Measuring the Success of Large-Scale, Multi-Faceted Programs in Accelerating Energy Efficiency Decisions

Tom Talerico, TecMRKT Works
Ellyn Krevitz, Department of Energy
Gretchen Jordan, Sandia National Laboratories
Nick Hall, TecMRKT Works
John Reed, TecMRKT Works

ABSTRACT

A challenge in market transformation program evaluation is how to effectively measure changes to the energy-related decision making process and to measure or test for how much of the observed effects result from market transformation programs. For market transformation programs that may take years to produce results, evaluations must, in the early years, focus on program-induced changes to the decision-making process. This paper presents a methodology for measuring these effects.

The United States Department of Energy's (DOE) Federal Energy Management Program (FEMP) is a large-scale, multi-faceted program targeted to Federal agencies. FEMP helps Federal agencies reduce their costs, increase energy efficiency, use renewable energy, and conserve water by transforming the way in which energy-related decisions are made. An evaluation of FEMP was conducted in 2001 that focused on the decision-making process and the speed of that process among decision-makers who use FEMP services and those who do not. This paper describes how FEMP is influencing Federal agencies to change their decision-making process in ways that lead to the institutionalization of energy efficient practices and cause the adoption and use of energy efficient technologies over time. This research is unique in that it isolates FEMP's effect in inducing changes through the use of a control group of Federal facilities that do not use FEMP services.

Background

The Federal government is the largest single energy consumer in the United States. FEMP works to reduce the cost and environmental impact of the Federal government by advancing energy efficiency and water conservation, promoting the use of distributed and renewable energy, and improving utility management decisions at Federal sites. Despite energy bills that total approximately $4 billion annually for Federal buildings and other facilities, the government's building-related energy costs have actually dropped more than 20 percent per square foot since 1985, thanks in large part to the work of FEMP. FEMP's long-term goal is to reduce building energy use per square foot by 35 percent (compared to 1985 levels of use) by 2010.

To meet this goal, FEMP offers services in the following four main areas: financing, technical assistance, outreach, and policy. *Financing services* help Federal agencies leverage funds for energy efficiency improvements through new financing partnerships with the private sector. *Technical assistance* allows agencies to take advantage of innovative

technologies and training opportunities. *Outreach* helps agencies learn about new energy-saving strategies, gain recognition for outstanding energy achievements, and keep current on the government's progress in meeting mandated energy management goals and challenges. *Policy-related activities* ensure coordination among the many agencies working to meet national energy-use goals.

This paper is based on an evaluation of FEMP that was conducted in 2001 (Hall et al. 2002). The 2001 FEMP evaluation addressed a broad range of issues across each of the four areas above. The focus of this paper is on two specific programs that the evaluation addressed in detail: the FEMP Energy Savings Performance Contract (EPSCs) program and the FEMP SAVEnergy Audit program. *FEMP ESPCs* allow Federal agencies to finance the capital costs of energy- and water-saving equipment and renewable energy systems at their facilities. The financing involves contracts with private energy service companies (ESCOs), where the project costs are paid back over time from the energy savings. Throughout the paper, these contracts will be referred to as performance contracts. *FEMP SAVEnergy Audits* provide direct assistance to Federal agencies in identifying and implementing energy efficiency and water conservation measures at their facilities.

Methodology

Many market transformation programs are designed to impact customer decisions long before the technologies are actually installed. Evaluations of market transformation programs need to use techniques that measure the effects on these decisions; otherwise, the true impacts of market transformation programs might go unrecognized (Hall & Reed 1997). The 2001 FEMP evaluation used a technique based on the diffusion of innovation model. An overview of this technique is presented below.

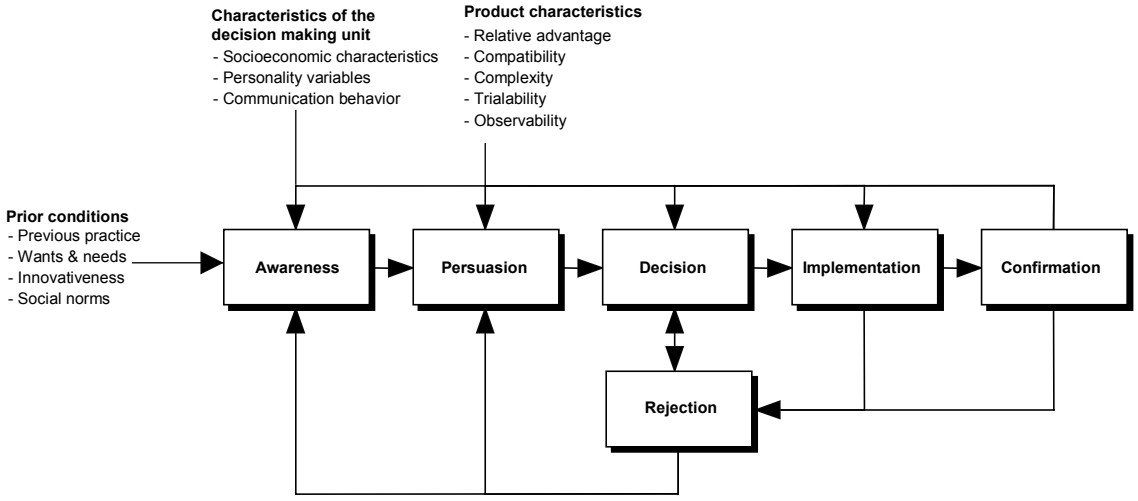
Diffusion of Innovation Model

The technology diffusion literature provides much information about how new ideas and practices spread in the market. Technology diffusion and adoption theory suggests that customers move through a systematic series of events before they adopt a new method of operation or technology. Figure 1 illustrates a widely accepted model of the diffusion of innovations (Rogers 1995). This model is based on a long research tradition and defines a process by which market actors, in this case government employees and others, adopt a new innovation. The model identifies the following six stages in adopting a new technology: (1) unaware stage, (2) awareness stage, (3) persuasion stage (information gathering), (4) decision stage (yes or no), (5) implementation stage, and (6) confirmation stage (behavior is reinforced or repeated). These stages are discussed below.

First, actors must become aware of the innovation. Once aware, the actor enters a persuasion or information gathering stage. In this stage, the actor seeks and processes information in order to decide whether to adopt the innovation. How quickly the actor moves from the awareness stage to the information gathering stage varies with the circumstances and can range from a few hours to many years. Following the persuasion stage, the market actor moves from information seeking to a decision. That decision might be to adopt the new technology, to postpone adoption, or to continue the search for information. The decision to

adopt and the implementation of the decision are separate acts and may also be separated in time (Erickson et al. 1996). For example, a market actor might decide to buy a new camera, but might also decide to wait several weeks because the cash might not be available, because a new technology might be introduced, or because the decision maker might expect a drop in the price of the camera. Finally, market actors constantly reevaluate or confirm their decisions. This may result in continuance or discontinuance of the adoption. Because markets and products are constantly evolving, a decision to purchase a technology today may be followed by a decision not to purchase that technology in the future.

Figure 1. Model of Innovation Adoption and Diffusion



Source: Revised from Rogers 1995 by N Hall

Application of Diffusion of Innovation Model

There are several advantages to using the theory of diffusion of innovation to assess market change. The theory describes a series of stages. Because of this, changes in the market can be tracked more closely than if one is simply attempting to count the number of widgets that are adopted. This means that there are opportunities to more carefully identify where programs are being successful and where additional interventions may be required.

Assessing FEMP's impact on the market requires having before and after measurements. The challenge for the 2001 FEMP evaluation was that no data were available for the period before participants became familiar with FEMP services. In order to overcome this challenge, a recall design was used that incorporated a nonparticipant control group. Previous FEMP evaluation studies (Hall & Jordan 1999; Hall, Jordan, & McNeil Technologies 1999; Hall et al. 2000) applied the diffusion of innovation model to show impacts, but did so without examining the activities of nonparticipants. The 2001 FEMP evaluation's analysis of nonparticipant activities is an enhancement to previous work given that it is difficult to make inferences about change in the absence of a control group against which to compare outcomes.

Results are based on telephone surveys with 413 decision-makers that use FEMP services and 398 decision-makers that do not use FEMP services. The surveys contained a battery of questions that are used to identify the stage of adoption that each participant and nonparticipant has reached for the energy services of interest. Further, the surveys were structured to assess before and after effects. For the energy services of interest, participants were asked about their behavior before they heard about FEMP and after they became involved with FEMP. Nonparticipants were asked about their behavior before they heard about FEMP and after they heard about FEMP.

The survey goal was draw a sample of FEMP participants and a comparable sample of nonparticipants who are potential customers of FEMP. As shown in Table 1, the distribution of survey completes for participants and nonparticipants in the FEMP ESPC and SAVEnergy Audit programs represents a good cross-section of agencies, DOE regions, and job responsibilities. Although there are differences between participants and nonparticipants within some of the segments, the evaluation found no systematic differences in the movement in the adoption cycle for performance contracts and energy audits by agency group, DOE region, or job responsibility.

Table 1. Distribution of FEMP ESPC and SAVEnergy Audit Participants and Nonparticipants by Agency Group, DOE Region, and Job Responsibility

Segment	ESPC Program			SAVEnergy Audit Program		
	Percent of parts (N=101)	Percent of aware nonparts (N=117)	Percent of unaware nonparts (N=188)	Percent of parts (N=77)	Percent of aware nonparts (N=121)	Percent of unaware nonparts (N=207)
Agency group						
DOD	31	31	30	17	28	34
Big four	23	17	13	26	26	22
Second tier	27	31	34	38	26	28
Third tier	4	6	7	12	6	4
Contractors	16	15	15	8	14	12
DOE region						
Boston	7	3	3	4	7	6
Philadelphia	19	21	20	32	26	12
Atlanta	12	19	7	10	13	10
Chicago	19	24	50	21	25	54
Denver	20	16	9	17	17	11
Seattle	24	17	11	16	12	8
Job responsibility						
Project expeditors	7	15	25	5	16	26
Project planners	30	22	18	29	26	15
People w/primary energy responsibilities	51	46	24	51	40	32
People w/operations and maintenance responsibilities	12	16	34	16	18	27

FEMP-Induced Changes to Decision-Making Process

Effect on Use of Performance Contracts

FEMP-induced changes to the decision-making process in the use of performance contracts to finance energy improvements are identified by comparing the movement of participants and nonparticipants in the adoption cycle for performance contracts. The analysis includes the period before respondents heard about FEMP ESPCs and the period since they became involved with / heard about FEMP ESPCs.

ESPC participants. The movement of FEMP ESPC participants in the adoption cycle for performance contracts is illustrated in columns (1)-(3) of Table 2. Before hearing about FEMP ESPCs, 24 percent of participants were unaware of the existence of performance contracts (unaware stage), 27 percent had just become aware of performance contracts (awareness stage), 12 percent had already begun collecting information about performance contracts (persuasion stage), 10 percent had decided to not use performance contracts (decision stage – no), three percent had decided to use performance contracts but had not implemented them yet (decision stage – yes), seven percent had implemented performance contracts one time (implementation stage), and 18 percent had implemented performance contracts repeatedly (confirmation).

Table 2. Movement of FEMP ESPC Participants and Nonparticipants through the Adoption Cycle

Stage of adoption	Percent of participants (N=101)			Percent of aware nonparticipants (N=117)			(7) Percent of unaware nonpartici pants (N=188)
	(1) Before hearing about FEMP	(2) Since involve-ment with FEMP	(3) Move-ment from (-) / to (+) stage	(4) Before hearing about FEMP	(5) Since hearing about FEMP	(6) Move-ment from (-) / to (+) stage	
Unaware	24	0	-24	21	0	-21	63
Aware	27	10	-17	31	40	+9	24
Persuasion	12	7	-5	9	10	+1	5
Decision – no	10	7	-3	14	16	+2	1
Decision – yes	3	21	+18	8	9	+1	1
Implementation	7	24	+17	4	6	+2	4
Confirmation	18	32	+14	14	18	+4	2

Since involvement with FEMP ESPCs, no participants remain unaware of performance contracts (unaware stage) and only 10 percent indicate that they have just become aware of performance contracts (awareness stage). These results indicate that FEMP ESPCs have moved about 41 percent of participants at least through the first two stages of the adoption cycle. More importantly perhaps, the same type of movement also occurs on the top end of the diffusion scale. Since involvement with FEMP ESPCs, 56 percent of participants are in either the implementation or confirmation stage, compared to 25 percent before hearing about FEMP ESPCs. This means that an additional 31 percent of participants moved into either the implementation or confirmation stage.

Aware ESPC nonparticipants. The movement of FEMP ESPC nonparticipants who are aware of FEMP ESPCs is illustrated in columns (4)-(6) of Table 2. Before hearing about FEMP ESPCs, 21 percent of aware nonparticipants were unaware of performance contracts (unaware stage), 31 percent had just become aware of performance contracts (awareness stage), nine percent had already begun collecting information about performance contracts (persuasion stage), 14 percent had decided to not use performance contracts (decision stage – no), eight percent had decided to use performance contracts but had not yet implemented them (decision stage – yes), four percent had implemented performance contracts one time (implementation stage), and 14 percent had implemented performance contracts repeatedly (confirmation).

Since hearing about FEMP ESPCs, no aware nonparticipants are unaware of performance contracts (unaware stage) and 40 percent have just become aware of performance contracts (awareness stage). These results indicate that 12 percent of aware ESPC nonparticipants have moved at least through the first two stages of the adoption cycle. This is significantly less than the 45 percent of participants who moved through the first two stages of the adoption cycle and supports the conclusion that FEMP ESPCs are a factor underlying the movement of participants through the adoption cycle. Moreover, the same types of results are found on the top end of the diffusion scale. Since hearing about FEMP ESPCs, 24 percent of aware nonparticipants are in either the implementation or confirmation stage, compared to 18 percent before hearing about FEMP ESPCs. This means that only six percent of aware nonparticipants moved into either the implementation or confirmation stage. Again, this is significantly less than the 31 percent of participants who moved through the last two stages of the adoption cycle and supports the conclusion that FEMP ESPCs are a factor underlying the movement.

The results also indicate that participants and aware nonparticipants were similar in their progress with regard to the use of performance contracts before exposure to FEMP. As shown in columns (1) and (4) of Table 2, 28 percent of participants and 26 percent of aware nonparticipants had either made the decision to use (decision stage – yes) or had used performance contracts (implementation or confirmation) before they heard about FEMP. The similarity between participants and aware nonparticipants is more pronounced when compared to unaware nonparticipants. As shown in column (7) of Table 2, only seven percent of unaware nonparticipants have either made the decision to use (decision stage – yes) or have used performance contracts (implementation or confirmation).

Unaware ESPC nonparticipants. The position of FEMP ESPC nonparticipants who are unaware of FEMP ESPCs is illustrated column (7) of Table 2. The analysis includes only the period before this group heard about FEMP ESPCs, since there can be no "after period" because these nonparticipants are unaware of FEMP ESPCs. Sixty-three percent of unaware nonparticipants are unaware of performance contracts (unaware stage), 24 percent have just become aware of performance contracts (awareness stage), five percent have already begun collecting information about performance contracts (persuasion stage), one percent had decided to not use performance contracts (decision stage – no), one percent had decided to use performance contracts but had not implemented them yet (decision stage – yes), four percent have implemented performance contracts one time (implementation stage), and two percent have implemented performance contracts repeatedly (confirmation).

Effect on Use of Energy Audits

As with performance contracts, FEMP-induced changes to the decision-making process in the use of energy audits to identify energy improvements are identified by comparing the movement of participants and nonparticipants in the adoption cycle for energy audits over time.

SAVEnergy Audit participants. The movement of SAVEnergy Audit participants in the adoption cycle for energy audits is illustrated in columns (1)-(3) of Table 3. Before hearing about FEMP SAVEnergy Audits, 14 percent of participants were unaware of energy audits (unaware stage), 29 percent had just become aware of energy audits (awareness stage), 10 percent had already begun collecting information about energy audits (persuasion stage), four percent had decided to not use energy audits (decision stage – no), four percent had decided to use energy audits but had not yet done so (decision stage – yes), eight percent had implemented energy audits one time (implementation stage), and 31 percent had implemented energy audits repeatedly (confirmation).

Table 3. Movement of FEMP SAVEnergy Audit Participants and Nonparticipants through the Adoption Cycle

Stage of adoption	Percent of participants (N=77)			Percent of aware nonparticipants (N=121)			(7) Percent of unaware nonpartici pants (N=207)
	(1) Before hearing about FEMP	(2) Since involve-ment with FEMP	(3) Move-ment from (-) / to (+) stage	(4) Before hearing about FEMP	(5) Since hearing about FEMP	(6) Move-ment from (-) / to (+) stage	
Unaware	14	0	-14	8	0	-8	40
Aware	29	0	-29	29	33	+4	35
Persuasion	10	1	-9	7	5	-2	6
Decision – no	4	0	-4	9	10	+1	1
Decision – yes	4	0	-4	3	4	+1	1
Implementation	8	33	+25	17	20	+3	8
Confirmation	31	66	+35	26	28	+2	8

Since involvement with FEMP SAVEnergy Audits, no participants were in the unaware or aware stage. These results indicate that FEMP SAVEnergy Audits program have moved about 43 percent of participants at least through the first two stages of the adoption cycle. Moreover, the same type of movement also occurred on the top end of the diffusion scale. Since involvement with FEMP SAVEnergy Audits, 99 percent of participants were in either the implementation or confirmation stage, compared to 39 percent before hearing about FEMP SAVEnergy Audits. This means that an additional 60 percent of participants moved into either the implementation or confirmation stage.

Aware SAVEnergy Audit nonparticipants. The movement of SAVEnergy Audit nonparticipants who are aware of FEMP SAVEnergy Audits is illustrated in columns (4)-(6) of Table 3. Before hearing about FEMP SAVEnergy Audits, eight percent of aware nonparticipants were unaware of energy audits (unaware stage), 29 percent had just become

aware of energy audits (awareness stage), seven percent had already begun collecting information about energy audits (persuasion stage), nine percent had decided to not use energy audits (decision stage – no), three percent had decided to use energy audits but had not yet implemented them (decision stage – yes), 17 percent had implemented energy audits one time (implementation stage), and 26 percent had implemented energy audits repeatedly (confirmation).

Since hearing about FEMP SAVEnergy Audits, no aware nonparticipants are unaware of energy audits (unaware stage) and 33 percent had just become aware of energy audits (awareness stage). These results indicate that only 4 percent of aware nonparticipants have moved at least through the first two stages of the adoption cycle. This is significantly less than the 43 percent of participants who have moved through the first two stages of the adoption cycle and supports the conclusion that FEMP SAVEnergy Audits are a factor underlying the movement of participants through the adoption cycle. Moreover, the same types of results are found on the top end of the diffusion scale. Since hearing about FEMP SAVEnergy Audits, 48 percent of aware nonparticipants are in either the implementation or confirmation stage, compared to 43 percent before hearing about FEMP SAVEnergy Audits. This means that only five percent of aware nonparticipants moved into either the implementation or confirmation stage. Again, this is significantly less than the 60 percent of participants who moved through the last two stages of the adoption cycle and supports the conclusion that FEMP SAVEnergy Audits are a factor underlying the movement of participants through the adoption cycle.

As with performance contracts, the results also indicate that participants and aware nonparticipants were similar in their progress with regard to the use of energy audits before exposure to FEMP. As shown in columns (1) and (4) of Table 3, 43 percent of participants and 46 percent of aware nonparticipants had either made the decision to use (decision stage – yes) or had used energy audits (implementation or confirmation) before they heard about FEMP. The similarity between participants and aware nonparticipants is more pronounced when compared to unaware nonparticipants. As shown in column (7) of Table 3, only 17 percent of unaware nonparticipants have either made the decision to use (decision stage – yes) or have used energy audits (implementation or confirmation).

Unaware SAVEnergy Audit nonparticipants. The position of SAVEnergy Audit nonparticipants who are unaware of SAVEnergy Audits is illustrated in column (7) of Table 3. The analysis includes only the period before this group heard about SAVEnergy Audits, since there can be no "after period" because these nonparticipants are unaware of SAVEnergy Audits. Forty percent of the unaware nonparticipants are unaware of energy audits (unaware stage), 35 percent have just become aware (awareness stage), six percent have already begun collecting information about energy audits (persuasion stage), one percent had decided to not use energy audits (decision stage – no), one percent had decided to use energy audits but had not yet implemented them (decision stage – yes), eight percent have implemented energy audits one time (implementation stage), and eight percent have implemented energy audits repeatedly (confirmation).

Other Indicators of FEMP's Effects

Market actors operate in a market context. Attempts to influence actors can be short-lived or can have long-term consequences. Further, actors influence each other. If market transformation is to be successful, the initial market effects and reductions in market barriers must inspire behavior on the part of market actors that leads to further market effects and the further erosion of market barriers. Transitory behavior by market actors will not result in market transformation. Understanding the market effects of FEMP programs and how they may reduce or circumvent market barriers will aid market transformation efforts by pointing out how programs like FEMP can best leverage their resources to induce long lasting effects. This section presents results that assist FEMP management in understanding how FEMP is used and the associated effects.

Sharing of FEMP Information

Sharing FEMP information with others has the potential to multiply FEMP's impacts within its target markets and greatly speed market transformation. Customer networking is identified as the most effective method for spreading the diffusion of innovation (Rogers 1995). When customer networking becomes the dominant mode of information transfer about a new technology, the market is said to be in the maturing stages of being transformed with respect to a specific product or service (Moore 1991).

Table 4. Sharing Information about FEMP with Colleagues

Type of respondent	Shared information about FEMP with colleagues	
	Percent	N
ESPC participants	81	101
SAVEnergy Audit participants	70	77

ESPC and SAVEnergy Audit participants share information about FEMP (Table 4), multiplying the impact of FEMP marketing efforts. The 81 percent of ESPC participants who share information do so with an average of 47 individuals inside their organization and 43 individuals in other organizations. The 70 percent of SAVEnergy Audit participants who share information do so with an average of 41 individuals inside their organization and 18 individuals in other organizations. These data indicate that FEMP customers share information, substantially increasing visibility of FEMP.

Use of FEMP Services

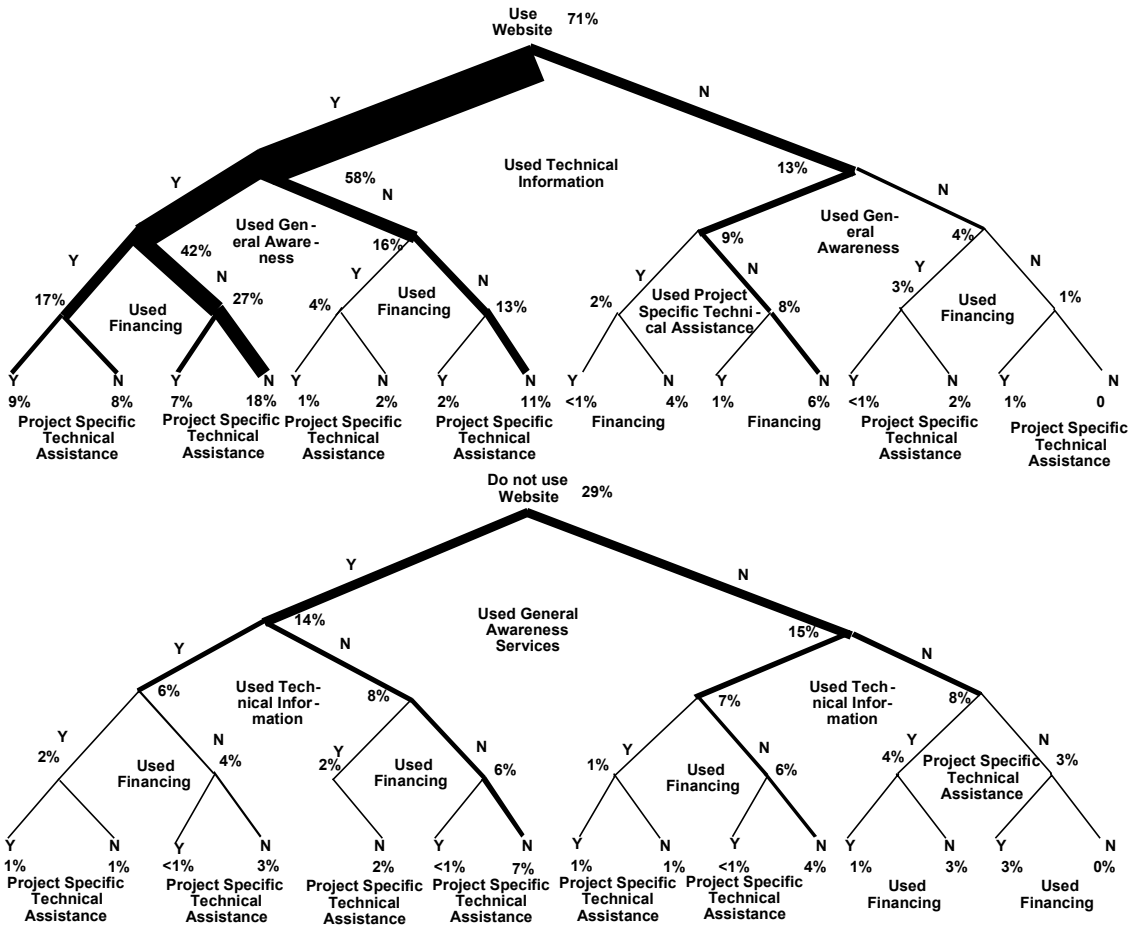
An important issue is how people use FEMP services. The question is one of whether many participants use a few services or a few participants use many services. Table 5 demonstrates that most FEMP participants use multiple services.

Table 5. Participant use of FEMP services

Number of services used	Percent of participants (N=413)
5	8
4	16
3	29
2	31
1	16

Figure 2 presents a tree diagram showing how participants use five areas of FEMP services: the website, technical information, general awareness and outreach efforts, financing services, and project-specific technical assistance.

Figure 2. Tree Diagram of Use of FEMP Services



The tree traces usage from the most commonly used services to the least commonly used. If most customers use a few services and there is no relationship between using one service and another, the branches of the tree will appear thin and spread out. If a few people use many services and there is a linkage between the services that are used, then the tree will have a few thick branches and the rest are likely to be thin. By following the thickness of the branches through the tree structure, one can see how participants use multiple FEMP services.

We started the tree with FEMP website use because users of the FEMP website are the most numerous. We know that 71 percent of all participants use the website. Normally, we would place the branch of the tree for those who do not use the website to the right of those who do. However, because of the width of the tree, we have stacked the two branches. Those who do not use the website are 29 percent of the participants.

The most commonly used combination of services is the website, technical information, and general awareness and outreach efforts. Fifty-eight percent of participants use the website and technical information. Forty-two percent use the website, technical information, and general awareness services. If we continue down the left-hand side of the participant tree, we find that more than half of those who use project-specific technical assistance and / or financing services also use the website, technical information, and general awareness and outreach efforts. If we examine the remainder of the tree, we see only small percentages of participants (1-3 percent) use financing services and project-specific technical assistance in combination with other services. What these data demonstrate is that the various FEMP services reinforce each other and that FEMP customers are on average strong multiple service users.

Implications for FEMP

The evaluation has provided valuable information to assist FEMP in efforts to improve program effectiveness and leverage its resources to induce long lasting effects. Because most participants use multiple FEMP services, FEMP is planning efforts to focus on the use of cross-program marketing to increase awareness and use of FEMP services. In addition, FEMP is planning to include more extensive customer follow-up contact, as this contact will yield positive results given that once a customer uses FEMP services the likelihood of continued use is relatively high. FEMP is also planning to develop a strategy to target the sizable audience of nonparticipants that are interested in participation. This strategy would emphasize the use of technical information services and general awareness and outreach efforts as an entrée into the use of more project-focused FEMP services among nonparticipants. Finally, FEMP is planning to develop marketing strategies that emphasize customer referrals and networking. These strategies will be effective at increasing awareness and use of FEMP due to the high satisfaction levels among FEMP customers and the fact that FEMP participants share information with their peers, substantially increasing visibility of FEMP.

Conclusions

The application of the diffusion of innovation model with the use of a nonparticipant control group has demonstrated that FEMP ESPCs and SAVEnergy Audits are influencing Federal agencies to change their decision-making process in ways that cause the accelerated adoption and use of performance contracts and energy audits. The application of this methodology can improve the ability of market transformation program evaluations to effectively measure changes to the energy-related decision making process and to measure or test for how much of the observed effects result from market transformation programs.

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