# A Theory-based Approach to Market Transformation

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## ABSTRACT

Market transformation (MT) programs face numerous challenges in identifying targets, understanding markets, and intervening effectively in them. Traditional energy efficiency program approaches generally lack the tools necessary to meet those challenges. New energy market realities and new public purposes roles for government that emphasize market connectivity will require more sophisticated forms of MT that focus on *markets* rather than end-users. One such approach, being developed by the California Energy Commission, stresses the importance of theory-based MT, with tight linkages between existing theory, program design, empirical testing of crucial assumptions, evaluation, and theory development. Feedback and iterative learning are involved at all stages. Because a clear understanding of market dynamics is crucial to this approach, multidisciplinary research plays a key role.

## Introduction

In this paper we sketch an approach to market transformation (MT) appropriate to the new realities of the 21st Century. We first discuss sources of MT thinking and assess the usefulness to MT interventions of energy efficiency strategies and research agendas inherited from the period of efficiency resource acquisition. Our main point is that, as a result of changes in energy efficiency programs, *what we need to know to conduct successful programs has also changed.* This provides the context for our description of a systematic strategy for MT being developed by the California Energy Commission (CEC). This strategy has the advantage of recognizing the need for new knowledge, careful program design, pilot testing, and real-time evaluation with feedback loops. It is a logical step in the evolution of energy efficiency policy—but also one that requires a rethinking of the relationships between government, business, consumers, and the scientific community in order to achieve significant energy efficiency gains in dynamic markets.

## From Resource Acquisition to Market Transformation

"Transformations" of markets have been taking place in and around the energy system for almost as long as energy markets have existed. During the past decade, however, the term *market transformation* has gained a more technical meaning—that is, a policy objective of encouraging or inducing social, technological and economic change in the direction of greater energy efficiency. Some efforts have been made to unpack the idea of market transformation in order to construct a formal definition (for example, Geller & Nadel 1994, Prahl & Schlegel 1995, Eto, Prahl & Schlegel 1996). Unfortunately, these efforts are now colored by their financial implications. In some jurisdictions it is, or seems likely to become, policy to favor MT programs in the allocation of funds. Where this is the case, the definition of MT may be crucial in decisions concerning which programs are funded and which are not. We are not interested here in creating definitions that will decide for us what programs should be funded. [We discuss other criteria for making these decisions below.] For our purposes it is sufficient that, at least in prospect, an MT program's benefits are lasting (in the sense of not requiring continuing intervention in the market) and the value of the program's benefits exceed its costs. We will refer to this, following California Energy Commission terminology, as sustainable, cost-beneficial improvement (SCBI).

This said, it is possible to get a better "feel" for the meaning of MT by examining the evolution of energy-efficiency policy. The efficiency revolution of the past two decades began with a focus on energy shortages and the need for new fuel sources (which dominated policy debates in the 1970s). The concern with shortage lead to a policy of energy "conservation."[1] Energy conservation was, in the minds of many, associated with sacrifice—less comfort, less travel, etc. [Older readers will remember President Jimmy Carter on television wearing a sweater indoors and declaring that the energy crisis was the moral equivalent of war.] Gradually the perception of shortage lessened and existing energy consumption began to be viewed as a new, low-cost, source of supply that could be delivered via various demand-side management (DSM) efforts. DSM, therefore, is a resource acquisition strategy—one that involves techno-economic fitting (and retrofitting) of more efficient devices/machines into existing building designs and production processes.

Energy conservation efforts of the 1970s accomplished some "transformations" (for example, changing thermostat-setting norms, ushering in renewable energy technologies), as did both government interventions and utility demand-side management (DSM) initiatives in the 1980s and 1990s (via building codes, appliance standards, promoting ESCos, subsidizing more efficient appliances, lighting, etc.).[2] But these successes were quite limited in light of what seemed to be technically feasible. Beginning in the early 1990s, the possibility of systematically intervening in the buying and selling of energy-using goods "upstream" from the end-use consumer (the point at which DSM action had traditionally been focused) entered the efficiency discourse. The term "market transformation" was first introduced in this context. The term reflects a broadening of the focus for energy efficiency policy from end users to the markets of which end users are a part.

Many actors and interests are involved in both the energy system and the efficiency movement, and a number of these contributed to early MT thinking and experimentation (Geller & Nadel 1994). Interest in transforming markets follows from ideas originally developed in the context of neo-classical economics about "market failure" (in this case, the tendency of markets to overlook the economic benefits of energy efficiency because of various "market barriers"). It was thought that MT interventions might be aimed at these barriers in ways that utility DSM and government programs could not.[3] Interest in MT was also stimulated by European efforts to affect technological efficiency through systematic procurement (for example, Westling 1991, 1994 [reviewed in Conway 1995], Nilsson 1992). Finally, MT's origins are also found in the pragmatic recognition of some DSM managers that efforts to improve the efficiencies of

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[1] We put quotation marks here because we are well aware that the First Law of Thermodynamics assures us that energy will be conserved. When the term was in common use, energy conservation conveyed the meaning of husbanding something that was thought to be scarce (that is, fuel).

[2] For discussion of the market effects of DSM, see Eto, Prahl & Schlegel. (1996), and for a chronicle of early market transformation efforts, see Geller & Nadel (1994) and Tatutani (1995). For case studies of the evolution of MT from some of its roots in the context of DSM and 1990s government interventions, see Kunkle & Lutzenhiser (1998).

[3] The "barriers" shorthand is somewhat unfortunate. It is a useful term, since it points to phenomena that can impede technological change. But it also glosses over the complex processes at work in market systems. What appear as "barriers" to energy analysts, are normal ways of doing business that can have high economic and non-economic value to the market actors involved (Lutzenhiser 1994). Business-as-usual "behind the barriers" can be both highly inefficient in energy terms and completely sensible to market actors when considering the perceived risks, uncertainties, and other high transaction costs faced by would-be efficiency innovators.

technologies such as refrigerators and air conditioners might be more successful if manufacturers could be induced to change the products offered in the market (for example, Tatutani 1995).

Over the past two years, interest in MT has grown rapidly, as evidenced by national conferences and regional MT initiatives. Significant impetus comes from the combined effects of declining energy prices, movements to restructure the electricity industry, and accompanying financial limits on DSM activities (discussed below). But it is quite likely that interest in MT would have grown (perhaps more slowly) as a natural evolution of theory and practice in the energy efficiency movement. In the regions with which we are most familiar (California and the Pacific Northwest), action is now underway to reconstitute most energy efficiency activities in an MT mode. Attention is being given to the market effects of past DSM practices (Eto, Prahl & Schlegel 1996) and to the realignment of existing government and utility programs with new MT goals (Gardner & Foley 1995, Gordon & Eckman 1995).[4] As DSM practitioners across the U.S. explore ways that their experience can be applied to MT, reactions range from defending the status quo, to shifting program emphases (for example, from consumer incentives to producer/distributor incentives). While the situation varies from case to case, a common problem can be found in the limitations that the tools, language and logic inherited from the utility DSM period bring to the problem of designing and executing MT strategies.

The limits of research and evaluation from the regulated DSM environment also merit mention because of the much greater significance of these activities for MT. Research agendas under DSM have focused largely on technical problems in engineering and building science. Issues related to program design have received little systematic attention, and evaluation research has focused almost exclusively on quantifying energy impacts while controlling for effects of free ridership and secular trends. Some behavioral research has considered the motivations, attitudes, and actions of consumers faced with energy-efficiency choices, and a few studies have examined efficiency choices in firms (see Lutzenhiser 1993 for a review of both lines of research). To the extent that the consumer is influential in markets for energy-using goods (and there are some reasons to be skeptical about her sovereignty, see Shove et al. 1998), the consumer literature can be helpful for MT. But, because our focus has broadened to the entire market, we need a much better understanding of a wide variety of other market participants (from producers and distributors, to vendors, regulators and providers of secondary market services). The limited work to date on program evaluation and consumer behavior is simply not sufficient to inform the development of MT programs with a clear focus on *markets*.

## A Theory-based Approach

Faced with a situation in which our experience with MT is limited and our knowledge about the workings of markets for energy-using goods is services is very incomplete, designing market transformation programs is very challenging. Certainly we want our programs to be successful, but we also want to be certain that our programs help us to learn from experience. Under these circumstances it may seem paradoxical to suggest that MT programs ought to be theory-based. Indeed, the current state of MT theory must be described as rudimentary. The apparent paradox is resolved if one takes theory-based to mean both reliant on available theory and also productive of new theory. Thus a theory-based program is designed not only to make use of available theory (gathered from a variety of scientific and pragmatic sources) but also to test it and extend it.

[4] The work of the Northwest Energy Efficiency Alliance (NEEA) provides an instructive example of how an inherited suite of DSM programs can be remolded into MT interventions.

The California Energy Commission (CEC), with the support and collaboration of the University of California's California Institute for Energy Efficiency (CIEE), is developing one such approach to MT intervention in complex market environments. A central and distinguishing characteristic of the CEC approach is its reliance on theory to identify opportunities, design program initiatives, guide testing of crucial program assumptions, and contribute to the advancement of our knowledge of how markets for major energy using goods and services work and might be improved. A schematic diagram that illustrates the structure of this approach is shown in Figure 1.

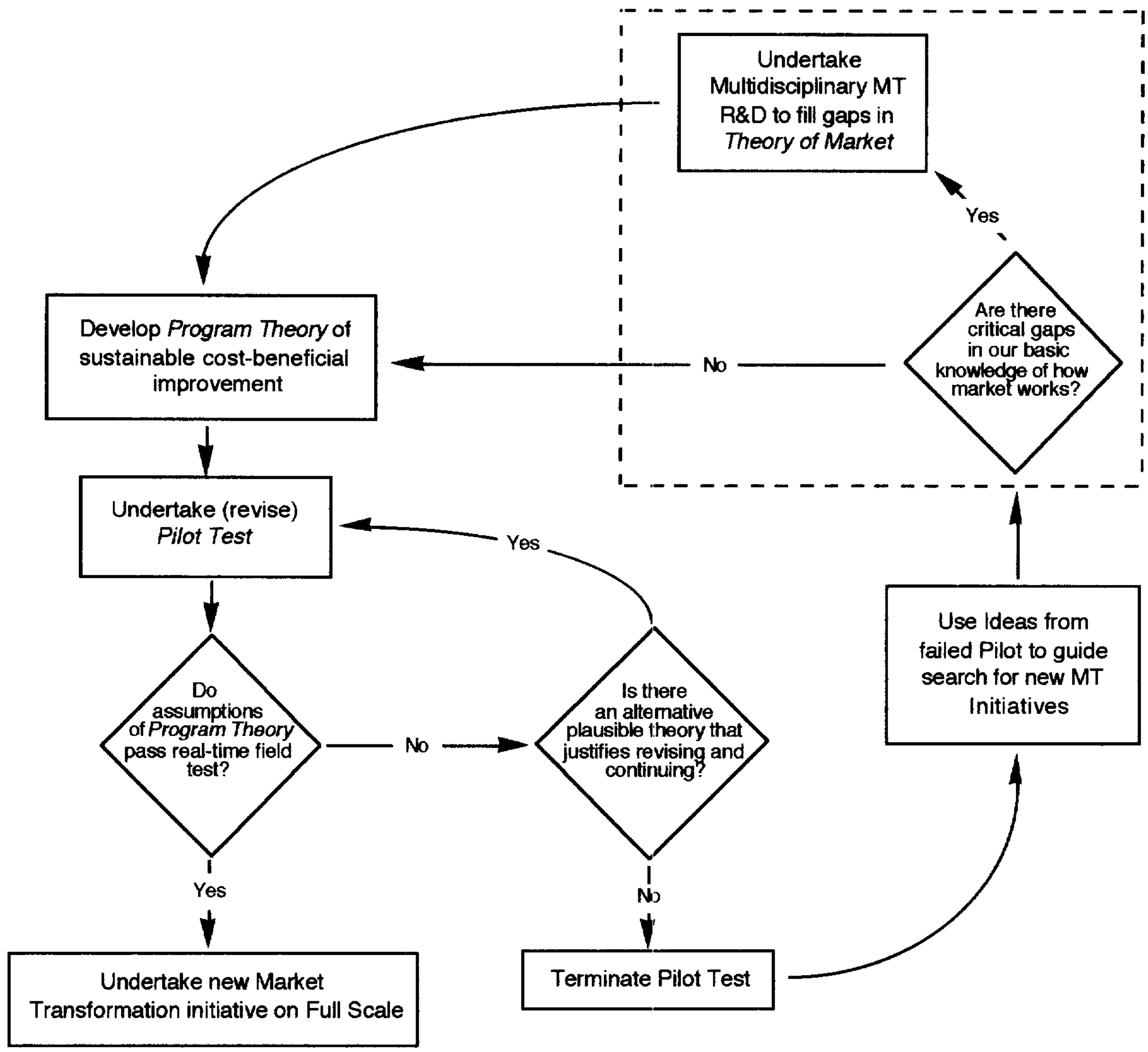


**Figure 1.** Theory-based Market Transformation Development

## Grounding in Plausible Theory

An essential element of the CEC approach is its emphasis on an ongoing learning process aimed at achieving well-targeted MT program actions. To be well-targeted, program actions must be designed, pilot tested and evaluated in an iterative, almost simultaneous process.

During the design phase each program must have a plausible program theory. This means establishing a well-reasoned basis (the program theory) for believing that the proposed MT initiative will lead to a sustainable cost-beneficial improvement (SCBI) in market performance. All of the program assumptions need to be explicitly identified and assessed. This *ex ante* "armchair" plausibility test should be eclectic, drawing on all available sources of relevant intelligence including (a) the normally tacit knowledge of experienced program operators and market actors, and (b) the available literature, both theoretical and empirical, from all of those disciplines (that is, economics, sociology, psychology, engineering, law, etc.) that can contribute to our understanding of the market structure and performance and the plausibility of our proposed program assumptions.

### Pilot Testing to Maximize Learning and Minimize Risk

An instructive analogy may be drawn between attempts by private profit-orientated firms to improve (that is, transform) markets by introducing new products and public market transformation initiatives. Both private and public attempts to transform markets involve risks. However there is one crucial difference. Private new product market transformation initiatives are subjected to a direct and immediate market test. Indeed, 80 percent of all new products fail this test. This high failure rate reflects the extreme difficulty that private firms have in predicting market behavior. There is, unfortunately, no reason to believe that would-be public market transformers should do any better at making such predictions. This means that we should be prepared to see many, if not most, of our MT initiatives, especially as originally designed, to fail (that is, not to succeed in achieving a SCBI). This also means that we need to take precautions to reduce the risk and costs of failure. The CEC strategy of using a well-reasoned plausible theory for program design is one means of doing this. Using pilot-scale tests before attempting full-scale implementation of any new MT initiative is another means.

The pilot stage moves beyond "armchair" theory to address practical realities. During this stage, program practitioners and evaluators collaborate. That is, the evaluator's role is not limited to after-the-fact assessment, but is integrated in a real-time way. By having program designers and evaluators work together from the outset, actions that are destined to fail are more likely to be identified and either eliminated or modified early in the program development process to maximize learning and minimize risk.

For pilot programs that show promise, evaluation provides a guide for "fine-tuning" since programs rarely work in practice exactly as they are originally designed real-time. Rather they evolve as program participants adopt to circumstances that are not anticipated in the program designs and their underlying theories. The results of a recent CEC evaluation of an innovative MT intervention (focused on markets for residential duct performance testing in new housing in Irvine, CA), where several aspects of the program design were distinctly changed in practice, illustrates this point (see Bender et al. 1998). In this case, the third party inspector went beyond the call of duty to check insulation installation defects not covered in the official testing protocols. And despite the sponsor's (the City of Irvine) belief that it would help sell the program to builders, the participating builder decided against using the city's IQ+ brochure promoting the use of testing for fear that it would increase liability risk.

### Rethinking Evaluation

Making such changes in practice is necessary but not sufficient for ultimate MT program success. For determining its desirability and ultimate sustainability we must also test a program's crucial assumptions.[5] To elaborate, sustainability refers to the indefinite continuation of some change in the market. Our confidence in predictions of sustainability will be greater if these predictions are both supported by empirical data about program performance and grounded in theory. This, in turn, requires that we be confident about crucial assumptions contained in our program theory.

A second, closely related, point is that any theory of sustainable MT invariably includes an expected change in the behavior or practice of some market actors. The likelihood of such a behavioral change depends upon these actors being more satisfied after changing than before, or being under some constraint to change, or (more often) some combination of satisfaction and constraint.[6] It thus depends on whether market actors see through their own eyes—that is, in their own characteristic ways of framing the situation—that their changed practice is either desirable or unavoidable.

Both of these points indicate the need for MT evaluation to go well beyond the traditional DSM program focus on quantifying energy savings-benefit impacts. To determine future sustainability, MT evaluators must focus on validating the crucial assumptions contained in a theory pertaining to the future. Moreover, to do this evaluators must incorporate all of the costs and benefits that are seen through the eyes of key market actors, including those that pertain to non-energy aspects, and including those that are beyond the evaluator's ability to quantify.

For example, the CEC theorized that the Irvine Project would create both energy-savings and other kinds of benefits. We applied traditional methods to quantify estimated net energy saving benefits. But because of Irvine's mild climate, these benefits were too small to provide a plausible case for sustainability. However, we assumed in our original program theory that the improved practices sought by Irvine would be sustainable due to other kinds of benefits that would be seen by builders and/or their HVAC subcontractors including (a) a reduction in call-back costs, (b) a reduction in costs through right-sizing of HVAC ducts and equipment, and (c) reduced liability risk. Because they were crucial to our belief about (that is, theory of) sustainability, we directed evaluation effort at testing the validity of these assumptions. In many cases we found our initial assumptions to be inconsistent with perceptions of the relevant market actors. Nevertheless, we learned a great deal from the evaluation process. For example, although there are a significant number of HVAC related call backs most of these pertain to functions, such as mechanical start up problems, that are unrelated to the improvements yielded by the Irvine Project. Rather, builders and HVAC subs see the flow and duct leak problems addressed by the Irvine Project as being too subtle, i.e. too difficult for home buyers to detect, to trigger significant call backs. Contrary to our original theory, they thus see little call back cost reduction benefits attributable to the program (see Bender et al. 1998).

Again we emphasize that validating program sustainability theories requires going beyond quantifying energy saving benefits to test crucial assumptions about how market actors perceive non-energy related costs and benefits. Overall determination of SCBI will, as a consequence, invariably depend on integration of qualitative and quantitative assessments. Finally, even if, as in the case of Irvine, many of our original assumptions are proven wrong the results serve to improve our theories, advance our knowledge of how the market operates, and create the basis for better MT initiatives in the future.

Just as we must, for purposes of sustainability, be concerned with the broad range of cost and benefits that are relevant to private market actors, so we must also be concerned with the broad range of "societal" costs and benefits as that are relevant to public policy makers concerned with the government's

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[5] See Weiss (1997) for a discussion of the current state of the art in theory-based evaluation.

[6] We use "constraint" rather broadly here. A constraint can be legal (for example, appliance standards), or normative (for example, peer pressure), or simply a change in the choices available in the market.

role in improving market functioning. For example, the CEC in its latest strategic plan sees well-functioning markets as contributing to realization of a cleaner environment and more affordable competitively priced energy as well as increased energy efficiency. A still broader list of public virtues that some public policy makers connect with well-functioning markets would include (a) enhanced freedom of choice by means of the orderly provision that markets make for aggregating freely made individual choices, and (b) enhanced prospects for achieving and maintaining long run material welfare by means of the powerful incentives that markets provide for dynamic learning, discovery, and innovation. In sum, energy efficiency, although the *raison d'etre* of MT, should be seen as a co-benefit of MT programs along with other kinds of benefits of interest to both private market actors and public policy makers.

## A Critical Role for Systematic MT Research on Market Dynamics

As shown in Figure 1, research is an integral part of the theory-based approach. While creative efforts to identify market barriers are now underway in utility and government circles as interest in MT grows, more than creativity will be needed to progress beyond our early 1980s framing of the "barriers problem" (for example, Blumstein et al. 1980). DSM-based program experience and research agendas provide only a few of the concepts, theories and methods required to guide strategic interventions in markets.[7] While some efforts have been made to consider energy efficiency innovation at the market level (see Lovins 1992, Lutzenhiser 1994, also several papers in Huntington, Schipper & Sanstad 1994), to support successful MT policies we need new knowledge about the institutional arrangements, regulatory dynamics, organizational networks, firm practices, consumer-vendor interactions, etc. that govern the behavior of actors in markets.

The theory-based approach suggests that the agenda for research to develop this new knowledge should be derived in part from the results of program evaluations. But to carry out this program we also need multi-disciplinary research to synthesize, fill in the detail, and advance our practical knowledge of markets in ways that help identify MT opportunities. There is vast literature from various academic disciplines that provides extremely useful insights about how various characteristics of markets influence their performance. The ACEEE "human dimensions" research tradition can contribute to a better understanding of consumer motivations, social constraints, and organizational choices related to energy use.[8] Other insights into how markets (as collective systems of consumers, producers, intermediaries and facilitating actors) work and how they change is available in the social science literatures on technology (for example, see Dosi 1982, Hughes 1989, Thomas 1994, Cowan 1996, Utterback 1996), organizations (Perrow 1986, Powell & DiMaggio 1991, Williamson 1996, Scott 1998), economic sociology (Smelser & Swedberg 1994), and institutional economics (Hodgeson 1998). Some major strides have also been made in understanding the evolution of technology markets in Europe (for example, see Martin 1996, Giovannini & Baranzini 1997, Shove 1995, Guy 1994, Wilhite & Lutzenhiser 1997), where attention to shaping technologies and economies along more socially and environmentally sustainable lines has been underway for more than a decade.

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[7] The goal of DSM has been primarily to acquire conserved energy at the lowest possible price, as opportunities presented themselves, particularly through the use of consumer incentives. There has been no reason for DSM program managers or efficiency researchers to develop a sophisticated understanding of markets when resource acquisition goals could easily be met without one.

[8] See reviews of work on the human dimensions of energy use in Stern & Aronson (1984), Stern, Young & Druckman. (1992), Lutzenhiser (1992, 1993), Lutzenhiser, Harris & Olsen (1998).

While extremely useful, all of these literatures typically (a) address academic (and, therefore, often highly abstract universal) theories that transcend individual markets, and/or are (b) limited by the characteristic assumptions and associated "blind spots" of narrow discipline-specific paradigms. To exploit the strengths and overcome the limitations of these literatures we are developing a multi-disciplinary market transformation research program to monitor, synthesize and build a bridge between the academic literature and the more detailed realistic understanding of market structure and performance that we need to identify feasible concrete MT opportunities. This approach to identifying market transformation potential (MTP) contrasts with the prevailing focus on technical-economic potential (TEP). From our perspective, the TEP approach may provide useful information. But, like other single-discipline frameworks, it is limited by its characteristic assumptions (for example, technology is fixed) and blind spots (for example, omission of non-energy benefits and omission of market characteristics that influence technology adoption).

To illustrate the kinds of MT research needed, we offer a few examples from residential and commercial construction markets—identified through an ongoing dialogue between academic researchers, energy efficiency practitioners and MT evaluators under the auspices of CEC and CIEE. While the residential construction industry thrives on innovation, it continues to produce buildings that fall far short of demonstrated efficiency potentials. To fashion MT initiatives that are likely to permanently change industry practices, among other things we need to better understand consumer and builder conceptions of "quality" in buildings and just how the invisibility of energy benefits and the difficulty of recognizing defects (such as those targetted by the Irvine Project) work to encourage a superficial definition of quality. We also need to better understand how changing conditions in the industry (for example, growth in firm size, disintermediation of the supply chain, vertical integration of large firms, labor-replacement and deskilling) are likely to affect innovation and influence MT intervention potentials. We need to learn more about how customary relationships between the trades are involved in installation quality problems. And, we need to better understand the ways in which dependencies of builders upon subcontractors and suppliers for information, design expertise, equipment, and materials constrain innovation—as do product liabilty concerns and regulatory regimes (which, ironically, may include otherwise progressive zoning regulations, energy efficiency building codes, and design standards for mechanical systems). A variety of other poorly-understood features of residential buildings markets have also been identified as potentially crucial to MT success and, therefore, as areas in which research is required to inform MT program design in this market.

We are developing a similar inventory of key unknowns in the commercial buildings market—related, for example, to the mechanics of design negotiation (architect-builder-buyer interactions), the ways in which the interests of future owners and leasees are (and are not) represented in the design process, and how the new market-based practice of building "commissioning" might have the potential to transform portions of the market by empowering building owners (although resisted, perhaps, by other market actors). A variety of other features of commercial buildings markets also warrant MT research attention on the grounds that they may offer potentials for MT intervention, but are not well enough understood at this point to allow us to formulate plausible program theories. We have found a similarly interesting range of uncertainties in other areas that we are now investigating for MT potential, including markets for lighting, advanced billing/smart metering, and urban land development. Appliances, procurement and similar topics offer additional research challenges.

## Implications for MT and the Prospects for Improved Energy Efficiency

In concluding, it is worth noting how our new approach to MT follows logically from traditional utility DSM—essentially following an evolutionary path that is attributable to competitive restructuring. To elaborate on this theme: recall that the concept of utility DSM grew out of a belief that utilities could lower costs by attending to opportunities on the demand side as well as the supply side of the meter. But if there is anything that restructuring makes clear it is that, if we are to focus on the structure and performance of markets, then we cannot limit ourselves to the "demand side" (that is, only consumers). All markets, including markets for electricity, have both supply and demand sides. Intrinsic to the very notion of market transformation is the requirement that we attend to the crucial interactions between supply and demand. To intervene more effectively, we need to approach *markets* as complex systems of supply-demand interactions undergoing evolutionary change that *might* be directed more toward efficiency, environmental benefits and social well-being by thoughtful, strategic action.

Indeed, from this perspective, electric industry competitive restructuring is itself a major market transformation. Moreover it is a transformation that clearly demonstrates the point about crucial interactions. That is, despite the fact that competitive restructuring focuses on the supply side (that is, increasing competition for electric generation) it has dramatic implications for the demand side—including traditional utility DSM. Among the most important consequences for utility DSM are: (a) we can no longer tie the benefits of DSM to avoided power plant costs, and (b) public good surcharges (used to fund DSM) are now separated from utility management and control. Taken in combination these two consequences clarify the fact that whatever the successor to national utility DSM is, it is no longer a utility program. It is a public program. A corollary consequence, as we have seen with other public good surcharge programs (for example, the Public Interest Energy Research [PIER] program in California), is that there is no longer any necessary connection between such programs and either the utility or the utility regulator. In other words, competitive restructuring has essentially unbundled public good programs. Regardless of how they are funded, these programs are now more properly construed as a part of government's broader public responsibilities. The relevant public debate is, therefore, not what should or will happen to utility DSM—but what should or will happen to these kinds of government public good programs.

Freed from the constraint of being a utility program (and under the jurisdiction of a utility regulator) market transformation, as we envision it, is thus a very different kind of program. Instead of utilities (in their role as energy service deliverers to their customers), it places the government (and its role as guardian of overall market structure and performance) at center stage. Instead of preoccupation with the comparatively small fraction of energy services provided by utilities, it encompasses the totality of all energy goods and services—a market that is many times larger. In effect, this direct government role frees up market transformation to take a longer term, broader public interest perspective (beyond the emphasis, characteristic of traditional utility DSM, on quantifiable short-term energy savings). This is reflected in our broad MT goal of realizing sustainable cost-beneficial improvements, and it is necessary for energy efficiency advances to be made in the complex world of the 21st Century.

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