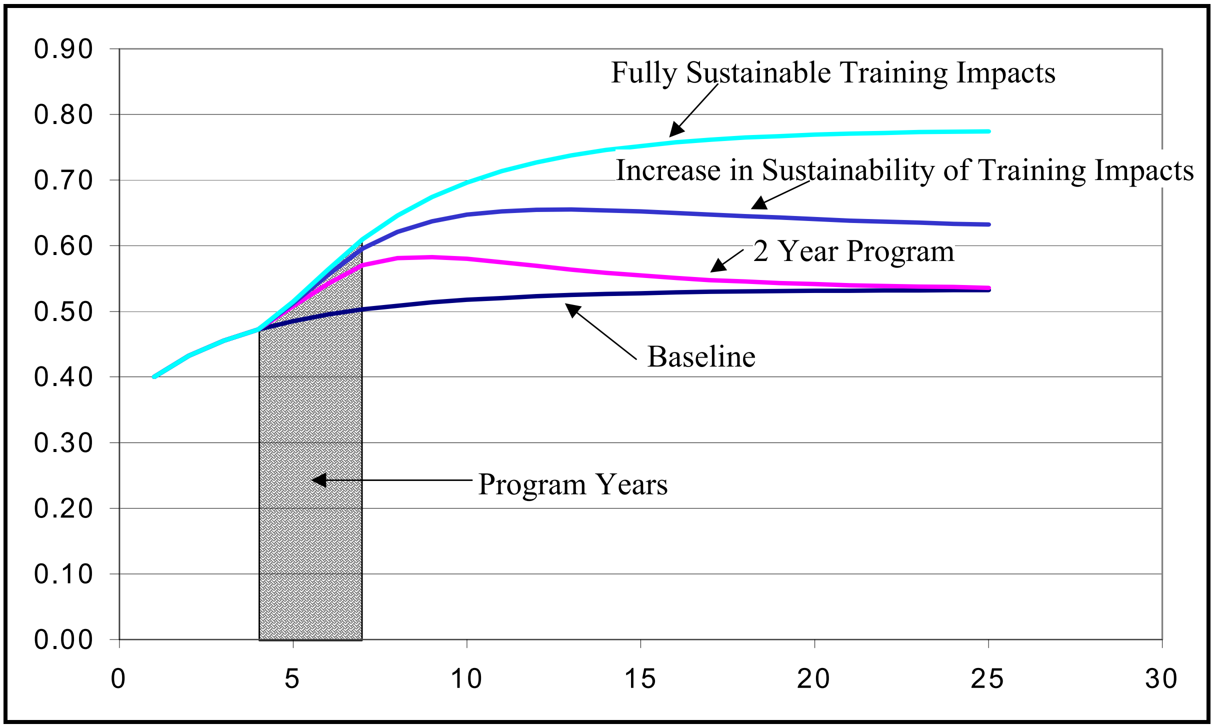
$$\begin{aligned} SPAwareness_t &= (\alpha_5 + \alpha_6 INT_t) SPAwareness_{t-1} \\ &+ (\alpha_7 + \alpha_8 INT_t)(\alpha_9 - SPAwareness_{t-1}) \end{aligned} \tag{6}$$

where α_8 represents the impact of salesperson training on the awareness of previously unaware salespersons and α_6 depicts the effects of the intervention on the retention of salesperson awareness. This formulation essentially recognizes that salesperson training has some degree of natural sustainability even after the training is discontinued, as reflected by the value of α_5. This sustainability tends to accentuate and prolong impacts on awareness. The parameter α_9 is the potential fraction of salespersons that can be made aware through the sales training. For example, a value of 0.80 indicates that 80% of all salespersons can be made aware through the sales training initiative.

Figure 7-6 shows the path of customer awareness associated with three years of a salesperson training initiative, where the following parameter values have been assumed: $\alpha_0=0.9$, $\alpha_1=.05$, $\alpha_2=0.08$, $\alpha_3=.1$, $\alpha_4=1.0$, $\alpha_6=.5$, $\alpha_7=.1$, $\alpha_8=.4$, and $\alpha_9=1.0$. Three alternative values of the sustainability fraction relating to the impact of the intervention on salesperson awareness are used: $\alpha_5=.7$, $\alpha_5=.9$, and $\alpha_5=1.0$. These assumptions reflect various levels of sustainability, with the value of 1.0 indicating complete sustainability. It is important to understand the implication of this latter value. Given salesperson turnover, full sustainability of the impacts of training would be observed only if the private market took over the function of training after the intervention was removed. Unless this happens, the intervention will have only transitory effects. Even though these effects may be important and contribute significantly to cost-effectiveness, they would not completely remove the need for further awareness-oriented interventions.

Note that, even with partial sustainability of salesperson awareness, the impacts of the training intervention on customer awareness actually grow for a while after the discontinuation of training before starting to decline. However, these effects do eventually decline except in the case where full sustainability is assumed, and this, as noted above, is likely to occur only when the private market takes over the function of training. The general point here is that different assumptions about the dynamics of the impact of an intervention can lead to a variety of paths of market effects. It should also be noted that market transformation interventions may lead to greater degrees of sustainability than resource acquisition as a result of their direct and indirect effects on awareness.

Figure 7-6: Impact of Salesperson Training on Customer Awareness



Demonstration Effects. Several prospective analyses of market effects, including some developed by the Northeast Energy Efficiency Partnerships, Inc. and the Northwest Energy Efficiency Alliance, have projected growing market effects after the removal of interventions. The models discussed above do not generate such time paths, even when full sustainability of impacts is assumed. That is, they may generate forecasts in which market effects stay constant over time, but do not yield forecasts in which market effects actually grow. Of course, other models may generate such forecasts. An example would be a model incorporating "demonstration effects" or the tendency for changes in activity to induce further changes through the demonstration of attractiveness. In this context, such a model would incorporate the phenomenon that aware decision makers make others aware. One formal option in this regard is a form of a Bass diffusion model (Bass 1969). While the Bass model is typically applied directly to adoptions, it can be applied to the concept of awareness formation as well.

A Bass diffusion version of the awareness model could be specified as:

$$Awareness_t = Awareness_{t-1} + (\alpha_{10} + \alpha_{11} INT_t + \alpha_{12} Awareness_{t-1})(\alpha_{13} - Awareness_{t-1}) \quad (7)$$

Note that this model is different from the general model specified above in two respects. First, the sustainability term (the coefficient on lagged awareness) is implicitly set equal to

1.0, which reflects that once one becomes aware, one stays aware.[5] Second, the demonstration effect is conveyed by the interaction of $Awareness_{t-1}$ and (α_{13} -$Awareness_{t-1}$). The intuitive interpretation of this interaction is that the more people are aware, the greater the proportion of unaware people who become informed during period *t*.[6] Note that the size of the demonstration effect depends on the parameter α_{12}.

Figure 7-7 depicts the influence of an intervention on awareness in the model encompassing different levels of the demonstration effect. In particular, Figure 7-7 illustrates the impacts of two years of interventions using the following assumptions.

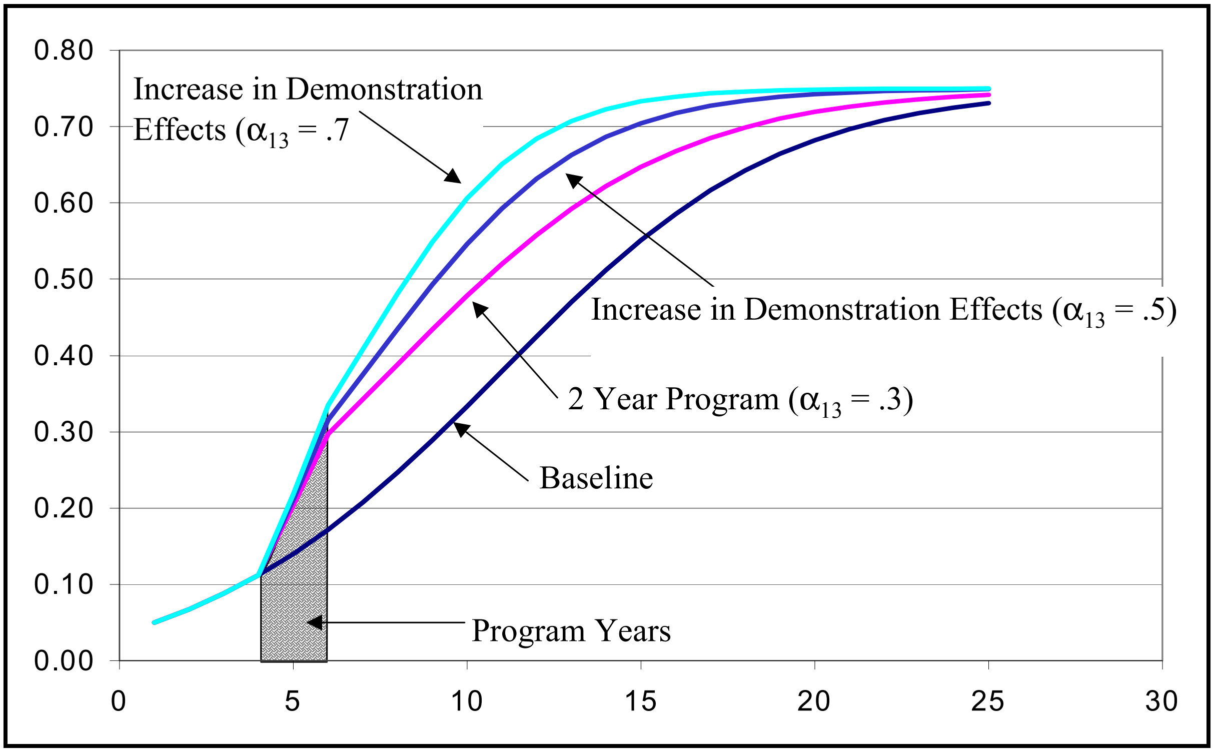
- Each year, the natural evolution of the market informs 1% of the previously unaware decision makers (α_{10}=0.01).
- Eighty percent of all decision makers can become aware (α_{13}=0.8).
- The program administrator runs a program where the effect of one program year's offering is to inform 10% of those previously unaware of some EEM ($\alpha_3 INT_t$=0.1).
- The demonstration effects vary with α_{12}=0.3, α_{12}=0.4, and α_{12}=0.5.

As shown, these models are capable of yielding growing effects on awareness over time, even after the intervention is withdrawn. Of course, the assumptions underlying this type of specification are probably quite optimistic. The assumption that decision makers who are aware never lose awareness ignores the fact that new decision makers replace old ones, that people forget, and that technologies change. The existence of strong demonstration effects is based on an assumption that individuals "mix" enough for all unaware individuals to be exposed to those who are aware. Nonetheless, some form of demonstration effect can probably be justified on theoretical grounds, and data can be used to test for its strength. The purpose here is not to argue for one model or the other, but rather to demonstrate the application of formal dynamic models to the estimation of market effects.

5 The parallel to this in the Bass model of adoptions is that an adoption cannot be rescinded or repeated.

6 Again, $_{13}$ reflects the potential for the proportion of decision makers that can become aware.

Figure 7-7: Impact of Demonstration Effects on Customer Awareness

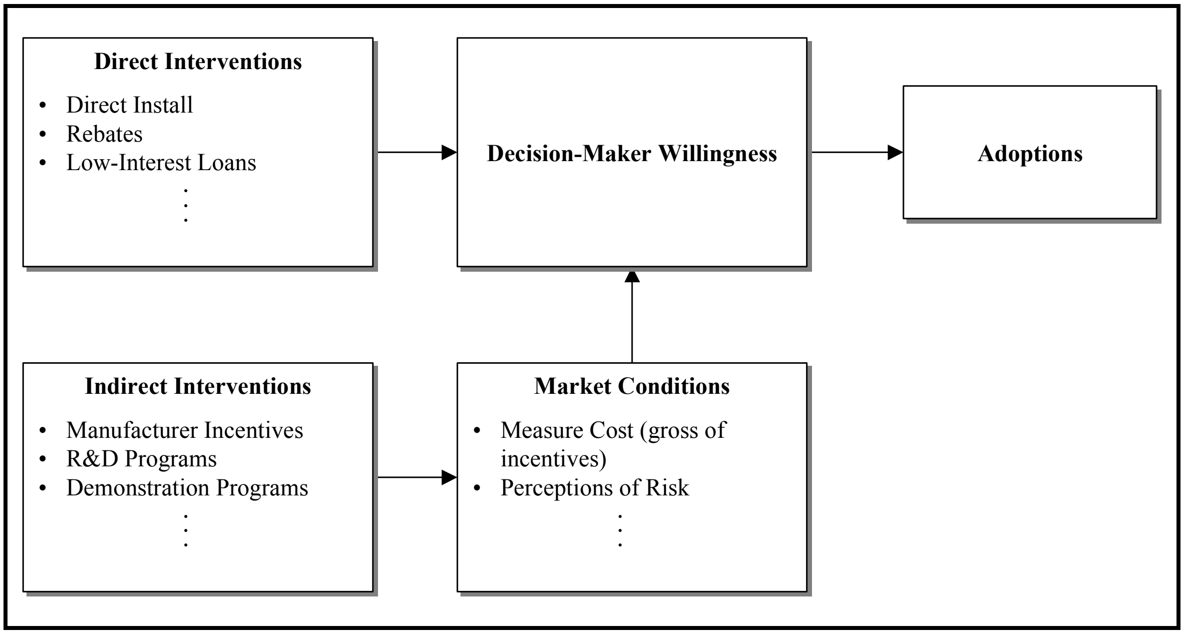


7.5.6. Willingness

Overview. In general, willingness refers to the decision maker's perceptions of the efficacy of adopting the measure in question. It is critical to understand that willingness in this context refers to the actual, not the reported, willingness of aware decision makers to adopt an energy efficient technology. Clearly, there may be major differences between reported and actual willingness to adopt, but we are unable to explore the reasons for these differences here. Suffice it to say that willingness would be measured in the development of this portion of the model by the proportion of aware customers who actually adopted the measure in question when it was available. In the simplest of resource acquisition frameworks, willingness was generally linked to a rate of return, a payback, or some other indicator of financial efficacy. However, under market transformation analysis, other determinants of willingness are also recognized, like the availability of financing, perceptions of risk, and concerns about performance. Moreover, the focus is sometimes on market imperfections that distort the perception of benefits, like split incentives and poor organizational practices.

As shown in Figure 7-8, specific interventions can have a direct impact on the level of willingness of the potential adopter or an indirect influence through informing individuals who influence the decision maker or changing market conditions. In assessing these effects, it should be remembered that willingness is a dynamic concept that can change over time, with or without interventions.

Figure 7-8: Intervention Effects on Willingness



Direct Effects on Willingness. Interventions may have direct effects on willingness to adopt an energy efficiency measure through the use of interventions that directly affect its perceived benefits and costs. Many resource acquisition initiatives focused on such interventions, including rebates, low- or zero-interest loans, or direct installation. Even these types of interventions may have effects in subsequent years because of the dynamics of willingness formation. In general, people tend to change their willingness only partially over time as conditions change. This can be expressed as:

$$\begin{aligned} Willingness_t &= (\beta_0 + \beta_1 INT_t) Willingness_{t-1} \\ &\quad + (\beta_2 + \beta_3 INT_t)(\beta_4 - Willingness_{t-1}) \end{aligned} \qquad (8)$$

where the following meanings can be attached to the parameters:

- β_0 represents the proportion of previously willing customers remaining willing in the absence of the intervention. This is a natural sustainability rate for willingness.[7]
- β_1 reflects the impact of the intervention on the proportion of previously willing customers who stay willing.

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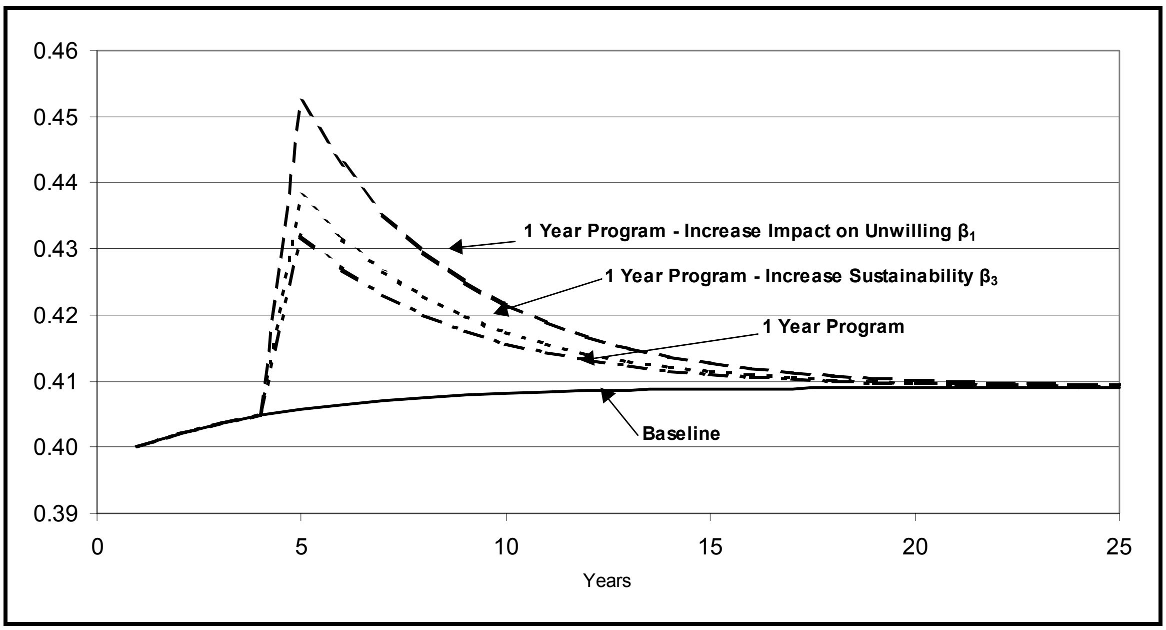
7 The value of the parameter $_0$ is probably low. This means that the effects of changes in willingness induced by activities directly attributable to the intervention (say, rebates) will probably be short-lived.

- β_2 reflects the proportion of unwilling customers who become willing during the period due to reasons unrelated to the intervention. Such changes in willingness could be due to changes unrelated to the intervention in measure costs, measure features, perceived measure risks, or energy prices.
- β_3 is the proportion of previously unwilling decision makers made willing in period *t* through interventions. This term generally reflects intervention-induced changes in the perceived benefits and costs of the measure in question.
- β_4 is the potential proportion of decision makers that can be made willing through interventions.

Figure 7-9 illustrates the sensitivity of these parameters on the willingness impact of a direct intervention. In particular, Figure 7-9 shows the impact of a one year intervention on willingness (β_0=.9, β_1=.05, β_2=.09, β_3=.01, and β_4=1.0), the impact of doubling the impact on the sustainability of the intervention (β_1=.1), and the impact of doubling of the impact on the previously unwilling decision makers (β_3=.02).

Figure 7-9: Direct Intervention Impacts on Willingness



Indirect Effects on Willingness. Some types of interventions may have more complex and long-lasting indirect impacts on willingness. This would be true, for example, of an intervention that has more or less permanent impacts on perceived benefits and costs or perceived risks. Suppose, for instance, that the initiative induces a permanent decrease in measure costs. Then, even after the intervention is withdrawn, the current period impact will persist. This phenomenon could be expressed as follows. First, note that the impact on willingness is a direct function of the payback on the measure in question:

$$Willingness_t = (\beta_0 + \beta_1 Payback_t)Willingness_{t-1} + (\beta_2 + \beta_3 Payback_t)(\beta_4 - Willingness_{t-1}) \quad (9)$$

where both β_1 and β_3 are negative to reflect the inverse relationship between payback and measure attractiveness. The impact of the intervention on the payback in terms of its sustainability and its immediate impact can be represented as:

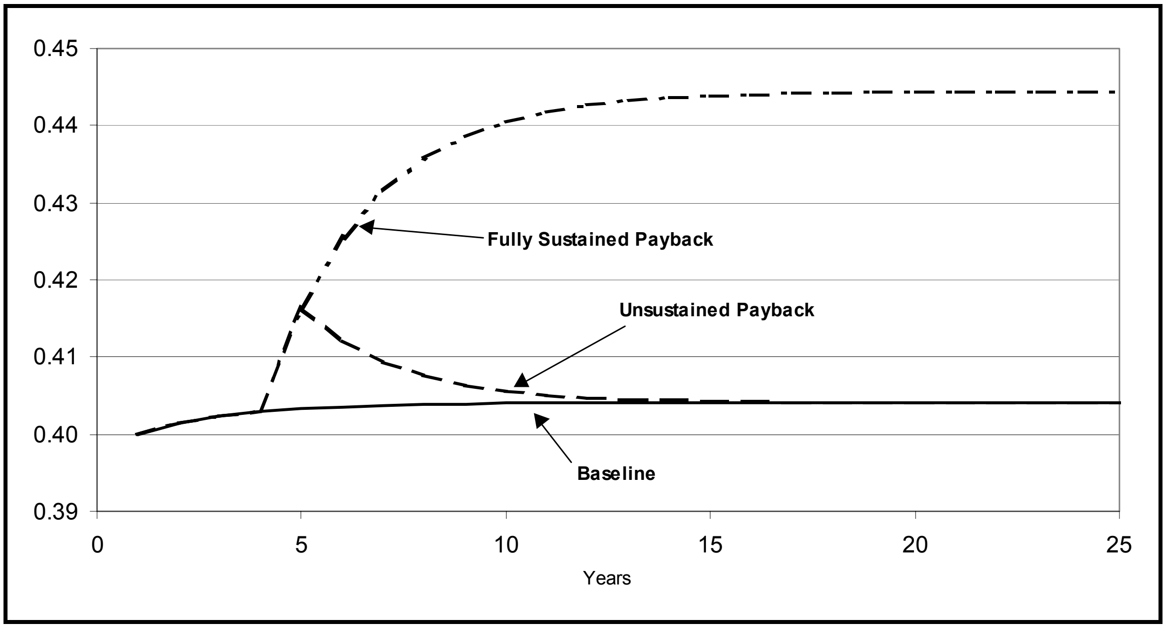
$$Payback_t = \beta_5 + \beta_6 Payback_{t-1} + \beta_7 INT_t \quad (10)$$

In this relationship, the coefficient β_5 is the assumed payback given no interventions, β_7 reflects the current period impact of an intervention on the payback, and β_6 reflects the sustainability of this impact on the payback after the intervention is withdrawn.[8] Here one can distinguish among different types of interventions. Some, like rebates, can be expected to have very low sustainability (β_6 will be low, perhaps even 0). Others, such as initiatives designed to improve manufacturing processes, may have highly sustainable impacts (i.e., β_6 will be close to 1.0). Only if the payback is lowered permanently will the overall impact of the intervention be fully sustainable.

Note that, in more general terms, the sustainability of an intervention that indirectly affects willingness will depend on two factors: the sustainability of the intervention's effects on a determinant of willingness, and the sustainability of the response of willingness to change in that determinant. In the example discussed above, the overall sustainability would be dependent upon the value of β_0 in the willingness equation as well as the value of β_6) in the payback equation. Figure 7-10 presents the simulation of willingness impacts of two one-year programs: one with fully sustainable impacts on payback (β_6 = 1.0) and one with completely unsustained impacts on payback (β_6 = 0.0). This has some implications for the sustainability of various intervention strategies. Resource acquisition strategies, which tend to target short-lived changes in measure paybacks, can be expected to have correspondingly short-lived effects on willingness. However, market transformation and research and development interventions that focus on changing perceptions relating to risk and performance are likely to induce effects with greater sustainability.

8 Note also that the long-term steady state for willingness can be expressed in terms of payback and the model parameters. In particular, the steady state for willingness is $(_{2}+ {}_{3}Payback_t)/(1-(_{0}+ {}_{1}Payback_t))$.

Figure 7-10: Willingness Impacts of Interventions with Different Sustainability



Demonstration Effects. As discussed earlier in the context of awareness formation, it is possible that willingness is affected by demonstration effects. For instance, these effects could affect willingness through changes in risk perceptions, discount rates, or impressions of aesthetics. A willingness model incorporating such demonstration effects might be specified as a Bass model of the form:

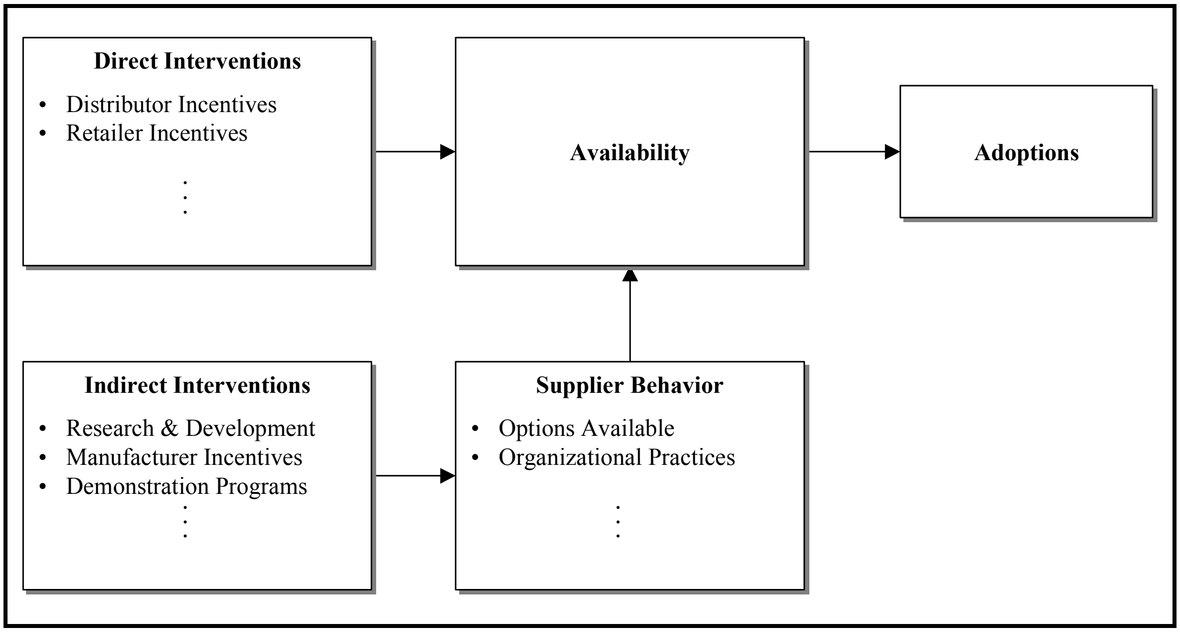
$$Willingness_t - Willingness_{t-1} = \begin{pmatrix} \beta_8 + \beta_9 INT_t \\ +\beta_{10} Willingness_{t-1} \end{pmatrix} \left(\beta_{11} - Willingness_{t-1}\right) \quad (11)$$

where the parameter β_{10} reflects the strength of the demonstration effect. As shown for awareness, this type of model would be capable of generating growing willingness levels even after the removal of interventions. Again, however, such a model would implicitly require somewhat unrealistic assumptions. For instance, it would assume that once willing, a decision maker would never become unwilling. Given the strong dependence of willingness on variable factors like paybacks, this type of Bass model would probably not apply particularly well to willingness.

7.5.7. Availability

Availability is a key factor for some energy efficiency measures, especially emerging technologies. Due to market inertia, the availability of new measures may develop slowly over time in response to both intervention and non- intervention factors. As illustrated in Figure 7-11, interventions or portfolios of interventions can affect availability directly through interventions that directly affect stocking practices (say, retailer and distributor incentives), or indirectly through interventions that change the characteristics and perceptions of the energy efficiency products (e.g., incentivizing the broadening of product options or demonstrating the viability of technologies). These effects are considered below.

Figure 7-11: Intervention Effects on Availability



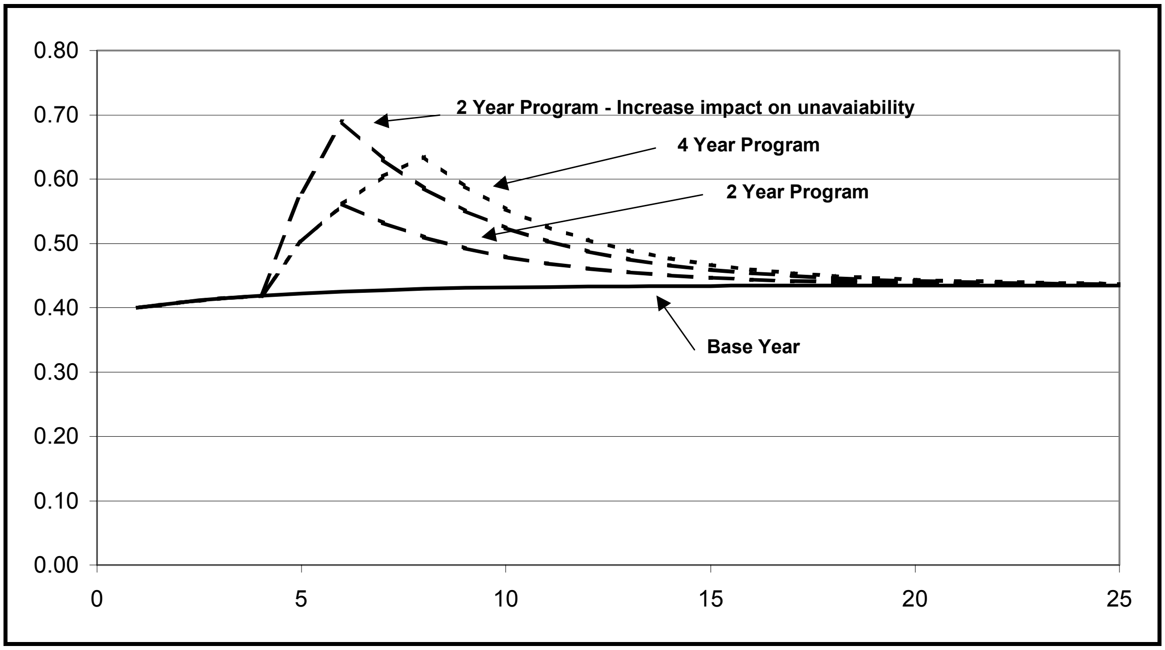
Direct Intervention Impacts on Availability. The following specification can be used to capture the dynamics of direct intervention impacts on availability:

$$\begin{aligned} Availability_t = {} & (\gamma_0 + \gamma_1 INT_t) Availability_{t-1} \\ & + (\gamma_2 + \gamma_3 INT_t)(\gamma_4 - Availability_{t-1}) \end{aligned} \qquad (12)$$

where γ_0 is the availability sustainability rate in the absence of interventions, γ_2 is the natural rate of new availability, and γ_1 and γ_3 are the intervention impacts. Given the structure of this specification, the impacts of temporary interventions will be only partially sustainable, with the degree of post-intervention sustainability depending on the value of γ_0. The parameter γ_4 is the potential availability for the EEM.

Figure 7-12 illustrates the impact on availability of an increase in the impacts and operating the intervention for a longer period. In particular, Figure 7-12 presents a two-year intervention (γ_0=0.9, γ_1=0.05, γ_2=0.1, γ_3=0.1, and γ_4=1.0,), a two-year intervention with impacts doubled (γ_3=0.2), and a four-year program using the initial impacts.

Figure 7-12: Effects on Availability of Increases in the Impacts and Duration of the Intervention



Indirect Impacts on Availability. A variety of interventions may have indirect impacts on the availability of energy efficiency measures. Manufacturer incentives for the development of energy efficiency options (e.g., the Golden Carrot Program) may more or less permanently affect availability. To capture this kind of effect, the following specification might be used:

$$Availability_t = (\gamma_0 + \gamma_1 Options_t) Availability_{t-1} + (\gamma_2 + \gamma_3 Options_t)(\gamma_4 - Availability_{t-1}) \qquad (13)$$

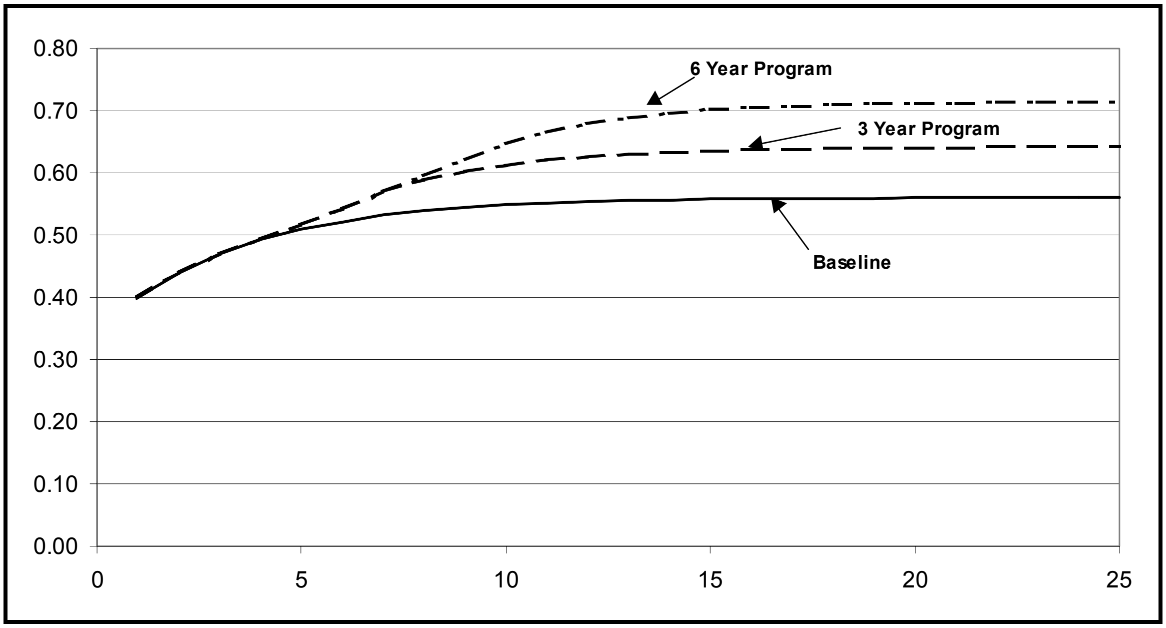
where $Options_t$ is the number of equipment options in the marketplace and where:

$$Options_t = Options_{t-1} + \gamma_5 INT_t \qquad (14)$$

Note that the coefficient of the lagged value of the number of options is equal to 1.0, which captures the assumption that changes in the number of options are permanent. This essentially means that manufacturers would need to maintain the higher number of options even in the absence of inducements. For this to happen, purely private market inducements (profits associated with offering these options) would need to be altered permanently. This type of effect, which is generally associated with market transformation interventions, could occur for instance if manufacturers are induced to recognize the enhanced profitability of diverse product offerings. Obviously, this assumption could be softened to allow for limited sustainability of increases in the range of options. The limited sustainability would reflect the inability of the market to provide the incentives necessary to induce the manufacturer to maintain the higher range of options.

Figure 7-13 depicts the impact of conducting the intervention for three years and six years, using the following assumed parameter values (γ_0=0.9, γ_1=0.05, γ_2=0.1, γ_3=0.1, γ_4=1.0, and γ_5=0.1,).

Figure 7-13: Effects on Availability of Interventions of Various Lengths



Demonstration Effects. Demonstration effects could also influence the impact of intervention on availability. Under some assumptions, such demonstration effects could significantly amplify these impacts and perhaps cause them to grow over time after an intervention is withdrawn.

7.5.8. Integration of Elements

The joint impacts of interventions that affect awareness, willingness, and availability can be assessed through the combination of the relationships affecting these direct determinants. This system of relationships comprises a simulation model that can be used to develop forecasts of adoptions with and without certain interventions, and these forecasts can be used to estimate market effects over the forecast period.

If we were to limit ourselves to the simple direct effects discussed above, for instance, the model could be represented as:

$$AdoptionsRate_t = Awareness_t \bullet Willingness_t \bullet Availability_t \qquad (15)$$

where:

$$Awareness_t = (\alpha_0 + \alpha_1 INT_t)Awareness_{t-1} + (\alpha_2 + \alpha_3 INT_t)(\alpha_4 - Awareness_{t-1})$$

$$Willingness_t = (\beta_0 + \beta_1 INT_t)Willingness_{t-1} + (\beta_2 + \beta_3 INT_t)(\beta_4 - Willingness_{t-1})$$

$$Availability_t = (\gamma_0 + \gamma_1 INT_t)Availability_{t-1} + (\gamma_2 + \gamma_3 INT_t)(\gamma_4 - Availability_{t-1})$$

Similar models could be specified to include indirect effects and/or to incorporate demonstration effects.

7.5.9. Estimating Key Parameters

The values of the key parameters in the awareness, willingness, and availability equations are subject to fairly straightforward interpretation, and can be estimated in the course of planning and/or MA&E. In the planning process, the initial parameter values can be projected based on the designs of the initiatives and information obtained from other similar initiatives, or perhaps on various judgmental approaches. The application of Delphi approaches would appear to be a particularly attractive option in this regard, as would interviews with customer representatives, program staff, or other knowledgeable parties.

For the purposes of retrospective MA&E and cost-effectiveness analysis, these parameters can be estimated in a variety of ways. A number of options are discussed below.

Awareness. In the simple models presented above, the parameters relating to awareness reflected fairly concrete concepts, like the current period impact of an intervention on customer awareness or salesperson awareness, sustainability rates for awareness, and so on. Many of the techniques discussed in Section 6 could be used to estimate these parameters.

- Current awareness levels could be estimated using decision-maker and decision-influencer surveys. These estimates could be developed before the intervention or during the operation of the intervention, although their application to calibrating the model would differ depending upon the context in which the research was done.
- The current period impact of marketing and promotions on decision-maker (e.g., customer) awareness could be assessed using several of the techniques described in Section 6, including pre/post surveys and self-reported impacts from surveys of decision makers and decision influencers.
- The current period impact of decision-influencer (e.g., salesperson) training on decision-maker (salesperson) awareness could be estimated using pre- and post-training tests, as is now being done for the Residential Lighting and Appliance Program.

- The effect of decision-influencer (salesperson) awareness on decision-maker (customer) awareness could be ascertained through secret shoppers, customer exit surveys, comparisons of customer awareness across areas with various levels of salesperson awareness or sales person training, decision-maker surveys, or other approaches.
- The overall sustainability rates for customer and/or salesperson awareness could be determined through customer and/or salesperson surveys immediately before and after interventions. At times, sustainability factors can probably be inferred indirectly from other kinds of data. For instance, a sustainability factor could be estimated for a salesperson training intervention by looking at turnover rates for salespersons.

Willingness. Parameters associated with the willingness portion of the model could also be estimated using relatively standard techniques like those discussed in Section 6.

- Surveys of buying intentions could be used to estimate current levels of willingness.
- Conjoint analysis could be used to estimate the impacts of specific product attributes and perceptions on stated willingness.
- Payback distributions estimated with survey data could be used to infer relationships between willingness and the components of payback.
- Panel data or sequential surveys on buying intentions before and after interventions could be used to assess the impacts of these interventions.

Availability. Finally, availability parameters could be developed using a wide range of techniques.

- Floor stocking studies, shelf surveys, and other types of analysis could be used to assess current availability.
- Statistical analyses of the changes in stocking patterns before and after certain interventions, or comparisons of floorstock shares across areas with and without the intervention in question, could be employed to estimate the impacts of these interventions on availability.
- Retailer and manufacturer surveys could be used to assess impacts of interventions on decisions relating to availability.

A key point here is that the use of a simulation model of this sort does not necessitate that all parameters are estimated using the same approach. Eclectic approaches can be used.

7.5.10. Calibration to First-Year Adoptions

Before implementing the simulation model, it would be useful to calibrate it into current adoption rates. Although in theory there are various ways to calibrate the model (including using time series data to estimate all of the parameter values), a simple process is likely necessary in practice. First, suppose we develop initial estimates of the model parameters and construct the estimated model as:

$$AdoptionsRate_t^0 = Awareness_t^0 \bullet Willingness_t^0 \bullet Availability_t^0 \quad (16)$$

where:

$$\begin{aligned} Awareness_t^0 &= (\alpha_0^0 + \alpha_1^0 INT_t)Awareness_{t-1}^0 \\ &+ (\alpha_2^0 + \alpha_3^0 INT_t)(\alpha_4^0 - Awareness_{t-1}^0) \end{aligned} \quad (17)$$

$$\begin{aligned} Willingness_t^0 &= (\beta_0^0 + \beta_1^0 INT_t)Willingness_{t-1}^0 \\ &+ (\beta_2^0 + \beta_3^0 INT_t)(\beta_4^0 - Willingness_{t-1}^0) \end{aligned} \quad (18)$$

$$\begin{aligned} Availability_t^0 &= (\gamma_0^0 + \gamma_1^0 INT_t)Availability_{t-1}^0 \\ &+ (\gamma_2^0 + \gamma_3^0 INT_t)(\gamma_4^0 - Availability_{t-1}^0) \end{aligned} \quad (19)$$

where the superscript *0* denotes the initial estimate of each parameter or the implied current value of the variable in question.

No matter how careful the estimation of model parameters, there is no reason the initial estimate of the adoption rate should be equal to the actual current rate. This is partially the result of the very simple structure of the model—for instance, the fact that the adoption rate is presumed to be the product of the three immediate determinants. As a result, it is wise to calibrate the model prior to using it. There are several options for doing so. Perhaps the simplest option is to develop a multiplier for the adoption rate equation that makes it consistent with the observed current adoption rate. This multiplier would be the value, call it *M*, that makes the following equation true:

$$AdoptionsRate_t^a = M \bullet Awareness_t^0 \bullet Willingness_t^0 \bullet Availability_t^0 \quad (20)$$

where the superscript *a* denotes the actual value in time *t*. An alternative would be to adjust the parameter values from equations 17 to 19 judgmentally to make the predicted adoption rate equal to the actual rate in the current period.

7.5.11. Simulation of Market Effects

Once the model parameters are estimated and the model is calibrated to current adoptions, the model can be used to perform a series of simulations under various scenarios. To illustrate this application of the model, a series of simulations has been performed with alternative assumed parameter values and strategies. Given the simplicity of the model, this process is a fairly straightforward spreadsheet exercise. Baseline assumed parameter values are provided in Table 7-1.[9]

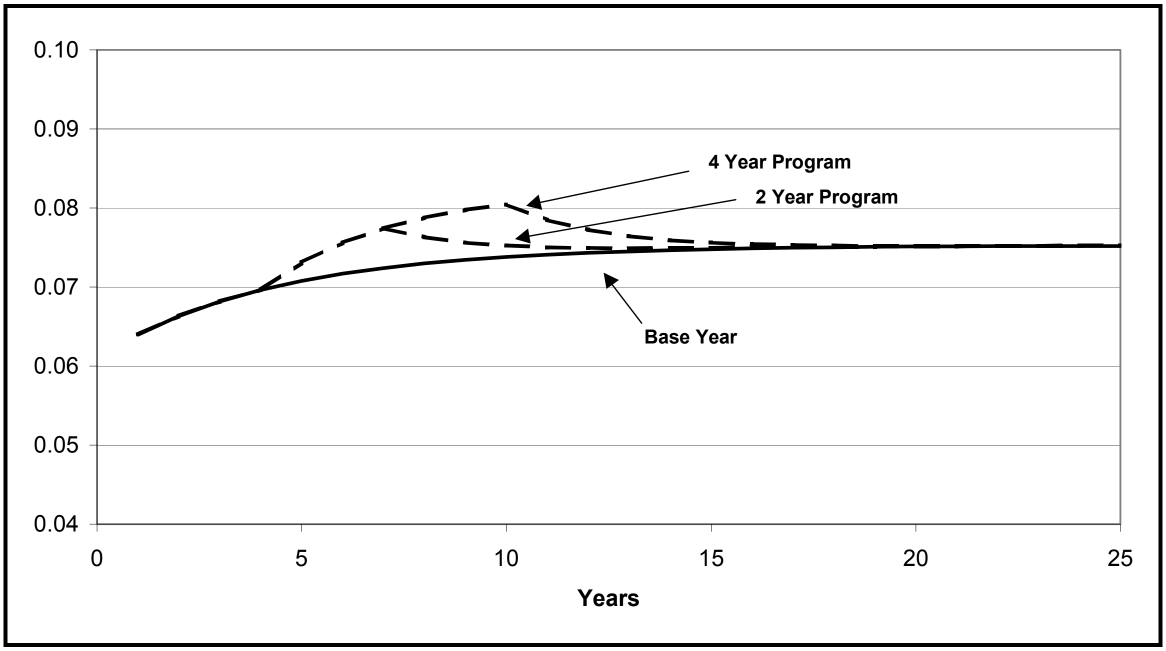
Table 7-1: Baseline Assumed Parameter Values

	Equation		
Parameter Concept	**Awareness**	**Willingness**	**Availability**
Sustainability	.9	.9	.9
Intervention Impact on Sustainability	.1	.05	.05
Natural Increase	.08	.09	.1
Current Year Intervention-Induced Increase	.1	.01	.1

[9] Note that the potential is set to one for awareness ($_4$= 1.0), willingness ($_3$=1.0) and availability (γ_4=1.0).

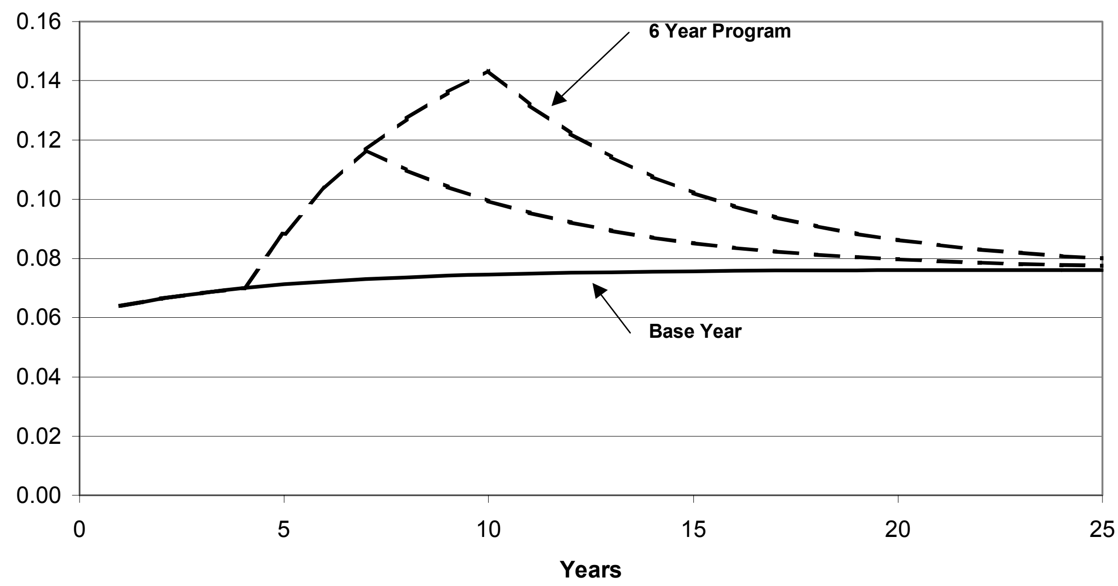
Multi-Year Intervention Offering Rebates. Figure 7-14 illustrates the effects from a two-year and four-year rebate intervention. In both cases, the impacts of the rebates on payback are assumed to last only for as long as the interventions are offered. However, the impacts from the rebates are sustained to some extent by the indirect impact on willingness. This might result from more or less permanent impacts on perceived benefits and costs or perceived risks due to the intervention of rebates.

Figure 7-14: Effects on Adoptions of Multi-Year Rebate Initiative



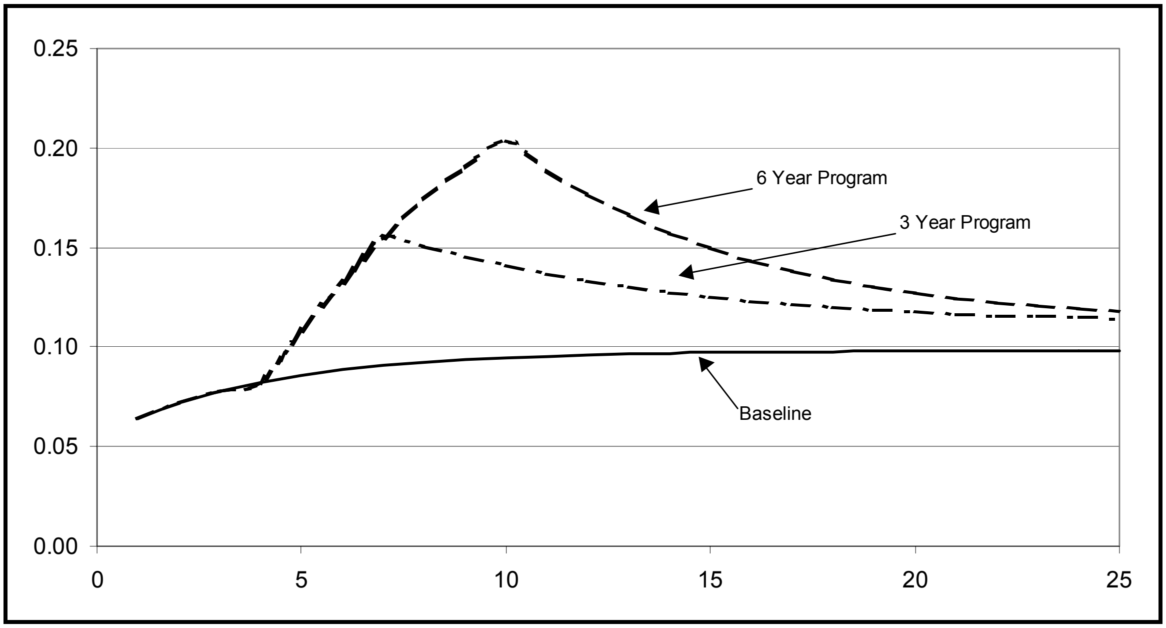
Multi-Year Intervention Offering Informational Services. Figure 7-15 illustrates an example of a three-year and six-year informational initiative assumed to indirectly impact awareness. The time path of adoptions from the model simulations provides an insight into the sustainability of the effects of the informational initiative on adoptions. For instance, to the extent that informational impacts may not be completely sustainable might signal the need for changes in intervention strategies. These changes might include periodic reinforcement of information services and continued training.

Figure 7-15: Effect on Adoptions of an Initiative Offering Informational Services



Initiative Offering Manufacturing Incentives for Research and Development. This example illustrates a three-year and six-year initiative offering incentives to manufacturers to develop a new high efficiency alternative. As shown in Figure 7-16, the intervention has caused permanent impacts on the adoptions of high efficiency measures through its indirect effect on measure availability.

Figure 7-16: Effects on Adoptions of an Initiative Offering Manufacturer Incentives for Research and Development



7.6 Summary and Conclusions

7.6.1. Summary

This section has discussed market dynamics and the use of dynamic models to estimate market effects. As shown in Section 8.3, baselines for market effects need to be recognized as dynamic phenomena. That is, baselines change over time and are influenced by past activity attributable to the intervention. Developing a baseline involves specifying and estimating the relationships that determine the market characteristic for which the baseline is being determined. Section 8.4 discusses some options for forecasting market effects, including Delphi approaches, analyses of time series market data such as diffusion models and market share models, and adoption process models.

Section 8.5 outlines a general dynamic modeling framework that can serve as a framework for estimating long-term market effects. The approach has some of the spirit of an adoption process model, in that it explicitly incorporates awareness formation, willingness determination, and availability. It can also be modified to incorporate some of the flavor of diffusion models by including demonstration effects in the determination of awareness, willingness, and availability. The model can be specified to incorporate both direct and indirect effects of various interventions. Some selected model results were used to illustrate the application of the framework to the estimation of market effects. Furthermore, methods of parameterizing the model and calibrating it to observed behavior were discussed.

7.6.2. Conclusions

The most recent evaluations of market transformation initiatives have focused on near-term market effects. In order to assess the cost-effectiveness of all publicly funded interventions used in a specific market, however, it is necessary to estimate the ultimate impacts of these interventions on adoptions and energy and demand savings. Formal dynamic frameworks like the ones discussed in this monograph could be extremely useful tools for helping planners and evaluators understand the process by which market interventions (market transformation as well as other interventions) affect near-term and intermediate-term indicators as well as adoptions of energy efficiency measures. Of course, it should be recognized that the models discussed here are meant only to illustrate the application of dynamic models to the estimation of market effects.

The development of frameworks like the ones described above offers several distinct advantages over more heuristic approaches.

- The process of constructing this type of model forces planners to make specific assumptions about the impacts of interventions. These assumptions relate to paths of influence of interventions, as well as to the values of the model parameters.
- In general, each model parameter has a specific meaning. Each one provides a means of formalizing an assumption or observation about the marketplace.
- Models representing a wide range of phenomena can be developed and tested. For instance, as shown above, both the direct and indirect effects of interventions on the market can be modeled. Moreover, to the extent that the context of the analysis warrants it, various types of demonstration effects that may enhance sustainability can be taken into account.
- Once the model is specified in conceptual terms, it can provide a framework for designing evaluations. That is, it focuses evaluations partly on the estimation of key parameters. From another perspective, the formal simulation model provides an overall framework for integrating the results of evaluations.
- Once parameterized and calibrated to current adoption rates, the model offers a means of developing specific intervention strategies. That is, the model can be used to simulate different combinations of interventions as well as various tactics for implementing these interventions over time.

Constructing and parameterizing such frameworks will obviously require a significant amount of effort. Nonetheless, several factors may act to keep the required effort manageable:

- Parameters can be estimated using a variety of approaches. This could entail a mix of time series econometric analyses, judgmental approaches, and survey-based techniques.
- Some parameters are probably reasonably transferable. As a result, the impact analysis of a given residential intervention may yield parameter estimates that can be applied to the other evaluations. This practice has been followed quite frequently in the evaluation of resource acquisition initiatives. For instance, it is common for a planner or an evaluator to select a net-to-gross ratio on the basis other studies of similar initiatives.
- Sensitivity analysis is fairly easy to conduct using the types of simple models specified above. This sensitivity analysis can be used to test the importance of various parameter values, and analysis can be focused on those that prove to be most critical.

8

Assessment of Cost-Effectiveness

8.1 Overview

This section deals with the assessment of the cost-effectiveness of energy efficiency initiatives, with an emphasis on applying the California Public Purpose Test (PPT) to the assessment of market transformation initiatives. It has a strong link to several previous chapters. Indeed, the support of cost-effectiveness analysis has been a central theme of this report. Some of the more obvious key interconnections are highlighted below.

- The theoretical roots of public cost-effectiveness analysis are based on improvements in allocative efficiency brought about by public initiatives and policies. The effects of energy efficiency initiatives on allocation were discussed in Section 2. As will be demonstrated, the design of the PPT is consistent with the welfare analysis contained in Section 2.
- The perspective taken in this section can be applied to an entire portfolio of policy interventions, including the five types discussed in Section 3. Of course, it should be recognized that one of these interventions types—equity initiatives—is typically justified on the grounds of equity, as well as allocative efficiency. The cost-effectiveness tests that will be discussed do not explicitly consider equity.
- Several design issues discussed in Section 4 are also pertinent to the assessment of cost-effectiveness, in the sense that a carefully crafted cost-effectiveness analysis will provide useful feedback on such design issues.
- Chapters 5 and 6 discussed the purposes and uses of program tracking and cost-effectiveness analysis, issues that need to be confronted in market progress evaluations, and the steps taken in market progress evaluation. While tracking and market progress evaluations serve a variety of purposes broader than just the estimation of cost-effectiveness, cost-effectiveness analysis is strongly dependent on those activities.
- Section 7 discussed the use of dynamic frameworks to forecast the market effects of energy efficiency policies. The primary focus was on forecasting adoptions effects, which are the dominant (but not sole) drivers of the benefits and costs covered by cost-effectiveness analysis. The cost-effectiveness framework incorporates these forecasts of adoptions, associates them with the relevant costs and benefits, and integrates them into the determination of cost-effectiveness.

8.2 Introduction

The remainder of this section discusses conceptual and practical issues associated with assessing cost-effectiveness. Subsection 8.3 discusses historical approaches to cost-effectiveness analysis in California and describes the current policy rules relating to cost-effectiveness. Subsection 8.4 focuses on the PPT, the framework currently used in California. It defines the structure of the PPT and discusses the measurement of various categories of benefits and costs. Subsection 8.5 considers the consistency of the framework with the theoretical concepts of benefits and costs defined in the economic efficiency analysis presented in Section 2. Subsection 8.6 considers various policy issues associated with the application of the PPT. Subsection 8.7 summarizes the analysis and offers conclusions and recommendations.

8.3 Policy Background

8.3.1. Pre-1998 Cost-Effectiveness Tests

A variety of frameworks has historically been used in California to assess cost-effectiveness of energy efficiency initiatives. In the late 1970s, the CPUC implemented a least cost planning strategy, whereby demand-side reductions in energy usage were compared to supply additions. The *Standard Practice Manual*, sponsored jointly by the CPUC and the CEC, provided several methodologies for conducting cost-benefit analyses of utility-administered demand-side management (DSM) programs. This document was created to provide a "standardized methodology for benefit-cost analyses" of utility programs in California. The first version of the *Standard Practice Manual* was published in 1983. Prior to its development, "no such official guidelines exist[ed] for utility-sponsored programs" (p.1). A revised version, published in 1987, incorporated numerous changes and clarifications that resulted from public workshops and comments and papers prepared by many participants in California's energy efficiency market (CEC, CPUC 1987).

The *Standard Practice Manual* established several tests that can be used to evaluate the cost-effectiveness of publicly funded energy efficiency initiatives. These include the Ratepayer Impact Measure Test (RIM), the Utility Cost Test (UC), the Participant Test, the Total Resource Cost Test (TRC), and the Societal Test. Definitions of these tests as they appear in the *Standard Practice Manual* are provided below. These metrics vary in terms of 1) their applicability to different program types (load management, conservation, fuel substitution), 2) the cost and benefit elements included in the calculation, 3) the methods by which the cost and benefit elements are computed, and 4) the uses of the results.

- ***Ratepayer Impact Measure Test (RIM).*** "The Ratepayer Impact Test measures what happens to customer bills or rates due to changes in utility revenues and operating costs caused by the program … This test indicates the direction and magnitude of the expected change in customer bills or rate levels" (p.17).

- ***Utility Cost Test (UC).*** "The Utility Cost Test measures the net costs of a demand-side management program as a resource option based on the costs incurred by the utility … and excluding any net costs incurred by the participant. The benefits are similar to TRC benefits. Costs are defined more narrowly" (p.33).
- ***Participant Test.*** "The Participant Test is the measure of the quantifiable benefits and costs to the customer due to participation in a program. Since many customers do not base their decision to participate in a program entirely on quantifiable variables, this test cannot be a complete measure of the benefits and costs of a program to a customer" (p.9). The Participant Test assesses cost-effectiveness from the participating customer's perspective.
- ***Total Resource Cost Test (TRC).*** As defined in the *Standard Practice Manual,* "[t]he Total Resource Cost Test measures the net costs of a demand-side management program as a resource option based on the total costs of the program, including both the participants' and the utility's costs" (p. 25).
- ***Societal Test.*** The Societal Test, a modified version of the TRC, adopts a societal rather a utility service area perspective. The primary difference between the Societal and TRC test is that the Societal Test "accounts for externalities… excludes tax credit benefits, and uses a societal discount rate" (p.25).

Beginning in 1995, to be eligible for ratepayer funding, DSM programs that are eligible for utility incentives (shareholder earnings) had to be cost-effective on a forecast basis. Each shared-savings program had to pass both the TRC and UC tests of cost-effectiveness as a condition for funding (CPUC 1999). This was not the case for other programs, such as general information programs (CEC 1987).

> *"For generalized information programs (e.g. when customer are provided generic information on means of reducing utility bills without the benefit of on-site evaluations or customer billing data) cost-effectiveness tests are not expected because of the extreme difficulty in establishing meaningful estimates of load impacts."*

8.3.2. Post-1998 Cost-Effectiveness Tests

California State Assembly Bill (AB) 1890 was passed in 1996. In addition to restructuring California's electric power industry, AB 1890 established a surcharge to ensure the funding of energy efficiency programs. Subsequently, CPUC Decision 97-02-014 brought about major changes in California's energy efficiency industry (CPUC 1997). This decision represented a major shift in the CPUC's policy objectives with respect to ratepayer-funded energy efficiency programs from strictly achieving energy and demand savings to transforming markets and to privatizing the market for energy efficiency products and services. The CPUC also created the California Board for Energy Efficiency (CBEE), an advisory body to assist the CPUC in establishing and implementing energy efficiency policies in the state.

The changes in policy objectives with respect to these initiatives motivated the CBEE and its Technical Service Consultants to examine the applicability of the existing cost-benefit analysis methodologies to the new market transformation paradigm. Their efforts focused on 1) better aligning the standard of cost-effectiveness with the CBEE's policy rules, and 2) standardizing the practice of incorporating non-energy benefits/costs and externalities in the cost-benefit analyses. They called their new test the Public Purpose Test (PPT) and recommended that it be adopted as part of a revision to the CPUC's Policy Rules for Energy Efficiency Activities.

The PPT is based upon the Societal Test, and therefore accounts for positive and negative externalities and non-energy benefits and costs. The TRC and Societal Tests both allow for the inclusion of spillover effects, but the estimation of spillover effects appears to be spotty and inconsistent across the utilities. The PPT is designed to account for non-energy benefits and costs and spillover effects more comprehensively and accurately than the Societal Test.

> *"As currently described in the Standard Practice Manual … the Societal Test does not clearly allow for the inclusion of all non-energy benefits or costs (although it does appear to allow for the inclusion of some non-energy benefits and costs."* (CPUC 1999)
>
> *"…references to 'indirect' costs and benefits in the Standard Practice Manual are imprecise and new definitions are appropriate to clarify distinctions between various types of program outcomes that, while eligible for inclusion in the past, have been treated inconsistently."* (Eto et al. 1998)

A summary of the major similarities and differences between the PPT, the TRC, and the Societal Test is provided below.

- The PPT and the Societal Tests adopt a societal perspective by accounting for non-energy benefits/costs and positive/negative externalities.
- Elements included in the PPT that were not traditionally included in TRC calculations include spillover savings, non-energy costs/benefits, positive/negative externalities, and reductions in the cost of measures or practices caused by the program.
- The PPT is applied at the portfolio level, while the TRC and Societal Tests are applied at the program, and sometimes even the measure level.

- The PPT is cast in terms of market acceleration, current and future adoption impacts attributable to a program, while the TRC focuses on the lifecycle of measures or activities installed or undertaken in a single program year.

In addition, the PPT is applied in practice differently than its predecessors, mostly because of the design and structure of energy efficiency programs. The market transformation paradigm relaxes the requirement that *programs* must be cost-effective. This change is reflected in the structure of the PPT, which is applied at the *program portfolio* level. The purpose of this change was to encourage investment in interventions that may not produce measurable savings in the early years, but are more cost-effective over time as market effects compound in later years.

8.3.3. Applicable Policy Rules

In April 1999, CPUC Resolution E-3592 approved modifications to the Policy Rules and, in so doing, adopted the PPT as the standard for cost-effectiveness. The CPUC also approved the adoption of statewide input values for 1) avoided electricity generation, 2) avoided electricity transmission and distribution costs, 3) avoided natural gas consumption by end users, 4) electricity and natural gas environmental externalities, 5) a common estimate of the ratio of net to gross benefits from publicly funded programs of 1.0, and 6) a real societal discount rate of 5% or a nominal discount rate of 8.15%.

The current Policy Rules (CPUC 1999) regarding the cost-effectiveness of energy efficiency programs are as follows:

- Publicly funded energy efficiency programs should be cost-effective (II-1).
- "PGC-funded activities are expected to be cost-effective using the public purpose test (as the standard of cost-effectiveness)…" (IV-1).
- "A prospective showing of cost-effectiveness for the entire portfolio of PGC-funded activities and programs … is a threshold condition for eligibility of PGC funds" (IV-1).
- "On-going demonstration of continued expectations for cost-effectiveness of the portfolio using the public purpose test, as the standard of cost-effectiveness (on at least an annual basis), is a condition for continued receipt of PGC funds" (IV-3).
- "For individual programs within an administrator's portfolio, cost-effectiveness using the public purpose test … is important but not the only criteria for PGC funds" (IV-4).
- "Cost-effectiveness, for both entire portfolios of PGC-funded programs and for individual programs, is an important measure of value and performance" (V-2).

- The Public Purpose Test is measure of cost-effectiveness that includes "certain elements that have not traditionally been included in the practice of calculating the TRC" (V-2).
- "The PPT may be calculated by treating programs as multi- (rather than single) year activities so that programs explicitly designed as integrated, multi-year strategies, which may have modest benefits (and/or high start-up costs) in early program years, can be evaluated considering the expected larger benefits (and/or lower costs) in later program years" (V-3).
- "The PPT shall not be relied on exclusively in making funding allocation decisions among programs and/or Administrators…" (V-5).
- Evidence of the removal of market barriers, as evidenced by market effects, "is another important measure of the value of programs" (V-6).
- The CBEE will continue to discuss and refine Public Purpose Test and other cost-effectiveness measures (V-8).

8.4 The Structure of the Public Purpose Test

8.4.1. PPT Concepts Relating to Impacts

In most general terms, the PPT relies on the comparison of benefits and costs associated with the impacts of some policy (a measure, an intervention, or a portfolio). The literature on the PPT contains descriptions of different kinds of impacts. Some general characterizations occasionally found in policy literature are discussed below to clarify their role in this description of the PPT.

Energy and Non-Energy Impacts. Overall impacts of an intervention, a program, or a policy can be decomposed into energy and non-energy impacts. Energy impacts, which are changes in energy usage, can be expressed in dollars using some means of valuing these changes in energy usage. Non-energy impacts encompass all other effects of interventions, programs, or policies, and can generally be monitored using some means of valuation. These impacts are considered benefits or costs depending upon whether they are favorable or unfavorable from a societal perspective. This discussion of the PPT will distinguish between energy and non-energy benefits and costs.

Primary and Secondary Impacts. Eto et al. distinguish between what they call primary and secondary energy impacts (Eto et al 1998). Primary impacts are essentially effects on the energy application being targeted by the intervention(s), while secondary impacts are changes in usage associated with other applications. An example of a primary impact would be changes in lighting usage associated with a lighting program, while a corresponding secondary impact would be the indirect change in heating and cooling energy usage stemming from the reduction in internal gains from lighting. When energy impacts are referenced below, both primary and secondary impacts will be implicitly included, but no distinction between these types of impacts will be maintained.

Transaction-Specific and Non-Transaction-Specific. Describing the application of the PPT, Eto et al. (1998) refer to program impacts as *transaction-specific* and *non-transaction-specific*. Transaction-specific effects are those impacts associated with actions taken as a direct part of an intervention (the receipt of training, the redemption of a rebate coupon, etc.). Non-transaction-specific impacts are those arising indirectly from the intervention. This used to be termed spillover effects in resource acquisition jargon. However, there is one subtle but important difference between spillover and non-transaction impacts. Relatively little attention was paid to spillover because it was supposedly small for resource acquisition, whereas non-transaction-specific impacts are more broadly defined (including, for instance, a wide range of informational effects) and are presumably more important under market transformation. Consequently, the implementation of the PPT entails far more attention to non-transaction-specific impacts than was the case in practice for other tests under the resource acquisition paradigm. The dynamic framework discussed in Section 7 covers both transaction-specific and non-transaction-specific effects, but does not distinguish between them. Insofar as these two types of effects need not be estimated separately in this kind of framework, the distinction between transaction-specific and non-transaction-specific effects will not be referenced in the remainder of this section.

Acceleration Effects. As recognized in the literature, the PPT is explicitly designed to encompass consideration of market acceleration effects.[1] In the context of this section, acceleration effects are not separate from, but rather a means of characterizing the dynamic effects discussed in Section 7. In the evaluation of resource acquisition interventions, impacts were seen as one-period phenomena, so acceleration effects were not particularly relevant. However, acceleration effects are central to the assessment of market transformation interventions. Methods of estimating market acceleration are in their infancy, and relatively few attempts have been made to fully incorporate dynamic market effects into PPT calculations. However, as discussed in Section 7, these acceleration effects can be estimated using sensibly specified dynamic models.

The need to recognize market dynamics is a major difference between the common approach to evaluation of resource acquisition initiatives and the necessary means of evaluating market transformation initiatives. Under the resource acquisition paradigm, only program-period adoption effects were typically considered, and the only long-term issue was the persistence of the energy effects of program-period adoptions. In evaluating market transformation

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[1] In their February 4, 1998 recommendations to the CBEE, the CBEE Technical Services Consultants refer to these impacts as the "long term impacts of the program on the rate at which the measure or service of interest diffuses through the population" (Eto et al. 1998)

interventions, it is necessary to recognize both the sustainability of adoption effects and the persistence of the energy impacts associated with the projected adoptions.

8.4.2. Policy Benefits

In the context of the PPT, benefits can be classified as energy benefits, environmental benefits, other resource benefits, and other non-energy benefits.[2] These are related to measure adoptions attributable to the policy, and would cover current-period as well as subsequent-period adoptions. These benefits are considered below.

Energy Benefits. Energy benefits are defined as the economic value of the energy and demand savings stimulated by the interventions being assessed. These changes in usage should include both direct and indirect effects, as discussed earlier. These benefits are typically measured as induced changes in energy consumption, valued using some mix of avoided costs. Statewide values of avoided costs are prescribed for use in implementing the test. Natural gas benefits are valued using avoided gas costs that are quantified as weighted averages of the costs of core gas sales across utilities. Electricity benefits are to be valued using three types of avoided electricity costs: avoided distribution costs, avoided transmission costs, and avoided electricity generation costs. Avoided distribution and transmission costs are similar to those used before deregulation. Avoided generation costs are designed to cover both avoided energy costs and avoided capacity costs, and, as a consequence of the deregulation of the generation function, are measured in terms of market prices. For energy costs, the Policy Rules prescribe using the California Energy Commission's forecast of market-clearing PX prices. Capacity costs are quantified as the forecasted values of the price of ancillary services (spinning reserve, etc.)

One of the drawbacks of the PPT as it is implemented in California is that it makes use of avoided electricity costs weighted and averaged across hours. Given the dramatically different time-of-use distribution of energy impacts across measures and markets, this procedure may tend to significantly oversimplify the calculation of true societal costs. Given the high peak prices observed in the California market during extreme summer conditions, it could be argued that this simplified approach substantially undervalues on-peak reductions in usage. Recent events in California's market have rekindled interest in peak-clipping for precisely this reason, and the PPT should clearly be refined to encompass measure-specific or market-specific calculations of avoided costs.

Environmental Benefits. Environmental externalities associated with air quality impacts of electricity generation are captured fairly simply in the PPT, through the application of an environmental adder. This adder represents the aggregate of estimated costs of various

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[2] It should be noted that the categorization of PPT benefits and costs differs across various sources. The taxonomy used here is designed to provide as much symmetry as possible across benefits and costs.

pollutants, converted to $ per kWh. With the exception of global warming effects, it is generally based on market prices of emission offsets. As discussed in Section 6, considerable work has been done on the valuation of environmental externalities, although the range of estimates of value is relatively wide.

Other Resource Benefits. Other resource benefits could include water savings and savings of other fuels (propane, kerosene, coal, etc.), to the extent that these are true resource savings at given levels of service.

Other Non-Energy Benefits. Section 6 reviewed a wide range of other non-energy benefits that could be incorporated into the PPT, including changes in comfort, reduced arrearages, reduced maintenance costs, improved productivity, etc. Given the nature of market transformation interventions, these benefits could also include reduced transactions costs as well as reduced measure production costs.

8.4.3. Policy Costs

In the PPT framework, policy costs can be categorized as administrative costs, incremental measure costs, non-energy costs, and environmental costs. Non-energy costs and environmental costs are included as categories to preserve symmetry with the treatment of benefits. The elements of costs are discussed below.

Administrative Costs. Administrative costs encompass the real resource costs of program administration, including the costs of administrative personnel, program promotions, overhead, measurement and evaluation, and shareholder incentives. In this context, administrative costs are not defined to include the costs of various incentives (e.g., customer rebates and salesperson incentives) that may be offered to encourage certain types of behavior. The exclusion of these incentive costs reflects the fact that they are essentially transfer payments. That is, from a societal perspective they involve offsetting costs (to the program administrator) and benefits (to the recipient).[3]

Incremental Measure Costs. Incremental measure costs are essentially the costs of obtaining energy efficiency. In the case of an add-on device (say, an ASD or ceiling insulation), the incremental cost is simply the installed cost of the measure itself. In the case of equipment that is available in various levels of efficiency (e.g., a central air conditioner), the incremental cost is the excess of the cost of the high efficiency unit over the cost of the base (reference) unit.

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[3] Note that there is some question about the complete omission of these transfer payments from the cost-effectiveness analysis. As we will argue below, it may make sense to include them as both benefits and costs in the construction of benefit-cost ratios.

Environmental Costs. Environmental impacts are typically associated with benefits. However, interventions may also cause positive environmental costs. For instance, relamping may be associated with lamp disposal costs.

Other Resource Costs. The adoption of energy efficiency measures could indirectly cause other resource costs to be incurred, although examples of this type of effect do not come readily to mind.

Other Non-Energy Costs. A variety of non-energy costs may be associated with energy efficiency activities, including downtime during installation, reduced service levels, or poor aesthetics.

8.4.4. Discounting

Insofar as benefits and costs are spread out over time, their comparison requires the development of present values. In turn, this necessitates the use of a discount rate. In the PPT, a societal discount rate is used. The CPUC currently mandates the use of a 5% real societal rate or an 8.15% nominal rate, but this value will be changed from time to time as market conditions warrant.

8.4.5. PPT Measures of Overall Cost-Effectiveness

The PPT framework can be used to construct two measures of overall cost-effectiveness: an estimate of net benefits and a PPT ratio. Both measures are constructed using estimates of the present values of benefits and costs, as discussed below.

Present Value of Benefits. The present discounted value of gross benefits can be represented as:

$$PVB = \sum_{t=1}^{T} \frac{EnBen_t + ExtBen_t + OthResBen_t + OthNonEnBen_t}{(1+r)^t}$$

where:

$EnBen_t$ = energy benefits in period t

$ExtBen_t$ = externality benefits in period t

$OthResBen_t$ = other resource benefits in period t

$OthNonEnBen_t$ = other non-energy benefits in period t

The period over which benefits are considered is represented by *t*. As noted earlier, it is important that this period be defined to encompass long-term effects on adoptions as well as the lifetimes of the energy impacts associated with these adoptions.

Present Value of Costs. Similarly, the present value of costs associated with a portfolio or an intervention can be expressed as:

$$PVC = \sum_{t=1}^{T} \frac{AdminCost_t + MeasCost_t + ExtCost_t + OthResCost_t + OthNonEnCost_t}{(1+r)^t}$$

where:

$AdminCost_t$	=	administration costs in period *t*
$MeasCost_t$	=	incremental measure costs in period *t*
$ExtCost_t$	=	externality costs in period *t*
$OthResCost_t$	=	other resource costs in period *t*
$OthNonEnCost_t$	=	other non-energy costs in period *t*

Net Benefits. The net benefits indicator is defined as the difference between lifetime benefits and costs, each discounted back to the present using a societal discount rate.

$$NPB = PVB - PVC$$

The PPT Ratio is essentially ratio of benefits and costs. Using the benefit and cost expressions from above, the ratio (PPTR) could be expressed as:

$$PPTR = \frac{PVB}{PVC}$$

or

$$PPTR = \frac{\sum_{t=1}^{T} \frac{EnBen_t + ExtBen_t + OthResBen_t + OthNonEnergyBen_t}{(1+r)^t}}{\sum_{t=1}^{T} \frac{AdminCost_t + MeasCost_t + ExtCosts_t + OthResCost_t + OthNonEnCost_t}{(1+r)^t}}$$

Given this structure, any portfolio or intervention with a PPTR greater than 1.0 could be said to be cost-effective. However, if ranking interventions on the basis of the PPTR, this formulation may not be the most appropriate one. Ranking is typically used to optimize a portfolio, and this optimization is generally done subject to a budget constraint. The budget constraint is typically associated with costs, but the costs in the denominator of this expression are not those that are typically subject to such a constraint. For portfolio optimization and the ranking of individual interventions, it makes more sense from a policy perspective to reorganize benefits and costs so that constrained costs (those defining the administrator's budget) are in the denominator and other costs are incorporated in the numerator as negative benefits. Calling this alternative ratio *PPTR**, one would have:

$$PPTR^* = \frac{\sum_{t=1}^{T} \frac{EnBen_t + NetExtBen_t + NetOthResBen_t + NetOthNonEnBen_t + Inc_t}{(1+r)^t}}{\sum_{t=1}^{T} \frac{AdminCosts_t + Inc_t}{(1+r)^t}}$$

where:

$NetExtBen_t$	= net externality benefits	=	$ExtBen_t - ExtCost_t$
$NetOthResBen_t$	= net other resource benefits	=	$OthResBen_t - OthResCost_t$
$NetOthNonEnBen_t$	= net other non-energy benefits	=	$OthNonEnBen_t - OthNonEnCost_t$
Inc_t	= total incentives paid to customers		

8.5 Consistency of the PPT with the Public Policy Framework

It can be shown that the PPT is conceptually consistent with the policy analysis contained in Section 2.[4] More specifically, it can be shown that net benefits as determined by the PPT reflect the net benefits derived from the policy analysis.

In Section 2, the benefit of a public intervention was shown as the sum of two items: the reduction in deadweight loss in the market for energy efficiency and the avoided externality cost in the energy market. Costs in that analysis were identified as administrative costs. Thus, the net benefits of a policy (without loss of generality, net benefits in present value form will be referred to as *NPB*) can be expressed as:

$$NPB = RedDeadWeightLoss + NetExtBen - AdminCost$$

where *RedDeadWeightLoss* is the reduction in deadweight loss attributable to the policy, *NetExtBen* is the net externalities benefit, as defined earlier, and *AdminCost* is the

[4] Indeed, this correspondence was initially incorporated in an earlier draft of Section 2, and should be credited to Miriam Goldberg.

administrative cost. (Note that the time subscripts have been dropped to reflect the fact that the policy analysis is in static form.)

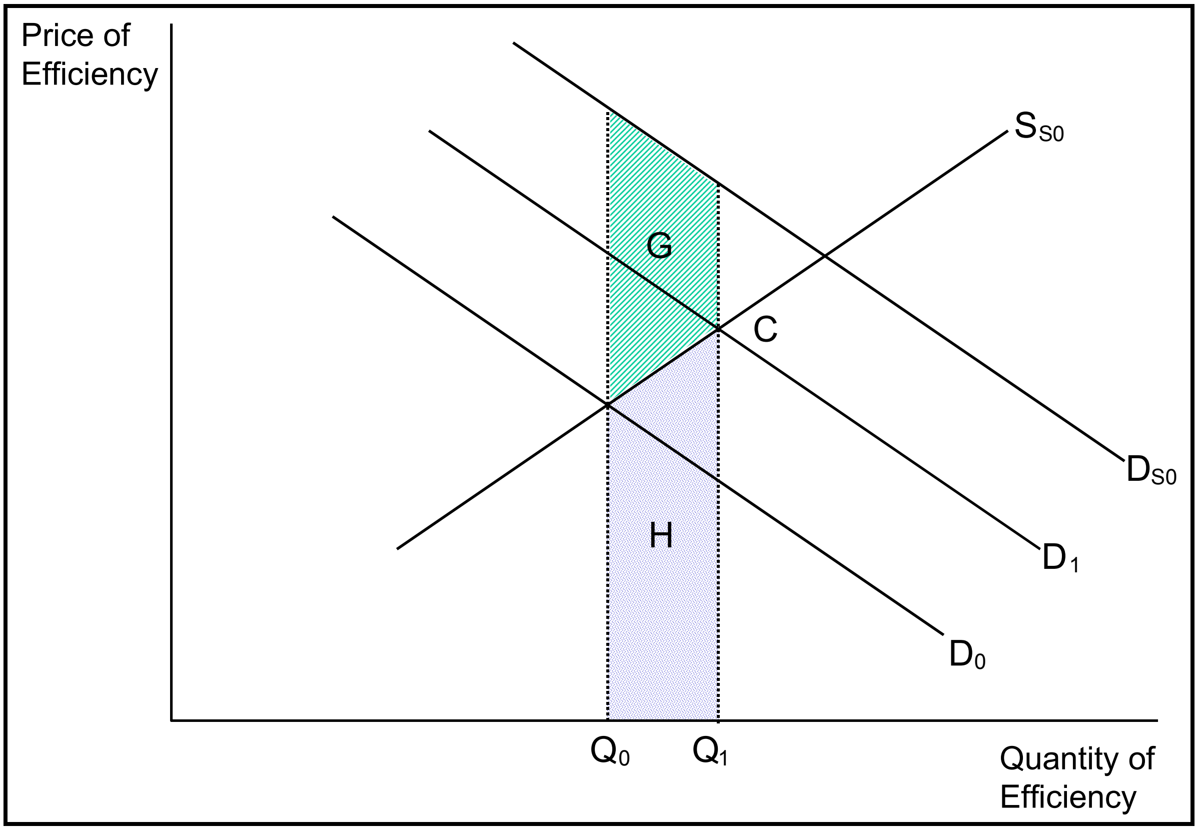
It can be shown that the reduction in deadweight loss is essentially the benefit derived from the energy efficiency market. In order to interpret the reduction in deadweight loss, we refer to Figure 8-1, which is a somewhat simplified form of the policy analysis contained in Figure 2-3. D_0 is the initial market demand curve in the absence of public policy. The socially optimal demand curve D_{SO} reflects perfect information and the use of societal rather than consumer discount rates. An intervention moves the demand curve to D_1, closer to socially optimal than the starting point D_0, but not fully socially optimal. The deadweight loss reduction is the shaded area G in the figure. Area G could be written as the difference between two areas: G+H, which represents the societal valuation of the additional units of the energy efficiency measure, and H, which reflects the incremental costs of the additional units of the measure. So this could be written:

$$RedDeadWeightLoss = (G + H) - H$$

However, G+H represents the societal value of the incremental efficient products adopted (excluding the value of the avoided externality). This value is based on the energy benefits associated with the use of the product, plus the net other resource benefits and other non-energy benefits. So, using the terms developed earlier, it could be specified that:

$$G + H = EnBen + NetOthResBen + NetOthNonEnBen$$

Figure 8-1: Evaluating Deadweight Loss



Area H, on the other hand, is the area under the private supply curve and reflects the private incremental cost of the energy efficiency measure. In terms of the earlier analysis, one could specify that:

$$H = MeasCost$$

Consequently, the reduction in deadweight loss can be expressed as:

$$RedDeadWeightLoss = EnBen + NetOthResBen + NetOthNonEnBen - MeasCost$$

Correspondingly, the net benefit of the policy can be specified as:

$$NPB = EnBen + NetOthResBen + NetOthNonEnBen + NetExtBen - AdminCost - MeasCost$$

which is the same specification as implied by the PPT.[5]

5 It should be noted that the PPT ratio is considerably different from the benefit-cost ratio that would be implied by the policy analysis in Section 2, insofar as the denominator in the latter ratio would include only administrative costs.

Thus, the deadweight loss portion of the benefits in this framework can be evaluated one of two ways. One is by assessing the demand and supply curve shifts and calculating the areas in Figure 2-3 and Figure 2-4. The advantage of this approach is that there is no need to account explicitly for the various factors that determine consumers' willingness to buy efficiency products. These factors, including positive and negative non-energy attributes of the products, and consumer tastes and preferences, are embodied in the demand curve. It is not necessary to assign a dollar value to the change in light quality, the aesthetics of new fixtures, or less frequent changing of light bulbs.

The other method of evaluating the deadweight loss reduction is by this explicit summing of the components of the net consumer benefits. That summing accounts for the avoided market cost of energy, measure costs, and other benefits and costs associated with the measure adoption. The advantage of this approach is that two large components, the avoided cost of energy and the measure costs, are straightforward to assess. The danger is that the hunt for other benefits and costs will focus on more tractable components, and on benefits, and leave some of the attributes and tastes unaccounted for that may in fact account for a substantial part of the reason the demand for the efficient product is lower than its energy value would suggest.

Having verified the consistency of the PPT with the policy analysis developed in Section 2, it seems reasonable to consider the consistency of other benefit-cost tests sometimes used in the assessment of cost-effectiveness of energy efficiency initiatives. Clearly, partial tests like utility cost tests, participant tests, and nonparticipant tests are inconsistent with that framework because they (intentionally) focus on benefits and costs from the perspective of an individual entity rather than from a public perspective. However, it should also be recognized that the TRC test, which is commonly used in a number of states, is also inconsistent with the policy analysis. It departs from that analysis in four ways:

- First, it does not provide for consideration of adoption impacts beyond the intervention period. While this is not a serious drawback in the case of resource acquisition, for which impacts are likely to be strongly concentrated in the intervention period, this is a problem for other intervention strategies (market transformation, infrastructure, and research and development) designed to have longer term effects.
- Second, the TRC ignores non-energy benefits and costs. While the incorporation of these benefits and costs often suffers from double-counting, some such benefits and costs can be justified in the cost effectiveness analysis. Of course, if these benefits and costs are very low, this shortcoming in the TRC is not particularly troublesome.
- Third, the TRC does not make use of a societal discount rate. Admittedly, however, there is considerably controversy in the literature relating to the proper

discount rate to use for the evaluation of public policies, so it is difficult to assess the seriousness of this issue.

- Fourth and most critically, it ignores environmental benefits and costs. This is critical in the context of the analysis of Section 2, insofar as environmental costs associated with energy production provide the strongest rationale for public intervention in the area of energy efficiency. Of course, it should be recognized that valuing environmental costs and benefits is not any easy task. However, ignoring these benefits and costs essentially assigns a zero value to them, and this value does not appear appropriate

8.6 Policy Issues Associated with the Application of the PPT

8.6.1. Introduction

The PPT is consistent with the general rationale for public intervention in energy efficiency markets, and is a comprehensive framework for the assessment of cost-effectiveness of energy efficiency interventions. It seems fair to say, however, that its application has not been without confusion. To a considerable extent, this confusion is attributable to the fundamental differences between resource acquisition and market transformation policies. It may also be because of the brief time over which the test has been implemented. The remainder of this section considers some policy issues associated with the application of the PPT.

8.6.2. Isolating Effects of Multiple Interventions Targeting Same Markets

One of the most vexing problems facing evaluators under the market transformation paradigm is the difficulty in isolating the market effects of multiple interventions targeting the same markets. Of course, there have always been overlapping interventions, so the nature of the problem has not changed. However, the degree of overlap is likely to be greater when market transformation is pursued than under the previous paradigm of resource acquisition, for two reasons.

First, resource acquisition intervention designs tended to focus on interventions that yielded what Eto et al. (1998) refer to as transaction-specific impacts, while market transformation interventions can be expected to yield a mix of transaction-specific and non-transaction-specific impacts. Although transaction-specific impacts can be assigned to interventions in a straightforward way, non-transaction-specific impacts cannot. Tracking was formerly facilitated by the participant focus of those interventions. Indeed, impact analyses often explicitly included variables reflecting participation in other interventions. This luxury generally does not exist when analyzing overlapping market transformation interventions.

Second, various initiatives may actually support the same type of intervention strategy. For instance, California's residential lighting and appliance programs are designed to build awareness of the ENERGY STAR® label, as are general informational programs sponsored by the utilities as well as efforts funded through the ENERGY STAR program.

Given the interactions of intervention effects, it is probably necessary to drop the intervention-oriented approach to cost-effectiveness analysis. Simply conducting the analysis at the intervention level, then summing across interventions to ascertain the benefits and costs of the portfolio is not likely to yield consistent results. The key test of cost-effectiveness should be at the level of the market, encompassing all of the "interventions" aimed at the market. This point is pursued further below.

8.6.3. The Appropriate Level of Application of the PPT

The CPUC Policy Rules indicate that the PPT should be used to assess both programs and the entire portfolio of programs. The rules require the portfolio to be cost-effective, but indicate only that cost-effectiveness is important but not necessary for individual interventions. In general, it seems useful to make distinctions between requirements for the portfolio and those of individual activities in the portfolio. As indicated above, assessing the cost-effectiveness of individual programs is complicated by the fact that multiple programs often target the same market. In this sense, conducting the PPT is probably more feasible at the portfolio level. On the other hand, the overall portfolio may cover a wide range of markets, and it would seem reasonable to require cost-effectiveness at the portfolio level *for individual markets*.

Of course, the PPT can provide useful information at lower levels than the market portfolio as well. In spite of the difficulties in isolating the effects of individual programs in some markets, it may be possible to estimate the impacts of individual *interventions* aimed at a market. (The distinction here is that programs are administrative concepts, whereas interventions are specific types of activities designed to move the market.) The dynamic models described in Section 7 can be simulated with and without specific interventions, and these simulations can be used to assess the cost-effectiveness of these interventions. While this approach may be difficult to implement in some cases, it is a critical element of the overall process of portfolio design. Even if a set of interventions aimed at a market prove to be cost-effective, analysis should still be used to refine the program design. And even if a set of interventions fails cost-effectiveness, there may be other portfolio designs that would be highly cost-effective.

8.6.4. Application of the PPT to Various Intervention Strategies

Most of the discussion about the PPT focuses on the assessment of market transformation initiatives and portfolios. However, there are at least two reasons for applying the framework to a wider range of energy efficiency strategies:

- First, if a portfolio aimed at a specific market includes a range of interventions other than market transformation strategies—as several authors in this report have argued should be the case—then it would be necessary to use a single framework to assess the cost-effectiveness of this portfolio. That is, if other kinds of intervention strategies like resource acquisition, research and development, and infrastructure maintenance are used, they should be incorporated into a single assessment, thus avoiding the asymmetric treatment of these strategies. Of course, it may not always be easy to isolate the effects of specific interventions; nonetheless, as argued elsewhere, this may not be critical. If market transformation and infrastructure interventions affect awareness of decision makers or decision influencers, for instance, and if the overall result of this set of interventions is cost-effective, it may not be possible or essential to attribute effects to these individual interventions. It should also be recognized that the specific means of estimating impacts of various intervention strategies may be different. For example, we may want to use participant/nonparticipant comparisons to estimate impacts of resource acquisition interventions (in terms of Section 7, to parameterize the portion of the dynamic model relating to the resource acquisition intervention impact on willingness), but use survey-based approaches to estimate impacts of market transformation interventions on various aspects of behavior.
- Second, from a policy perspective, there is no reason why resource acquisition strategies should be evaluated using a narrower framework like the TRC, while market transformation strategies are analyzed using a societal perspective. The assessment of publicly funded energy efficiency should encompass all societal benefits and costs to the extent feasible. This is not to say that all costs and benefits can be measured with enough precision to warrant their inclusion in a cost-effectiveness analysis, but rather to suggest that the choice of inclusion should not depend on the type of general energy efficiency strategy.

The one possible exception to the general recommendation of consistency in cost-effectiveness frameworks is the case of equity programs. Equity programs (principally low income programs) are designed partly to redistribute discretionary income as well as to improve the allocation of resources. Like most cost-effectiveness tests, the PPT and the TRC focus strictly on effects on allocative efficiency. This follows from the fact that these tests compare dollar values of savings and costs without regard to the identity of the recipients of these benefits and costs. When public programs are designed to redistribute income as well as to affect the use of resources, the evaluation of such programs typically requires the use of a benefit-cost framework that considers the distribution of benefits and costs across specified groups. In California, the energy efficiency community is now considering the proper means of evaluating low income programs.

8.6.5. Assessing Impacts of Multiple Year Interventions

The paradigm of market transformation explicitly recognizes the need to use multiple year interventions to move the market in any meaningful way. In many cases, interventions are scheduled to change over time as part of a long-run strategy. This is a different perspective than used under previous paradigms, at least in degree if not in kind. Until recently, IOUs were required to demonstrate that their energy efficiency programs were cost-effective on an annual basis, that annual program expenditures were equal to or less than the value of energy savings attributable to the program in that year. The market transformation paradigm relaxes the requirement that programs must be cost-effective in a given year, and this change is reflected in the structure of the PPT. As indicated in the Policy Rules, "the PPT may be calculated by treating programs as multi- (rather than single) year activities…(Appendix D, p. D-5)." The purpose of this change was to encourage investment in interventions that may not produce measurable savings in the early years but over time are more cost-effective because they produce market acceleration effects that are minimal at first but compound in later years. Clearly, taking into account these multiple year impacts requires a considerable degree of understanding about the interactions of program efforts. This, in turn, necessitates a clearer understanding of the dynamics of market actor behavior.

The dynamic framework discussed in Section 7 is applicable to multiyear interventions and is capable of accounting for the contributions of interventions applied under individual program years. Of course, this type of application requires careful specification of the kinds of impacts expected under the scheduled interventions, and necessitates tracking actual market changes and comparing them to expected changes. To the extent that deviations between observed and estimated changes are observed, the parameters of the model need to be readjusted and the model needs to be calibrated for further use.

8.6.6. The Proper Timing of Cost-Effectiveness Analysis

The proper timing of cost-effectiveness analysis was discussed in Section 5. As indicated there, cost-effectiveness analysis serves many purposes, so there is no single best frequency for its application. The use of cost-effectiveness analysis in the process of program planning and refinement (its formative application, using the terminology of Section 5) should be conducted as frequently as new information that could be used to refine assumptions becomes available. Some types of retrospective cost-effectiveness analysis may be tied to regulatory reporting cycles, although it could also be conducted each time market data are updated. The cost-effectiveness analysis should be structured to allow for flexibility in the use of these data to update assumptions. It should be remembered here that no matter what the frequency of the cost-effectiveness analysis, the time frame of the analysis remains the lifetime of the market effects induced by the interventions in question.

8.6.7. Prospective and Retrospective Applications

The CBEE's policy rules require that program portfolios, but not necessarily individual programs, be cost-effective. The cost-effectiveness of these portfolios must be maintained on both a prospective basis (rule II-1) and on an ongoing basis (rule II-3). In discussing the evaluation of market transformation interventions, it is useful to consider the practical differences in implementing the PPT on a prospective and a retrospective basis. The primary difference relates to the development of assumptions. When cost-effectiveness is considered from a prospective basis, as in the planning process, forecasted impacts and the associated benefits and costs will be based on planning assumptions. In the context of the discussion in Section 7, this means that parameters would be based on planning assumptions, and these assumptions would in turn be based on the results of other studies, informed judgments, and any other available information. When the PPT is conducted from a retrospective perspective, the assumptions (model parameters) would presumably be refined based on observed changes in market behavior. This refinement is the key purpose of evaluation in this context. That is, the estimation of near-term and (if possible) ultimate market effects should be focused on the refinement of assumptions (parameters) used to forecast subsequent period effects over the full lifetimes of these effects.

In this context, the primary difference between resource acquisition and market transformation evaluations is that the effects of resource acquisition interventions are more strongly concentrated in the program period (except, of course, that impacts persist over the lifetimes of the measures). While this difference has considerable practical significance (e.g., making it much less important to forecast these subsequent period effects), this is a difference in degree rather than in kind.

8.6.8. Applying the PPT to a Broader Range of Ultimate Market Effects

The evaluation of resource acquisition initiatives concentrated almost exclusively on the estimation of incremental adoptions and induced energy/demand savings. Correspondingly, cost-effectiveness analysis focused on valuing the program-induced energy and demand savings. Market transformation initiatives may affect social welfare in ways that do not fit neatly into this cost-effectiveness approach. Most importantly, such initiatives may cause significant reductions in information cost, transaction costs, and technology costs. Informational programs like ENERGY STAR awareness campaigns reduce the cost of information to market actors. Initiatives that improve measure availability may reduce transaction costs. Initiatives aimed at emerging technologies may be successful in reducing production costs. While these effects may lead to increased energy/demand savings, they have societal value distinct from the benefits of savings. The literature of benefit-cost analysis offers means of valuing these changes in terms of producer and consumer surplus, but this literature has not generally been brought to bear on the evaluation of market transformation interventions.[6]

Considerable work still needs to be done on estimating the effects of interventions on information, transaction, and technology costs. Moreover, there is a need to develop a means of estimating the societal benefits associated with these impacts and integrating these benefits into benefit-cost frameworks like the PPT.

8.6.9. Clarifying Some Issues

Before leaving this discussion of cost-effectiveness analysis, it may be useful to consider two issues currently being addressed in California: the specification of net-to-gross ratios for market transformation programs and the development of market transformation multipliers. While at least the second of these issues may not have much relevance to professionals in other states, both have a bearing on California utilities' attempts to respond to a recent public decision issued by the CPUC.

Net-to-Gross Ratios. As discussed elsewhere in this report, recent evaluations of resource acquisition programs made consistent use of net-to-gross ratios. These ratios essentially reflected the ratios of net program effects (which are adjusted for free ridership and spillover) and gross program effects (which relate to the activities of program participants). In the context of adoptions of energy efficiency measures, gross effects have been defined as adoptions of participants and net adoptions have been defined as the net difference in adoptions attributable to the program. The concept of a net-to-gross ratio has been very useful in evaluating resource acquisition programs, insofar as years of evaluation have produced some rough consensus with respect to the typical values of these ratios for different types of market and programs. A practical effect of this approximate consensus has been that different parties to regulatory proceedings have been able to make judgments on the "reasonableness" of various net-to-gross ratios. The CPUC, for instance, seems to have focused strongly on the net-to-gross ratios assumed by utilities for the purposes of estimating net program effects, because these ratios can be compared to those from other studies.

Unfortunately, some parties to regulatory proceedings—including the CPUC itself—have tried to extend the concept of net-to-gross ratios to the assessment of market transformation programs. In its July 6, 2000 decision on the utility applications for approval of PY2000 and PY2001 programs, the Commission ordered the California utilities to "develop net-to-gross (NTG) ratios to be used for Program Year (PY) 2001 programs."

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[6] One notable exception to this statement is a conceptual analysis by Shel Feldman (1996).

Market Effects Multipliers. The second concept about which there has been considerable confusion is the notion of a market effects multiplier. In the California utilities' PY99 program filings, for instance, the PPT calculations were based on the available information regarding single-year energy impacts. In their 2000 filings, utilities included market effects for a few programs based on some simple market transformation multipliers developed earlier by RER on the basis of existing literature on market effects (RER 1999). These multipliers were developed in response to a recommendation of the CBEE to incorporate long-term market effects in estimates of benefits and costs. The market effects studies conducted to that point in California were unable to provide such market effects estimates for two reasons. First, the programs that were being assessed were not really designed to be market transformation programs, although they may have had some market transformation effects. Second, most of the market assessments focused exclusively on near-term market effects (rather than the kinds of long-term adoption effects that were needed for full assessments of cost-effectiveness).

In order to provide some means of estimating of long-term adoption effects for at least a few measures, RER essentially used a few existing studies that had provided information on long-term market effects to develop ratios of long-term adoption effects to program year effects. These ratios, which were termed market effects multipliers, were provided to the California utilities for a restricted set of energy efficiency measures. As was pointed out at the time, these multipliers were meant only to fill a temporary gap in assumptions so that the incorporation of long-term adoption effects into the PPT could be demonstrated. The multipliers were never intended to be the focus of future MA&E efforts. Instead, future MA&E should be directed toward the development of dynamic frameworks likes the ones illustrated in Section 7. Using these frameworks, forecasts of adoptions should be developed with and without the interventions in question and long-term market effects should be estimated. As market data become available through the course of MA&E studies, the assumptions underlying these models (primarily the parameters) should be refined and the estimates redone.

8.7 Summary and Conclusions

8.7.1. Summary

This section discusses the assessment of cost-effectiveness of energy efficiency programs. Subsection 8.3 reviewed the historical context of cost-effectiveness analysis in California and outlined the current policy rules under which California's utilities operate. Subsection 8.4 described the structure of the PPT, the primary framework mandated for use in assessing market transformation portfolios and programs. As noted there, the PPT is a societal cost-effectiveness model designed explicitly to take into account the dynamics of market transformation. Subsection 8.5 considered the consistency of the PPT with the policy analysis presented in Section 2 of this report. It was found that the PPT is generally consistent with this analysis. Subsection 8.6 discussed a variety of policy issues associated with the implementation of the PPT, including the following:

- The problems of isolating the effects of multiple programs targeting the same markets,
- Questions relating to the appropriate level of application of the PPT,
- The appropriateness of applying the PPT to other intervention strategies,
- The use of the framework to assess impacts of multiple year interventions,
- The proper timing of cost-effectiveness analysis,
- Differences in the retrospective and prospective applications of the model, and
- Difficulties in applying the PPT to a broader range of market effects than is typically considered.

Subsection 8.6 also discussed two concepts currently raised in a recent decision of the California Public Utilities Commission: net-to-gross ratios and market effects multipliers.

8.7.2. Conclusions

The analysis in the report suggests a number of conclusions and recommendations relating to cost effectiveness.

- The PPT is a reasonable framework for assessing the cost-effectiveness of energy efficiency portfolios and interventions. It is consistent with the policy analysis presented in Section 2, and is designed to take into account the dynamic impacts of market transformation interventions.
- Other tests like the TRC are not consistent with the policy analysis developed in Section 2, insofar as they do not consider environmental benefits and costs, societal discount rates, non-energy benefits and costs, and potential subsequent-period adoption impacts.
- Cost-effectiveness of energy efficiency interventions is best determined at the market level. This follows from the fact that a variety of overlapping interventions may be aimed at a specific market and their effects may be difficult to disentangle. Nonetheless, it also will generally be useful to attempt to assess the contributions of specific interventions to overall cost-effectiveness in order to support the process of program design and refinement.
- Because the focus of cost-effectiveness analysis is at the market level, almost all interventions used for that market should be assessed using the same cost-effectiveness model. While resource acquisition strategies may not have the same long-lived dynamic effects, they can still be assessed (along with other strategies) by the PPT. Conceptually, the assessment of infrastructure and research and development interventions should also entail the use of the PPT; however, it should be recognized that the nature of these interventions may make the

estimation of energy impacts extremely difficult. The assessment of equity programs (e.g., low-income programs) should probably involve the use of a broader cost-effectiveness approach that takes into account the distributional effects of these programs.

- The PPT is flexible enough to be used for the evaluation of multiyear interventions. This application simply requires the estimation of the ultimate market effects of the multiyear intervention and the conversion of these effects into benefits and costs. One option for conducting multiyear analyses is to make use of a dynamic framework like the one described in Section 7.
- The proper timing of the application of the PPT depends upon the rationale for its use. Retrospective cost-effectiveness may be tied to regulatory cycles, although it can be conducted each time market data are updated. The frequency of prospective applications should be tied to the schedule for program planning and refinement.
- The primary differences in retrospective and prospective applications of the PPT involve the means of developing assumptions. In prospective applications, these assumptions may be based on informed judgments, while in the retrospective applications they should be based on evidence gathered from the marketplace during the course of market assessment and evaluation activities.

9

Conclusions and Recommendations

9.1 Introduction

A number of conclusions and recommendation are identified throughout the report. The following is a summary of the most important conclusions and recommendations organized into the following topics:

- The economic rationale for energy efficiency policy,
- The role of market transformation in energy efficiency policy,
- The design of market interventions,
- The evaluation of the effects of energy efficiency interventions,
- The incorporation of market dynamics in the evaluation of market effects, and
- The application of cost-effectiveness tests to energy efficiency interventions.

9.2 The Economic Rationale for Energy Efficiency Policy

- A theoretical justification for public policy to promote energy efficiency relies on a mix of market failures, including externalities in energy markets as well as a series of failures in markets for energy efficiency products markets, including lack of information, consumer discount rates effectively higher than societal discount rates, and public goods issues associated with technology research and development.
- Even if there is no failure in the energy efficiency market, it may be worthwhile to intervene in the market to reduce externality costs in the energy market. Moreover, the problem of environmental externalities in energy production is never solved by changing the market for energy efficient products, even if these changes are completely sustainable. As long as the externality remains in the energy market and is not addressed directly through taxes or some other means of internalization, there will be a need for continuing intervention in the energy efficient products markets.
- Assessing the cost-effectiveness of public interventions relating to energy efficiency entails quantifying the economic improvement in the market for efficient products and services, as well as valuing the avoided externality in the energy market.

9.3 The Role of Market Transformation in Energy Efficiency Policy

- Effective energy efficiency policy requires a balanced portfolio of intervention strategies. These strategies should include market transformation, resource acquisition, infrastructure, research and development, and equity interventions. These strategies all have a place in ensuring a more efficient allocation of energy resources.
- Market transformation interventions may be an effective strategy if significant market failures are evident in the market for energy efficient products and services. However, this strategy should be used in conjunction with other strategies in order to optimize the overall mix of the energy efficiency portfolio.
- Interventions designed to promote a particular technology, practice, or service may be phased out as adoptions of that technology, practice, or service reach a targeted and self-sustaining level in that market. However, as long as there are externalities associated with energy production or usage, there will be a continuing need for interventions to develop and promote the next generation of technologies, better practices, and improved services to enable the more efficient use of energy.
- If there are no failures in the efficiency market that can be practically addressed through market transformation efforts, ongoing resource acquisition interventions may be the most effective strategy. Moreover, infrastructure and research and development contribute strategically to the overall goals of a mixed portfolio and need to be given appropriate levels of support within the mix.
- As is the case with any portfolio, the appropriate mix of energy efficiency strategies may vary across markets and over time. Designers should consider the most effective combination of strategies for a particular market at a particular time. For instance, extreme market conditions like the price spikes currently being experienced in California may affect the benefits of interventions and may influence the choice of specific strategies.

9.4 The Design of Market Interventions

- The use of an energy efficiency initiative should be focused by articulating the logic of the initiative, whether that initiative is in the form of a research and development, infrastructure, resource acquisition-directed, or market transformation-directed effort. In each case, the logic should trace the effects of the initiative through to the final expected goal of the intervention.
- If the intervention strategy is either resource acquisition or market transformation, prospective cost-effectiveness analysis should include the levels and timing of expected energy savings under various assumptions. In the event that the intervention strategy is intended to evolve over time, the appropriate transition strategy should be discussed, as well as the point at which it is to be employed.

- While the ultimate goal of infrastructure and research and development interventions is to reduce energy consumption, it may be extremely difficult to isolate the impacts of these interventions on consumption.

9.5 The Evaluation of the Effects of Energy Efficiency Interventions

- A comprehensive evaluation design should integrate summative approaches designed to estimate the savings of a given intervention design, and formative approaches designed to develop recommendations for the improvement of interventions.
- Both types of evaluations should test the logic underlying the design of the intervention. The results of summative evaluations should be used to refine the estimates of market effects, and the results of formative evaluations should be used to refine the design of the intervention.
- Summative evaluations should focus on impacts on adoptions of energy efficiency measures and the associated energy savings, as well as on indicators of other market effects leading to these impacts.
- Most of the attention in recent assessments of market transformation interventions has been on near-term market effects. It is important to extend the scope of these assessments to deal more formally with effects on ultimate market indicators such as impacts on adoptions and the associated energy and demand impacts.
- Evaluation approaches can include performance data tracking, structure and function studies (which traditionally include process and market evaluation and market assessments), and benefit studies (which include cost-effectiveness analysis, impact evaluation, and engineering analysis). Though the specific application varies, there is a role for all three approaches in most evaluations of energy efficiency interventions.

9.6 Incorporation of Market Dynamics in the Evaluation of Market Effects

- Especially for market transformation interventions, the estimation of ultimate market effects should be viewed as a forecasting exercise. To the extent that the effects of interventions last beyond the duration of the intervention, these effects should be derived from forecasts of adoptions and energy savings with and without the intervention in question.
- Planners and evaluators should consider the use of formal dynamic models to represent the dynamic process through which interventions affect adoptions and savings. Dynamic models are simply descriptions (typically algebraic) of the path via which interventions are expected to affect adoptions of energy efficiency measures and consumption of energy. These models can be used to forecast

market effects in both prospective and retrospective applications, and can support both program planning and evaluation.

- The design and implementation of reasonable dynamic models is not a new process, but rather one that simply formalizes the intervention logic. Because it is not a traditional means of expressing intervention logic, it will take some time to implement. Nonetheless, the long-term benefits of this approach could be substantial. The process of constructing this type of model will force planners to make specific assumptions about the impacts of program interventions. These assumptions relate to the paths of influence of interventions, as well as to the values of the parameters of the model. Moreover, the formal simulation model provides an overall framework for integrating the results of program evaluations, as well as for developing and testing alternative intervention strategies.

9.7 Assessment of Cost-Effectiveness

- Cost-effectiveness of energy efficiency interventions is best determined at the market level. This follows from the fact that a variety of overlapping interventions may be aimed at a specific market and their effects may be difficult to disentangle. Nonetheless, it also will generally be useful to attempt to assess the contributions of specific interventions to overall cost-effectiveness in order to support the process of intervention design and refinement.
- Because the focus of cost-effectiveness analysis is at the market level, almost all interventions used for that market should be assessed using the same cost-effectiveness model. The sole possible exception to this practice could be for equity programs, which are designed to affect distribution of income as well as efficiency in resource acquisition.
- The Public Purpose Test (PPT) is a reasonable framework for assessing the cost-effectiveness of energy efficiency interventions other than equity programs. It is consistent with the policy analysis presented in Section 2, and is designed to take into account the dynamic impacts of market transformation interventions as well as the full range of costs and benefits underlying the basic rational for public intervention in energy efficiency markets. More specifically, the PPT is designed to include environmental benefits/costs as well as a variety of non-energy benefits and costs that influence the optimal level of energy efficiency. Other tests like the Total Resource Cost Test are not consistent with the policy analysis for a variety of reasons, the most important being that they ignore environmental costs and benefits.
- The PPT should be used in both prospective and retrospective assessments. The primary differences in retrospective and prospective applications of the PPT involve the means of developing assumptions. In prospective applications, these assumptions may be based on informed judgments, while in the retrospective applications they should be based on evidence gathered from the marketplace during the course of market assessment and evaluation activities.

10

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