Is One Model of Market Transformation Enough for Public Benefit Market-transformation Programs?

Harley Barnes, Ph.D., Aspen Systems Corporation, Rockville, MD
Jon Maxwell, P.E., Aspen Systems Corporation, College Station, TX
William Steigelmann, P.E., Aspen Systems Corporation, Rockville, MD

ABSTRACT

The currently accepted model of market transformation defines the concept so broadly that it obscures the fact that the technology markets that can reasonably be transformed may, at present, only be segments of the entire market. This is inadvertently creating a problem for designers, administrators, and evaluators of market-transformation initiatives regarding how to define what constitutes success within the time period of authorization for these initiatives. The initiatives of greatest concern are those promoting efficient and renewable-energy technologies, and efficiency-maintenance practices that have long economic paybacks or other attributes that seriously obstruct market acceptance. These constitute most of the market-transformation initiatives in the field today. This problem can be overcome if the *market* in market transformation is interpreted to mean *segments* of the entire market. The authors use innovation-diffusion theory to divide the entire market into diffusion segments. They use payback to illustrate mapping of market-transformation initiatives to specific diffusion segments. Diffusion theory is also used to illustrate how market-transformation policy can, in principle, promote transformation of the entire market segment-by-segment. Finally, the paper shows that it is practical to measure market potential and market-transformation progress within diffusion segments.

The Need

The co-authors discovered the need for the ideas in this paper when they compared notes on three publicly funded market-transformation programs they had evaluated. They compared the presently authorized time periods of these programs with their opinions on what their programs should be expected to accomplish within these time periods. They concluded that a serious problem exists for some programs. Energy-efficiency and renewable-energy advocates may be inadvertently courting failure for market-transformation policy by asking program administrators to transform markets for technologies[1] that have long paybacks (more than two years) within these periods. This paper proposes an expanded understanding of market transformation that the authors believe will overcome the problem.

Publicly Funded Market-Transformation Programs

The policy of using public resources to transform markets for energy-efficiency and renewable energy emerged in the early 1990s. It was proposed at least partly in response to restructuring of the electric utility industry. The policy aims to create strong, lasting consumer preferences for energy-efficient and renewable-energy market choices through public intervention (Dickerson et al. 2001, 1-2;

[1] In this paper, the term "technology" will include energy-efficient and renewable-energy technologies and efficiency-maintenance practices.

Keating et al. 1998). It has been adopted by several states as the policy goal for publicly funded energy-efficiency and renewable-energy programs.

Currently, 23 states are operating publicly funded energy-efficiency and/or customer-sited renewable-energy programs (Davies 2002, App B). The authors of this paper have identified six of these as having committed program funds to market-transformation goals.[2] Other states are using public funding to support regional organizations that operate market-transformation programs on behalf of groups of states. However, it is not so much the number of states using market transformation as a policy goal that gives rise to concern about its success, as it is the level of funding by these states. These six states with market-transformation policy goals are providing from 67% to 74% of the total public-benefit funding for energy efficiency and 76% to 85% of the total public funding for renewable energy.[3] These are important investments in the states' long-term quality of life, environmental health, energy price stability, and energy security.

The Issue for Publicly Funded Market-Transformation Programs

A study prepared for the New Jersey Board of Public Utilities in 2002 researched 23 states with public-benefit-funded programs. Part of its focus included the status of market-transformation programs in states having them. The study's report included the following observation:

> Many of the states' program staff feel that market transformation (MT) is too sophisticated a concept for them, . . . They fear that the results of MT are long term (which is true), whereas they are concerned with immediate and short-term results upon which their superiors and regulators judge them. Finally some of them admit that they simply do not know what is meant by market transformation (Davies 2002, 32).

Currently, there is one "model" of market transformation. Nearly everyone who writes on the subject defines it, but all of the definitions that we have reviewed are variants on the very robust concept that was defined in 1996 for the California DSM Measurement Advisory Committee: "a reduction in market barriers resulting from a market intervention, as evidenced by a set of market effects, that lasts after the intervention has been withdrawn, reduced, or changed." (Eto, Prahl & Schlegel 1996, 7). We refer to this as the "traditional model" of market transformation. The concept of *market* in the definition is not differentiated, leading one to think of it as the entire market for which the technology has potential, e.g., the entire residential sector, or all industries with compressed air systems.

The traditional model certainly describes the desired outcome, but is it reasonable to expect that current initiatives for *every* technology can produce lasting market effects in the potential market within their current periods of authorization? Some have doubted it (Eto, Prahl & Schlegel 1996, 41). The average period of legislative authorization for the existing set of publicly funded market-transformation initiatives is 8.3 years. The authorizing legislation or rulings are up for extension between 2004 through 2012.[4] If a lasting market effect cannot be credibly demonstrated within the program period, especially for programs that promote technologies with long paybacks, then what will evaluators be able to say

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[2] The six are, California, Massachusetts, Montana, New Jersey, New York, and Wisconsin. We understand that two of these states have partly backed away from their market transformation goal since legislating it; however, this does not necessarily mean that the goal will not revive during the current period of legislative authorization.

[3] The amount depends on whose data you use. The percentages used here are developed from Union of Concerned Scientists 2002, and Davies 2002, App B. The percentages do not include the $16,200,000 reported as donor funding for market transformation initiatives in 2001 by the Northwest Energy Efficiency Alliance (NEEA 2001).

[4] Calculated from data in Union of Concerned Scientists 2002. Since legislatures are not elected for eight-year periods, the authorization periods may be shortened (or lengthened) at any time. The problem is aggravated when regulatory bodies authorize legislatively approved funding on an annual basis.

about them when these programs come up for renewal, and what will happen to the programs as a consequence?[5] The recent state budget deficits that have induced governors to divert public-benefit funds to meet state operating budgets give the issue more urgency.

At present, two commonly prescribed approaches to promoting technologies that have long paybacks are (1) to market an attribute that consumers value more highly than energy savings, e.g., the freedom from frequent replacements offered by compact fluorescent lamps (CFLs) and hope that this will succeed in transforming the market, or (2) avoid claiming we have transformed a market and settle for claiming *progress* toward that goal. Both of these approaches implicitly presume that there is only one market. Here lies the source of the issue: the traditional market-transformation model is so robust that it does not lead policy makers, program designers, or evaluators to think more narrowly about which *market* it is realistic to transform within a period of legislative authorization. We believe there is a tendency to think of the market as a mass market considering of all households or all commercial buildings that can have the appropriate end use. *We suggest that policy makers, program designers, and evaluators more narrowly define the market they are trying to transform with a specific program initiative before establishing goals or exit strategies for it.*

Dividing Up the "Market" in Market Transformation

What should these more narrowly defined markets look like? We found two published articles that suggested the success of market-transformation initiatives could be related to more narrowly defined market segments (Hall & Reed 1999; Peters et al. 1998, VI-36, 37). Peters et al. suggest that diffusion-of-innovation theory may be relevant. Hall and Reed use the classic S-shaped diffusion curve to define stages of the market that market transformers are trying to transform. To answer our question, we expanded and developed these suggestions. We use innovation-diffusion theory to illustrate how market-transformation initiatives might be mapped to discrete market segments by using stages of the diffusion curve and the attributes of the technologies the initiatives are promoting.[6]
Figure 1 shows the classic S-shaped diffusion curve that is the basis for many market penetration studies. (We peak the diffusion at 80% to represent that reality that new technologies rarely will fully penetration the market for which they are intended.) In Figure 1, we call the full market that the technology hopes to penetrate the "mass" market. (We believe this is the market that most program designers, administrators, and evaluators have in mind today.)

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[5] Some states do not have sunset provisions in their legislation for publicly funded energy programs. These states are not included in the average of 8.3 years.

[6] Mast et al proposed estimating market effects using the diffusion model, but the purpose is different from ours (Mast et al. 1999). For a critique of diffusion models for forecasting market effects, somewhat akin to our purpose, see Dickerson et al. 2001, 7-7.

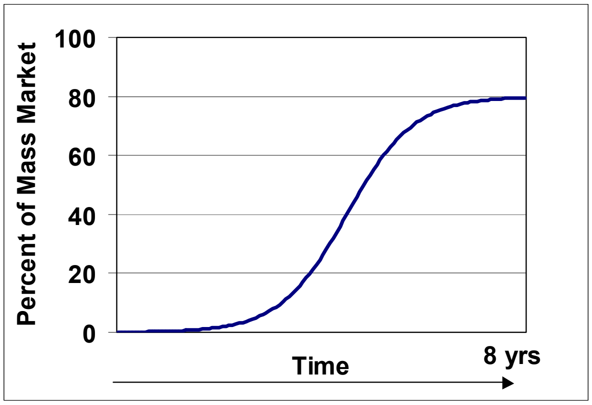

Figure 1. Classical S-Shaped Market Diffusion Curve

We offer three propositions based on the diffusion curve to construct the relationship between market segments and market-transformation success:

1. The mass market for a technology can be divided into longitudinal stages, or diffusion segments, based on the technologies progress along a diffusion curve.
2. Market-transformation initiatives promoting technologies (as we have defined the term) may be assigned, or "mapped," to these diffusion segments.
3. Technologies that are the focus of market-transformation initiatives can move from diffusion segment to diffusion segment.

Proposition 1: The Mass Market Can Be Divided into Diffusion Segments

Diffusion theory describes the progressive penetration of a new technology into the mass market to which it applies (Mansfield 1961; Bass 1969; Blackman 1974). The mass market represented by the diffusion curve can be divided into longitudinal stages according to when consumers in the mass market adopt the new technology (Bass 1969, 216). The actual shape of the diffusion curve is not as important as the proposition that successful products diffuse into the mass market in stages over time. Hall and Reed use five longitudinal diffusion stages to subdivide the mass market this way: "innovators," "early adopters," "early majority," "late majority," and "laggards,"[7] We choose to define three stages, or diffusion segments, to avoid overcomplicating our illustration. They are:

- "Early-adopter segment:" Consumers willing to try a new technology before it's performance has been demonstrated in the market.
- "Swing segment:" More cautious consumers who will try a technology provided others in the market have demonstrated that its characteristics meet one or more of their needs. A technology's performance in this segment can influence whether it eventually captures the mass market.
- "Last-in-line segment:" Consumers who have stringent acceptance criteria and wait for the market to demonstrate that their criteria are fully met.

Figure 2 shows when these three segments occur in the diffusion of a new technology.

[7] Bass divides the mass market into similar diffusion segments (Bass 1969, 216).

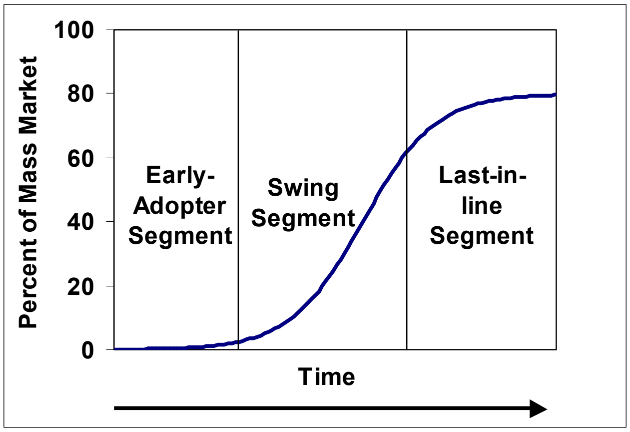

Figure 2. Market Diffusion Curve with Longitudinal Diffusion Segments

Proposition 2: Market-Transformation Initiatives Can Be Mapped to Diffusion Segments

For diffusion segments to be useful, we must be able to map market-transformation initiatives to them. Two steps can accomplish this. First, select technology attributes that you believe the different segments will value. These attributes will influence how rapidly the segment will accept the technology. To illustrate, we have assumed that one attribute, economic payback,[8] will meet this requirement for each of the segments.

Second, establish the values of the technology attributes that determine the segment in which the technology and its initiative belong. We define three technology payback categories and associated values, and use them to map technology initiatives to the diffusion segments:

- Long-term: greater than 6 years to recover the initial investment: we assume that the early-adopter market will tolerate such long paybacks because their principal interest is in the technology itself
- Mid-term: >2-6 years to recover the initial investment: we assume that the swing market will tolerate such mid-term paybacks as long as it is within the technology's estimated useful life to them.
- Short term: 0-2 years to recover the initial investment: The last-in-line folks will wait until they are certain they can recover their investment quickly.

We based the 0-2 years short-term-payback category on our review of literature discussing commercial building owners' requirements for energy-efficiency investments. The mid-term payback period reflects the average length of homeownership (and, therefore, homeowners' presumed tolerance of a longer payback for residential technologies), and the long-term period is everything else, which we presume will interest only a small segment of individuals with uncommon zeal for uncommon technologies. *This*

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[8] The attributes selected should be related to barriers hindering sustained market penetration in the segment. Payback (the attribute includes initial cost) appears so often in the literature as the condition of technology acceptance that we are comfortable using it to map initiatives to segments; however, it is not the only one. Attributes such as risk, awareness, hassle required to evaluate pros and cons, lack of supply channels, local codes, and others are also determinants of adoption. If these alternative attributes or groups of attributes can be attributed to specific technologies, scaled, and mapped as determinants of membership in three (or more) mutually exclusive groups, they can be included with, or substituted for, payback. We acknowledge that this may be more easily said that done, especially if the attributes that map a technology to a segment differ from segment to segment. However, we believe that the threat to market transformation policy makes it worth the effort.

payback typology and the mappings in Table 1 below are not intended to be definitive; they are offered to illustrate the second proposition.

Table 1 illustrates a mapping for selected energy-efficient technology initiatives into our three payback categories. Energy rates and technology prices vary by region; therefore, payback periods vary by region, and the mapping will vary by region. Payback (or other attribute) categories should be established for each mass market to which the technology applies.

Table 1 Classification of Market Transformation Initiatives for Selected Energy-Efficiency Technologies into Payback-Period Categories

1. Technologies with Long-term Payback (>6 yrs)	2. Technologies with Mid-term Payback (>2-6 yrs)	3. Technologies with Short-term Payback (0-2 yrs)
Ground-source heat pumps	Central air conditioners	Commercial CFL applications
Residential CFL applications	Duct sealing	Compressed-air system optimization
Super-efficient refrigerators	Efficient clothes washers	ENERGY STAR® home electronics
Customer-sited photovoltaic systems	Heat pump hot water heaters at time of normal replacement	T8 fluorescent fixtures in new construction
Customer-sited wind systems	Variable-speed drives	LED traffic lights
	Premium-efficiency motors <100 hp at time of normal replacement	LED in place of incandescent exit signs
	T8 fluorescent fixtures as retrofits	

Proposition 3: Technologies Can Move between Diffusion Segments

Diffusion theory holds that technologies begin with what we are calling the early-adopter market and, if they have enough value, eventually capture the mass market. Applied to our diffusion segments, this means that if a technology's value to consumers can be demonstrated it will eventually move through the diffusion segments to capture the mass market. In our illustration, payback is the principal value, and we use it to illustrate the third proposition by suggesting that as more consumers buy a technology, economies of scale will lower its price so that its payback can become attractive to succeeding segments. Thus, reduction in payback is what drives technologies through the segments. In the real world, changes in other attributes besides payback may be the drivers of the movement between segments.[9]

This raises an important question: "Do all new technologies have to go through the entire diffusion process, or can they begin in any segment if they are introduced with the appropriate payback?" For example, if a manufacturer introduces a new technology with less than a two-year payback, should it begin in the early-adopter segment or in the last-in-line segment? In answering this, we keep in mind that our goal is helping policy makers set realistic market-transformation policy.

[9] We do not want to create the impression that we take the drivers of transition between segments lightly. In our illustration, we have used payback as the attribute that maps technologies and their initiatives to diffusion segments. It is intuitively easy to theorize that increased acceptance by one diffusion segment can produce economies of scale that reduce the price of the technology and, therefore, its payback. When other attributes are used to map technologies to diffusion segments, however, the problem of how to drive technologies to the next segment may be more difficult, and the further question of how much acceptance is required in one segment to reduce payback (or other barrier) to the acceptable threshold of the next poses its own difficulties. The inter-segment drivers may even change from segment to segment. The topic of how program initiatives can drive technologies to the next segment is crucial for an overall theory of market transformation but is secondary to the focus of this paper.

Such a new technology would probably catch on rapidly, but we expect the first buyers will still be the early adopters. Although our propositions would classify such a new technology (using payback as the principal attribute of value) immediately into the last-in-line segment, we expect it to go through the early adopter and swing segments first. But we also expect it to capture these segments very quickly, and therefore, *for market-transformation policy purposes*, we would be justified in immediately classifying it into the last-in-line segment. As a matter of policy, we should immediately set transformation of the mass market as the goal for program's promoting technology. We handle this apparent contradiction in our scheme by offering a corollary to our three propositions

Corollary to Three Propositions: A Technology that Maps to a Segment also Maps to All Segments that Precede It in the Diffusion Process

If a technology meets the requirement for being classified into a segment, it also satisfies the requirements for being classified into each diffusion segment preceding it in the diffusion process. Figure 3 shows the passage of technologies through the diffusion segments and the possibility of beginning in a later segment.

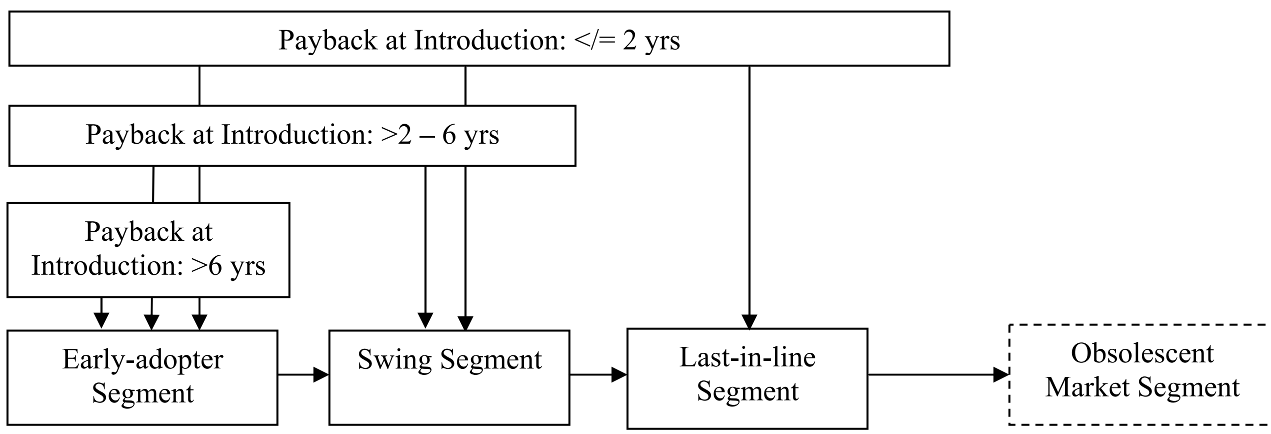

Figure 3. Introduction into and Passage of Efficient Technologies through Market-Diffusion Segments

Redefining the Market for Market-transformation "Success"

Our three propositions provide a basis for narrowing the scopes of the markets that market-transformation policy should be targeting. Diffusion-segment markets, based on diffusion theory and the attributes of the energy-efficient technologies, should be the markets on which market-transformation success is judged. Table 2 summarizes the application of the three propositions.

Table 2: The Diffusion Segment Markets and Market-transformation Goals for Market-transformation Initiatives

Attribute(s) of the Initiative	The Market to Transform (Diffusion Segments)	The Goal of Market-transformation Policy[10]
Technology payback is greater than 6 years	Early-adopter Segment	Achieve a high percentage market penetration of the early-adopter segment and reduce the payback of the technology so that it becomes attractive for the swing segment.
Technology payback is greater than 2 years to 6 years	Early-adopter Segment + Swing Segment	Achieve a high percentage market penetration of the swing segment and reduce the payback of the technology so that it becomes attractive for the last-in-line segment.
Technology payback is 2 years or less	Last-in-line Segment + Swing Segment + Last-in-line Segment	Achieve a high percentage market penetration of the mass market.

The Practicality of Diffusion Segments for Design and Evaluation

We have described, in theory, an alternative framework for establishing market-transformation goals against which to measure success. We must now ask, is it practical? Practicality in this case means (1) the market potentials of the diffusion-segments can be quantified for program design and evaluation purposes, and (2) market transformation progress can be measured for evaluation purposes.

Diffusion Segment Market Potential

We have mapped market-transformation initiatives to diffusion segments using customers' criteria for the maximum acceptable time to recover their investment, i.e., payback. Payback is a customer psychographic characteristic. Other psychographic characteristics exist (e.g., risk aversity), and there also may be physical characteristics (e.g., physical ability of a building to use a technology). The Electric Power Research Institute's (EPRI's) CLASSIFY methodology and similar conjoint/cluster-analysis methodologies will discriminate between diffusion segments on psychographic variables for both residential and commercial customers. Such methodologies can be used to quantify the size of the diffusion segments on the basis of psychographic characteristics.

CLASSIFY and comparable methodologies require a customer survey. At the same time that the survey is conducted, market assessors can evaluate the physical characteristics of the customers' buildings to develop statistical estimates of the proportion of each segment that has the physical ability (technical potential) to use the technology.

We conclude that the diffusion segments can be identified and their size can be quantified using existing marketing research and evaluation methodologies.

[10] Table 3 will expand these goals in the case of technologies for which energy efficiency is a continuous variable.

Market-transformation Progress Measurement

We need to introduce three concepts to help us assess the ability to measure progress toward market transformation in diffusion segments. First, we distinguish between evaluation measurement before and after market transformation. Measurement of indicators *before* market transformation should focus on (1) progress in changing suppliers' marketing practices and (2) the resulting changes in consumer acceptance. Examples are changes in the supplier advertising and the ultimate effect of these changes in consumer behavior such as a change in market share (Feldman 1995; Dickerson et al. 2001, 2-14). Measurement *after* market transformation focuses on the ultimate effects. For example, market share should remain high after market transformation. Our discussion of progress focuses on the measurement of indicators *before* market transformation.

Second, technologies can be marketed by stimulating demand in order to "pull" more of the product into the market, by using supply to "push" the product into the market, or both. Successful strategies often employ both strategies. We assume that evaluating market-transformation progress requires measuring market effects due to both.

Third, we note that the efficiency attribute for efficient technologies can be either a discrete or continuous variable. Some of the technologies in Table 1 are considered efficient by virtue of major design differences relative to alternative technologies serving the same end-use. LED exit signs, CFLs and T8 fluorescent lamps provide examples. We do not think of them as having degrees of efficiency.

For the remaining technologies the efficiency attribute is a continuous variable. The technology can have varying degrees of efficiency. Examples include refrigerators, room air conditioners, motors, and maintenance practices. This distinction in the type of variable is necessary when evaluating the practicality of measuring progress because it affects the choice and interpretation of the progress metrics. Market-share growth is a suitable indicator of progress for technologies for which efficiency is a discrete variable, but it requires special interpretation in the case of technologies for which efficiency is a continuous variable. The definition of what is "efficient" changes periodically for the latter. For example, the ENERGY STAR® efficiency criterion for a refrigerator has increased twice since 1999 and will increase again in 2004. This often requires that periodic decreases in market share be accepted even though the trend would be positive if the efficiency criterion were stable.

Table 3 on the next page suggests quantifiable indicators that are available to measure progress toward market transformation in each of the diffusion segments. Each indicator can be quantified by appropriate survey research. Table 3 also illustrates how the indicators could be used to provide evidence of progress within the individual diffusion segments. We conclude from Table 3 that progress toward market transformation can be measured quantitatively within the diffusion segments.

With both market potential and progress in market transformation measurable within diffusion segments, we conclude that it is practical to use diffusion segments for market-transformation policy purposes.

Table 3: Illustration of Quantifiable Market-transformation Progress Indicators and How They Can Be Used to Indicate Market-transformation Progress in Each Diffusion Segment

		Evidence of Progress		
Marketing Strategy	***Indicator***	**Early-Adopter Segment**	**Swing Segment**	**Last-in-Line Segment**
Supply/ push	*Number of manufacturers Producing qualifying models*	Small[11] number in field throughout the program period	Moderate number in field throughout the program period	Nearly all manufacturers are in field throughout the program period
	Number of retailers or contractors active in selling or installing the technology or offering the maintenance service	Small number remain active throughout the program period	Large number remain active throughout the program period	Nearly all remain active throughout the program period
	Retail price and payback	Both decline during the program period	Both decline during the program period. Desirable goal for payback to reach two years.	Payback remains at or less than two years during the program period.
Demand/ pull	Efficiency is a discrete variable: *(1) Market penetration in the early-adopter segment, (2) Market share.*	(1) The market penetration in the early-adopter segment is high, or, if a CLASSIFY-type study was performed for market potential, the market penetration in the mass market is at a level that is equivalent to a high percentage of the early-adopter market potential. (2) Market share is growing in the early-adopter or mass market.	(1) The market penetration in the early-adopter and swing segments is high, or, if a CLASSIFY-type study was performed for market potential, the market penetration in the mass market is at a level that is equivalent to a high percentage of the early-adopter plus swing market potentials. (2) Market share continues to grow in the mass market or early-adopter and swing markets beyond what it was at the end of the early adopter stage.	(1) Market penetration in the mass market is high. (2) Market share continues to grow in the mass market.
	Efficiency is a continuous variable: *(1) Market share. (2) Market average efficiency of technology shipments in the mass market.*	(1) Market share is growing in the early-adopter or mass market during periods when the definition of efficiency is stable. (2) Average efficiency of technology shipments or sales in the mass market continues to increase.	(1) Market share continues to grow in the mass market or early-adopter and swing markets beyond what it was at the end of the early adopter segment during periods when the definition of efficiency is stable. (2) Average efficiency of technology shipments or sales in the mass market continues to increase beyond that in the early-adopter segment.	(1) Market share continues to grow in the mass market during periods when the definition of efficiency is stable. (2) Average efficiency of technology shipments or sales in the mass market continues to increase beyond that in the swing segment.

[11] The paper does not define words such as "small," "moderate," or "large" because the quantitative definitions will vary with the technology and from jurisdiction to jurisdiction depending on local or regional circumstances.

Conclusion

Concern exists that some market-transformation programs may be too ambitious to succeed within their period of program authorization. We propose that this concern arises from not recognizing that technologies appeal to different segments of the market at different times in their development. We propose that innovation-diffusion theory can be used to identify these segments. We recommend that market-transformation policy makers, program administrators, and evaluators tailor their activities to diffusion segments rather assume that the mass market is applicable in all situations. We propose that technology attributes such as payback period can be useful for mapping the technologies to diffusion segments. We believe this approach will help market-transformation policy makers and designers to establish more realistic goals, administration practices, and evaluation procedures for market-transformation programs, and thereby help to sustain the use of this important policy.

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