ORNL/CON-502

OAK RIDGE NATIONAL LABORATORY

MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

CUSTOMER RESPONSE TO BESTPRACTICES TRAINING AND SOFTWARE TOOLS PROVIDED BY DOE'S INDUSTRIAL TECHNOLOGIES PROGRAM

Martin Schweitzer
Michaela A. Martin
Richard L. Schmoyer

UT-BATTELLE

ORNL-27 (4-00)

ORNL/CON-502

CUSTOMER RESPONSE TO BESTPRACTICES TRAINING AND SOFTWARE TOOLS PROVIDED BY DOE'S INDUSTRIAL TECHNOLOGIES PROGRAM

Martin Schweitzer
Michaela A. Martin
Richard L. Schmoyer

Date Published: March 2008

Prepared for
U.S. Department of Energy
INDUSTRIAL TECHNOLOGIES PROGRAM
Budget Activity Number ED1907042

Prepared by
OAK RIDGE NATIONAL LABORATORY
Oak Ridge, Tennessee 37831
Managed by
UT-BATTELLE
for the
U.S. DEPARTMENT OF ENERGY
Under contract DE-AC05-00OR22725

TABLE OF CONTENTS

LIST OF FIGURES

Figure **Page**

LIST OF TABLES

Table **Page**

EXECUTIVE SUMMARY

BACKGROUND

The BestPractices program area, which has evolved into the Save Energy Now (SEN) Initiative, is a component of the U.S. Department of Energy's (DOE's) Industrial Technologies Program (ITP) that provides technical assistance and disseminates information on energy-efficient technologies and practices to U.S. industrial firms. The BestPractices approach to information dissemination includes conducting training sessions which address energy-intensive systems (compressed air, steam, process heat, pumps, motors, and fans) and distributing DOE software tools on those same topics.

The current report documents a recent Oak Ridge National Laboratory (ORNL) study undertaken to determine the implementation rate, attribution rate, and reduction factor for industrial end-users who received BestPractices training and registered software in FY 2006. The *implementation rate* is the proportion of service recipients taking energy-saving actions as a result of the service received. The *attribution rate* applies to those individuals taking energy-saving actions as a result of the services received and represents the portion of the savings achieved through those actions that is due to the service. The *reduction factor* is the saving that is realized from program-induced measures as a proportion of the potential savings that could be achieved if *all* service recipients took action. In addition to examining those factors, the ORNL study collected information on selected characteristics of service recipients, the perceived value of the services provided, and the potential energy savings that can be achieved through implementation of measures identified from the training or software. Because the provision of training is distinctly different from the provision of software tools, the two efforts were examined independently and the findings for each are reported separately.

STUDY DESIGN

The data for this study were collected through two telephone surveys: one targeting individuals who received BestPractices training in FY 2006 and the other targeting those who received and registered selected DOE software tools during the same period. The critical issue of attribution was addressed by asking a series of questions designed to elicit information from respondents on the extent to which their energy-saving actions were influenced by the services they received. Samples were selected, service recipients were contacted, and the responses were used to estimate mean values for the factors of interest, perform regression analyses and comparisons of means, and draw inferences about the target populations. While the surveys were addressed to individuals, the focus of the study was actually on the end-user manufacturing plants at which survey respondents influenced energy consumption.

POPULATION CHARACTERISTICS

For training, the study population consisted of all end-user plants whose staff received DOE training (other than webcasts) during Fiscal Year 2006. Of that population, 44.3% received training on compressed air, 25.7% on steam, 9.1% on process heat, 7.6% on fans, 7.1% on pumps, and 6.1% on motors. Our survey findings indicate that 32.7% percent of the facilities receiving training were large (annual energy costs greater than $2.5 million), 56.9% were medium (annual energy costs between $100,000 and $2.5 million), and 10.4% were small (annual energy costs less than $100,000). Nearly 68% of survey respondents influenced energy use at a single plant and only about 13% had influence over more than five plants.

On the software side, the study population was all end user facilities whose staff registered relevant DOE software tools during FY 2006. Of that population, 29.8% received tools on motors, 19.1% on steam, 16.1% on compressed air, 13.1% on process heat, 11.7% on pumps, and 10.2% on fans. The size mix was very similar to that for training, with an estimated 36.0% of the facilities being large, 57.1% medium, and 6.9% small. Over 52% of the software recipients interviewed influenced energy use at a single plant and another 24% influenced two to five plants.

It is important to note that, using uniform definitions of plant size, this study found substantially more large facilities in the population of service recipients (32.7% for training and 36.0% for software) than indicated in the Best Practices Tracking Database (26.4% for training and 27.7% for software) for the period of study.

SURVEY RESPONSE

Surveys were completed by 347 training recipients out of an original sample of 933 individuals. The number of eligible individuals was eventually reduced to 807 in an effort to avoid interviewing more than one person receiving training on the same topic at a single facility. The 347 completions represent 43% of the eligible individuals. Nearly all of the non-response was due to the subject terminating the call before the introduction was completed, the subject no longer working for the company contacted, wrong or disconnected phone numbers, or the call being answered by a machine or voice mail. As an approximation, we are assuming that this non-response does not bias our survey results.

For software, 206 surveys were completed out of an original sample of 606 registered individuals. During the survey process, the number of eligible individuals was reduced to 594, giving us a response rate of 35%. The primary reasons for non-response were the same as those explained above for training and, once again, we are assuming that the non-response does not bias our results.

VALUE OF SERVICES PROVIDED

Training recipients reported that the training they received was beneficial overall and that it was well worth the registration fee. The specific items to which they gave the highest ratings were the performance of the instructor and the helpfulness of the course materials and handouts. The scores given by software recipients were not as high as those given by those who received training, but they did express agreement with the statement that the DOE software was beneficial overall.

Regarding the helpfulness of possible additional features or formats, training recipients gave their highest ratings to more customized assistance, more hands-on exercises, more examples of projects that utilize the technologies addressed, and continuing education courses, with the lowest scores going to more financial information and web-based short courses. For software recipients, the highest marks were given to adding capability to simulate systems dynamically and allowing more flexibility in system design options, while the lowest score went to offering a metric version of the software.

ACTIONS TAKEN BY SERVICE RECIPIENTS

Implementation Rate

The implementation rate is the proportion of service recipients taking energy-saving actions as a result of the service received. We found that almost precisely half (49.8%) of those individuals receiving training took subsequent action that they credited, at least in part, to the training (Table ES.1). This agrees closely with findings from other studies. We also found that the implementation rate varied significantly by the energy system or topic addressed by the training, ranging from a low of 16.9% for fans to a high of 62.5% for compressed air. The implementation rate for motors and process heat training fell within about five percentage points of the overall mean, with pumps and steam being somewhat lower. A comparison of mean implementation rates for those who engaged in various energy management practices and those who did not revealed that training recipients whose companies had a corporate or facility energy manager had a significantly greater implementation rate than companies without an energy manager. A regression analysis conducted to explore possible relationships between the overall implementation rate and the perceived value of services found that those who felt more strongly that the greatest amount of time was spent on the subjects of most importance to them were more likely to take action as a result of their training.

Table ES.1. Mean implementation rate, attribution rate, and reduction factor for BestPractices training and software recipients, FY 2006

	Training Recipients			Software Recipients		
Energy System	Implementation Rate (N)[a]	Attribution Rate (N)[a]	Reduction Factor (N)[a]	Implementation Rate (N)[a]	Attribution Rate (N)[a]	Reduction Factor (N)[a]
All Combined	49.8 % (347)	61.1 % (176)	30.4 % (347)	23.9 % (206)	56.3 % (52)	13.5 % (206)
Compressed Air	62.5 % (146)	67.0 % (92)	41.9 % (146)	19.9 % (21)	32.6 % (4)	6.5 % (21)
Motors	55.2 % (27)	65.8 % (15)	36.3 % (27)	24.6 % (69)	63.1 % (17)	15.6 % (69)
Process Heat	48.1 % (36)	38.7 % (18)	18.6 % (36)	27.9 % (22)	71.2 % (6)	19.9 % (22)
Pumps	42.5 % (29)	67.0 % (13)	28.5 % (29)	17.7 % (23)	79.4 % (4)	14.1% (23)
Steam	38.7 % (92)	52.3 % (35)	20.2 % (92)	36.6 % (54)	50.6 % (20)	18.5 % (54)
Fans	16.9 % (17)	53.7 % (30)	9.1 % (17)	6.6 % (17)	--[b] (1)	--[b] (17)

[a]Number of survey respondents is shown in parentheses below each percentage value.
[b]No reliable estimate for this could be calculated because only a single respondent provided *all* the necessary data.

For software, almost 24% of registered recipients implemented measures as a result of the service they received. This is similar to the findings of another recent study which reported implementation rates of about 20% for those receiving software tools. The implementation rate varied from a low of 6.6% for fans to a high of 36.6% for steam. The implementation rate for those receiving and registering software on process heat, motors, and compressed air all fell within four percentage points of the overall mean, while the implementation rate for pumps was slightly lower. Software recipients whose companies had a formal energy management plan had a significantly greater implementation rate than companies without such a plan. In addition, software recipients who gave higher marks to the software for its ease of navigation and data input were more likely to implement energy-saving measures.

Attribution Rate

The attribution rate applies to those individuals taking energy-saving actions as a result of the services received and represents the portion of achieved savings that is due to the BestPractices service. The concept of attribution is very important in quantifying program effects because not all of the savings achieved by program participants is due to measures installed as a result of the services received. For all training recipients combined, the mean attribution rate was 61.1%. That figure was derived from survey responses showing that nearly 52% of those taking action as a result of the training would probably have done nothing without that assistance, meaning that all of their savings is attributable to the training. A substantial number of respondents reported that they probably would have taken some energy-saving actions anyway but that the training stimulated them to do more. For that group, additional measures stimulated by the training accounted for approximately 20% of their total savings. Combining the attributed savings for both groups yields the mean attribution rate of 61.1% noted above. As with the implementation rate, the attribution rate varies significantly by the energy system addressed, with a low of 38.7% for process heat and a high of 67.0% for pumps and compressed air.

For those who registered software in FY 2006, the mean attribution rate was 56.3%, which is close to that reported by training recipients. About 48% of those taking action in response to the software they registered would probably have done nothing without it. The attribution rate varied widely by energy system, from a low of 32.6% for compressed air to a high of 79.4% for pumps.

Reduction Factor

The reduction factor is the saving that is realized from actions taken in response to the service received as a proportion of the savings that could be achieved if *all* service recipients took action. This is equivalent to the product of the implementation rate times the attribution rate. Larger reduction factors indicate greater savings. The mean reduction factor for all training recipients was 30.4%. Disaggregating this by the energy system addressed, we find a low of 9.1% for fans and a high of 41.9% for compressed air. The reduction factor for pumps was relatively close to the overall mean, while steam and process heat both had reduction factors that were substantially lower.

The overall reduction factor for software was 13.5%, with by-topic rates ranging from a low of 6.5% for compressed air to a high of 19.9% for process heat. The reduction factor for steam was almost as high as for process heat, while both motors and pumps had reduction factors within about two percentage points of the overall mean. The low reduction factor for compressed air is in marked contrast to the findings reported above for training, where the reduction factor for compressed air was higher than for any other topic area.

POSSIBLE SAVINGS

As used here, the *plant energy cost savings potential* is the percentage by which total annual plant energy costs could be reduced by implementing all measures that program participants identified since receiving the BestPractices service. The *achieved energy cost savings rate* is the percentage by which total annual energy costs are reduced by those measures that are actually taken. The data used to calculate both these factors came from the surveys of BestPractices service recipients. Achieved savings tend to be substantially less than potential savings because only a portion of identified measures are generally implemented. Table ES.2 shows the reported values for both potential and achieved savings for training and software recipients who took action due to the service received, overall and for each energy system addressed.

Table ES.2. Mean plant energy cost savings potential and achieved energy cost savings rate for those taking action due to BestPractices services received, FY 2006

	Training Recipients		Software Recipients	
Energy System	Plant Energy Cost Savings Potential (N)[a]	Achieved Energy Cost Savings Rate (N)[a]	Plant Energy Cost Savings Potential (N)[a]	Achieved Energy Cost Savings Rate (N)[a]
All Combined	11.3 % (162)	3.1 % (156)	11.2 % (50)	3.7 % (47)
Compressed Air	12.7 % (85)	3.7 % (84)	9.1 % (4)	0.7 % (3)
Steam	11.4 % (35)	2.9 % (33)	10.0 % (18)	4.0 % (18)
Process Heat	8.1 % (17)	1.0 % (14)	4.4 % (6)	1.3 % (6)
Motors	6.6 % (14)	1.2 % (14)	19.5 % (17)	6.4 % (16)
Pumps	4.7 % (9)	1.2 % (9)	3.6 % (4)	1.6% (4)
Fans[a]	-- (2)	-- (2)	-- (1)	-- (0)

[a]Number of survey respondents is shown in parentheses below each percentage value.
[b]No reliable estimates could be calculated for this topic because of the extremely small number of respondents.

Training recipients reported, on average, a reduction of 3.1% in their total annual plant energy costs due to the measures that they implemented, at least in part, as a result of the training they received. This achieved savings rate varies substantially by the energy system addressed, from a high of 3.7% for compressed air to a low of 1.0% for process heat. It is important to note that these mean savings numbers refer to the average plant-wide savings achieved by measures taken to address a *single* energy system.

For software, the overall achieved cost savings rate appears to be higher than for training but, in actuality, the level of uncertainty regarding the software estimate makes it virtually indistinguishable from the training number.

CONCLUSIONS

- The proportion of program participants receiving services related to the various energy systems differed dramatically from training to software.

- The BestPractices Tracking Database, which records estimates of participant energy baseline data from secondary sources, tends to undercount large plants.

- A higher proportion of software registrants than training recipients were managers of various types, which may explain why software recipients tended to influence energy consumption at more plants than training recipients.

- On average, both training and software recipients expressed the opinion that the service they received was beneficial overall, but the value ascribed to current services and possible additional features tended to vary by the energy system addressed.

- Almost precisely 50% of all training recipients and just under 24% of software recipients took action as a result of the service they received, which is consistent with the overall implementation rates found in past studies.

- High implementation rates were found to be associated with the following: various energy management practices; having the greatest amount of time in training sessions spent on the subjects of most importance to attendees; having training instructors who are knowledgeable and well-prepared; and having software tools characterized by their ease of navigation and data input.

- Not all measures implemented by everyone who reported taking action as a result of the services they received was due to those services, because some individuals who were influenced by the program would have taken *some* action anyway.

- Very different implementation rates and reduction factors were associated with the various energy systems addressed by BestPractices services and there were substantial differences between training and software recipients, indicating that the characteristics of the training and software processes in effect during the study period allowed them to better encourage action on some energy systems than on others.

- On average, the energy-saving measures addressing a single energy system that were implemented by training and software recipients reduced total annual plant energy costs by roughly 3%.

- The achieved savings rate varied substantially by the energy system addressed, and differences between training and software recipients imply that the training procedures in effect during the study period were better able to lead to savings on some topics than others and that the same was true for software.

RECOMMENDATIONS

- Service recipients should be encouraged to periodically update their contact information for the BestPractices Tracking Database.

- When services are delivered, recipients should be asked to identify the broad category into which their annual energy consumption falls, rather than having the program use the Large Energy User Database to estimate participant energy baselines.

- The BestPractices program should encourage industrial firms − especially where such practices are less common − to engage in energy management activities such as employing an energy manager, preparing energy plans, and establishing energy reduction targets.

- The BestPractices program should ensure that its training instructors are knowledgeable and well-prepared and that the greatest amount of time is spent on the subjects of most importance to attendees.

- DOE software tools should be examined to make sure that navigation and data input are as easy as possible.

- BestPractices program managers should examine the value ascribed to current and possible future services by recipients of training and software for each individual energy system to identify fruitful areas for program improvements or new services targeting a specific topic.

- BestPractices program managers should examine how their operations and procedures influence the observed differences between training and software recipients in client participation, implementation, and achieved savings and use their findings to suggest possible program design changes.

- Future studies should explore what can be done to increase recipient actions associated with those energy systems where the implementation rate is currently low.

- In future studies of software recipients, a larger sample should be used to increase the proportion of the population that is represented; in addition, stratifying by geographic region (for both software and training studies) should be considered.

1. INTRODUCTION

1.1. BACKGROUND

The Industrial Technologies Program (ITP) is the part of the U.S. Department of Energy's (DOE's) Office of Energy Efficiency and Renewable Energy (EERE) portfolio that works with the U.S. industrial sector to improve its energy efficiency (DOE 2006). One component of ITP is the BestPractices program area, which has evolved into the Save Energy Now (SEN) Initiative. This ITP effort provides technical assistance and disseminates information on energy-efficient technologies and practices to U.S. industrial firms. The BestPractices approach to disseminating important information and imparting critical skills to industry includes conducting training sessions and distributing software tools (DOE 2007).

DOE provides industrial sector training for a number of purposes, ranging from increasing energy efficiency awareness to designating Qualified Specialists as experts with system-specific DOE assessment and analysis software tools. This study focuses on industrial end users, who are concerned with energy consumption and efficiency opportunities in their own manufacturing plants.

The principal energy systems (also referred to in this report as "topics") addressed by BestPractices training sessions are compressed air, steam, process heat, pumps, motors, and fans. DOE software tools have been developed to address all those topics. The specific BestPractices training courses and software tools provided to the end users who are the subject of this study are shown in Table 1.1.

Table 1.1 BestPractices end user training and software tools addressed in this study

Energy system	Training course	DOE software
Compressed Air	Compressed Air Challenge (CAC) Fundamentals CAC Advanced	Air Master Plus
Steam	Steam System Assessment	3E Plus Steam System Assessment Tool (SSAT) Steam System Scoping Tool (SSST)
Process Heat	Process Heating Assessment	Process Heat Assessment Tool (PHAST)
Pumps	Pump System Assessment	Pumping System Assessment Tool (PSAT)
Motors	Motor Systems Management	Motor Master Plus Motor Master Plus International
Fans	Fan System Assessment	Fan System Assessment Tool (FSAT)

Staff at Oak Ridge National Laboratory (ORNL) have conducted a number of evaluations of the BestPractices program area, beginning with its Fiscal Year (FY) 2001 efforts, to estimate the energy and cost savings resulting from program activities (Truett, Martin, and Tonn 2003; Martin and Truett 2004; Martin and Truett 2005; Martin and Truett 2006). A peer review of the FY 2002 study (Wolf et al. 2004) recommended a number of improvements to the evaluation methodology, several of which have been adopted in subsequent studies. One of those recommendations was that DOE should undertake a study to obtain additional information on attribution and reduction factors. This report documents the findings of a recent ORNL study that was conducted to gather and analyze that information.

1.1. STUDY OBJECTIVES

The primary purpose of the current study is to document the implementation rate, attribution rate, and reduction factor for FY 2006 recipients of training and software tools provided by the BestPractices program. The implementation rate is the proportion of service recipients taking energy-saving actions as a result of the service received. The attribution rate applies to those individuals taking energy-saving actions as a result of the services received and represents the portion of the savings achieved through those actions that is due to the service. The reduction factor is the saving that is realized from program-induced measures as a proportion of the potential savings that could be achieved if *all* service recipients took action[1]. Because the provision of training is distinctly different from the provision of software tools, each set of service recipients was studied independently and the findings for each group are reported separately in this document.

In addition to calculating and reporting overall implementation rates, attribution rates, and reduction factors for training and software recipients, this study also disaggregates those findings by the energy system addressed and by plant size. As noted above, the energy systems addressed are steam, process heat, compressed air, pumps, motors, and fans. The size categories are small, medium, and large[2]. Not surprisingly, the level of uncertainty due to sampling associated with statistics calculated for the individual energy systems and size categories is greater than for all recipients combined because the size of the individual sub-samples is smaller than the overall sample.

While the primary focus of this study is on calculating implementation rates, attribution rates, and reduction factors, as described above, we also collected information on selected characteristics of service recipients, the perceived value of the services provided, and the possible savings that can be achieved by the measures implemented. Each of those topics is addressed in its own chapter.

1.2. SCOPE OF REPORT

This document describes the recent ORNL study of DOE's BestPractices program area and presents key findings from that effort. **Chapter 2** discusses the research methods employed in this study, describing the sampling process, data collection procedure, and data analysis approach. In **Chapter 3**, we provide a detailed description of the survey respondents, giving separate information for training and software recipients and then comparing the two groups on key factors. **Chapter 4** provides information on the perceived value of the BestPractices services provided, overall and for key components, and also presents findings on the potential usefulness of potential new features and formats. In **Chapter 5**, key findings related to implementation rates, attribution rates, and reduction factors for training and software recipients are discussed, and information

---

[1] The reduction factor is equivalent to the product of the implementation rate times the attribution rate and is used in ORNL's annual analyses of BestPractices activities to calculate savings based on the number of unique plants receiving services.

[2] Small plants are defined as those with an annual cost of purchased energy that is less than $100,000. Medium plants are those whose annual energy costs are between $100,000 and $2.5 million. Plants with annual energy costs greater than $2.5 million are classified as large.

is also presented on the number of plants implementing measures and the reported influence of BestPractices services on the decision to implement energy-saving measures. Once again, information is presented for training and software recipients separately and key findings for the two groups are compared. **Chapter 6** discusses possible cost savings from the actions taken by training and software recipients, both separately and in comparison to each other. **Chapter 7** presents conclusions regarding the subjects covered in the previous chapters and offers recommendations for future actions. Finally, **Appendices A and B** contain the survey instruments used to gather data for this study.

2. RESEARCH METHODS

2.1. OVERALL STUDY DESIGN AND POPULATIONS OF INTEREST

All the data needed for this study were collected through two telephone surveys: one targeting individuals who received BestPractices training in FY 2006 and the other targeting those who received and registered selected DOE software tools during that same period. The critical issue of attribution was addressed by asking a series of questions designed to elicit information from respondents on the extent to which their energy-saving actions were influenced by the services they received[3]. Samples were selected, service recipients were contacted, and the responses were used to estimate mean values for the factors of interest, perform regression analyses and comparisons of means, and draw inferences about the target populations. Because substantial portions of the two target populations were sampled, finite population correction factors were applied to the standard errors (i.e., variability estimates) of the mean estimates, and the standard errors are thus smaller than they would have been had only very small proportions of the target populations been sampled.

While the above-mentioned surveys were addressed to individuals, the focus of the study was actually on the manufacturing plants or facilities at which survey respondents influenced energy consumption. Because survey responses of different individuals from the same plant regarding the same energy system were expected to be very similar, an effort was made to avoid interviewing more than one individual from any particular plant about any given topic[4]. Furthermore, to avoid undue burdens on individual respondents, no individual was interviewed about more than one topic. However, different individuals from the same plant could be surveyed if they received services addressing different energy systems[5].

- Of those industrial plants whose staff received BestPractices training in FY 2006, over 44% were trained on compressed air and nearly 26% were trained on steam.
- For those plants whose staff received DOE software, the most common topics were motors (nearly 30% of facilities), steam (19% of facilities), and compressed air (16% of facilities).

For training, the study population consisted of all end-user facilities whose staff received BestPractices training (other than webcasts) during FY 2006. This information was taken from the BestPractices Tracking Database which contains records for all service recipients. Table 2.1 shows the number and percentage of all facilities receiving BestPractices services in FY2006 that fell into each unique combination of plant size and energy system. Summing the percentages for the different size categories within each energy system shows that 44.3% of the population of interest received training on compressed air, 25.7% on steam, 9.1% on process heat, 7.7% on fans, 7.1% on pumps, and 6.1% on motors.

---

[3] An alternative approach that was considered for determining attribution was to compare the actions taken by service recipients and a control group of non-participants. Direct measurement of subjects' actions and the associated outcomes eliminates some of the potential for inaccuracy that can accompany the use of self-reported data. However, such an approach would require the collection of extensive data on measures installed and the associated savings as well as a matching of treatment and control plants regarding their savings potential, and that effort would require resources beyond those available for this study.

[4] Despite our best efforts, we ended up interviewing multiple respondents about the same topic at 26 different plants with the training survey and at a single plant with the software survey. Adjustments were made during the data analysis process to avoid counting the effects of the same service at the same plant multiple times.

[5] If a single plant received services on more than one topic, we examined each one (as long as service recipients were different individuals) because the effect of actions taken to address any given energy system (e.g., motors) would be distinct from the effect of actions addressing a different energy system (e.g., fans).

On the software side, the study population was all end user facilities whose staff registered relevant DOE software tools during FY 2006. When the percentages within each energy system are summed, we find that 29.8% of that population received tools on motors, 19.0% on steam, 16.2% on compressed air, 13.1% on process heat, 11.7% on pumps, and 10.2% on fans (Table 2.1).

The BestPractices Tracking Database contains a single plant address for each service recipient. Accordingly, we treated the facility listed for each respondent in the database as his or her "primary plant." In many cases, survey respondents reported that they influenced energy consumption at multiple plants. However, we assigned a single plant size category to each respondent to represent the annual cost of purchased energy at their primary plant. For respondents with a single plant, we used the size category that they reported in the survey, regardless of what was listed for them in the tracking database.

Table 2.1 Distribution of study populations, by energy system and plant size

Energy System	Plant Size	Number of Facilities in Training Population	Percentage of Training Population (%)	Number of Facilities in Software Population	Percentage of Software Population (%)
Compressed Air	Small	39	6.5	0	0
	Medium	169	28.1	158	10.3
	Large	59	9.7	90	5.9
Steam	Small	12	2.0	0	0
	Medium	72	11.9	156	10.1
	Large	71	11.8	137	8.9
Process Heat	Small	4	0.6	59	3.8
	Medium	25	4.2	70	4.5
	Large	26	4.3	73	4.8
Fans	Small	4	0.7	8	0.5
	Medium	25	4.2	97	6.3
	Large	17	2.8	52	3.4
Pumps	Small	2	0.3	9	0.6
	Medium	23	3.8	98	6.4
	Large	18	3.0	73	4.7
Motors	Small	2	0.2	30	2.0
	Medium	28	4.7	299	19.4
	Large	7	1.2	129	8.4
All Systems	Small	63	10.4	106	6.9
	Medium	343	56.9	878	57.1
	Large	197	32.7	554	36.0
TOTAL		603	100.0	1538	100.0

If a respondent had multiple plants, we used the size category reported in the survey if all plants were the same size. For respondents who reported having multiple plants of different sizes, we based their size category on the designation given in the BestPractices Tracking Database[6].

- According to the survey data, substantially more of the industrial plants receiving BestPractices services in FY 2006 were large than indicated by the BestPractices Tracking Database.

The survey results indicated that many plants that were classified as "not large" in the BestPractices Tracking Database were in fact large. After taking into account the frequency with which large, medium, and small plants were reported by survey respondents, we estimated that 32.7% percent of the population of facilities receiving training in FY2006 were large, 56.9% were medium, and 10.4% were small. In comparison, the tracking database, which used the same definitions of plant size employed in the study, originally indicated that only 26.4% of the population consisted of large plants. For software, the survey-adjusted size mix was very similar to that for training. We estimated that 36.0% of the population of facilities receiving software in FY2006 were large, 57.1% were medium, and 6.9% were small. In contrast, the tracking database originally showed that only 27.7% of those plants were large.

2.2. SAMPLE SELECTION

- Stratified sampling was used to ensure the inclusion of adequate numbers of respondents from the various plant size categories and all the energy systems addressed by BestPractices.

Stratified sampling was used to ensure that adequate numbers of respondents were obtained for key plant size categories and the energy systems addressed by BestPractices training and software. Each stratum is a unique combination of plant size and energy system (e.g., large-compressed air, medium-steam). Because this study focused on six different energy systems and three distinct plant size categories, there were a total of 18 strata (6x3). Those 18 strata and the population of each are shown in Table 2.1. Within each stratum, a pre-determined number of plants was randomly sampled and an effort was made to interview one service recipient from each plant. The service recipients were selected to represent the sampled plants because, as noted in Section 2.1, the focus of the study was on the plants themselves rather than on the individuals who influenced energy consumption there. To reduce the burden on respondents, no individual was surveyed regarding the services that they received for more than one energy system, even if they received training or software on multiple topics.

If more than one person from a selected plant received services which was especially common for training, then the individual to survey was selected as follows from a list of all that plant's service recipients: Individuals who received training or software on a single energy system were selected before individuals (if any) who received services on two energy systems, individuals who received services on two topics were selected before any who received services on three topics, and so on. The reason for this hierarchy was to maximize the number of eligible respondents. An individual who received training or software on only one energy system would not be eligible for selection if another individual from the same plant was selected to be surveyed about that same topic. On the other hand, an individual who received services on more than one

[6] The plant size information contained in the database came from secondary sources (an existing Large Energy User Database) and classified each primary plant as being either "Large" or "Not Large." However, the survey elicited data on three different plant sizes – "Small," "Medium," and "Large" – so we had to classify the plants listed as "Not Large" in the database as either "Small" or "Medium." If the database listed the primary plant as "Not Large" (or the database said the plant was "Large" but the respondent said that *all* their plants were either "Small" or "Medium"), we classified the plant as "Small" if at least 25% of the reported plants were that size. Otherwise, the primary plant was designated as being "Medium."

energy system would remain eligible for selection even if another person from the same plant was interviewed about one of those topics.

- Separate survey instruments were used for training and software recipients.

A list of all individuals receiving training in FY2006 was taken from the BestPractices Tracking Database. A list of software recipients was taken from BestPractices records of all those who registered software during the first half of FY 2006 because we did not have a list covering the entire year at the time the sample was selected. In our judgment, a set of software recipients taken from the first half of the year adequately represents participants from the entire year because number of recipients is substantial and there is no reason to believe that the behavior of those receiving software in the last half of the year would differ systematically from the behavior of those getting software during the first half of the year[7].

- The issues of implementation and attribution were addressed by a series of questions asking respondents about the energy-saving measures they identified and implemented and the likelihood that those actions would have been taken in the absence of the BestPractices service received.

For the training survey, we started with a set of 933 eligible individuals. This number was eventually reduced to 807, however, because some individuals were removed from the list because someone else from their facility was interviewed about the same topic. For the software survey, we started with 606 eligible individuals and that number was eventually reduced to 594 for the same reason given for training. The loss of eligible subjects was considerably greater for the training survey because it was much more common for a single plant to have multiple individuals receive training on the same topic than it was for more than one individual from a given plant to register the same software.

2.3. DATA COLLECTION

The first step in the design of the survey instruments used to collect data for this study was to review other recent studies of energy efficiency and renewable energy training and technical assistance programs. A number of relevant documents were reviewed (e.g., Aloha Systems 2006; McRae and Scholl 2004; Wirtshafter Associates 2005; Zebedee and Associates 2006), which provided good information on how various other programs had been evaluated. Among other things, those reports provided useful information on study design, key topics addressed, and the wording of the survey questions. In addition, we reviewed the survey used in ORNL's 2005 survey of BestPractices Qualified Specialists for ideas on how to craft the necessary questions. The issue of attribution was central to this study, as noted in Chapter 1, and we obtained useful information on that topic from a study of Utility Energy Service Contracts conducted by ORNL (Schweitzer 2006) as well as from a recent memo on the subject prepared by Dr. Harley Barnes of Lockheed Martin Corporation who has studied the issue of attribution and its measurement.

Following the literature review described above, separate survey instruments were developed for the training and software studies. These surveys were very similar, but they differed on some questions because one instrument was focused on the specifics of training programs while the other addressed the circumstances and issues surrounding provision of software tools. In both surveys, the issue of implementation was addressed

---

[7] A comparison of software recipients from the first and second halves of FY2006 showed that both groups were very similar in their distribution of plant sizes and energy systems addressed. And although the amount of time in which action could be taken was longer for those who received services in the first half of FY2006, even those who registered software at the very end of FY2006 had nearly a year in which to act by the time they were surveyed. In addition, survey recipients were asked to report past actions *plus* anything in the process of being implemented with an expected completion date within the next 12 months.

by a series of four related questions (A12, A14, A18, and A19, shown in Appendices A and B). The first two asked respondents if they had identified any energy-saving or energy cost-saving measures for their plants since receiving BestPractices services and, if so, if they had implemented (or were in the process of implementing) any of those measures. The third question asked respondents how likely it was that they would have implemented any of those measures without the services they received. The final question in the series was aimed at those who indicated they might have implemented measures even without the BestPractices service and asked if the service resulted in *more* actions being taken than would have otherwise been the case. The implementation rate is defined in this report as the proportion of service recipients taking energy-saving actions as a result of the BestPractices service received.

The issue of attribution was addressed by the four questions mentioned in the previous paragraph (A12, A14, A18, and A19) plus an additional one (A20) which asked respondents who reported taking more actions as a result of BestPractices services to estimate the percentage of their annual energy cost reduction that was due to the additional measures taken as a result of the service received. This multi-question approach to determining attribution (rather than simply asking if any actions were taken as a result of the services received) was designed to avoid over-stating program results by eliciting information on how much of the savings resulting from respondents' actions was due to the service received and how much was due to other influences.

The information needed to calculate plant energy cost savings potential came from two survey questions. The first was A12 which, as noted above, asked if the respondent had identified any energy-saving or energy cost-saving measures since receiving BestPractices services. The second question (A13) asked those who had identified measures for the percentage by which total annual plant energy costs could be reduced by implementing those measures. The data necessary for determining *achieved* energy cost savings came from those same two questions plus two additional ones (A14 and A15). The first of those additional questions asked if the respondent had implemented, or was in the process of implementing, any of the measures that they had identified. If they responded in the affirmative, the next question asked for the approximate percentage of the potential energy cost reduction achieved by the measures taken.

It is important to note that, because of the cyclical nature of industrial processes, there can be a substantial time lag before a recipient of BestPractices services actually gets the opportunity to implement measures addressed by the training or software that they received. By asking respondents to report on measures that they had implemented *or were in the process of implementing with an expected completion date within the next 12 months*, this issue was addressed to a significant extent. However, it is possible that a few respondents might have under-reported their actions due to an exceptionally long lag time between the receipt of BestPractices services and their eventual implementation of measures.

Once the initial survey instruments were developed, they were pre-tested on four training recipients and four software recipients. We then revised the surveys, based on the pre-testers' responses, to make them easier to understand and ensure that subsequent respondents would not be confused by any of the questions. The revised surveys were submitted to the Office of Management and Budget (OMB) and received approval under an existing generic clearance for DOE to conduct customer surveys. The final survey instruments are shown in Appendices A and B.

Opinion Research Corporation (ORC) was contracted to conduct the telephone interviews using the survey instruments that ORNL developed. Those interviews were carried out over a five week period, from August 1 to September 4, 2007.

2.4. DATA ANALYSIS

> - The quantitative analysis performed for this study consisted of:
>   - Calculating means and confidence intervals;
>   - Generating frequency distributions;
>   - Performing comparison of means tests; and
>   - Running regression analyses
> - Weights were calculated for each sample stratum.
> - All calculations were performed separately for training and software recipients.

A relatively small number of survey respondents reported that they did not remember receiving the training or software listed for them in the BestPractices Tracking Database[8]. In those cases, we erred on the side of underestimating program savings by assuming that the respondent actually had received the service in question but that the lack of memory indicated that no energy-saving measures had been implemented as a result of that service. Similarly, some software recipients reported that they had never opened the software in question, and they also were treated as if they took no action due to the software received. A much larger proportion of the individuals contacted did not respond to the survey at all, for a variety of reasons that will be discussed in Section 3.1.1. As an approximation, we are assuming that this non-response does not bias the survey results.

To calculate the implementation rate from the questions discussed in Section 2.3, we assumed that respondents who reported that it was "very unlikely" or "somewhat unlikely" that they would have implemented any measures without the services they received took action due to the BestPractices program. For the purpose of determining the attribution rate, it was assumed that 100% of those respondents' actions were attributable to the services received, since they said it was unlikely that anything would have been done otherwise. Those who indicated that they might have implemented measures even without BestPractices but that they took more actions as a result of the service they received were also included in the group of respondents who took action due to the program. The amount of their savings that was attributed to the program was the percentage of their annual energy cost reduction that they said was due to the additional measures taken as a result of the service they received.

To calculate plant energy cost savings potential, we examined the information provided by those survey respondents who said they had identified energy-saving or energy cost-saving measures since receiving BestPractices services. Their plant energy cost savings *potential* was the reported percentage by which total annual plant energy costs could be reduced by implementing all the measures that they had identified. As noted in Section 2.3, respondents who reported implementing energy-saving or energy cost-saving measures were asked for the approximate percentage of the potential energy cost reduction achieved by the measures taken. The *achieved* energy cost savings rate was calculated by multiplying that number by the reported plant energy cost savings potential. For example, if a respondent said that total annual plant energy costs could be reduced by 12% by implementing all the measures they had identified and they further reported that they had achieved 25% of those potential savings by measures they had implemented, the achieved savings rate would be 3% (25% of 12%).

Much of the analysis performed for this study consisted of calculating mean values and confidence intervals for the implementation rate, attribution rate, reduction factor, and other variables studied. For categorical variables, we generated frequency distributions showing what proportion of respondents fell into each category. As noted in Chapter 1, the relevant statistics were calculated for all service recipients combined and also for subgroups representing each energy system addressed by BestPractices services and each

[8] About 20 respondents listed in the Tracking Database as training recipients and about 30 listed as software recipients reported no recollection of having received the service in question.

broad category of plant size. In many of those disaggregated analyses, we performed a comparison of means test to see if the mean values for the various subgroups (energy system or size category) differed significantly among themselves. In those cases, we performed all possible comparisons and report in this document the nominal significance levels from those tests. We also ran comparison of means tests in a few instances to check for differences among other groups, such as those who engaged in various energy management procedures and those who did not. Finally, regression analyses were performed to test for possible relationships between the implementation of measures and the value that recipients placed on the service they received and its various elements. All calculations were performed for training recipients and registered software recipients separately.

Using the number of unique plants with survey respondents falling into each stratum and the size of the population for each stratum, weights were calculated showing how much the response from each unique plant should be counted in order to yield results that accurately represent the entire population in terms of the stratifying factors (energy system and plant size)[9]. The SAS Surveymeans procedure was used to generate mean values and confidence intervals that incorporated the appropriate weight for each plant and used a finite population correction factor in calculating the confidence intervals. The SAS Surveyreg procedure was used to do comparisons of means and regression analyses that likewise took into account the key characteristics of the sample and the larger population from which it was drawn. Because the focus of the study was on the industrial plants at which service recipients influenced energy use, a CLUSTER statement was used in the SAS Surveymeans and Surveyreg procedures to treat each plant, rather than each individual respondent, as the primary sampling unit. In those relatively few cases where multiple respondents were interviewed on the same topic at the same plant, the weight of each response was adjusted so that the entire set of responses from a single plant (regardless of the number of respondents) received the same weight as every other plant in the same stratum.

[9] The population of each stratum was calculated using the survey-adjusted estimates for each plant size category and *not* the original numbers from the BestPractices Tracking Database.

3. DESCRIPTION OF SURVEY RESPONDENTS

3.1. TRAINING SURVEY

3.1.1. Training Survey Response Rate

Surveys were completed by 347 training recipients out of an original set of 933 eligible individuals. The number of eligible individuals was eventually reduced to 807 in an effort to avoid interviewing more than one person receiving training on the same energy system at a single facility. The 347 completions[10] represent 43% of the eligible individuals. Nearly all of the non-response was due to the subject terminating the call before the introduction was completed (17% of eligible individuals), the subject no longer working for the company contacted (15%), wrong or disconnected phone numbers (9%), or the call being answered by a machine or voice mail (6%). As noted in Chapter 2, we are assuming that this non-response does not bias the survey results.

- Forty-three percent of the eligible individuals in the sample responded to the training survey.
- The greatest number of training survey respondents was associated with medium plants and relatively few were associated with small plants.
- The number of plants represented by responding individuals accounted for approximately half (or more) of the study population for nearly every stratum.

Table 3.1 shows the distribution of survey respondents by energy system and plant size. The fourth column shows the percent of all survey respondents who fell into each unique category of training topic and plant size. About 42% of the respondents received training on compressed air and another 27% received steam training. The number of respondents who were trained on each of the other energy systems was considerably less. On the lowest end of the scale, only about 5% of respondents received training related to fans. For each energy system addressed by the training, small plants accounted for the lowest number of participants. For all energy systems combined, medium plants represented the greatest share of the survey respondents, followed by large plants.

Each of the unique categories of energy system and plant size shown in Table 3.1 makes up a stratum of the survey sample and study population. The last column in the table shows, for each stratum, the number of plants represented by the individual survey respondents as a percentage of all plants in the study population. For example, the number of small plants receiving compressed air training whose staff responded to the survey represented 48.4% of all small plants whose staff were trained on that topic. In the training survey, the number of plants represented by responding individuals accounted for approximately half, or more, of the study population for nearly every stratum. The only exception is on the topic of fans, where responding plants accounted for only about one-fourth of the entire population for two of the three relevant strata.

[10] Because multiple respondents were interviewed about the same energy system at some plants, despite our efforts to avoid this, the 347 survey respondents represented only 309 unique plant-system combinations.

Table 3.1 Distribution of respondents, by energy system and plant size: training survey

Energy System	Plant Size	Number of Respondents	Number of Respondents in Each Stratum as Percentage of ALL Survey Respondents Combined (%)	Number of Responding *Plants* as Percentage of Unique Plants within Each Stratum (%)
Compressed Air	Small	22	6.3	48.4
	Medium	88	25.4	49.6
	Large	36	10.4	54.7
Steam	Small	6	1.7	48.4
	Medium	46	13.3	47.4
	Large	40	11.5	52.2
Process Heat	Small	2	0.6	54.3
	Medium	16	4.6	55.0
	Large	18	5.2	58.0
Pumps	Small	1	0.3	52.0
	Medium	14	4.0	56.8
	Large	14	4.0	60.5
Motors	Small	1	0.3	70.6
	Medium	21	6.1	70.6
	Large	5	1.4	55.2
Fans	Small	1	0.3	25.0
	Medium	7	2.0	27.5
	Large	9	2.6	48.3
All Combined		347	100.0	–

3.1.2. Key Characteristics of Training Survey Respondents

The title or position of training recipients who responded to the survey is shown in Table 3.2. Fifteen percent of survey respondents were project engineers, about 14% were plant or facility engineers, and 13% were process engineers. Taken together, engineers of all types accounted for about 45% of the total number of survey respondents. Maintenance supervisors, managers, and staff made up another 21% of all those who responded to the survey. Another substantial type of respondent was managers of various kinds, who represented about 15% of all those who took the survey. The remaining respondents were plant or facility technicians or fell into the "other" category.

Table 3.2 Title or position of respondents: training survey

Title/Position	Number	Percentage of All Survey Respondents (%)
Project Engineer	52	15.0
Plant/Facility Engineer	49	14.1
Process Engineer	45	13.0
Other Engineer	10	2.9
Maintenance Supervisor	32	9.2
Maintenance Manager	21	6.1
Maintenance Staff	19	5.5
Energy/Utility Manager	29	8.4
Plant Manager	16	4.6
Operations/Production Manager	7	2.0
General Manager	5	1.4
Other Managers	24	6.4
Plant/Facility Technician	18	5.2
Other	20	5.8
All Combined	347	100.0

Table 3.3 shows the principal products of survey respondents' plants. Almost 17% of all those who responded to the training survey were associated with plants that manufactured food and kindred products, while nearly 15% worked for facilities that fell under the category of chemicals and allied products. The fewest respondents were associated with lumber and wood products, instruments and related products, furniture and fixtures, and textile mill products.

As shown in Figure 3.1, nearly 68% of those who responded to the training survey reported influencing energy consumption at a single plant, and another 20% influenced between two and five plants. An additional 6% of training survey respondents had influence over energy use at six to ten plants. On the other end of the scale, about 4% of survey respondents influenced more than 20 plants and about 1% influenced more than 50 plants, with a single individual claiming to influence 300 facilities. Put another way, the median number of plants influenced by training survey respondents was 1 and the 75th percentile was 2. The mean value for number of plants influenced was about five, but that number reflects a relatively small number of respondents who reported influencing a very large number of plants.

Table 3.3 Principal products of respondents' plants: training survey

Principal Product	Number	Percentage of All Survey Respondents (%)
Food and kindred products	58	16.7
Chemicals and allied Products	51	14.7
Fabricated metal products	30	8.6
Paper and allied products	29	8.4
Primary metal industries	22	6.3
Electronic and other electric equipment	22	6.3
Transportation equipment	19	5.5
Rubber and miscellaneous plastics products	14	4.0
Miscellaneous manufacturing industries	16	4.6
Stone, clay, and glass products	14	4.0
Industrial machinery and equipment	11	3.2
Petroleum and coal products	5	1.4
Printing and publishing	4	1.2
Lumber and wood products	3	0.9
Instruments and related products	3	0.9
Furniture and fixtures	3	0.9
Textile mill products	2	.06
Other	41	11.8
All Combined	347	100.0

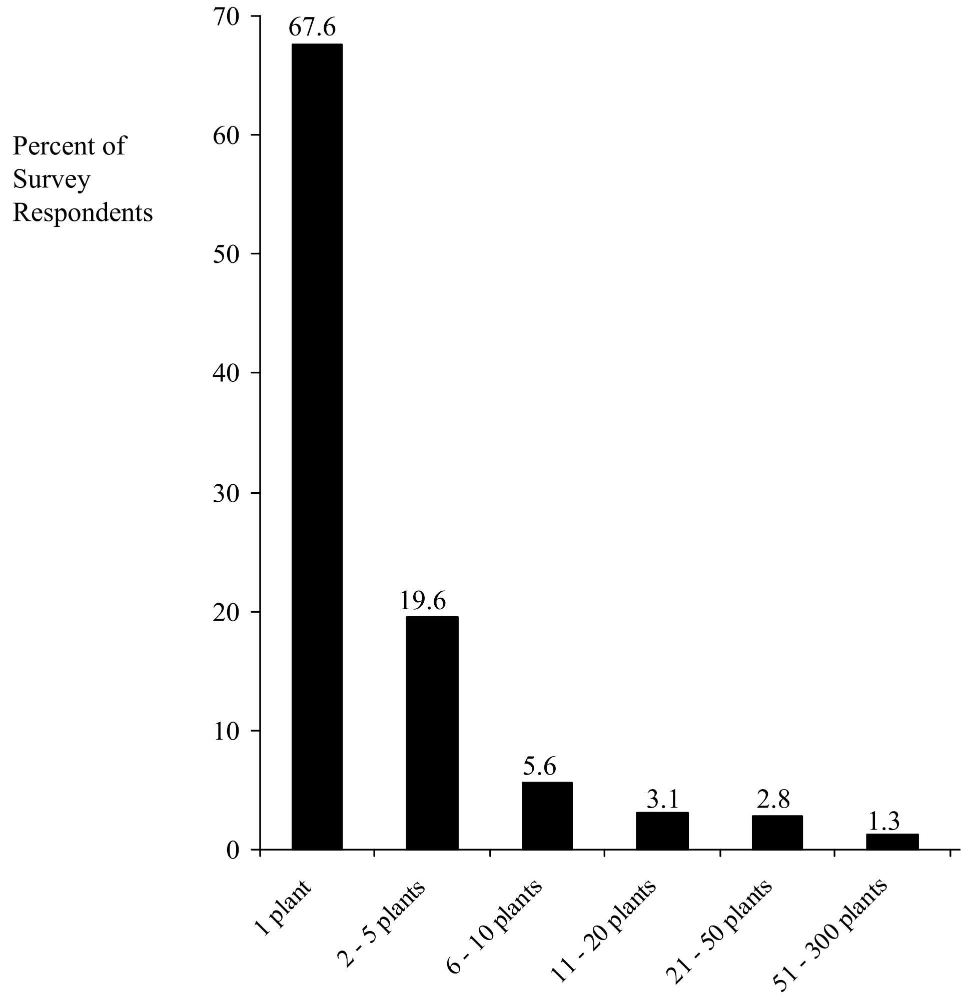

Figure 3.1 Number of plants influenced by respondents: training survey

Respondents to the training survey were about evenly split between those who received one or more DOE software tools on the topic of interest (54%) and those who did not receive such software (46%). There was, however, substantial variation in this area among the different energy systems addressed by the training. On one end of the scale, only about 28% of the survey respondents who received compressed air training also received DOE software on that topic. In contrast, more than 80% of the respondents who were trained on fans, motors, and process heat received software on those topics. In the remaining topic areas, between 65 and 70% of those respondents who participated in training on pumps and steam also received relevant software tools.

3.1.3. Energy Management Procedures of Respondent Companies

Sixty-one percent of all survey respondents reported that their company had a formal energy management plan to help guide their energy-related decisions, 59% reported that they had been subject to corporate or facility mandates to reduce plant energy intensity by a targeted percentage, and 55% reported that their company had a corporate or facility energy manager.

As shown in Figure 3.2, there was substantial variation on all these items when survey responses were disaggregated by plant size, with a higher percentage of larger plants having the specified energy management procedures than smaller ones. A comparison of means revealed that training recipients with large plants were significantly more likely to report having an energy management plan than training recipients with either medium or small facilities ($p<.0001$). In addition, a significantly higher proportion of those with medium plants had an energy management plan than did those with small facilities ($p=.03$). On the other two energy management procedures, training recipients with large facilities were significantly more likely than those with medium or small plants to report having an energy reduction target and an energy manager ($p<.0001$). Also, those with medium plants were more likely than those with small plants to have a mandated energy reduction target ($p = .02$).

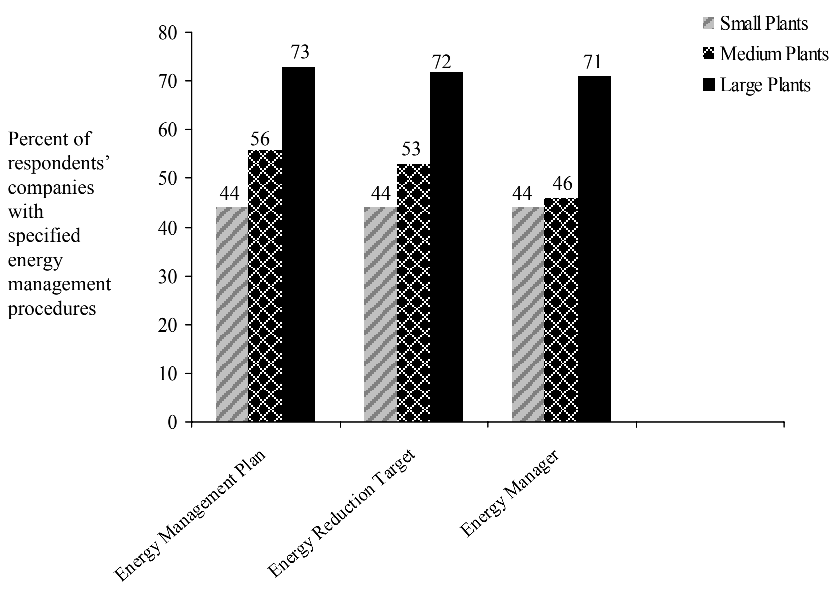

Figure 3.2 Energy management procedures at respondents' companies: training survey

3.2. SOFTWARE SURVEY

3.2.1. Software Survey Response Rate

Two hundred six surveys were completed by software recipients[11] out of an original set of 606 individuals. During the survey process, the number of eligible individuals was reduced to 594, giving us a response rate of 35%. The primary reasons for non-response were the same as those explained in Section 3.1.1 for training. Twenty-three percent of eligible individuals terminated the call before the introduction was completed, 13% no longer worked for the company contacted, 10% had wrong or disconnected phone numbers, and 5% had the call answered by a machine or voice mail. Once again, we are assuming that the non-response does not bias our results.

- Thirty-five percent of the eligible individuals in the sample responded to the software survey.
- The greatest number of software survey respondents was associated with medium plants, followed relatively closely by large plants.
- The number of plants represented by responding individuals accounted for between 10 and 20% of the study population for most strata.

Table 3.4 shows the distribution of survey respondents by energy system and plant size.

Table 3.4 Distribution of respondents, by energy system and plant size: software survey

Energy System	Plant Size	Number of Respondents	Number of Respondents in Each Stratum as Percentage of ALL Survey Respondents Combined (%)	Number of Responding *Plants* as Percentage of Unique Plants within Each Stratum (%)
Motors	Small	4	1.9	13.1
	Medium	42	20.4	14.1
	Large	23	11.2	17.9
Steam	Small	0	0	0
	Medium	26	12.6	16.7
	Large	28	13.6	19.7
Pumps	Small	1	0.5	11.3
	Medium	12	5.8	12.2
	Large	10	4.9	13.7
Process Heat	Small	4	1.9	6.8
	Medium	6	2.9	8.6
	Large	12	5.8	16.4
Compressed Air	Small	0	0	0
	Medium	12	5.8	7.6
	Large	9	4.4	10.0
Fans	Small	1	0.5	13.3
	Medium	11	5.3	11.3
	Large	5	2.4	9.6
All Combined		206	100.0	–

[11] Those 206 survey completions represent 205 unique plant-topic combinations.

Nearly 34% of the respondents received software on motors and another 26% received software on steam. The number of respondents who received software on each of the other topics was considerably less. On the lowest end of the scale, about 8% of respondents received software on fans. For each energy system addressed by the software, the number of recipients from small plants was much less than the number from the other size categories. For all topics combined, medium plants represented the greatest share of the survey respondents, followed by large plants.

The last column in Table 3.4 shows for each stratum, the number of plants represented by the individual survey respondents as a percentage of all plants in the study population. The number of plants represented by responding individuals accounted for between 10 and 20% of the study population for the majority of strata. In most of the other strata, responding plants accounted for between seven and ten percent of the study population[12].

3.2.2. Key Characteristics of Software Survey Respondents

The title or position of software recipients who responded to the survey is shown in Table 3.5. Sixteen percent of survey respondents were project engineers, nearly 13% were

Table 3.5 Title or position of respondents: software survey

Title/Position	Number	Percentage of All Survey Respondents (%)
Project Engineer	33	16.0
Process Engineer	26	12.6
Plant/Facility Engineer	13	6.3
Other Engineer	18	8.7
Energy/Utility Manager	19	9.2
Operations/Production Manager	8	3.9
Plant Manager	4	1.9
General Manager	2	1.0
Other Manager	28	13.6
Maintenance Supervisor	12	5.8
Maintenance Manager	9	4.4
Maintenance Staff	5	2.4

[12] For two strata, small-steam and small-compressed air, there were no facilities in the population, so values of zero were assigned to the *percenaget of all survey respondents* and *percentage of unique plants* for those strata.

process engineers, 6% were plant or facility engineers, and another 9% fell into the "other engineer" category. All together, engineers of various types accounted for about 44% of the total number of survey respondents. Managers of various kinds also responded in substantial numbers, representing nearly 30% of all those who took the software survey. Maintenance supervisors, managers, and staff made up another 13% of respondents. All others responding to the survey were either plant or facility technicians or fell into the broad general category of "other."

Table 3.6 shows the principal products of survey respondents' plants. Nearly 20% of all those who responded to the software survey were associated with plants that manufactured chemicals and allied products, another 10% worked for facilities that fell under the category of food and kindred products, and an additional 10% were employed by manufacturers of paper and allied products. The fewest respondents were associated with lumber and wood products and with industrial machinery and equipment.

Table 3.6 Principal products of respondents' plants: software survey

Principal Product	Number	Percentage of All Survey Respondents (%)
Chemicals and allied products	40	19.4
Food and kindred products	21	10.2
Paper and allied products	21	10.2
Rubber and miscellaneous plastics products	12	5.8
Fabricated metal products	10	4.9
Electronic and other electric equipment	9	4.4
Stone, clay, and glass products	8	3.9
Primary metal industries	7	3.4
Petroleum and coal industries	7	3.4
Transportation equipment	6	2.9
Lumber and wood products	4	1.9
Industrial machinery and equipment	3	1.5
Other	58	28.2
All Combined	206	100.0

A little more than half of software survey respondents (52.5%) influenced energy consumption at a single plant, and another 24% influenced between two and five plants (Figure 3.3). An additional 8% of survey respondents had influence over energy use at six to ten plants. On the other end of the scale, nearly 10% of survey respondents influenced more than 20 plants and about 4% influenced more than 50 plants, with a single individual influencing 200 facilities. The median number of plants influenced by software survey respondents was 1 and the 75th percentile was 5. The mean value for number of plants influenced was close to 10, but that number reflects those individuals who influenced many more facilities than did the typical respondent.

3.2.3. Energy Management Procedures of Respondent Companies

Nearly 66% of all software survey respondents reported that they had been subject to corporate or facility mandates to reduce plant energy intensity by a targeted percentage, 59% reported that their company had a formal energy management plan, and 58% reported that their company had a corporate or facility energy manager.

Figure 3.4 show that there was substantial variation on all the above items when survey responses were disaggregated by plant size. A comparison of means revealed that software recipients with large plants were significantly more likely to have both an energy manager (p=.001) and an energy management plan (p = .008) than

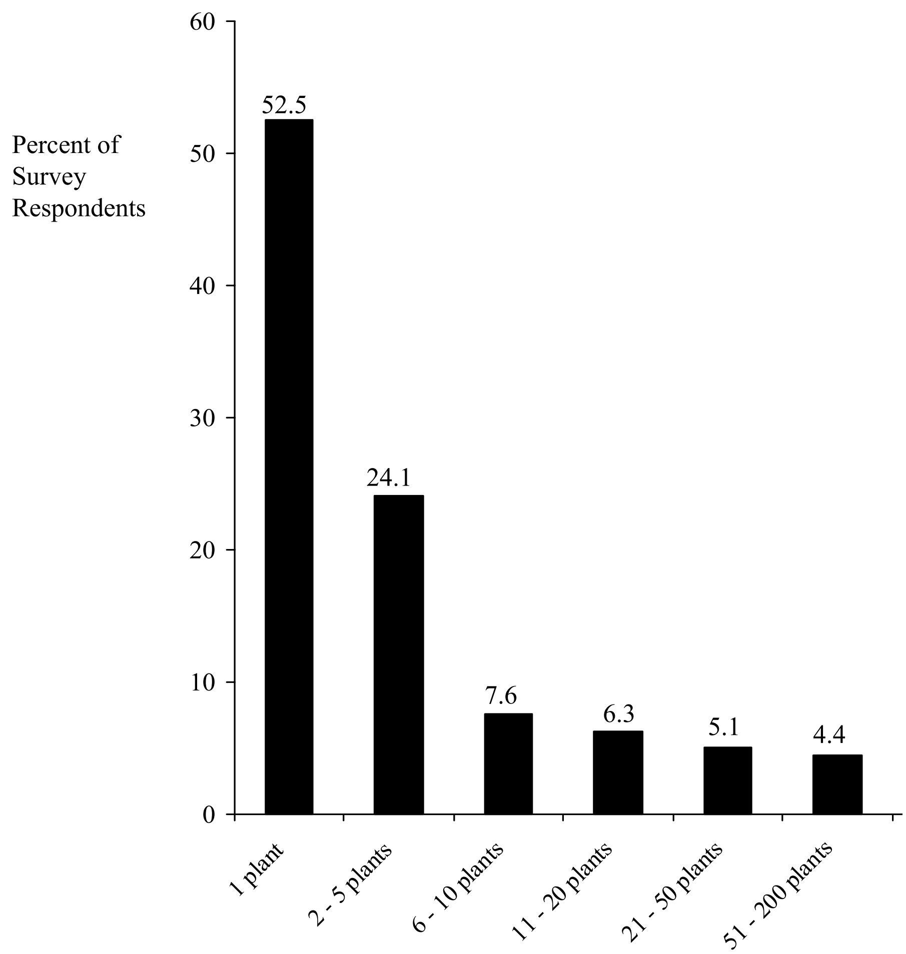

Figure 3.3 Number of plants influenced by respondents: software survey

software recipients with medium facilities. In contrast, a significantly higher proportion of those with small plants had an energy reduction target than did those with either medium or large facilities ($p<.0001$). This last finding should be treated with some skepticism, because staff representing only 10 small plants responded to the software survey (as compared to staff from 86 large facilities and 109 medium facilities).

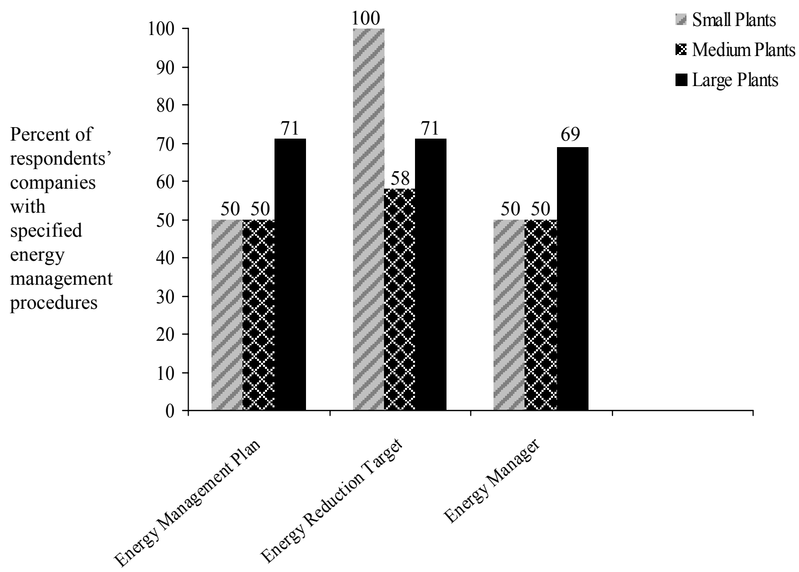

Figure 3.4 Energy management procedures at respondents' companies: software survey

3.3. COMPARISON OF TRAINING AND SOFTWARE RESPONDENTS ON KEY FACTORS

- Response rate was slightly higher for the training survey (43%) than for the software survey (35%).
- Non-response was assumed to be non-biasing for both surveys.
- The number of plants represented by individual respondents to the training survey represented a much larger proportion of the study population (approximately 50% or more for every stratum) than did the number of plants represented by software survey respondents (10-20% for each stratum).
- The largest proportion of survey respondents received training on compressed air, followed by steam.
- The energy system with the greatest number of *software* recipients was motors.
- For both training and software survey respondents, the topic with the lowest representation was fans.
- More training and software survey respondents were associated with medium plants than with any other size category.
- Relatively few respondents were associated with small plants.
- Most survey respondents were either engineers, managers, or involved in plant maintenance.
- Large numbers of respondents to both surveys were involved with the production of chemicals, food, or paper.

- Less than one-third of respondents to the training survey influenced energy use at multiple plants, but nearly half of software survey recipients influenced more than one plant.
- For both training and software survey respondents, the median number of plants influenced was one.
- The *mean* number of facilities influenced by survey respondents was about five for those receiving training and nearly 10 for those who received software, with the mean values in both cases reflecting the presence of a relatively few respondents who influenced energy use at a large number of plants.
- Larger plants were significantly more likely to engage in formal energy management practices than smaller ones.

4. VALUE OF BESTPRACTICES SERVICES

4.1. TRAINING RECIPIENTS

4.1.1. Value of Overall Training and Key Components

Survey respondents were presented with a series of statements pertaining to the value of the training that they received and were asked how strongly they agreed or disagreed with those statements on a five point scale, with 1 being "strongly agree" and 5 being "strongly disagree." The statements addressed the value of the training overall, the content of the training session, and the manner in which the information was presented. Figure 4.1 shows the mean value for every item, in order of their rated importance. The statement with which training recipients agreed most strongly was "The instructor was knowledgeable and well-prepared." Training recipients also expressed substantial agreement with the following three statements: "The value that your company received

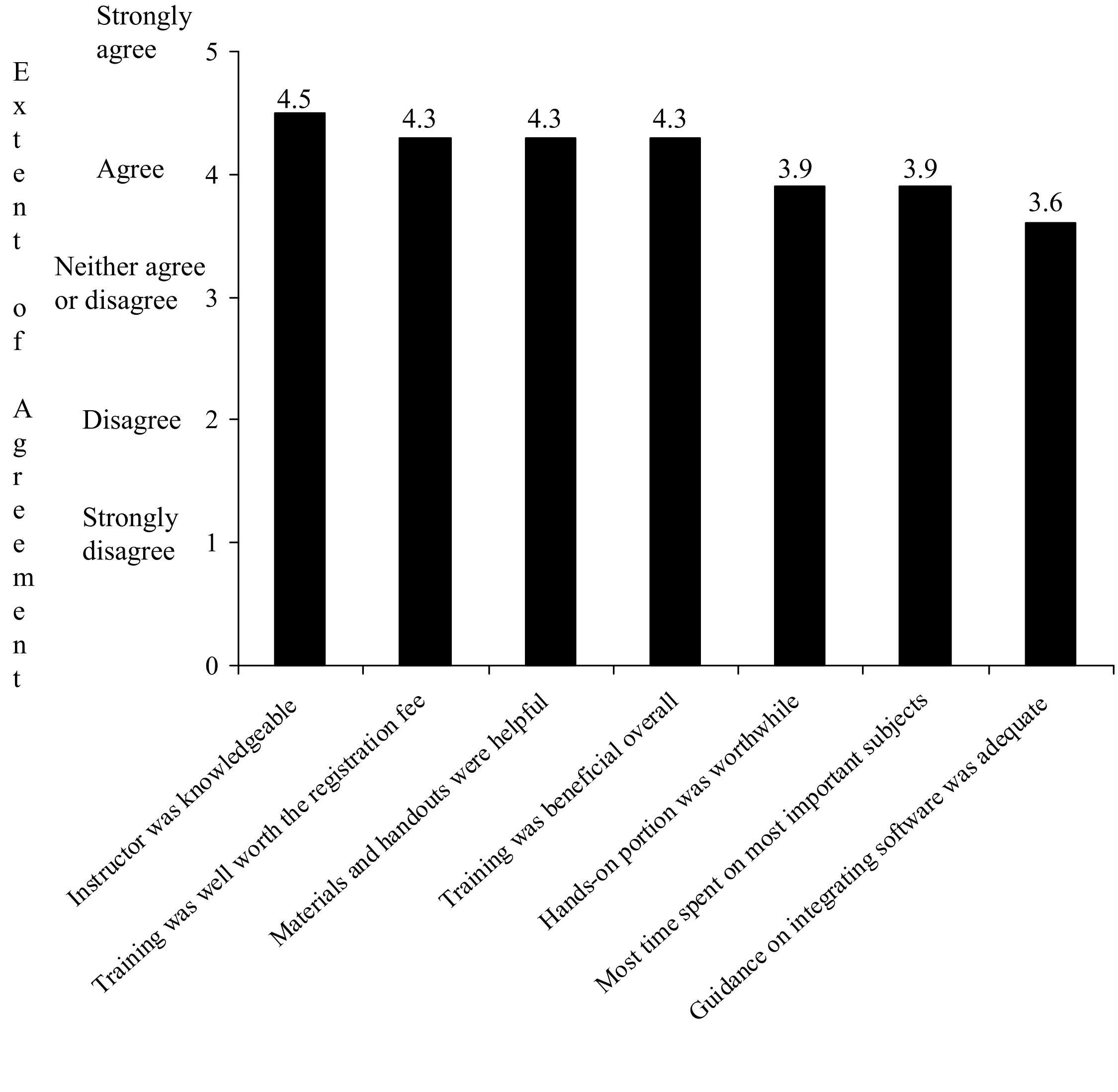

Figure 4.1 Value of Training

from the training was well worth the registration fee that was paid;" "The course materials and handouts were helpful;" and "Overall, the training was beneficial." Respondents agreed least strongly with the statement that "Guidance on how to integrate DOE's software tools into your company's overall energy management approach was adequate." The scores shown in Figure 1 (and all the other figures in this chapter) represent the mean value of the individual answers given by all survey respondents regardless of the energy system for which they received BestPractices services. In reality, the scores given by survey respondents tended to vary – often significantly – by the energy system addressed.

- Recipients of compressed air training rated the value of the overall training and its components higher than did those who received training on other topics.
- Recipients of steam training rated the value of most items lower than other training recipients did.
- Service recipients from small plants rated the value of the overall training and several components lower than did those from larger facilities.
- Larger plants tended to assign the greatest value to the overall training.

When responses to the value items shown in Figure 4.1 were disaggregated by the energy system addressed by the training, we found that those who received compressed air training had scores that were at or near the top of the range for all items except the last one (*guidance on integrating software was adequate*). The mean scores for those receiving compressed air training were significantly greater than the mean scores for recipients of training on one or more of the other energy systems at the .05 level of significance or better. In contrast, recipients of steam training had scores at or near the *bottom* of the range for five of the seven value items (everything except *instructor was knowledgeable* and *hands-on portion was worthwhile*). For those five items, the mean scores of those who received steam training were significantly different (at the .05 level or better) than the mean scores for recipients of training on one or more other energy systems.

Responses to the value items were also disaggregated by plant size. A comparison of mean scores for the different size categories revealed that there was no statistically significant difference on the instructor being knowledgeable and well-prepared or on the greatest amount of time being spent on the most important subjects. On all the other items except for the one about the hands-on portion of the training being worthwhile, respondents from small facilities had significantly lower mean scores than one or both of the other size categories at the .05 significance level or better. And for two items (*training was well worth fee* and *training was beneficial overall*) the scores for large plants were significantly greater than for *both* medium and small plants.

4.1.2. Potential Usefulness of Additional Features

- Recipients of training on pumps rated the usefulness of many potential new training features higher than did those who received training on other topics.
- Recipients of compressed air training rated the usefulness of all the potential new training features *lower* than other training recipients did.
- Service recipients from small plants rated the usefulness of several potential new training features lower than did those from medium and large facilities.

Survey respondents were asked how much the usefulness of the training could be increased by adding various features. They were asked to answer using a five point scale, with 1 being "not at all" and 5 being "very substantially." As shown in Figure 4.2, most of the additional features were given ratings in the moderately useful range, with the highest scores going to *more customized assistance for the respondents' own facilities*, *more hands-on problems and exercises*, and *more examples of projects utilizing the technologies addressed*. Of all the items listed, *more financial information* was judged to be least useful.

Training recipients who received compressed air training gave relatively low scores to the usefulness of the various additional features shown in Figure 4.2. For all those items, the mean scores for those receiving compressed air training were significantly lower than the mean scores for recipients of training on one or more of the other topics at the .05 level of significance or better. For four of the six areas (all except *more financial information* and *more customized assistance*), recipients of pumps training had mean scores that were significantly greater than the mean scores for those who received training on one or more other topics at the .05 level or better.

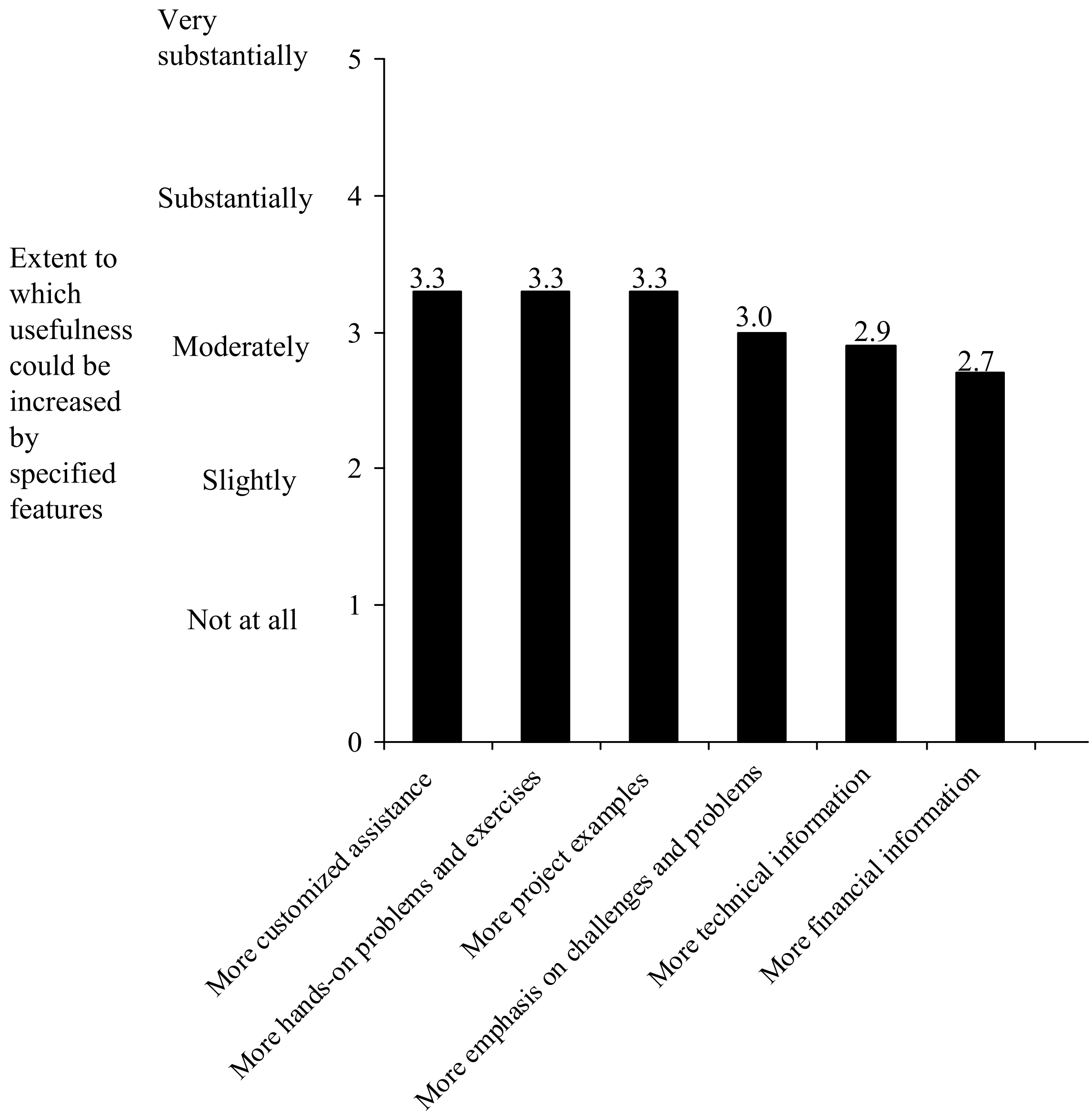

Figure 4.2 Usefulness of potential new training features

We found no statistically significant difference in the perceived usefulness of three additional features among the various size categories. Those items were: *more hands-on problems and exercises*; *more examples of projects utilizing the technologies addressed*; and *more financial information*. On the other three items, respondents from small facilities had significantly lower scores than respondents in both of the other size categories at the .02 level or better.

● Recipients of training on steam and compressed air tended to rate the value of possible future training formats lower than did those who received training on other topics.
● Service recipients from small plants rated the value of one possible future training format (continuing education courses) lower than did those from medium and large facilities.

4.1.3. Potential Usefulness of New Formats

Survey respondents were asked how valuable three possible formats would be in future training sessions, using a five point scale with 1 being "not at all" and 5 being "very substantially." Figure 4.3 shows that, on average, the perceived value of all three formats fell in the moderate range. The greatest value was ascribed to *continuing education/professional development courses*, while the lowest value was given to *one or two hour web-based short courses*.

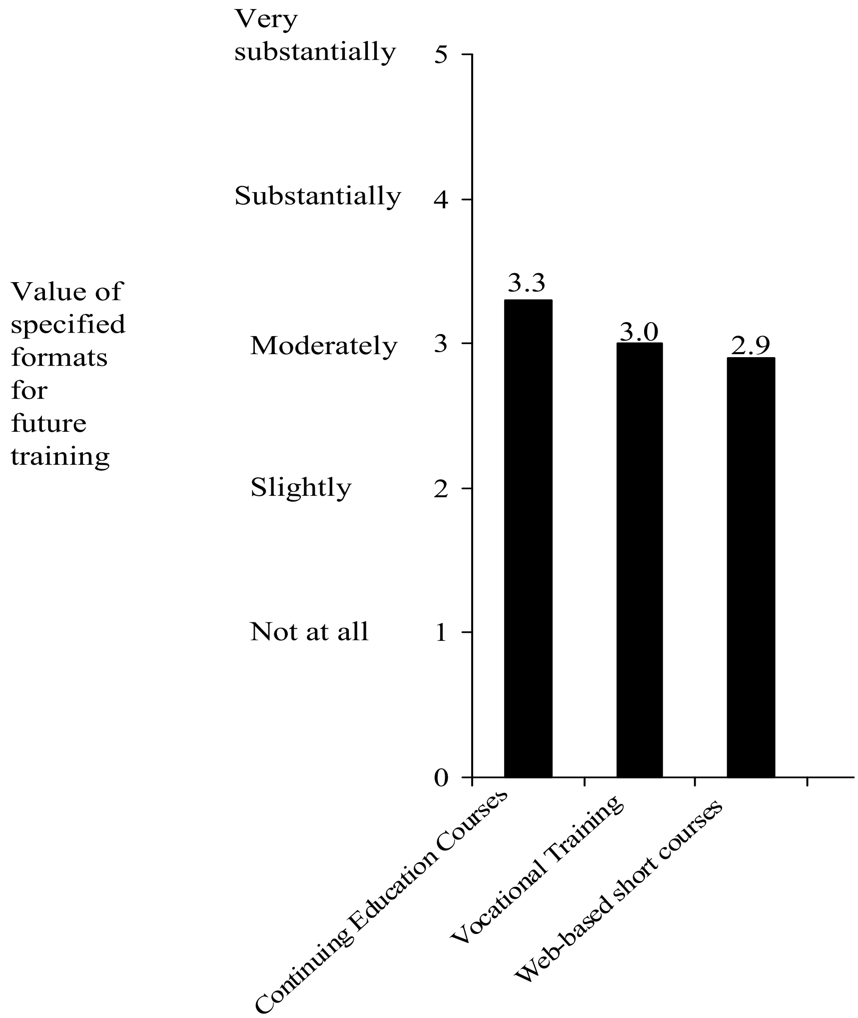

Figure 4.3 Value of possible future training formats

When disaggregating by the energy system addressed, those individuals who received compressed air training gave the lowest ratings to two of the three possible formats addressed in the survey: *continuing education courses* and *web-based short courses*. Their mean scores on those items were significantly lower than the mean scores for those who received training on one or more of the other energy systems at the .05 level of significance or better. In addition, recipients of steam training had scores that were at the low end of the range for all three items, and those mean scores differed from the mean scores for recipients of training on another topic at the .05 significance level or better.

Disaggregating by plant size, there was no significant difference among the various size categories in the value ascribed to *vocational training* or *web-based short courses*. For the other format, small facilities had significantly lower scores than both of the other size categories at the .01 level or better.

4.2. SOFTWARE RECIPIENTS

4.2.1. Value of Overall Software and Key Features

Software recipients were asked how strongly they agreed or disagreed with a series of statements pertaining to the value of the software that they received. These statements addressed the value of the software overall as well as specific features of the tools provided by DOE. As shown in Figure 4.4, software recipients gave similar scores to all four items, but the statement with which they agreed most strongly was "Overall, the DOE software was beneficial."

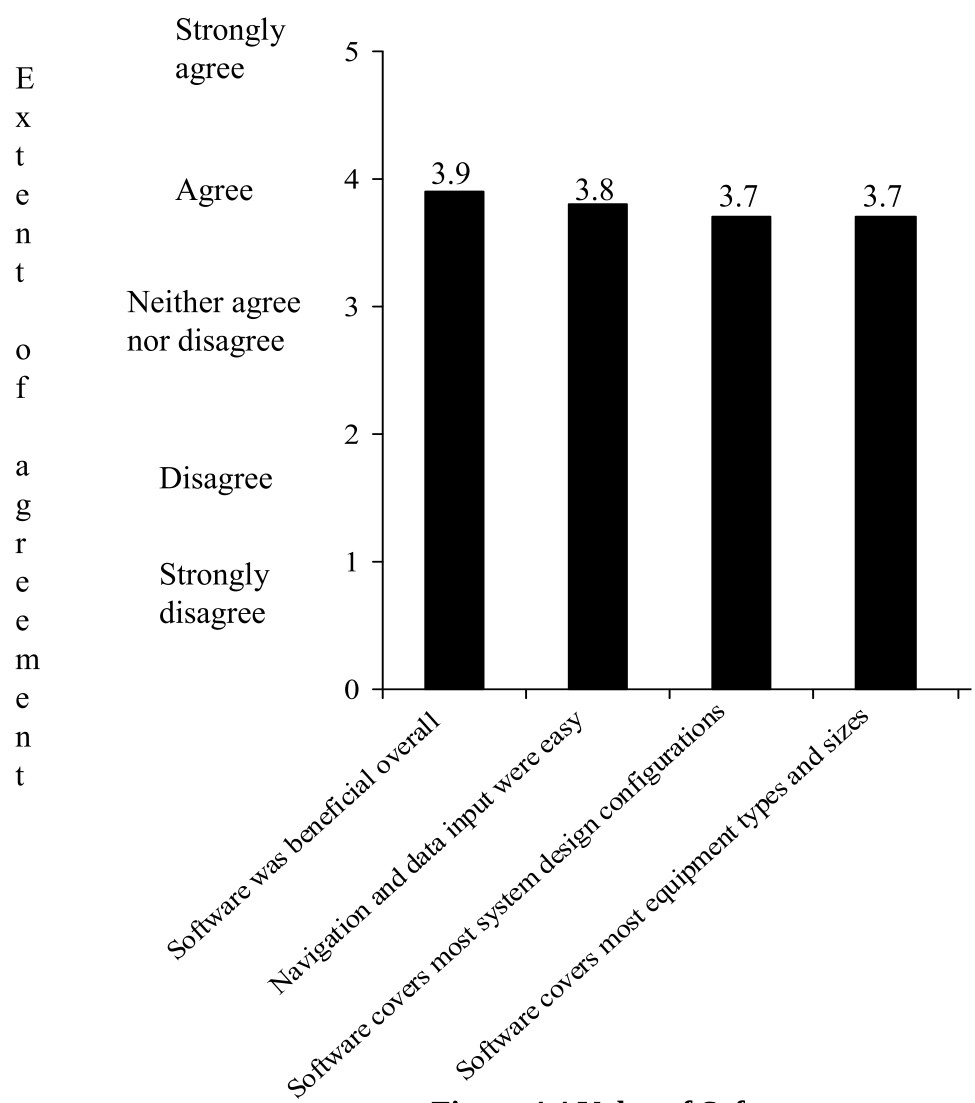

Figure 4.4 Value of Software

- Recipients of software on pumps and steam rated the value of the overall software and its ease of navigation and data input higher than did those who received software on other topics.
- Recipients of fans software rated the value of those same items lower than other software recipients did.

When survey responses were disaggregated by the energy system addressed by the software, we found no difference in mean scores among the various energy systems for two of the value items shown in Figure 4.4: *software covers most system design configurations* and *software covers most equipment types and sizes*. For the other two value items addressed in the software survey (*software was beneficial overall,* and n*avigation and data input were easy*), we found that those who received software on fans had scores that were at the bottom of the range and that their mean scores were significantly lower than the mean scores for recipients of software on one or more of the other energy systems at the .05 level of significance or better. In contrast, recipients of software on pumps and steam had mean scores that were significantly greater than the mean scores for recipients of software on one or more other energy systems. Once again, those differences were statistically significant at the .05 level or better.

A comparison of mean scores for the different size categories revealed no statistically significant difference by plant size for any of the four value items studied.

A regression analysis showed that energy/utility managers gave higher scores to the overall benefit of the software than did other respondents (p = .02).

4.2.2. Potential Usefulness of Additional Features

Survey respondents were asked how much the usefulness of the DOE software tools could be increased by adding nine different features. They were asked to respond to each of them using a five point scale, with 1 being "not at all" and 5 being "very substantially." As shown in figure 4.5, the highest scores went to *adding capability to simulate systems dynamically* and *allowing more flexibility in system design options*. On the other end of the scale, *offering SI (metric) version of the software* was judged to be least useful.

- Recipients of software on fans rated the usefulness of a number of potential new software features higher than did those who received software on other topics.
- Recipients of both steam and motors software rated the usefulness of several potential new software features lower than other software recipients did.
- Service recipients from small plants rated the usefulness of a few potential new software features higher than did those from larger facilities.

When survey responses were disaggregated by energy system, we found no difference in mean scores among the various energy systems for three items: *adding capability to simulate systems dynamically*, *providing guidance on data collection*, and *integrating with other energy analysis software*. Those who received software on fans had the highest or second-highest mean scores for four of the remaining features: *allowing more flexibility in system design options*, *providing improved guidelines and instructions*, *converting to web-based software tools*, and *providing technical support*. Their mean scores on those items were significantly greater than the mean scores for those receiving software on one or more of the other energy systems at the .05 level of significance or better. Recipients of steam software had mean scores that were at the low end of the scale for three of the same four items on which those receiving fan software were at or near the top (all except *allowing more flexibility in system design options*) and steam software recipients were also near the bottom for a fourth feature, *offering SI version of software*. On all those items, their mean scores were significantly lower (at the .05 significance level) than the mean scores for those receiving software on one or more other topics. Recipients of software on motors also had comparatively low scores on four items (*allowing more flexibility in system design options*, *including more energy saving options*, *providing improved guidelines and instructions*, and *offering SI version of software*), and their means scores were lower than the mean scores for software recipients on one or more other topics at the .05 level of significance or better.

We found no statistically significant difference among the various *size* categories for five of the additional features discussed above. For two of the four remaining items (*adding* *capability to simulate systems dynamically* and *integrating with other energy analysis software*), software recipients from small facilities had significantly higher scores than respondents in both of the other size categories at the .05 level or better. For another item

(*including more energy saving options*), small facilities had significantly higher scores than medium facilities (p=.05). For the final item (*offering SI version of software*), medium facilities gave significantly higher scores than did large facilities (p=.003).

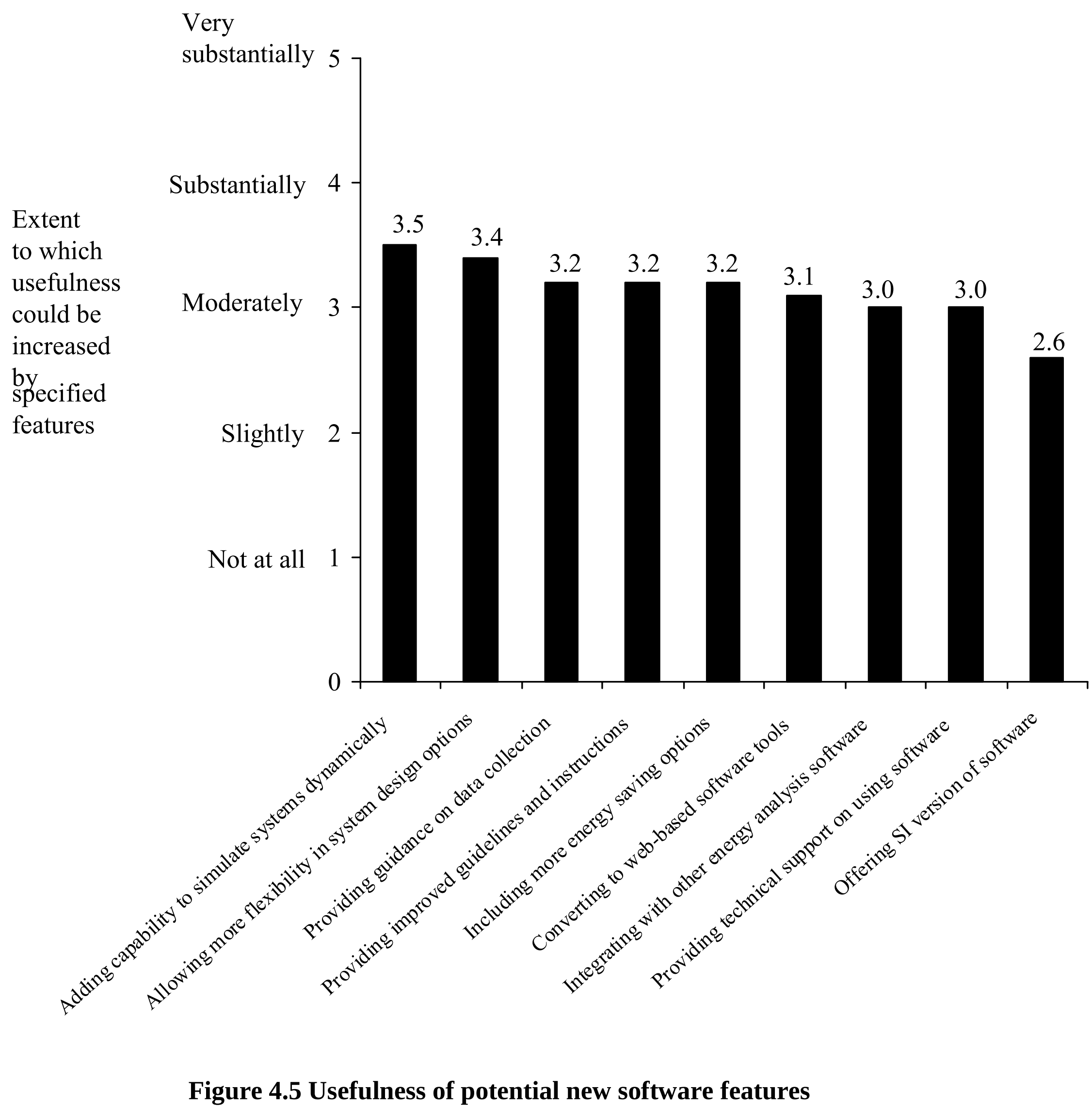

Figure 4.5 Usefulness of potential new software features

5. ACTIONS TAKEN BY SERVICE RECIPIENTS

5.1. TRAINING RECIPIENTS

5.1.1. Implementation Rate

The implementation rate is the proportion of service recipients taking energy-saving actions as a result of the service received. Based on the information provided by survey respondents, we found that almost precisely half (49.8%) of those individuals who received training in FY 2006 took subsequent action at their plants that they credited, at least in part, to their training (Table 5.1). This finding agrees closely with the findings from two recent studies of industrial sector training programs (Xenergy 2000; Xenergy 2003), which also found implementation rates of very close to 50%. The uncertainty due to sampling for the overall implementation rate found in this study is relatively small, as indicated by the narrow confidence intervals shown in Table 5.1.

Table 5.1. Implementation rate for training recipients, FY2006 – overall, by energy system, and by plant size

Energy system/ Plant size	Number	Mean value (%)	90% confidence interval	95% confidence interval
Overall	347	49.8	46.6 – 52.9	46.0 – 53.5
Compressed Air	146	62.5	57.7 – 67.4	56.8 – 68.3
Motors	27	55.2	45.7 – 64.8	43.7 – 66.7
Process Heat	36	48.1	38.5 – 57.8	36.5 – 59.8
Pumps	29	42.5	31.5 – 53.5	29.2 – 55.8
Steam	92	38.7	32.3 – 45.2	31.0 – 46.2
Fans	17	16.9	2.8 – 31.0	0 – 34.1
Small Plants	33	52.8	42.8 – 62.8	40.7 – 64.9
Medium Plants	192	49.1	44.8 – 53.3	44.1 – 54.1
Large Plants	122	49.9	44.5 – 55.3	43.5 – 56.3

Of those individuals who did *not* take action due to their training, about 47% identified no energy saving measures at all,[13] 39% identified measures but did not implement any of them, and the remainder implemented some energy-saving measures independently of the training they received.

Survey results were disaggregated by the energy system addressed by the training, and they showed that implementation rates varied substantially among the various energy systems addressed by the training. As shown in Table 5.1, implementation rates ranged from a high of 62.5% for compressed air training to a low of 16.9% for training that dealt with fans. The implementation rate for motors and process heat training fell within about five percentage points of the overall mean, with the implementation rates for pumps and steam being somewhat lower. As indicated by the confidence intervals, the uncertainty regarding the findings for individual training topics is greater than for all energy systems combined, and the magnitude of that uncertainty tends to be inversely related to the

[13] The group of survey respondents who identified no energy-saving measures included a relatively small number (22 out of 347 individuals responding to the survey) who said they did not remember receiving training.

number of respondents. Accordingly, the confidence intervals are tightest for compressed air and widest for fans.

A comparison of means test revealed that the mean implementation rate for those receiving compressed air training was significantly greater than the mean implementation rates for those who received training on fans ($p<.0001$), steam ($p<.0001$), pumps ($p=.006$), and process heat ($p=.03$). In addition, the mean implementation rate associated with fans training was significantly less than the implementation rates for training on motors ($p=.0001$), process heat ($p=.002$), pumps ($p=.02$), and steam ($p=.02$). Finally, the mean implementation rate for those trained on steam was significantly lower than for motors ($p=.02$).

- Recipients of compressed air training were more likely to take energy-saving actions as a result of that training than those who were trained on most other energy systems.
- Those receiving fans training were *less* likely to implement energy-saving measures than those who received training on any other energy system.
- BestPractices training recipients who had a corporate or facility energy manager or who were subject to plant energy reduction targets were more likely to take energy-saving actions than those without such energy management procedures.
- Training recipients who felt more strongly that the most time was spent on the most important subjects and that the instructor was knowledgeable and well-prepared were more likely to take action as a result of their training.

Survey results were also disaggregated by the size of the primary plant influenced by each respondent. Table 5.1 shows that the difference in implementation rates among the various size categories was not nearly as great as among training topics, with the range extending from 49.1% for medium plants to 52.8% for small plants. As indicated by the confidence intervals, the uncertainty regarding the findings for the individual size categories is greater than for all training recipients combined. Those confidence intervals are relatively narrow for medium and large plants and somewhat greater for small plants. None of the differences in implementation rate among the various size categories was found to be statistically significant at the .05 level.

A little more than half of the training recipients reported receiving DOE software tools on the same topic on which they were trained. A comparison of the mean implementation rate for those who received software and those who did not showed no significant difference between the two groups.

We also compared the mean implementation rate for training recipients who engaged in various energy management practices and those who did not. That analysis revealed that the mean implementation rate for companies with a corporate or facility energy manager was significantly greater ($p = .01$) than the implementation rate for companies without an energy manager. We also found that the implementation rate was higher for those who were subject to corporate or facility mandates to reduce plant energy intensity by a targeted percentage, but that difference narrowly missed being significant at the .05 level.

A regression analysis was performed to test for possible relationships between implementation and the value that training recipients assigned to their training overall and to various elements of that training. We found that training recipients who felt more strongly that the greatest amount of time was spent on the subjects of most importance to them were more likely to take action as a result of their training ($p=.04$). Similarly, there was a positive relationship between taking energy-saving actions and the belief that the instructor was knowledgeable and well-prepared, which just missed being significant at the .05 level.

5.1.2. Attribution Rate

The attribution rate applies to those individuals taking energy-saving actions as a result of the service they received, and it represents the portion of the savings achieved through the actions taken that is due to the service. For all training recipients combined, the mean attribution rate was 61.1% (Table 5.2). That figure was derived from survey responses showing that nearly 52% of those taking action as a result of the training would probably have done nothing without that assistance, meaning that all of their savings is attributable to the training. A substantial number of respondents reported that they probably would have taken some energy-saving actions anyway but that the training stimulated them to do more. For that group, additional measures stimulated by the training accounted for approximately 20% of their total savings. Combining the attributed savings for both groups yields the mean attribution rate of 61.1% noted above. Table 5.2 shows that the confidence interval surrounding this number (and therefore the uncertainty) is relatively small.

As with the implementation rate, the attribution rate varied significantly by the energy system addressed, with a high of 67.0% for pumps and compressed air and a low of 38.7% for process heat (Table 5.2). Once again, the confidence intervals indicate that the uncertainty regarding the findings for individual training topics is greater than for all

Table 5.2. Attribution rate for training recipients, FY2006– overall, by energy system, and by plant size

Energy system/ Plant size	Number	Mean value (%)	90% confidence interval	95% confidence interval
Overall	176	61.1	57.5 – 64.8	56.8 – 65.5
Pumps	13	67.0	54.2 – 79.9	51.2 – 82.9
Compressed Air	92	67.0	61.9 – 72.1	60.9 – 73.1
Motors	15	65.8	55.4 – 76.1	53.2 – 78.3
Steam	35	52.3	42.8 – 61.7	40.8 – 63.7
Fans	3	53.7	53.7 – 53.7	53.7 – 53.7
Process Heat	18	38.7	26.6 – 50.9	23.9 – 53.5
Small Plants	18	58.8	45.3 – 72.4	42.4 – 75.3
Medium Plants	98	66.4	61.5 – 71.4	60.5 – 72.3
Large Plants	60	52.9	46.9 – 58.8	45.7 – 60.0

- Recipients of process heat training tended to have a lower portion of their savings attributable to that training than those who were trained on most other energy systems.
- Training recipients from medium plants had a significantly higher attribution rate than those from large plants.

training recipients combined. The mean attribution rate for those receiving training on process heat was significantly lower than the mean attribution rates for those who received training on compressed air ($p = .004$), pumps ($p = .03$), and motors ($p = .03$). None of the other differences in attribution rate among the various energy systems proved to be statistically significant at the .05 level.

Table 5.2 shows that attribution rates for the different size categories were more similar than among training topics. The range extended from a low of 52.9% for large plants to a high of 66.4% for medium plants. The confidence intervals for medium and large plants were relatively narrow but they were somewhat wider for small facilities. The difference in attribution rates between large and medium plants was found to be statistically significant at the .02 level.

5.1.3. Reduction Factor

The reduction factor is the saving that is realized from actions taken in response to the service received as a proportion of the savings that could be achieved if *all* service recipients took action. This is equivalent to the product of the implementation rate times the attribution rate and is used in the ORNL metrics model to calculate savings based on the number of unique plants receiving services in each energy systems area. For example, if only half of those receiving BestPractices training on a particular topic implemented measures as a result of their training (implementation rate = 50%) and 60%

of the savings they achieved were a direct result of that training (attribution rate = 60%), then 30% of the maximum possible savings (60% of 50%) would be realized as a result of the program (reduction factor = 30%). As illustrated by this example, larger reduction factors would indicate greater savings. The mean reduction factor for all training recipients combined was 30.4%. The uncertainty regarding this reduction factor is relatively small, as indicated by the narrow confidence intervals shown in Table 5.3.

Disaggregated by the energy system addressed, the reduction factor ranged from a high of 41.9% for compressed air to a low of 9.1 % for fans (Table 5.3). The reduction factor for pumps was relatively close to the overall mean, while steam and process heat both had reduction factors that were substantially lower. The uncertainty regarding the findings for individual training topics is greater than for all training recipients combined and, as with the implementation rate, the confidence interval was tightest for compressed air and widest for fans.

- Recipients of compressed air training had a higher mean reduction factor than those who were trained on most other energy systems.
- Recipients of motors training had a higher mean reduction factor than those trained on several other energy systems.
- Those receiving fans training had a *lower* mean reduction factor than those who received training on most other energy systems.

A comparison of means showed that the mean reduction factor for those receiving compressed air training was significantly greater than the mean reduction factor for those who received training on fans ($p<.0001$), process heat ($p<.0001$), steam ($p<.0001$), and pumps ($p=.03$). In addition, the mean reduction factor associated with fans training was significantly less than the reduction factors for training on motors ($p<.0001$), pumps ($p=.006$), and steam ($p=.03$). The mean reduction factor for those trained on steam was significantly lower than for motors ($p=.005$). Finally, those receiving training on process heat had a significantly lower mean reduction factor than those who were trained on motors ($p=.005$).

Table 5.3. Reduction factor for training recipients, FY2006 – overall, by energy system, and by plant size

Energy system/ Plant size	Number	Mean value (%)	90% confidence interval	95% confidence interval
Overall	347	30.4	27.8 – 33.0	27.3 – 33.5
Compressed Air	146	41.9	37.4 – 46.5	36.5 – 47.3
Motors	27	36.3	28.9 – 43.7	27.3 – 45.3
Pumps	29	28.5	19.3 – 37.7	17.4 – 39.6
Steam	92	20.2	15.3 – 25.1	14.4 – 26.1
Process Heat	36	18.6	12.0 – 25.3	10.6 – 26.7
Fans	17	9.1	1.6 – 16.6	0 – 18.2
Small Plants	33	31.1	22.2 – 40.0	20.3 – 41.8
Medium Plants	192	32.6	29.1 – 36.2	28.4 – 36.9
Large Plants	122	26.4	22.1 – 30.7	21.3 – 31.5

Table 5.3 shows that the difference in reduction factors among the various size categories was considerably less than the difference among training topics, with the mean for each size category falling within four percentage points of the overall mean. None of the differences between mean reduction factors for the various size categories was statistically significant at the .05 level. The uncertainty regarding the findings for the individual size categories was greater than for all training recipients combined, with the greatest uncertainty (and broadest confidence interval) associated with small plants.

5.1.4. Additional Plants Implementing Measures

Slightly less than one-third of the survey respondents who took action as a result of their training reported that they influenced energy consumption at multiple plants. Of those, about 67% indicated that they had *implemented* energy-saving measures at more than one facility and reported the number of plants involved. On average, each person who took action as a result of their training implemented energy-saving measures at one primary facility *and* an additional 0.9 plants. Energy/utility managers reported influencing energy use at more plants than did other respondents, but the difference was not statistically significant at the .05 level. As shown in Table 5.4, medium-size facilities made up the greatest share of those additional plants, followed by large facilities. Small facilities accounted for a small fraction of the additional plants that implemented energy-saving measures. The size of the confidence intervals indicates that there is a moderate amount of uncertainty surrounding these numbers.

Table 5.4. Additional plants at which measures were implemented by training recipients, FY2006 [a]

Plant size	Mean value	90% confidence interval	95% confidence interval
Overall	0.9	0.5 – 1.2	0.4 – 1.3
Small Plants	0.1	0 – 0.1	0 – 0.1
Medium Plants	0.5	0.3 – 0.6	0.2 – 0.7
Large Plants	0.3	0.2 – 0.5	0.1 – 0.6

[a] These numbers apply only to survey respondents who took some action in response to the service received. The sum of small, medium, and large plants differs slightly from the overall number because of a few cases where data by plant size are missing or are not entirely consistent with information provided on total number of plants.

5.1.5. Reported Influence of Training on Implementation Decision

Survey respondents were asked to report the actions that they took in response to the training they received. As documented above, many of those respondents reported that they implemented energy-saving measures, at least in part, as a result of their training. To corroborate those self-reports, respondents were asked how much their decision to implement energy-saving measures was influenced by various types of information that the training provided. If individuals who reported taking action as a result of their training also said that their implementation decision was more heavily influenced by specific types of information than those who took action independently of the training, it provides a logical explanation of how the program influenced them and supports their claim that the training they received led to subsequent actions.

The answers given to each question were compared for three groups of training recipients. The first group consists of individuals who said that they would have taken action even without the training and that the training led to no additional energy-saving actions on their part. The second group is made up of those who said that they took action, at least in part, due to the training. This includes individuals who would not have taken any action without the training as well as those who would have taken some action anyway but were influenced to take *more* actions as a result of the training. The third group of interest is a subgroup of the second set of training recipients and consists of those who said they would probably have taken *no* actions if they had not received the training.

- Training recipients who took action as a result of that training ascribed substantially more importance to all types of information provided by the training than did those who took action independently of their training.

Figure 5.1 shows the extent to which the implementation decision of each of the three groups described above was influenced by different types of information that the training provided. It is clear that those service recipients who took action due to their training ascribed substantially more importance to all types of information provided by the training than those who took action independently of their training. A statistical comparison of the mean scores for those two groups shows that the difference between them was highly significant ($p<.0001$) for every item. It is also clear from Figure 5.1 that those who would have taken no action without the training had even higher scores than the larger group who took action, at least in part, as a result of the training they received. Finally, it is worth noting that the influence of most types of information provided by the training was roughly similar within groups with the marked exception of information on environmental benefits, which was reported to be much less important than the other items.

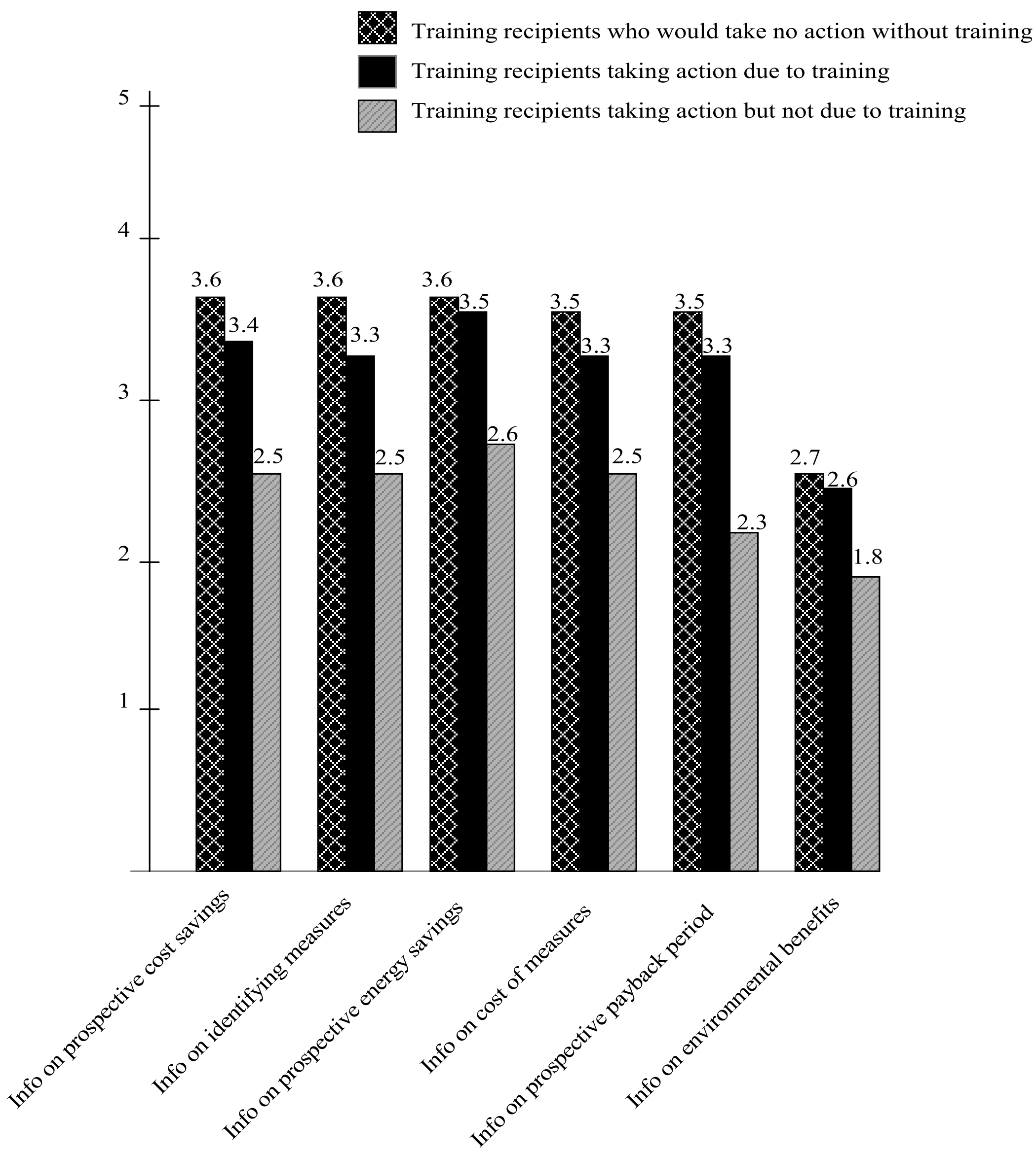

Figure 5.1. Mean influence of information provided by training on implementation decision

5.2. SOFTWARE RECIPIENTS

5.2.1. Implementation Rate

A little less than one-fourth (23.9%) of all those who received and registered DOE software tools in FY 2006 reported taking subsequent action that they credited, at least in part, to receiving that software. It was expected that this implementation rate would be substantially lower than the rate for training because other studies have shown much higher implementation rates for training than for software. In fact, the implementation rate for software recipients found in this study is slightly greater than the mean implementation rate of roughly 20% reported in another recent study of industrial sector software recipients (Xenergy 2000). There is a moderate amount of uncertainty regarding the overall implementation rate found in the current study, as indicated by the confidence intervals shown in Table 5.5.

Of those individuals who did *not* take action due to the software they received and registered, about 73% identified no energy saving measures at all,[14] another 18% identified measures but did not implement any of them, and the remainder implemented some energy-saving measures independently of the software they received.

Table 5.5. Implementation rate for software recipients, FY 2006 – overall, by energy system, and by plant size

Energy system/ Plant size	Number	Mean value (%)	90% confidence interval (%)	95% confidence interval (%)
Overall	206	23.9	19.1 – 28.8	18.1 – 29.8
Steam	54	36.6	26.5 – 46.8	24.4 – 48.8
Process Heat	22	27.9	9.2 – 46.6	5.2 – 50.5
Motors	69	24.6	16.5 – 32.8	14.9 – 34.4
Compressed Air	21	19.9	4.6 – 35.2	1.4 – 38.5
Pumps	23	17.7	4.5 – 30.9	1.7 – 33.7
Fans	17	6.6	0 – 17.8	0 – 20.2
Small Plants	10	28.3	0 – 58.5	0 – 66.3
Medium Plants	109	23.4	16.7 – 30.0	15.5 – 31.5
Large Plants	87	24.0	16.9 – 31.1	15.5 – 32.5

As with training, implementation rates varied substantially among the different energy systems addressed. Table 5.5 shows that implementation rates ranged from a high of 36.6% for steam to a low of 6.6% for fans. The implementation rate for motors, process heat, and compressed air all fell within four percentage points of the overall mean. As indicated by the confidence intervals, the uncertainty regarding the findings for individual software topics is considerably greater than for all energy systems combined, and the magnitude of that uncertainty tends to be greatest where the number of respondents is least.

- Recipients of software on fans were less likely to implement energy-saving measures than those who received software on a few other energy systems.

A comparison of means revealed that the mean implementation rate for those receiving software on fans was significantly less than the mean implementation rates for those who

[14] The group of survey respondents who identified no energy-saving measures included a sizable number of respondents (61out of the 206 individuals responding to the survey) who said they did not remember receiving the software or received the software but never opened it.

• Software recipients whose company had a formal energy management plan were more likely to take energy-saving actions than those without such a plan.
• Software recipients who gave higher marks to the software for its ease of navigation and data input were more likely to take action as a result of receiving that software.

received software on steam (p=.0009) or motors (p=.03). None of the other differences shown in Table 5.5 proved to be statistically significant at the .05 level, due in large part to the considerable uncertainty surrounding most of the by-topic implementation rates.

Table 5.5 shows that implementation rates among the various size categories varied much less than among the different energy systems addressed by the software. The numbers for both medium and large plants, which together accounted for nearly all software recipients, fell within one percentage point of the overall mean. The confidence intervals are only slightly greater for those two size categories than for all software recipients combined, but the level of uncertainty is much greater for small plants. None of the differences in implementation rate among the various size categories was found to be statistically significant at the .05 level.

A comparison of means showed that the mean implementation rate for companies with a formal energy management plan was significantly greater (p = .04) than the implementation rate for companies without such a plan.

A regression analysis testing for possible relationships between the perceived value of the software and implementation showed that software recipients who gave higher marks to the software for its ease of navigation and data input were more likely to implement energy-saving measures (p=.02).

5.2.2. Attribution Rate

As noted previously, the attribution rate applies to those individuals taking energy-saving actions as a result of the service they received and describes the portion of the associated savings that is due to the service. For all software recipients combined, the mean attribution rate was 56.3%. That figure was derived from survey responses showing that about 48% of those taking action due to the software would probably have done nothing without it and that the remainder of those whose actions were influenced by the software implemented *additional* measures accounting for approximately 16% of their total savings. As indicated by the confidence intervals in Table 5.6, there is a moderate amount of uncertainty regarding the overall attribution rate.

Table 5.6. Attribution rate for software recipients, FY 2006 – overall, by energy system, and by plant size

Energy system/ Plant size	Number	Mean value (%)	90% confidence interval (%)	95% confidence interval (%)
Overall	52	56.3	45.8 – 66.8	43.7 – 68.9
Pumps	4	79.4	23.1 - 100	0 - 100
Process Heat	6	71.2	24.5 - 100	8.0 - 100
Motors	17	63.1	45.6 – 80.6	41.8 – 84.4
Steam	20	50.6	35.0 – 66.3	31.7 – 69.6
Compressed Air	4	32.6	0 - 100	0 - 100
Fans[a]	1	--	--	--
Small Plants	3	83.5	0 - 100	0 - 100
Medium Plants	26	57.6	41.0 – 74.2	37.5 – 77.7
Large Plants	23	48.1	34.3 – 62.0	31.3 – 64.9

[a]No reliable estimates could be calculated for this topic because only a single respondent provided the necessary data

- None of the observed differences in attribution rate among the various energy systems or plant size categories proved to be statistically significant because of the substantial uncertainty surrounding the mean values.

The attribution rate varied significantly by the energy system addressed, with a high of 79.4% for pumps and a low of 32.6% for compressed air (Table 5.6). No reliable mean could be calculated for fans because only a single respondent who received software on this topic provided the necessary data. The uncertainty surrounding the mean values for the other energy systems ranged from moderate (pumps, motors, and steam) to very large (compressed air). Because of the magnitude of this uncertainty, none of the observed differences in attribution rate among the various energy systems was found to be statistically significant at the .05 level.

Table 5.6 shows that attribution rates also differed substantially for the different size categories, with a low of 48.1% for large plants and a high of 83.5% for small plants. As indicated by the confidence intervals, there was moderate uncertainty surrounding the mean value for medium and large plants and very great uncertainty for small plants (due in large part to the very small number of respondents in the latter size category). Accordingly, none of the differences in attribution rates among the various size categories was found to be statistically significant at the .05 level.

5.2.3. Reduction Factor

As noted previously, the reduction factor is the saving that is realized from program-induced actions as a proportion of the potential savings that could be achieved if all service recipients took action. The mean reduction factor for all software recipients combined was 13.5%. There is moderate uncertainty regarding this reduction factor, as indicated by the width of the confidence intervals shown in Table 5.7. As with the implementation rate, this reduction factor is substantially lower than the reduction factor for training and, once again, this was expected because of the close relationship between implementation rate and reduction factor.

Table 5.7. Reduction factor for software recipients, FY 2006 – overall, by energy system, and by plant size

Energy system/ Plant size	Number	Mean value (%)	90% confidence interval (%)	95% confidence interval (%)
Overall	206	13.5	9.8 – 17.2	9.1 – 17.9
Process Heat	22	19.9	3.2 – 36.5	0 – 40.0
Steam	54	18.5	11.1 – 25.9	9.7 – 27.4
Motors	69	15.6	9.1 – 22.0	7.8 – 23.3
Pumps	23	14.1	2.3 – 25.8	0 – 28.3
Compressed Air	21	6.5	0 – 15.3	0 – 17.2
Fans[a]	17	--	--	--
Small Plants	10	23.7	0 – 52.6	0 – 60.0
Medium Plants	109	13.5	8.5 – 18.4	7.5 – 19.4
Large Plants	87	11.5	6.9 – 16.2	6.0 – 17.1

[a]No reliable estimates could be calculated for this topic because only a single respondent provided all the necessary data.

Disaggregated by the energy system addressed, the reduction factor ranged from a high of 19.9% for process heat to a low of 6.5% for compressed air (Table 5.7). No reliable mean could be calculated for fans because only a single respondent provided data on attribution, a critical element in determining the reduction factor. The reduction factor for

● Because of the substantial uncertainty surrounding the mean values, none of the observed differences in reduction factor among the various energy systems or plant size categories proved to be statistically significant.

steam was almost as high as for process heat, while both motors and pumps had reduction factors within about two percentage points of the overall mean. The uncertainty regarding the estimated means was moderate to large for all the individual software topics.

A comparison of means test was conducted, but due to the substantial uncertainty regarding the mean reduction factor for the various software topics, none of the observed differences was found to be statistically significant at the .05 level.

Table 5.7 shows the difference in reduction factors among the various size categories. The mean reduction factors for medium and large plants were similar, but the reduction factor for small plants was substantially higher than for the other two. There was also considerably more uncertainty surrounding the estimated mean reduction factor for small plants. A comparison of means revealed no significant difference in reduction factors for the different size categories at the .05 level.

5.2.4. Additional Plants Implementing Measures

Slightly more than half of the survey respondents who took action as a result of receiving DOE software tools reported that they influenced energy consumption at multiple plants. Of those, about 55% indicated that they had implemented energy-saving measures at more than one facility. On average, each individual who took action as a result of receiving software implemented energy-saving measures at one primary facility *and* an additional 5.8 plants. However, it is important to note that the magnitude of the mean number of additional plants is due in large part to the fact that three individuals each reported taking action at 50 plants or more. Accordingly, there is great uncertainty surrounding the number of additional plants, as shown by the confidence intervals given in Table 5.8. As with training recipients, energy/utility managers reported influencing energy use at more plants than did other respondents, but the difference was not statistically significant at the .05 level. Medium-size facilities made up the great majority of the additional plants while small facilities accounted for very little of the total. Once again, the amount of uncertainty associated with the estimated mean values for the individual size categories is very substantial.

Table 5.8. Additional plants at which measures were implemented by software recipients, FY 2006 [a]

Plant size	Mean value	90% confidence interval	95% confidence interval
Overall	5.8	1.3 – 10.3	0.4 – 11.2
Small Plants	0.1	0 – 0.3	0 – 0.3
Medium Plants	4.6	0.8 – 8.4	0 – 9.2
Large Plants	0.8	0 – 1.7	0 – 1.9

[a] These numbers apply only to survey respondents who took some action in response to the service received. The sum of small, medium, and large plants differs slightly from the overall number because of a few cases where data by plant size are missing or are not entirely consistent with information provided on total number of plants.

5.2.5. Reported Influence of Training on Implementation Decision

Respondents were asked how much their decision to implement energy-saving measures was influenced by various types of information provided by the DOE software as a way of corroborating their reports of taking action in response to receiving that software. As

- Software recipients who took action as a result of receiving that software ascribed substantially more importance to all types of information provided by the software than did those who took action independently of the software.

explained in Section 5.1.5, the answers given to each question were compared for three groups of service recipients: (1) those who said that the software led to no additional energy-saving actions on their part; (2) those who said that they took action, at least in part, due to the software; and (3) those who said they would probably have taken *no* actions if they had not received the software.

Figure 5.2 shows the extent to which the implementation decision of each of the three groups described above was influenced by different types of information that the software

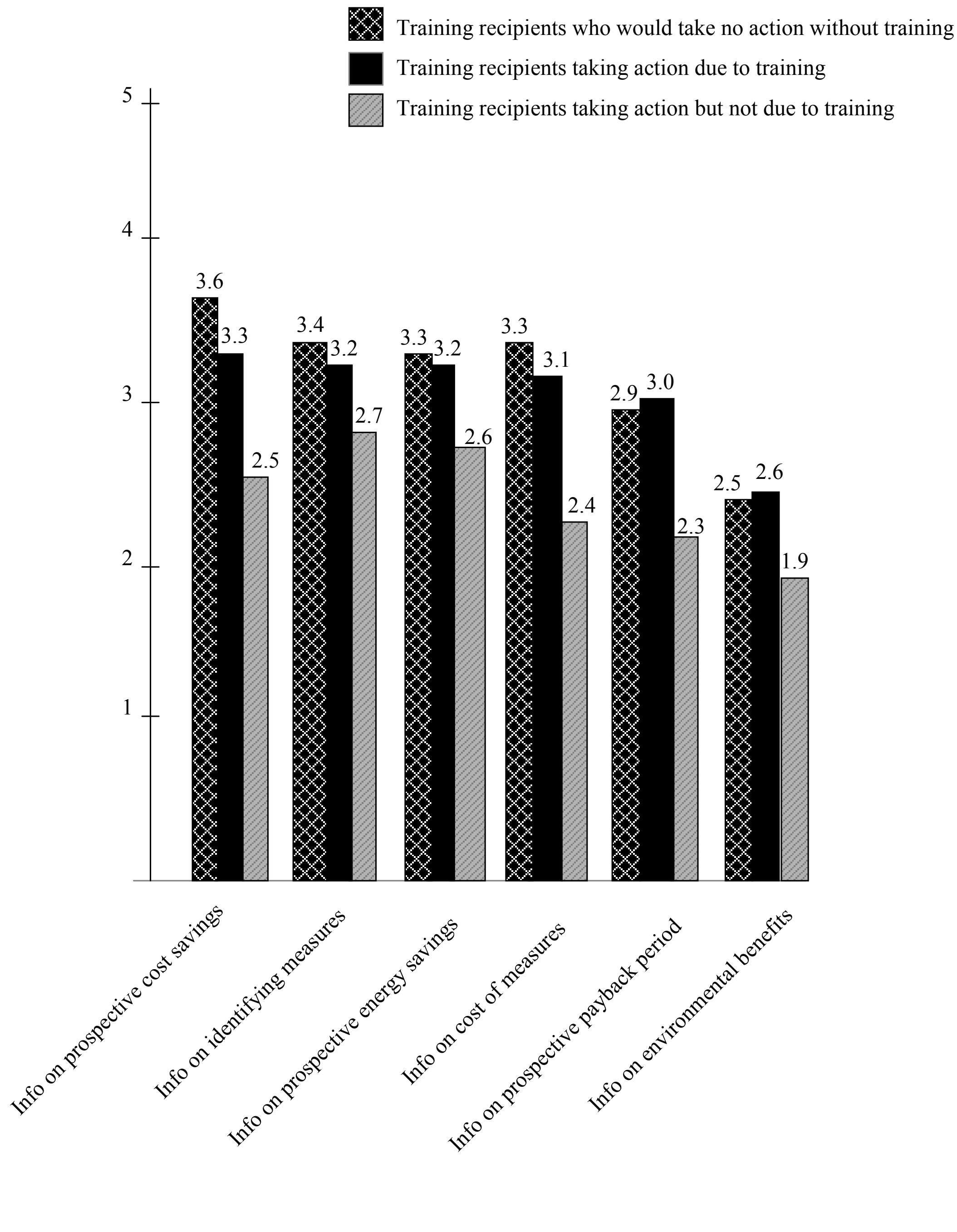

Figure 5.2. Mean influence of information provided by software on implementation decision

provided. Those who said that they took action due to the software they received ascribed substantially more importance to all types of information provided by the software than those who took action independently of the software. A statistical comparison of the mean scores for those two groups shows that the difference between them was statistically significant at the .04 level or better for every item. In addition, Figure 5.2 illustrates that, for the first four items, those who would have taken *no* action without the software had even higher scores than the larger group who took action, at least in part, as a result of the software they received. The influence of most types of information provided by the software was roughly similar within groups with the exception of information on environmental benefits, which was much less important than the other items.

- The mean implementation rate for those receiving training was substantially greater than for software recipients.
- Services related to fans had the lowest implementation rate for both training and software
- Those who received training on compressed air had a high implementation rate but recipients of software on the same topic had a relatively low implementation rate.
- Recipients of steam software had a high implementation rate but the implementation rate was low for those who received training on the same topic.
- Mean implementation rates were higher for training and software recipients who had various energy management procedures than for those without them.

5.3. COMPARISON OF TRAINING AND SOFTWARE RECIPIENTS ON KEY FACTORS

- As expected based on the findings from previous studies, the mean implementation rate for those receiving training (49.8%) was substantially greater than for software recipients (23.9%).
- Recipients of services related to fans had the lowest implementation rate for both training and software.
- Those who received training on compressed air had a high implementation rate but recipients of software on the same topic had a relatively low implementation rate.
- Recipients of steam software had a high implementation rate but the implementation rate was low for those who received training on the same topic.
- The confidence intervals for mean implementation rates, and all other variables studied, were much narrower for training than for software.
- When implementation rates, and other variables, were compared for the various energy systems addressed, many more significant differences were found among training recipients than among those receiving software and this is related to the narrower confidence intervals associated with the estimated mean values for training.
- No significant difference in implementation rate or reduction factor was found among the different plant size categories, either for training or software recipients.
- Mean implementation rates were higher for training and software recipients who had various energy management procedures than for those without them.
- The mean attribution rate was similar for those receiving training (61.1%) and software (56.3%).
- Services related to pumps had the highest attribution rate for both training and software
- Those who received training on compressed air had a relatively high attribution rate but recipients of software on the same topic had a low attribution rate.
- Recipients of process heat software had a relatively high attribution rate but the implementation rate was low for those who received training on the same topic.
- A few statistically significant differences were found for training recipients when comparing mean attribution rates for the various energy systems and plant size categories, but no such differences were found for those receiving software.
- As with the implementation rate, the mean reduction factor for those receiving training (30.4%) was substantially greater than for software recipients (13.5%).

- Those who received training on compressed air had a high reduction factor but recipients of software on the same topic had a low reduction factor.
- Recipients of software on process heat and steam had high reduction factors but the reduction factors were relatively low for those who received training on the same topics.
- The estimated mean number of *additional* plants influenced per service recipient was much larger for software than for training, but the substantial uncertainty surrounding the software value indicates that the apparent difference between training and software recipients on this factor may not be real.
- Training and software recipients who took action as a result of the services they received said that their implementation decisions were more heavily influenced by the information provided by those services than did those who reported taking action independently of BestPractices services.

6. POSSIBLE SAVINGS FROM ACTIONS TAKEN

6.1. TRAINING RECIPIENTS

6.1.1. Plant Energy Cost Savings Potential

As used in this report, plant energy cost savings potential is the percentage by which total annual plant energy costs could be reduced by implementing all measures that program participants identified since receiving Best Practices training or software. As explained in Chapter 2, the data used to calculate savings potential came from the surveys of BestPractices service recipients. Table 6.1 shows that those individuals taking action at their plants due to the training that they received had an average plant energy cost savings potential of 11.3%. It is important to note that this potential savings refers to the average plant-wide savings from measures that address a *single* energy system (e.g., steam)[15]. The uncertainty due to sampling reported here for the plant savings potential is relatively small, as indicated by the narrow confidence intervals shown in Table 6.1.

Table 6.1. Plant energy cost savings potential for those taking action due to training received, by energy system and plant size, FY 2006

Energy system/ Plant size	Number	Mean value (%)	90% confidence interval	95% confidence interval
All Systems	162	11.3	10.0 – 12.6	9.7 – 12.9
Compressed Air	85	12.7	10.8 – 14.5	10.5 – 14.9
Steam	35	11.4	7.9 – 15.0	7.2 – 15.7
Process Heat	17	8.1	3.5 – 12.6	2.5 – 13.6
Motors	14	6.6	5.1 – 8.1	4.8 – 8.4
Pumps	9	4.7	2.2 – 7.2	1.6 – 7.8
Fans[a]	2	--	--	--
Small Plants	15	16.1	11.7 – 20.5	10.7 – 21.5
Medium Plants	91	10.4	8.9 – 11.9	8.6 – 12.2
Large Plants	56	11.4	8.6 – 14.2	8.1 – 14.8

[a] No reliable estimates could be calculated for this topic because of the extremely small number of respondents

When survey results were disaggregated by the energy system addressed, we found that plant energy cost savings potential varied substantially among the different training topics. As shown in Table 6.1, plant savings potential ranged from a high of 12.7% for compressed air to a low of 4.7% for pumps. The savings potential for steam was almost exactly the same as the average for all the individual energy systems, while the potential savings for process heat and motors were substantially lower. A reliable estimate of savings potential could not be calculated for fans because of the extremely small number of respondents providing the necessary data on that topic. The confidence intervals presented in Table 6.1 show that the uncertainty regarding the findings for individual training topics is greater than for all energy systems, and the magnitude of that

[15] The mean savings of 11.3% reported here is the average of the savings associated with measures taken to address each energy system separately. If the savings associated with each individual energy system were *summed* rather than averaged, the result would be *total* potential savings rather than the *mean* single-energy-system savings reported here.

uncertainty relative to the mean value tends to be higher for training topics with fewer respondents.

- Recipients of compressed air training had a greater plant energy cost savings potential than did those who received training on a few other energy systems.
- Service recipients from small plants had a greater plant energy cost savings potential than did those from medium facilities.

A comparison of means test revealed that the mean plant energy cost savings potential for those receiving training on the topic of compressed air was significantly greater than the mean savings potential for recipients of training on pumps ($p<.0001$) and motors ($p=.003$). The mean plant savings potential for steam was also significantly greater than for pumps ($p=.009$).

Table 6.1 shows that the difference in plant energy cost savings potential among the various size categories was also substantial, with the range extending from 10.4% for medium plants to 16.1% for small plants. The difference between those two mean values was statistically significant at the .04 level. As indicated by the confidence intervals, the uncertainty regarding the findings for the individual size categories is greater than for all energy systems. Those confidence intervals are relatively narrow for medium plants and somewhat greater for small and large plants.

6.1.2. Achieved Energy Cost Savings Rate

The achieved energy cost savings rate is the percentage by which total annual energy costs are reduced by the measures that are actually taken. As with plant energy cost savings potential, the data used to calculate this came from the surveys of BestPractices service recipients. *Achieved* savings tend to be substantially less than the *potential* savings discussed in the previous section because only a portion of identified measures are generally implemented.[16] For training recipients who took action due to the service received, the mean achieved energy cost savings rate for a single energy system was 3.1%. The amount of uncertainty regarding this savings rate (as a proportion of the mean value) is a little greater than for plant savings potential, as indicated by the confidence intervals shown in Table 6.2.

Table 6.2. Achieved energy cost savings rate for those taking action due to training received, by energy system and plant size, FY 2006

Energy system/Plant size	Number	Mean value (%)	90% confidence interval	95% confidence interval
All Systems	156	3.1	2.5 – 3.7	2.4 – 3.8
Compressed Air	84	3.7	2.8 –4.7	2.6 – 4.9
Steam	33	2.9	1.7 – 4.1	1.5 – 4.4
Pumps	9	1.2	0.7 – 1.7	0.6 – 1.8
Motors	14	1.2	0.6 – 1.7	0.5 – 1.9
Process Heat	14	1.0	0 – 2.1	0 – 2.3
Fans[a]	2	--	--	--
Small Plants	15	3.0	1.8 – 4.2	1.6 – 4.4
Medium Plants	89	3.2	2.3 – 4.1	2.2 – 4.3
Large Plants	52	3.0	2.0 – 4.0	1.8 – 4.2

[a] No reliable estimates could be calculated for this topic because of the extremely small number of respondents

[16] Overall, slightly more than one-fourth of the energy cost savings associated with identified measures were achieved by the measures actually implemented by those taking action as a result of their training. The ratio of achieved energy cost savings to savings potential varies by the energy system addressed and by plant size, but none of the mean differences among those groups is significant at the .05 level.

Disaggregated by training topic, the achieved energy cost savings rate ranged from a high of 3.7% for compressed air to a low of 1.0 for process heat (Table 6.2). As with plant savings potential, the achieved energy cost savings rate for steam was very close to the average for all the individual energy systems, while the potential savings for pumps, motors, and process heat were substantially lower. Once again, the uncertainty regarding the findings for individual training topics is markedly greater than for all energy systems.

- Those who received training on compressed air and steam had greater achieved energy cost savings rates than did recipients of training on most other energy systems.

The mean achieved energy cost savings rate for those receiving compressed air training was significantly greater than the mean achieved savings rate for those who received training on pumps (p=.0002), motors (p=.0003), and process heat (p=.002). Also, the mean achieved energy cost savings rate for steam was significantly greater than for pumps (p=.03), motors (p=.03), and process heat (p=.05).

Table 6.2 shows that the mean achieved energy cost savings rates for the various size categories were very close to each other, with a low of 3.0% for small and large plants and a high of 3.2% for medium plants. The uncertainty regarding the findings for the individual size categories is somewhat greater than for all energy systems. None of the mean achieved energy cost savings rates for the various size categories differed significantly from each other at the .05 level.

6.2. SOFTWARE RECIPIENTS

6.2.1. Plant Energy Cost Savings Potential

Table 6.3 shows that those individuals taking action at their plants due to the software that they received had an average plant energy cost savings potential of 11.2%, which is almost exactly the same as for training recipients. Once again, it should be noted that this potential savings refers to the average plant-wide energy cost savings from measures that address a *single* energy system. There is a moderate amount of uncertainty regarding the plant savings potential reported here, as indicated by the confidence intervals shown in Table 6.3.

Table 6.3. Plant energy cost savings potential for those taking action due to software received, by energy system and plant size, FY 2006

Energy system/ Plant size	Number	Mean value (%)	90% confidence interval (%)	95% confidence interval (%)
All Systems	50	11.2	8.4 – 14.0	7.8 – 14.5
Motors	17	19.5	12.7 – 26.3	11.2 – 27.8
Steam	18	10.0	3.6 – 16.3	2.3 – 17.7
Compressed Air	4	9.1	0.3 – 17.9	0 – 22.1
Process Heat	6	4.4	0 – 9.4	0 – 11.2
Pumps	4	3.6	0.8 – 6.4	0 – 7.8
Fans[a]	1	--	--	--
Small Plants	3	33.7	0 – 72.5	0 –100
Medium Plants	26	11.3	7.0 – 15.5	6.2 – 16.4
Large Plants	21	5.4	1.9 – 9.0	1.1 – 9.8

[a] No reliable estimates could be calculated for this topic because only a single respondent provided the necessary data

There was a great deal of variation in plant energy cost savings potential among the different software topics, from a high of 19.5% for motors to a low of 3.6% for pumps. The savings potential for both steam and compressed air were relatively close to the average for all the individual energy systems, while the potential savings for process heat and pumps were considerably lower. As with training, a reliable estimate of savings potential could not be calculated for fans due to data limitations. The confidence intervals presented in Table 6.3 show that the uncertainty regarding the findings for individual software topics is greater than for all energy systems, often by a considerable amount.

- Recipients of motors software had a greater plant energy cost savings potential than did those who received software on a few other energy systems.

A comparison of means showed that the mean energy cost plant savings potential for those receiving software on motors was significantly greater than the mean savings potential for recipients of software on both pumps (p=.0007) and process heat (p=.002). Despite the substantial differences in mean savings potential for some of the other energy systems, no other statistically significant differences were found and that is due, in large part, to the substantial uncertainty surrounding many of the estimated mean values.

Table 6.3 shows that the difference in plant energy cost savings potential among the various size categories was also substantial, with the range extending from 5.4% for large plants to 33.7% for small plants. However, because of the great uncertainty surrounding those estimated mean values, especially for small plants, the difference between them was not found to be statistically significant at the .05 level.

6.2.2. Achieved Energy Cost Savings Rate

As noted in section 6.1.2, *achieved* energy cost savings tend to be substantially less than *potential* savings because only a portion of identified measures are generally implemented. For software recipients who took action due to the service received, the mean achieved energy cost savings rate for a single energy system was 3.7%. As indicated by the confidence intervals shown in Table 6.4, the amount of uncertainty regarding this achieved energy cost savings rate (as a proportion of the mean value) is greater than for plant savings potential.

Table 6.4. Achieved energy cost savings rate for those taking action due to software received, by energy system and plant size, FY 2006

Energy system/ Plant size	Number	Mean value (%)	90% confidence interval (%)	95% confidence interval (%)
All Systems	47	3.7	2.2 – 5.3	1.9 – 5.6
Motors	16	6.4	2.6 – 10.3	1.7 – 11.2
Steam	18	4.0	0.7 – 7.3	0 – 8.0
Pumps	4	1.6	0 – 5.0	0 – 6.6
Process Heat	6	1.3	0.5 – 2.1	0.3 – 2.3
Compressed Air	3	0.7	0 – 3.8	0 – 7.0
Fans[a]	0	--	--	--
Small Plants	3	11.2	0 – 29.6	0 – 48.2
Medium Plants	24	3.7	1.4 – 6.1	0.9 – 6.6
Large Plants	20	1.7	0 – 3.8	0 – 4.2

[a] No reliable estimates could be calculated for this topic because no respondents provided the necessary data

Disaggregated by software topic, the achieved energy cost savings rate ranged from a high of 6.4% for motors to a low of 0.7 % for compressed air (Table 6.4). The achieved energy cost savings rate for steam was close to the average for all the individual energy systems, while the potential savings for pumps and process heat were substantially lower.

- Those who received software on motors had a greater achieved energy cost savings rate than did recipients of software on a few other energy systems.

The uncertainty regarding the findings for individual software topics was substantially greater than for all energy systems. Accordingly, very few statistically significant differences were found among the various energy systems in terms of their mean achieved energy cost savings rate. In fact, the only significant differences found were between motors and both compressed air (p=.02) and process heat (p=.04).

Table 6.4 shows that there was considerable variation in the mean achieved energy cost savings rates for the various size categories, with a low of 1.7% for large plants and a high of 11.2% for small plants. As indicated by the breadth of the confidence intervals, there is considerable uncertainty surrounding those estimated means. Accordingly, none of the differences between the various size categories was found to be statistically significant at the .05 level.

6.3. COMPARISON OF TRAINING AND SOFTWARE RECIPIENTS

- The mean plant energy cost savings potential for all energy systems combined is nearly the same for both training and software recipients.
- Pumps had the lowest savings potential for both training and software recipients.
- Motors had exceptionally high savings potential for software recipients and relatively low savings potential for those who received training.
- The savings potential for steam was similar for recipients of both training and software.
- The amount of uncertainty surrounding potential *and* achieved savings estimates was considerably greater for software than for training recipients, and this applied to all systems combined as well as to individual energy systems and size categories.
- Due at least in part to the greater uncertainty, fewer statistically significant differences were found for software recipients when comparing mean potential and achieved plant savings for the different energy systems and size categories.
- The mean achieved cost savings rate appears to be a little higher for software than for training, but the substantial uncertainty regarding the software estimate makes it effectively indistinguishable from the training number.
- For training, the highest achieved cost savings rate was associated with compressed air, but software on that same topic had the lowest savings rate.
- For software, the highest achieved cost savings rate was associated with motors, but savings were low for training on that topic.
- No significant difference in achieved savings was found for the different size categories, either for training or software.

7. CONCLUSIONS AND RECOMMENDATIONS

7.1. CONCLUSIONS

The analysis performed for this study led to a number of important conclusions, as follows:

- The proportion of program participants receiving services related to the various energy systems differed dramatically from training to software. More end-user facilities had staff attending training sessions on compressed air than on any other topic, while the fewest facilities received training on motors. In contrast, motors was the leading topic on which BestPractices software was provided.

- The BestPractices Tracking Database tends to undercount large plants. The survey results from this study indicate that there are roughly one-fourth more large plants in the training and software recipient populations than indicated in the database.

- A higher proportion of software registrants than training recipients were managers of various types. This may explain why software recipients tended to influence energy consumption at more plants than training recipients.

- On average, both training and software recipients expressed the opinion that the service they received was beneficial overall. However, the value ascribed to current BestPractices services, specific elements of those services, and possible additional features and formats tended to vary – often significantly – by the energy system addressed.

- The findings of this study were largely consistent with the overall implementation rates found in past studies, with almost precisely 50% of all training recipients and just under 24% of software recipients taking action as a result of the service they received. Respondents' reports that their actions resulted from the services received were corroborated by the finding that the implementation decisions of those individuals were more heavily influenced by the information provided by BestPractices services than were the implementation decisions of those who said they took action independently of those services.

- High implementation rates were found to be associated with the following: various energy management practices; having the greatest amount of time in training sessions spent on the subjects of most importance to attendees; having training instructors who are knowledgeable and well-prepared; and having software tools characterized by their ease of navigation and data input.

- Not all measures implemented by everyone who reported taking action as a result of the services they received was due to those services. Some individuals implemented *additional* measures as a result of receiving BestPractices services, but they would have taken some action independently of the program. This explains why the reduction factors (30.4% for training and 13.5% for software) are less than the implementation rates for the corresponding service.

- Very different implementation rates and reduction factors were associated with the various energy systems addressed by BestPractices services, and some topics that showed relatively high rates for training had low rates for software, and vice versa. This indicates that the characteristics of the training and software processes in effect during the time period addressed by this study allowed them to better encourage action on some energy systems than on others.

- On average, training and software recipients implemented energy-saving measures that achieved a little more than one-fourth of the potential savings associated with all the measures that they identified. This represents a mean reduction in total annual plant energy costs of roughly 3% from the measures taken to address a single energy system.

- As with implementation rates and reduction factors, the achieved savings rate varied substantially by the energy system addressed. Some topics that had relatively high savings rates for training had low rates for software, and the reverse was also true This implies that the training procedures in effect during the time period addressed by this study were better able to lead to savings in some topical areas than in others, and that the same was true for software.

7.2. RECOMMENDATIONS

Based on the above conclusions and other findings presented elsewhere in this report, we offer the following recommendations for generating additional useful information and improving program performance:

- Service recipients should be encouraged to periodically update their contact information for the BestPractices Tracking Database.

- At the time that services are delivered, recipients should be asked to identify the broad cost category into which their annual energy consumption falls, rather than having the program use the Large Energy User Database to estimate participant energy baselines.

- The BestPractices program should encourage industrial firms ─ especially where such practices are less common ─ to engage in energy management activities such as the preparation of an energy plan, the use of an energy manager, and the establishment of energy reduction targets.

- For its training sessions, the BestPractices program should ensure that the instructors are knowledgeable and well-prepared and that the greatest amount of time is spent on the subjects of most importance to attendees. Improving trainer's skills by providing information and instruction on proven teaching techniques might also add to their effectiveness.

- DOE software tools should be examined to make sure that navigation and data input are as easy as possible.

- BestPractices program managers should examine the value ascribed to current and possible future services by recipients of training and software for each individual energy system. Elements of current training or software receiving especially low scores or possible additional features rated as highly valuable for a specific energy system would indicate a fruitful area for program improvements or new services targeting that topic.

- BestPractices program managers should examine their operations and procedures to determine why client participation, implementation, and achieved savings for some energy systems varied substantially between training recipients and those who received software. The findings from such an undertaking could suggest program design changes to enhance the results achieved by both training *and* software recipients.

- Future studies should explore what can be done to increase recipient actions associated with those energy systems where the implementation rate is currently low. This would involve interviewing recipients of services addressing low-performing systems and asking what would make them take action. Similarly, recipients of services in high-performing topical areas should be asked what led them to implement measures. As in the current study, training and software recipients should be examined separately.

- In future studies of software recipients, a larger sample should be used to increase the proportion of the population that is represented and, accordingly, tighten the confidence intervals around the mean values calculated for the factors studied. It might also be helpful (for both software *and* training studies) to stratify by geographic region to ensure that the sample is geographically representative.

8. REFERENCES

Aloha Systems, Inc., 2006. *Evaluation, Measurement, and Verification Final Report. HEED: Home Energy Efficient Design, A Statewide Tool for Residential Ratepayers*, CPUC Reference Numbers 1067-04 and 1068-04, May 19.

Martin, M. A., and T. Truett, 2004. *Estimation of Energy-Savings Outcomes from BestPractices Activities, Fiscal Year 2003, DRAFT*. Oak Ridge National Laboratory, November.

Martin, M. A., and T. Truett, 2005. *Estimation of Energy-Savings Outcomes from BestPractices Activities, Fiscal Year 2004, DRAFT*. Oak Ridge National Laboratory, September.

Martin, M. A., and T. Truett, 2006. *Estimates of Energy Savings Outcomes from BestPractices Activities, Fiscal Year 2005, DRAFT.* Oak Ridge National Laboratory, September.

McRae, M. R., and R. A. Scholl, 2004. *Evaluation of the 2003 Statewide Building Operator Certification and Training Program*, CALMAC ID: PGE0207.01. Prepared for Pacific Gas and Electric Company. Research Into Action, Inc., Portland, Oregon, February 25.

Schweitzer, M., 2006. *An Examination of Utility Energy Service Contracts, Federal Energy Management Program Assistance, and Associated Savings*, ORNL/CON-497, DRAFT. Oak Ridge National Laboratory, September.

Truett, L. F., M. A. Martin, B. E. Tonn, 2003. *Estimates of Energy Savings Resulting from the BestPractices Program, Fiscal Year 2002, DRAFT.* Oak Ridge National Laboratory, September.

U.S. Department of Energy, 2006. *Industrial Technologies Program, Improving the Energy Performance of U.S. Industry*. Energy Efficiency and Renewable Energy.

U.S. Department of Energy, 2007. *About BestPractices*. Energy Efficiency and Renewable Energy, Industrial Technologies Program,
http://www1.eere.energy.gov/industry/bestpractices/about_bestpractices.html

Wirtshafter Associates, Inc., 2005. *Evaluation of the 2003 Statewide Education and Training Services Program, Final Report*. Prepared for Southern California Edison, Pacific Gas and Electric Company, San Diego Gas and Eoectric Company, and Soutern California Gas Company, June 3.

Wolf, J., J. Reed, F. Fendt, and J. Siegel, 2004. *Industrial Technology Program BestPractices Peer Review Panel*, September 29.

Xenergy, Inc. 2000. *Final Report, Evaluation of the Motor Challenge Program*, Burlington, Massachusetts.

Xenergy, Inc. 2003. *Final Report, Evaluation of the Compressed Air Challenge Training Program*, Burlington, Massachusetts, Draft Final.

Zebedee and Associates, 2006. *Final EM&V Report for Green Building and Technical Assistance Program (CPUC 1299-04)*. CALMAC Study ID: SDR0004.01. Prepared for San Diego Regional Energy Office, July.

9. ACKNOWLEDGMENTS

We would like to thank the following people for their important contributions to this report. Paul Scheihing, Bob Gemmer, Jim Quinn, and Sandy Glatt of the U.S. Department of Energy provided valuable input regarding the design and operation of the BestPractices program and also reviewed this report. Michelle Mallory-Sosa of the National Renewable Energy Laboratory reviewed and commented on the survey instruments used to collect data for the study. Rob Penney of Washington State University provided helpful comments both on the survey instruments and on the draft report. Project Performance Corporation provided us with essential data on BestPractices service recipients, which were essential to this study. Harley Barnes, of Lockheed Martin Corporation, provided helpful information on measuring attribution and also reviewed the report and offered valuable comments on its content. Gil McCoy of Washington State University and Al Garcia of the California Energy Commission also reviewed the report and provided comments and suggestions that led to its improvement. Tony Wright, of Oak Ridge National Laboratory, provided helpful input and advice throughout the study process and reviewed the draft report. Bruce Tonn, another colleague at ORNL, also reviewed the document. We are very grateful to those individuals at selected industrial plants who took the time to pre-test the draft surveys. We are also very appreciative of all those individuals at industrial facilities throughout the country who responded to the final surveys. Finally, we wish to thank Tracy Clem at ORNL, who assembled the draft and final reports.

APPENDIX A. TRAINING SURVEY INSTRUMENT

OPINION RESEARCH CORPORATION
INDUSTRIAL TECHNOLOGIES
ORC PROJECT # 35736
OMB CONTROL #1901-0302

AUGUST 2007

TELEPHONE NUMBER: (____)________________ TIME ENDED: _____________

TIME STARTED:___________

LENGTH:_______(MINUTES)

DATE:____________________

INTERVIEWER:____________

I.D.:______________________

LIST OF TRAINING TOPICS:

01 COMPRESSED AIR
02 FANS
03 MOTOR SYSTEMS
04 PROCESS HEAT
05 PUMPING SYSTEMS
06 STEAM SYSTEMS

SA May I please speak with [INSERT NAME FROM SAMPLE]? [IF GATEKEEPER ASKS, SAY: Hello, my name is _____. I am calling from Opinion Research Corporation on behalf of the U.S. Department of Energy.]

01 YES → CONTINUE
02 NO, NOT AVAILABLE → CONTINUE, SCHEDULE CALLBACK
03 PERSON NO LONGER WITH COMPANY → TERMINATE AT SA (03)
99 REFUSED TO PARTICIPATE → TERMINATE, RECORD AS REFUSAL

[WHEN RESPONDENT IS ON THE PHONE, READ INTRODUCTION] Hello, my name is _____. I am calling from Opinion Research Corporation on behalf of the U.S. Department of Energy to conduct a survey about your experience with **[INSERT TRAINING TOPIC]** end-user training provided by the Industrial Technologies Program. You may have received a letter from James Quinn at the U.S. Department of Energy about our call.

SL [DO NOT READ LIST. RECORD PUNCH 99 IF RESPONDENT DOES NOT REQUEST A COPY OF THE LETTER]

21 SEND LETTER [PUNCH ONLY IF RESPONDENT REQUESTS A COPY OF THE LETTER]

99 DO NOT SEND LETTER

The questions in this survey will take approximately 15 minutes for you to answer, and the results will be used to help improve the program for future training recipients. Your answers will not be linked to your name or company and will be reported only in the aggregate. We greatly appreciate your taking the time to help us with this study. This call may be monitored or recorded for quality assurance purposes.

INTERVIEWER NOTE: IF AT ANY POINT DURING THE INTRODUCTION, THE RESPONDENT SAYS THEY DID NOT RECEIVE ANY TRAINING, RECORD S1 (02) AND GO TO S2.

We will begin by asking for some background information regarding you and your company.

S1 Please confirm that you received training on [INSERT TRAINING TOPIC] between Oct. 1, 2005 and Sept. 30, 2006.

01 YES, RECEIVED TRAINING → SKIP TO S4
02 NO, DID NOT RECEIVE TRAINING → CONTINUE
99 DON'T KNOW/DO NOT RECALL → CONTINUE

S2 Our records show that you received training on [INSERT TRAINING TOPIC] on [INSERT DATES THEY ATTENDED]. Do you recall receiving this training?

01 YES, RECALL TRAINING → SKIP TO S4
02 NO, DO NOT RECALL TRAINING → CONTINUE

[ASK IF S2 (02)]
S3 We still have some questions to ask you regarding DOE services and your company's energy management practices.

01 CONTINUE → CONTINUE
02 REFUSED → TERMINATE, RECORD AS REFUSAL TO S3

S4 According to our records and to verify, your company name is [INSERT COMPANY]. Is this correct?

01 YES
02 NO

[ASK IF S4 (02)]

S5 Please tell me, what is the correct name of your company? [RECORD TEXT]

S6 What is your title or position with your company? [DO NOT READ LIST. RECORD ONE ANSWER]

01 PLANT MANAGER
02 GENERAL MANAGER
03 MAINTENANCE MANAGER
04 PURCHASING MANAGER
05 ENERGY/UTILITY MANAGER

06 PLANT/FACILITY ENGINEER
07 PROCESS ENGINEER
08 PROJECT ENGINEER
09 CHIEF ELECTRICIAN
10 MAINTENANCE SUPERVISOR
11 MAINTENANCE STAFF
12 PLANT/FACILITY TECHNICIAN
195 OTHER [SPECIFY]
199 DON'T KNOW

IF S1 (01) OR S2 (01), CONTINUE. ALL OTHERS SKIP TO A5

A1 For how many manufacturing plants do you influence energy consumption? [RECORD NUMBER FROM 0-999, -01 FOR DON'T KNOW, -02 FOR REFUSED. IF DON'T KNOW GIVEN, PROBE FOR BEST GUESS]

[IF NUMBER GIVEN IS GREATER THAN 50, PROBE WITH: "Just to confirm, is this number JUST FOR the number of plants for which YOU influence energy consumption?]

IF A1 (0, -02), SKIP TO THANK YOU SCREEN IF A1 (1), CONTINUE. IF A1 (2-999, -01), SKIP TO INSTRUCTIONS BEFORE A3

A2 What is the approximate annual cost of purchased energy for that plant? Is it…[READ LIST. RECORD ONE ANSWER]

01 Less than $100,000
02 $100,000 to $2.5 million
03 Greater than $2.5 million
99 DON'T KNOW

[ASK IF A1 (2-999, -01)]
A3 How many of those [INSERT NUMBER FROM A1, INSERT NOTHING IF A1 (-01)] plants have approximate annual purchased energy costs in the following categories? [RECORD NUMBER FROM 0-999, -01 FOR DON'T KNOW, -02 FOR REFUSED. IF A1 (2-999), SUM OF A-C MUST EQUAL ANSWER FROM A1]

A. Less than $100,000
B. $100,000 to $2.5 million
C. Greater than $2.5 million

A4 What is the PRINCIPAL product of your manufacturing plant(s)? [DO NOT READ LIST. RECORD ONE ANSWER. IF RESPONDENT'S ANSWER MATCHES ONE OF THE ANSWERS BELOW, RECORD THAT ANSWER. IF NOT, ENTER INTO 195 OTHER SPECIFY]

20 FOOD AND KINDRED PRODUCTS
21 TOBACCO PRODUCTS
22 TEXTILE MILL PRODUCTS
23 APPAREL AND OTHER TEXTILE MILL PRODUCTS
24 LUMBER AND WOOD PRODUCTS

25 FURNITURE AND FIXTURES
26 PAPER AND ALLIED PRODUCTS
27 PRINTING AND PUBLISHING
28 CHEMICALS AND ALLIED PRODUCTS
29 PETROLEUM AND COAL PRODUCTS
30 RUBBER AND MISCELLANEOUS PLASTICS PRODUCTS
31 LEATHER AND LEATHER PRODUCTS
32 STONE, CLAY, AND GLASS PRODUCTS
33 PRIMARY METAL INDUSTRIES
34 FABRICATED METAL PRODUCTS
35 INDUSTRIAL MACHINERY AND EQUIPMENT
36 ELECTRONIC AND OTHER ELECTRIC EQUIPMENT
37 TRANSPORTATION EQUIPMENT
38 INSTRUMENTS AND RELATED PRODUCTS
39 MISCELLANEOUS MANUFACTURING INDUSTRIES
195 OTHER [SPECIFY]
199 DON'T KNOW

A5 Did you receive any of the following DOE software tools? [IF RESPONDENT IS NOT SURE, PROBE WITH ANSWER LIST]

01 YES
02 NO
99 DON'T KNOW

A Air Master Plus [ASK IF TOPIC 01]
B Fan System Assessment Tool, or FSAT [ASK IF TOPIC 02]
C Motor Master Plus [ASK IF TOPIC 03]
D Process Heat Assessment Tool, or PHAST [ASK IF TOPIC 04]
E Pumping System Assessment Tool, or PSAT [ASK IF TOPIC 05]
F 3E Plus, Steam System Assessment Tool, or Steam System Scoping Tool, also known as SSST [ASK IF TOPIC 06]

A6 Does your company have a formal energy management plan that helps guide your energy-related decisions? [IF RESPONDENT IS NOT SURE, PROBE WITH ANSWER LIST]

01 YES
02 NO
99 DON'T KNOW

A7 Have there been any corporate or facility mandates to reduce energy intensity by a targeted percentage, either annually or by a specific date, at the plant(s) for which you influence energy consumption? [IF RESPONDENT IS NOT SURE, PROBE WITH ANSWER LIST]

01 YES
02 NO
99 DON'T KNOW

[ASK IF S6 (01-04, 06-199). IF S6 (05), AUTO PUNCH INTO A8 (01)]

A8 Does your company have a corporate or facility energy manager? [IF RESPONDENT IS NOT SURE, PROBE WITH ANSWER LIST]

01 YES
02 NO
99 DON'T KNOW

IF S1 (01) OR S2 (01), AND A1 (1-999, -01), CONTINUE. ALL OTHERS SKIP TO THANK YOU SCREEN

A9 Now, I'm going to ask you some questions about the value of the training that you received on [INSERT TRAINING TOPIC]. Please tell me if you strongly disagree, disagree, neither agree nor disagree, agree or strongly agree with each of the following statements. [ROTATE B-G]

[IF TRAINING TOPIC IS COMPRESSED AIR, READ: If you attended more than one training session on Compressed Air, your answers should reflect your experience with both sessions combined.]

01 Strongly disagree
02 Disagree
03 Neither agree nor disagree
04 Agree
05 Strongly agree
98 NOT APPLICABLE
99 DON'T KNOW

A. Overall, the training was beneficial
B. The greatest amount of time was spent on the subjects most important to you
C. The instructor was knowledgeable and well-prepared
D. The course materials and handouts were helpful
E. The hands-on portion of the training was worthwhile
F. Guidance on how to integrate DOE's software tools into your company's overall energy management approach was adequate
G. The value that your company received from the training was well worth the registration fee that was paid

A10 Now, please tell me how much the usefulness of the training could be increased by adding each of the following.

How much could the usefulness of the training be increased by adding [INSERT]? Would you say … [ROTATE ITEMS]

01 Not at all
02 Slightly
03 Moderately
04 Substantially
05 Very substantially
99 DON'T KNOW

A. More hands-on problems and exercises
B. More examples of projects utilizing the technologies addressed
C. More emphasis on the challenges and problems associated with installation

D. More financial information
E. More technical information
F. More customized assistance for your own facility

A11 Using the same scale, how valuable would each of the following formats be in future training sessions for conveying information on energy-saving measures and techniques for your plant(s)? [ROTATE ITEMS]

01 Not at all
02 Slightly
03 Moderately
04 Substantially
05 Very substantially
99 DON'T KNOW

A. One or two hour web-based short courses
B. Continuing education/professional development courses
C. Vocational training at community college or technical school

Now I am going to ask you some questions about how you applied the training that you received.

A12 Since receiving the training, have you identified any [INSERT TRAINING TOPIC] related energy-saving or energy cost-saving measures for your plant(s) that were addressed by the training?

01 YES
02 NO
99 DON'T KNOW

IF IDENTIFIED ANY ENERGY-SAVING OR ENERGY COST-SAVING MEASURES, A12 [01], CONTINUE. ALL OTHERS SKIP TO THANK YOU SCREEN

A13 By approximately what percentage could the total annual energy costs at your plant(s) be reduced by implementing the measures that you identified? [RECORD NUMBER FROM 1-100, -01 FOR DON'T KNOW, -02 FOR REFUSED. IF DON'T KNOW GIVEN, PROBE FOR BEST GUESS. INTERVIEWER NOTE: IF RESPONDENT ASKS, SAY: This applies to energy costs alone, without factoring in the cost of the measures taken to achieve that reduction.]

A. RECORD LOWER BOUND [1-100]
B. RECORD UPPER BOUND [1-100]

A14 Have you implemented or are you in the process of implementing any of the measures that you identified with an expected completion date within the NEXT 12 MONTHS?

01 YES
02 NO
99 DON'T KNOW

IF IMPLEMENTED OR IN THE PROCESS OF IMPLEMENTING ANY MEASURES IN THE NEXT 12 MONTHS, A14 [01], CONTINUE. ALL OTHERS SKIP TO THANK YOU SCREEN

A15 Approximately what percentage of the potential annual energy cost reduction that you identified has been achieved, or will be achieved, by those measures? [RECORD NUMBER FROM 1-100, -01 FOR DON'T KNOW, -02 FOR REFUSED. IF DON'T KNOW GIVEN, PROBE FOR BEST GUESS]

A. RECORD LOWER BOUND [1-100]
B. RECORD UPPER BOUND [1-100]

IF A1 (2-999, -01), CONTINUE. IF A1 (1, -02), SKIP TO TEXT BEFORE A18

A16 You indicated earlier that you influence energy consumption at [INSERT NUMBER FROM A1, INSERT "YOUR" IF A1 (-01)] plants. At approximately how many of those plants have you implemented measures, or are in the process of implementing measures that will be completed in the NEXT 12 MONTHS? [RECORD NUMBER FROM 0-999, -01 FOR DON'T KNOW, -02 FOR REFUSED. IF DON'T KNOW GIVEN, PROBE FOR BEST GUESS. ANSWER CANNOT BE GREATER THAN ANSWER FROM A1]

[ASK IF A16 (1-999)]
A17 Of those plants, how many have annual energy costs in each of the following categories? [RECORD NUMBER FROM 0- 999, -01 FOR DON'T KNOW, -02 FOR REFUSED. SUM OF A-C MUST EQUAL ANSWER FROM A16]

A. Less than $100,000
B. $100,000 to $2.5 million
C. Greater than $2.5 million

Please answer the following question about the measures that have been implemented in your plant(s) since you received the end-user training, or that will be completed within the NEXT 12 MONTHS.

A18 How likely is it that you would implement any of those measures without the training you received? Would you say it is… [READ LIST. RECORD ONE ANSWER]

01 Very unlikely
02 Somewhat unlikely
03 Neither likely nor unlikely
04 Somewhat likely
05 Very likely
99 DON'T KNOW

IF A18 (03-05, 99), CONTINUE. ALL OTHERS SKIP TO A21

A19 Did the training result in MORE actions being taken than would have been the case if you had not attended the training?

01 YES
02 NO
99 DON'T KNOW

IF TRAINING RESULTED IN MORE ACTIONS BEING TAKEN, A19 [01], CONTINUE.

ALL OTHERS SKIP TO A21

A20 Approximately what percentage of the annual energy cost reduction that has been achieved, or will be achieved, is due to the ADDITIONAL measures taken as a result of the training that you received? [RECORD NUMBER FROM 1-100, -01 FOR DON'T KNOW, -02 FOR REFUSED. IF DON'T KNOW GIVEN, PROBE FOR BEST GUESS]

A. RECORD LOWER BOUND [1-100]
B. RECORD UPPER BOUND [1-100]

And finally…

A21 How much was the decision to implement energy-saving or energy cost-saving measures at your plant(s) influenced by information that the training provided on [INSERT]? Would you say … [ROTATE ITEMS]

01 Not at all
02 Slightly
03 Moderately
04 Substantially
05 Very substantially
99 DON'T KNOW

A. How to identify energy-saving measures
B. The cost of energy-saving measures
C. Prospective energy savings
D. Prospective cost savings
E. Prospective payback period
F. Environmental benefits

A22 Was there any other topic on which the training provided information that influenced the decision to implement energy-saving or energy cost-saving measures at your plant(s)?

195 YES [SPECIFY]
199 NO/DON'T KNOW

[ASK IF A22 (195)]
A23 And how much did that information influence the decision to implement energy-saving or energy cost-saving measures at your plant(s)? Would you say… [READ LIST. RECORD ONE ANSWER]

01 Not at all
02 Slightly
03 Moderately
04 Substantially
05 Very substantially
99 DON'T KNOW

Thank you very much for your time.

APPENDIX B. SOFTWARE SURVEY INSTRUMENT

OPINION RESEARCH CORPORATION
INDUSTRIAL TECHNOLOGIES
ORC PROJECT # 35736
OMB CONTROL #1901-0302

AUGUST 2007

TELEPHONE NUMBER: (____)____________________TIME ENDED: ______________

TIME STARTED:____________

LENGTH:_______(MINUTES)

DATE:______________________

INTERVIEWER:____________

I.D.:________________________

LIST OF TOPICS:

07	**COMPRESSED AIR**
08	**FANS**
09	**MOTOR SYSTEMS**
10	**PROCESS HEAT**
11	**PUMPING SYSTEMS**
12	**STEAM SYSTEMS**

LIST OF SOFTWARE:

G	**Air Master Plus [FOR TOPIC 01]**
H	**Fan System Assessment Tool, or FSAT [FOR TOPIC 02]**
I	**Motor Master Plus [FOR TOPIC 03]**
J	**Process Heat Assessment Tool, or PHAST [FOR TOPIC 04]**
K	**Pumping System Assessment Tool, or PSAT [FOR TOPIC 05]**
L	**3E Plus, Steam System Assessment Tool, or Steam System Scoping Tool, also known as SSST [FOR TOPIC 06]**

SA May I please speak with [INSERT NAME FROM SAMPLE]? [IF GATEKEEPER ASKS, SAY: Hello, my name is _____. I am calling from Opinion Research Corporation on behalf of the U.S. Department of Energy.]

03	YES → CONTINUE
04	NO, NOT AVAILABLE → CONTINUE, SCHEDULE CALLBACK
03	PERSON NO LONGER WITH COMPANY → TERMINATE AT SA (03)
99	REFUSED TO PARTICIPATE → TERMINATE, RECORD AS REFUSAL

[WHEN RESPONDENT IS ON THE PHONE, READ INTRODUCTION] Hello, my name is _____. I am calling from Opinion Research Corporation on behalf of the U.S. Department of Energy to conduct a survey about your experience with software tools addressing **[INSERT TOPIC]** provided by the Industrial Technologies Program. You may have received a letter from James Quinn at the U.S. Department of Energy about our call.

SL [DO NOT READ LIST. RECORD PUNCH 99 IF RESPONDENT DOES NOT REQUEST A COPY OF THE LETTER]

21 SEND LETTER [PUNCH ONLY IF RESPONDENT REQUESTS A COPY OF THE LETTER]
99 DO NOT SEND LETTER

The questions in this survey will take approximately 15 minutes for you to answer, and the results will be used to help improve the program for future software recipients. Your answers will not be linked to your name or company and will be reported only in the aggregate. We greatly appreciate your taking the time to help us with this study. This call may be monitored or recorded for quality assurance purposes.

INTERVIEWER NOTE: IF AT ANY POINT DURING THE INTRODUCTION, THE RESPONDENT SAYS THEY DID NOT RECEIVE ANY SOFTWARE, RECORD S1 (02) AND GO TO S2.

We will begin by asking for some background information regarding you and your company.

S1 Please confirm that you received DOE software addressing [INSERT TOPIC] between Oct. 1, 2005 and Sept. 30, 2006. The DOE software tools in this area are [INSERT NAME OF SOFTWARE BASED ON TOPIC].

01 YES, RECEIVED SOFTWARE → SKIP TO S4
02 NO, DID NOT RECEIVE SOFTWARE → CONTINUE
03 RECEIVED SOFTWARE BUT NEVER OPENED → SKIP TO S3
99 DON'T KNOW/DO NOT RECALL → CONTINUE

S2 Our records show that you received software on [INSERT TOPIC] on [INSERT DATE(S) THEY RECEIVED SOFTWARE]. Do you recall receiving this software?

01 YES, RECALL RECEIVING SOFTWARE → SKIP TO S4
02 NO, DO NOT RECALL RECEIVING SOFTWARE → CONTINUE
03 RECEIVED SOFTWARE BUT NEVER OPENED → CONTINUE

S3 We still have some questions to ask you regarding DOE services and your company's energy management practices.

01 CONTINUE → CONTINUE
02 REFUSED → TERMINATE, RECORD AS REFUSAL TO S3

S4 According to our records and to verify, your company name is [INSERT COMPANY]. Is this correct?

01 YES
02 NO

[ASK IF S4 (02)]
S5 Please tell me, what is the correct name of your company? [RECORD TEXT]

S6 What is your title or position with your company? [DO NOT READ LIST. RECORD ONE ANSWER]

13 PLANT MANAGER
14 GENERAL MANAGER
15 MAINTENANCE MANAGER
16 PURCHASING MANAGER
17 ENERGY/UTILITY MANAGER
18 PLANT/FACILITY ENGINEER
19 PROCESS ENGINEER
20 PROJECT ENGINEER
21 CHIEF ELECTRICIAN
22 MAINTENANCE SUPERVISOR
23 MAINTENANCE STAFF
24 PLANT/FACILITY TECHNICIAN
195 OTHER [SPECIFY]
199 DON'T KNOW

IF S1 (01) OR S2 (01), CONTINUE. ALL OTHERS SKIP TO A5

A1 For how many manufacturing plants do you influence energy consumption? [RECORD NUMBER FROM 0-999, -01 FOR DON'T KNOW, -02 FOR REFUSED. IF DON'T KNOW GIVEN, PROBE FOR BEST GUESS]

[IF NUMBER GIVEN IS GREATER THAN 50, PROBE WITH: "Just to confirm, is this number JUST FOR the number of plants for which YOU influence energy consumption?]

IF A1 (0, -02), SKIP TO THANK YOU SCREEN IF A1 (1), CONTINUE. IF A1 (2-999, -01), SKIP TO INSTRUCTIONS BEFORE A3

A2 What is the approximate annual cost of purchased energy for that plant? Is it…[READ LIST. RECORD ONE ANSWER]

01 Less than $100,000
02 $100,000 to $2.5 million
03 Greater than $2.5 million
99 DON'T KNOW

[ASK IF A1 (2-999, -01)]
A3 How many of those [INSERT NUMBER FROM A1, INSERT NOTHING IF A1 (-01)] plants have approximate annual purchased energy costs in the following categories? [RECORD NUMBER FROM 0-999, -01 FOR DON'T KNOW, -02 FOR REFUSED. IF A1 (2-999), SUM OF A-C MUST EQUAL ANSWER FROM A1]

A. Less than $100,000
B. $100,000 to $2.5 million
C. Greater than $2.5 million

A4 What is the PRINCIPAL product of your manufacturing plant(s)? [DO NOT READ LIST. RECORD ONE ANSWER. IF RESPONDENT'S ANSWER MATCHES ONE OF THE ANSWERS BELOW, RECORD THAT ANSWER. IF NOT, ENTER INTO 195 OTHER SPECIFY]

40 FOOD AND KINDRED PRODUCTS
41 TOBACCO PRODUCTS
42 TEXTILE MILL PRODUCTS
43 APPAREL AND OTHER TEXTILE MILL PRODUCTS
44 LUMBER AND WOOD PRODUCTS
45 FURNITURE AND FIXTURES
46 PAPER AND ALLIED PRODUCTS
47 PRINTING AND PUBLISHING
48 CHEMICALS AND ALLIED PRODUCTS
49 PETROLEUM AND COAL PRODUCTS
50 RUBBER AND MISCELLANEOUS PLASTICS PRODUCTS
51 LEATHER AND LEATHER PRODUCTS
52 STONE, CLAY, AND GLASS PRODUCTS
53 PRIMARY METAL INDUSTRIES
54 FABRICATED METAL PRODUCTS
55 INDUSTRIAL MACHINERY AND EQUIPMENT
56 ELECTRONIC AND OTHER ELECTRIC EQUIPMENT
57 TRANSPORTATION EQUIPMENT
58 INSTRUMENTS AND RELATED PRODUCTS
59 MISCELLANEOUS MANUFACTURING INDUSTRIES
195 OTHER [SPECIFY]
199 DON'T KNOW

A5 OMITTED

A6 Does your company have a formal energy management plan that helps guide your energy-related decisions? [IF RESPONDENT IS NOT SURE, PROBE WITH ANSWER LIST]

03 YES
04 NO
100 DON'T KNOW

A7 Have there been any corporate or facility mandates to reduce energy intensity by a targeted percentage, either annually or by a specific date, at the plant(s) for which you influence energy consumption? [IF RESPONDENT IS NOT SURE, PROBE WITH ANSWER LIST]

03 YES
04 NO
100 DON'T KNOW

[ASK IF S6 (01-04, 06-199). IF S6 (05), AUTO PUNCH INTO A8 (01)]
A8 Does your company have a corporate or facility energy manager? [IF RESPONDENT IS NOT SURE, PROBE WITH ANSWER LIST]

03 YES
04 NO
100 DON'T KNOW

IF S1 (01) OR S2 (01), AND A1 (1-999, -01), CONTINUE.
ALL OTHERS SKIP TO THANK YOU SCREEN

A9 Now, I'm going to ask you some questions about the value of the software that you received on [INSERT TOPIC]. Please tell me if you strongly disagree, disagree, neither agree nor disagree, agree or strongly agree with each of the following statements. [ROTATE B-D]

[IF TOPIC IS STEAM SYSTEMS, READ: If you received more than one software tool addressing Steam, your answers should reflect your experience with all those tools combined.]

06	Strongly disagree
07	Disagree
08	Neither agree nor disagree
09	Agree
10	Strongly agree
97	DID NOT OPEN SOFTWARE
99	NOT APPLICABLE
100	DON'T KNOW

A. Overall, the DOE software was beneficial
B. The software tool covers most equipment types and sizes in my plant(s)
C. The software addresses most system design configurations in my plant(s)
D. Navigation and data input are easy

IF PUNCH A9A-D (97) MENTIONED, SKIP IMMEDIATELY TO THANK YOU SCREEN.
ALL OTHERS CONTINUE

A10 Now, please tell me how much the usefulness of the DOE software tool could be increased by each of the following.

How much could the usefulness of the DOE software tool be increased by [INSERT]? Would you say … [ROTATE ITEMS]

06	Not at all
07	Slightly
08	Moderately
09	Substantially
10	Very substantially
100	DON'T KNOW

G. Converting to web-based software tools
H. Providing improved guidelines and instructions
I. Providing guidance on collection of data needed in software calculations
J. Providing technical support on using software
K. Offering SI, or metric units, version of the software
L. Integrating this software with other energy analysis software
M. Adding capability to simulate systems dynamically
N. Allowing more flexibility in system design options
O. Including more energy saving options for the system analyzed

A11 OMITTED

Now I am going to ask you some questions about how you applied the software that you received.

A12 Since receiving the DOE software tool, have you identified any [INSERT TOPIC] related energy-saving or energy cost-saving measures for your plant(s) that were addressed by the software?

03 YES
04 NO
100 DON'T KNOW

IF IDENTIFIED ANY ENERGY-SAVING OR ENERGY COST-SAVING MEASURES, A12 [01], CONTINUE. ALL OTHERS SKIP TO THANK YOU SCREEN

A13 By approximately what percentage could the total annual energy costs at your plant(s) be reduced by implementing the measures that you identified? [RECORD NUMBER FROM 1-100, -01 FOR DON'T KNOW, -02 FOR REFUSED. IF DON'T KNOW GIVEN, PROBE FOR BEST GUESS. INTERVIEWER NOTE: IF RESPONDENT ASKS, SAY: This applies to energy costs alone, without factoring in the cost of the measures taken to achieve that reduction.]

A. RECORD LOWER BOUND [1-100]
B. RECORD UPPER BOUND [1-100]

A14 Have you implemented or are you in the process of implementing any of the measures that you identified with an expected completion date within the NEXT 12 MONTHS?

03 YES
04 NO
100 DON'T KNOW

IF IMPLEMENTED OR IN THE PROCESS OF IMPLEMENTING ANY MEASURES IN THE NEXT 12 MONTHS, A14 [01], CONTINUE. ALL OTHERS SKIP TO THANK YOU SCREEN

A15 Approximately what percentage of the potential annual energy cost reduction that you identified has been achieved, or will be achieved, by those measures? [RECORD NUMBER FROM 1-100, -01 FOR DON'T KNOW, -02 FOR REFUSED. IF DON'T KNOW GIVEN, PROBE FOR BEST GUESS]

A. RECORD LOWER BOUND [1-100]
B. RECORD UPPER BOUND [1-100]

IF A1 (2-999, -01), CONTINUE. IF A1 (1, -02), SKIP TO TEXT BEFORE A18

A16 You indicated earlier that you influence energy consumption at [INSERT NUMBER FROM A1, INSERT "YOUR" IF A1 (-01)] plants. At approximately how many of those plants have you implemented measures, or are in the process of implementing measures that will be completed in the NEXT 12 MONTHS? [RECORD NUMBER FROM 0-999, -01 FOR DON'T KNOW, -02 FOR REFUSED. IF DON'T KNOW GIVEN, PROBE FOR BEST GUESS. ANSWER CANNOT BE GREATER THAN ANSWER FROM A1]

[ASK IF A16 (1-999)]

A17 Of those plants, how many have annual energy costs in each of the following categories? [RECORD NUMBER FROM 0- 999, -01 FOR DON'T KNOW, -02 FOR REFUSED. SUM OF A-C MUST EQUAL ANSWER FROM A16]

A. Less than $100,000
B. $100,000 to $2.5 million
C. Greater than $2.5 million

Please answer the following question about the measures that have been implemented in your plant(s) since you received the DOE software, or that will be completed within the NEXT 12 MONTHS.

A18 How likely is it that you would implement any of those measures without the DOE software you received? Would you say it is… [READ LIST. RECORD ONE ANSWER]

06 Very unlikely
07 Somewhat unlikely
08 Neither likely nor unlikely
09 Somewhat likely
10 Very likely
100 DON'T KNOW

IF A18 (03-05, 99), CONTINUE. ALL OTHERS SKIP TO A21

A19 Did the DOE software result in MORE actions being taken than would have been the case if you had not received the software?

03 YES
04 NO
100 DON'T KNOW

IF SOFTWARE RESULTED IN MORE ACTIONS BEING TAKEN, A19 [01], CONTINUE. ALL OTHERS SKIP TO A21

A20 Approximately what percentage of the annual energy cost reduction that has been achieved, or will be achieved, is due to the ADDITIONAL measures taken as a result of the software that you received? [RECORD NUMBER FROM 1-100, -01 FOR DON'T KNOW, -02 FOR REFUSED. IF DON'T KNOW GIVEN, PROBE FOR BEST GUESS]

A. RECORD LOWER BOUND [1-100]
B. RECORD UPPER BOUND [1-100]

And finally…

A21 How much was the decision to implement energy-saving or energy cost-saving measures at your plant(s) influenced by information that the DOE software provided on [INSERT]? Would you say … [ROTATE ITEMS]

06 Not at all
07 Slightly
08 Moderately
09 Substantially
10 Very substantially
100 DON'T KNOW

G. How to identify energy-saving measures
H. The cost of energy-saving measures
I. Prospective energy savings
J. Prospective cost savings
K. Prospective payback period
L. Environmental benefits

A22 Was there any other topic on which the DOE software provided information that influenced the decision to implement energy-saving or energy cost-saving measures at your plant(s)?

195 YES [SPECIFY]
199 NO/DON'T KNOW

[ASK IF A22 (195)]
A23 And how much did that information influence the decision to implement energy-saving or energy cost-saving measures at your plant(s)? Would you say… [READ LIST. RECORD ONE ANSWER]

06 Not at all
07 Slightly
08 Moderately
09 Substantially
10 Very substantially
100 DON'T KNOW

Thank you very much for your time.