

USING DIFFUSION AND COMMUNICATIONS THEORY TO EXPAND MARKET BARRIER EXAMINATION IN MT MEASUREMENT

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Summary

Most market transformation (MT) evaluations have looked for market barriers as defined by the Scoping Study by Eto et al., which focuses upon barriers as defined in transaction cost economics. A few have looked to diffusion of innovation literature to provide additional guidance on mechanisms of market change. This paper presents work that combines both of these with a look at communication flows and feedback loops. Attention to all these elements may be needed to ensure a transformed market that will be sustainable.

This paper presents a process offering a more structured approach for MT measurement design. This consisted of examining the market and the program in a series of steps. The steps lead to defining indicators for measurement that ensure inclusion of the different perspectives of market transformation (market barriers, diffusion factors, and communication flow mechanisms) and a more complete understanding of the linkages between program elements and market transformation. The process develops useful tools along the way that aid in complete MT measurement design. These steps and their tools are as follows:

Step	Tool
1. Define the markets and hypothesized market structures.	Market flow (product, communications, influence) diagrams
2. Define hypothesized market barriers and MT mechanisms (including diffusion factors and feedback/communication network elements) for each participant by market.	Matrix to summarize the market barriers, diffusion factors, and communication flow elements for each major market participant
3. Develop a program theory.	Program theory diagrams
4. Develop a program interventions and indicators matrix by category.	Intervention/indicator tables

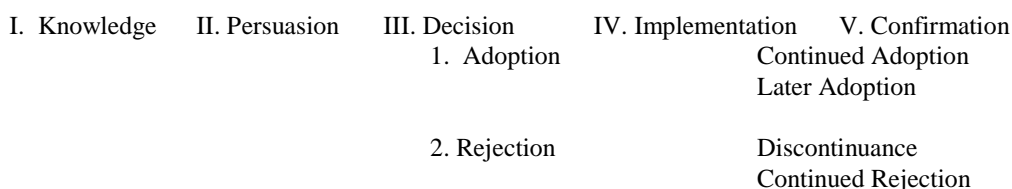
Introduction and Theoretical Foundations

A more structured approach for market transformation (MT) measurement design was created as part of the theoretical work of recent MT evaluations for Pacific Gas and Electric Company's (PG&E) Business Energy Management Services (BEMS), SmarterEnergy™, and Express Efficiency programs^a. This method is continually being refined and improved by the authors in subsequent work each is involved with. This paper presents this sequential approach and tools as the Structured MT Measurement Design Process. Examples are provided from the BEMS study.

Many of the early market transformation studies were primarily based upon combining procedures from demand-side management (DSM) evaluations and concepts from the *Scoping Study* (reference 1). A broader view of factors relating to market transformation was derived from additionally examining diffusion of innovation theory and its communications implications. The different emphases between the *Scoping Study* and the diffusion of innovations literature was highlighted in the *Market Effects Study* (reference 7, page ES-IX): the former emphasizes market participants and barriers, and the latter emphasizes communication flows and processes. Recent work by Mast (reference 3) has tried to map market barriers and diffusion factors to show similarities between the two. Here, however, they are not combined (as might be suggested by Mast) but each is included independently to ensure that each barrier and diffusion factor is addressed from their unique perspectives.

The most oft-cited summary of the diffusion of innovation theory is provided from Rogers' diagram as shown in Figure 1 below. Evident from this is the importance of communication flows and interactions between market participants (communication channels) in order to move from one stage of adoption/diffusion to the next and to do so with positive adoption, confirmation and continued adoption.

Communication Channels



Rogers, reference 9, page 163.

Figure 1 Innovation-Decision Process

The diffusion of innovations' literature also provides us with a list of six attributes of the product or services that influence the rate of diffusion. These rate of diffusion factors are important elements in measuring factors towards market transformation. These six factors are^b:

1. Fulfillment of need
2. Compatibility

^a The evaluations focused upon the small/medium commercial, and industrial market sectors.

^b Rogers, Everett M., with F. Floyd Shoemaker. Reference 10, pp. 137-157.

3. Relative advantage
4. Complexity
5. Observability
6. Trialability

Two communication elements complete the expansion of market barriers and MT mechanisms to be examined: feedback and communication networks. These are believed to be important elements of a transformed market. These are operationalized by examining whether championing of the product/service is occurring and whether follow-up between vendors and customers is available in the market (for confirmation in the diffusion process).

The second level of theory used to develop the approach and tools for the Structured MT Measurement Design Process examines how the program operates to create market transformation. This was an integral part of the study design phase allowing the development of a program theory, an essential step under a theory-based evaluation (TBE) approach. TBE is a broad descriptor of an evaluation approach that has been used in a number of policy fields for some time, and is especially germane in evaluations of market transformation programs. According to Weiss (reference 13), the central tenets behind theory-based evaluation (TBE) are that:

...the beliefs and assumptions underlying an intervention can be expressed in terms of a phased sequence of causes and effects (i.e., a program theory). The evaluation is expected to collect data to see how well each step of the sequence is in fact borne out. This approach to evaluation offers a way in which evaluation can tell not only how much change has occurred but also, if the sequence of steps appears as expected, how the change occurred. If the posited sequence breaks down along the way, the evaluation can tell at what point the breakdown occurred.

Utilizing this approach creates the “story” that will be used as part of testing program attribution. This latter benefit of the TBE approach follows from the ability of a program theory to chart the flow from intervention to outcome to further outcome and the interactions of outcomes. Measuring each step can provide information that can separate problems with the theory of causal effects (the basis of program design) from program failure to set a stage in motion. This is best illustrated in a figure developed by Weiss as given as Figure 2.

Successful Program	Program	set in motion	Causal process	which led to	Desired effect
Theory Failure	Program	set in motion	Causal process	did not lead to	Desired effect
Program Failure	Program	did not set in motion	Causal process	which would have led to	Desired effect

Weiss, reference 14, page 129.

Figure 2 Theory Failure & Program Implementation Failure

Each of these theory elements, when pieced together sequentially, generates a process that helps ensure a structured MT measurement design with breadth over several perspectives of MT influences, with linkages between theory, program interventions, and measurement indicators. Often prior MT measurement design has not been as inclusive of this breadth and linkages. It is much easier to miss an item that according to theory should be examined or leave out a component of the causal chain when this type of sequential process is not used. In this regard, using a sequential structured process can help provide quality control in the MT measurement design process. The steps to create this structured MT measurement design process and examples of its use are provided in the remainder of this paper.

Step 1. Market Structure and Flow Diagrams

The market(s) of interest to the study must first be identified and described. Either this is from the market assessment or is hypothesized in order to design the market assessment study. This can be accomplished through reviewing earlier studies in related markets or similar studies in the same market elsewhere. The goal of this effort is to obtain or develop tools that provide the background understanding of the market, its structure and current operation. Some of the key tools that can provide these are the development of:

- Product flow diagrams and supply-side segmentation schemes that map percentages of product as sold and purchased by various market actors in the market;
- Influence diagrams that summarize the factors that influence various participants and processes in the market; and
- Communication flow diagrams that identify communication channels and methods seen in the market.

Most market assessment studies include product flow diagrams. Influence and communication flows are examined less frequently. The product flow diagrams easily demonstrate who are the market participants and the importance of each in terms of market share. Influence and communication flow diagrams provide slightly different perspectives of the importance and methods of communication used by the different market participants. Each provides useful information to understanding market operation. (Examples are not provided due to space limitations and their availability in a number of MT studies. See reference 11 pages 4-12, 5-7, 5-16, 5-17, 5-18, 5-19, 5-20; and reference 12 pages 4-7, 4-16, 4-17, 4-18, 4-19 for some examples.)

Step 2. Develop Matrix of Hypothesized Market Barriers and MT Mechanisms (with diffusion factors and feedback/communication network elements) for Each Participant

Interviews with program staff, review of program materials, and prior related studies are used to derive the hypothesized market barriers and market transformation (MT) mechanisms for the primary markets. Each market must be examined separately. The list of hypothesized market barriers and MT mechanisms derived from the theoretical foundations effort is combined with the information from the interviews and reviews. This information is then used to create a

summary of these barriers and mechanisms for the three general levels of market actors in the product flow scheme: the customer, the vendor/contractor, and the distributor.

The barriers and MT mechanisms are identified as whether and to what degree they impede the transformation of the market for cost-effective adoption, in this example, of high efficiency packaged air conditioners (ACs). The table also uses symbols so that barriers and mechanisms can be easily seen as affecting market participants at a more macro level (all their energy efficiency considerations and not just this particular market) or affecting a particular segment of the market. These are also important information for both program design and MT measurement design.

The hypothesized market barriers and MT mechanisms table from the BEMS study (reference 11) for the commercial and industrial packaged AC market is presented as an example of this step, Table 1. The remainder of this section describes the findings shown graphically in the Table 1 example.

Macro-Level Barriers/Mechanisms

The high efficiency portion of the market is immature. As a small proportion of sales, information on high efficiency generally entails information costs for consumers. This barrier is a macro level barrier as it occurs across technologies/markets due to the generally immature nature of the high-efficiency market.

Access to financing or budget process constraints are generally a macro-level market barrier for small and institutional customers. These customers have difficulty financing any higher initial cost item although the item may have lower life cycle costs, regardless of the technology. Small customers often have many competing requirements to fund with significant cash flow concerns to stay in operation. Not too different from this, institutional customers often face budget processes based on lowest current cost rather than lowest life cycle costs. Budget allocations often require expenditures for similar items to be the same as prior purchased items, not allowing for additional costs to purchase cost-effective high efficiency models.

Simplifying decisions with rules that may be out-dated occurs within institutional budget processes that can not easily be changed, or with small businesses overwhelmed with the large number of decisions that must be managed by their owners. This type of decision-making process creates the bounded rationality market barrier on a macro-level for these customers.

The last macro-level barrier is the low-level barrier presented by hidden costs to institutional customers. Wherever maintenance or operating needs differ, institutional customers may have difficulties because their decision-making processes may include conflicting priorities and practices, and overlapping turf.

Market-Level Barriers/Mechanisms

Product unavailability is a significant market barrier for high efficiency at all levels of the chain

in the packaged AC market. These unavailability barriers occur primarily because suppliers often do not perceive a sufficient level of demand for them; that is, they have market uncertainty, often linked (on the supply side) with product unavailability (on the demand side).

Selling, carrying, knowing about, and servicing a larger variety of stock creates the transaction and hassle costs seen by the vendors and contractors.

The extent to which organizational practices are a market barrier generally depends on how mature is the overall efficiency market. The greater the penetration and length of time efficiency has been a part of the market the greater the likelihood that organizational practices have adapted to it. This is why organizational barriers are significant in the packaged AC market.

The last decision process barrier is that of split incentives. This barrier involves who has responsibility for the investment decision versus who pays the energy bill. This barrier depends on building ownership or the budgeting process for institutional customers, and does not depend upon the technology or market.

Market uncertainty is an important market barrier for vendors and distributors in the less mature market of packaged AC.

Generally, the feedback and communication network factors must work well to achieve sustainable transformed markets. Yet, not having these factors is only a small impediment for initial market transformation, at least in this market.

Similarly, many of the rate of diffusion factors are also not significant impediments for the current stage of market transformation in the packaged AC market. Poor market/technology performance on any of these factors, however, does slow the rate of diffusion and is important to recognize.

Step 3. Create Program Theory Diagrams

Program theory interviews with program staff and review of program material provide the foundation for the program theory diagrams. The program theory diagram process, when done carefully, can provide depth and quality assurance to the MT measurement and improve the MT effort. The program theory diagram needs to include each intermediate step in the process from an intervention to long-term expected outcomes. This series of “outcome → result → outcome → result” can be used by program personnel to double-check whether other interventions are warranted for different elements in the chain, anticipate the sequential nature of changing interventions as MT progresses, and assess whether their interventions are properly targeting leverage points as compared to the market structure and operation (from the market assessment). The program theory diagram provides a step-by-step check for what elements need to be considered for the MT measurement effort. It also provides a tool to be combined with MT measurement to help provide evidence for program attribution of the market effects, i.e., it tells the “story”.

**Table 1 Hypothesized Market Barriers & MT Mechanisms
C&I Market for Packaged AC**

	Customer	Vendor/ Contractor	Distributor
Product/Service Availability			
Unavailable	●●	●●	●●
Awareness			
Information costs	●*		
Asymmetric information			
Decision Process			
Transaction/Hassle costs		○	
Access to financing	▶* S I		
Bounded rationality	●*		
Organizational practices	●	○	○
Split incentives	D		
Perceived reliability & uncertainty			
Performance & market uncertainty	●	●	●
Hidden costs	○I*		
Inseparability of features			
Irreversibility			
Feedback/ Communication Network			
Championing	▶		
Follow-up available	▶		
Rate of Diffusion Factors			
Fulfillment of felt need			
Compatibility			
Relative advantage			
Complexity	○		
Observability	▶		
Trialability	▶		

Key: ●● = Most important barrier
 ● = Important barrier/ Level impedes market transformation
 ▶ = Moderate barrier/ Moderate impediment for MT
 ○ = Low level barrier/ Some impediment for MT
 * = Macro level across technologies/markets
 S = More important for smaller customers
 I = More important for institutional customers
 D = Depends on building ownership/ budgeting process for institutional customers.

To illustrate, Figure 3 presents the program theory model for the BEMS Program (reference 11). Because it has only one primary intervention, the provision of audits and information to the customer, it is relatively simple to create a program theory for this program. Other programs can be much more complicated, requiring multiple program theory diagram explaining supply-side versus demand-side interventions, outcomes, and results, and possibly with various levels of program interventions (downstream versus upstream interventions). The BEMS program is entirely targeted to the demand-side of the market.

In this example, as seen in Figure 3, there are four direct effects expected from this intervention. These, in order of their expected sequencing, are:

1. Increase awareness, and lower information costs.
2. Increase investigation of high efficiency options.
3. Provide customer with “stamp of approval” thereby lowering perceived risks.
4. Reduce hassle/transaction costs to customers and provide a reinforcement to their commitment to energy efficiency.

Each of these direct effects broadens and accelerates consideration and selection of high efficiency measures, increasing the short-term demand.

The increase in adoption in turn increases customers’ experience with high efficiency measures and practices. Through this experience they learn for themselves of the resulting lower operating costs and better performance of the measures. This then increases customers’ satisfaction with and knowledge of the measures. Satisfied customers will then be able to tell others about their positive experiences with the high efficiency measures. This increases the positive communications flow about the measures.

The increased short-term demand also plays a large role in encouraging increased short-term supply. This in turn can lead to long-term increases in supply through an increase in the number of suppliers, the amount of high efficiency equipment each supplier offers in the market, and lower prices due to increased economies of scale and increased competition.

Increased aggregated and long-term demand stems from customers’ increase in satisfaction with the measures and the increased positive communications flow about the measures.

As in any economic market, increased supply and demand interact with each other reinforcing the gains made. This is expected, indeed required, to create the sustainable transformed market. As part of this broader process, the communications flow about high-efficiency measures becomes a multi-actor feedback loop reinforcing the link between attitudes and behaviors, supporting the sustainability of MT.

Figure 3 Program Theory Example

Step 4. Create Intervention/Indicator Matrix

The next step involves taking the market barriers and MT mechanisms and matching them with the program interventions designed to address them. This is done at the category level in order to solve the problem of overlapping market barriers and to assure a workable analysis that leads to identification of the proximate and ultimate indicators to be measured to assess the baseline and market transformation. An example of the outcome from Step 4 is provided in the partial Intervention/Indicator Matrix in Table 2.

The indicators in the Intervention/Indicator Matrix provide the basis and serve as a checklist for the questions asked in the data collection effort (for the many market effects indicators that can be assessed via market actor survey responses). The instruments are then developed to capture these indicators with separate instruments for each of the different data collection audience, e.g., vendor interviews, customer surveys, etc.

Results

The sequential nature of this Structured MT Measurement Design Process provides a quality control process in the MT measurement design to ensure that each of the following occurs:

- that the appropriate market context is defined and the proper theoretical foundation is laid,
- market barriers, diffusion factors, and communication feedback systems are all considered,
- program theory is developed and understood with expected intermediate and long-term cause-and-effect relationships and outcomes are identified, and
- market effects indicators are based upon expected outcomes from program interventions given the program theory.

This approach ensures that evaluation strategies (1) reflect program planner intent, (2) focus funds on the most relevant MT effects indicators, and (3) identify theory and program failures in a timely and cost-effective manner.

Each of the authors and their firms are continuing to expand the usefulness of the Structured MT Design Process. As part of the evolving extension of this framework, QC is focusing on incorporating the stages of the consumer decision process into MT program planning and evaluation strategies, to further target these efforts and further flesh out the MT “story” for individual programs and elements. Dr. Megdal has developed an MT measurement information gap analysis process and manual. In a complementary fashion, XENERGY is focusing on further development with the program theory diagrams and a desire to use this framework to construct structural equation and/or path analysis models.

Table 2 Example of Program Interventions/Indicators Table (partial table)

Market Barrier Type/ Diffusion Factor	Program Intervention	Hypothesis	Market Effects Indicator
Customer			
Decision process	Provides easy to digest and packaged information for many HE options reducing hassle costs and bounded rationality problems.	Reduces costs and ease consideration of HE options.	High efficiency (HE) options worthy of consideration, believe they have enough information and the benefits warrant further action. Believe they can complete HE efforts that will significantly reduce their energy bills. Information provided helpful in decision process. Change considerations of HE for future decisions.
Feedback/ Communication Network	Program staff follow-up with audit participants to see if they have taken actions.	Allows participants to complete additional information and reinforces commitment. Communication and diffusion occurs from successful adopters.	Have they received follow-up? Do they talk to others about the program? Have they heard about the program in trade organizations? From business colleagues? Have they heard about the ____ measures in trade organizations? From business colleagues?
Rate of Diffusion Factors	Advertising and marketing (should be targeted to address impediments by market).	Increases level of diffusion factor to speed diffusion.	Measure perceptions of benefits and compatibility of each technology (as 1-3 above).

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