Auditing Audits:

Big Savings Found in Long-Term Assessment

Jonathan B. Maxwell, ERS, College Station, TX
Satyen Moray, ERS, Hartford, CT
Rebecca Reed Gagnon, NYSERDA, Albany, NY[1]

ABSTRACT

This paper presents an enhanced method for collecting and analyzing the measure adoption rate (MAR) and savings due to commercial and industrial energy audit programs. The method differs from previous approaches known to the authors in several key respects:

1. Long-term perspective. This evaluation collected data received through multiple interviews with recipients up to 8 years after study receipt, a longer elapsed time period than is typical.
2. Tracking adoption over time. This evaluation collected a large amount of data spanning many years, allowing construction of measure adoption rate curves that illustrate the temporal aspects of measure adoption instead of just a "snapshot" of the adoption rate.
3. Engineering interviews and validation site visits. Engineers administered the telephone-based survey to enable more accurate interpretation and quantification of partial implementation of technically complex measures. These same interviewers then visited a statistically selected subsample of respondent facilities to develop an on-site correction factor to adjust the telephone survey-based response rates.

In total, the evaluation determined outcomes for more than 2,400 measures recommended in more than 300 energy audits and found long-term adoption rates in excess of 65%, a rate that is significantly higher than other known studies. The authors conclude that both the evaluation method and program design characteristics contribute to the high adoption rate.

Introduction

This paper discusses evaluation techniques used to determine the impact of energy audit or study programs, specifically focusing on research on the measure adoption rate (MAR). After describing the subject program and evaluation objectives, the paper reviews the methods, results, and implications of the findings to the evaluation and program design communities.

Program Description

The New York State Energy Research and Development Authority (NYSERDA) Flexible Technical Assistance Program (FlexTech) provides objective and customized energy efficiency information to commercial and industrial customers by identifying and encouraging the implementation of cost-effective energy efficiency, peak-load curtailment, combined heat & power (CHP), and renewable generation studies. Roughly 100 studies are completed in a typical year and the focus tends to be larger facilities. The median

[1] Any opinions expressed, explicitly or implicitly, are those of the authors and do not necessarily represent those of the New York State Energy Research and Development Authority.

projected cost of implementing all recommended measures is about $300,000 per project. The average projected cost is almost $1,000,000 per project.

Participants may use either their own independent consultants or FlexTech Program consultants. Program consultants are competitively selected by NYSERDA and provide a statewide geographic distribution of needed technical services. Funding is cost-shared with NYSERDA typically paying 50% of the study cost.

Evaluation Objectives

The primary purpose of the FlexTech impact evaluation was to estimate the savings attributable to the program. In order to estimate the installed savings resulting from study funding, the evaluation needed to account for multiple layers of decision-making and performance, specifically: (1) which recommended measures study recipients implemented, (2) how much energy those implemented measures save compared to the study's predictions, (3) how NYSERDA's study funding influenced the recipients' decisions both to conduct the study and to implement measures, and (4) how participant experience influenced them to take additional actions beyond those recommended in the studies.

This paper focuses on methods and results associated with the first layer, measure adoption. The MAR is a ratio expressing the percentage of study-recommended savings that customers chose to adopt. This factor solely addresses the study recipient's choice to install. It does not consider actual savings relative to projections (a.k.a. savings realization rate) or the program's level of influence in decision-making (a.k.a. net-to-gross factor).

Measure Adoption Rate Research Methodology

Engineers conducted a telephone survey of facility managers or engineers to determine the MAR and date of adoption for measures recommended in a sample of studies completed between January 1, 2003 and September 30, 2009. Surveying started in May 2010 and continued for 3 months. A second round of calls regarding other than definitively resolved measures followed a year later, in May 2011. "Definitively resolved" means that the customer either installed the measure, decided not to install the measure, or partially installed the measure and decided not to install more of it for the foreseeable future. Data were analyzed as a function of time lapsed since study completion, and by study completion year.

Sample Design and Survey Disposition

The sample design for the survey used stratified random sampling. The sampling unit was the total energy savings on a source-equivalent basis.[2] Stratified ratio estimation (SRE) was considered as a potential sampling method because it allowed for efficient sampling design and generally requires a lower sample size for a targeted level of precision if there is a strong correlation between the tracking system savings and the implemented savings. However, a review of a previous NYSERDA FlexTech impact evaluations indicated that the correlation between tracked and implemented savings was not sufficiently strong to create an advantage for the SRE approach; hence, stratified random sampling was chosen as the sampling method.

The sample was selected to estimate the MAR for electric and natural gas measures at the study level and for upstate and downstate within the 90/10 confidence/relative precision standard. The population was

[2] To convert to source MMBtu, the kWh savings for the electric measures were adjusted to account for savings at the source of generation. This approach avoids the potential pitfall of ending up with a sample that contains a disproportionate number of natural gas studies. The source factor provided by NYSERDA of 9,949.2 Btu/kWh was based on a 3-year average (2006, 2007, and 2008), and includes a line loss factor of 7.2%. The number is based on natural gas, as natural gas represents the fuel source on the margin in New York State. Additional energy use from measures such as fuel switching was not considered for the purpose of sample weighting.

stratified by age of study in years, geographic location (upstate/downstate), and by source-equivalent energy savings (see footnote 2).

The sample frame was the 657 FlexTech studies completed between January 1, 2003 and September 30, 2009. Of these studies, 225 were considered to be in the "too small to measure" stratum. Savings for such projects were so small that the consequence of excluding them from the MAR analysis was negligible. This left 432 studies eligible for interviews. Engineers attempted calls to 411 study recipients in order to complete 301 interviews and 303 questionnaires.[3] Most of the failed attempts were study recipients who could not be reached in the allotted minimum of six attempts at different times of the day and week.

Response rates were reviewed by stratum to assess whether specific segments of the population were disproportionately represented in the survey responses. This analysis considered the impacts of region, age of the study, fuel type, and size stratum (random or census). Based on these results, the sample weights were adjusted for non-response by region (upstate and downstate), size stratum, and fuel type (studies with gas measures either in combination with electric or only gas measures versus studies with only electric measures).

The final outcome ultimately was determined for 2,452 unique measures. Sufficient MAR data was collected to report on adoption rates for energy efficiency versus cogeneration, electricity versus fossil fuel savings, and MAR by technology category.

Call Preparation

Engineers rather than non-technical interviewing professionals conducted the telephone survey with facility managers. While several engineers were experienced evaluation interviewers, the evaluation team provided extensive training on interviewing techniques to ensure accurate and unbiased data with maximum customer consideration in an ethical fashion. The training, led by Megdal & Associates[4], addressed such issues as who to interview, how to find that person, leading questions, attitude and tone, informed consent, appropriate probing techniques, translation of open-ended responses into data that can be tabulated, and interview time management. Each interviewer completed at least two mock interviews before calling actual respondents.

The call team was relatively large, about ten engineers. Preparation typically required 2 hours per study. The required time was higher for studies that covered large health care and educational campuses, that exceeded the average of eight recommendations, and that addressed technically complex measures. NYSERDA mailed advance letters to all targeted respondents.

Preparation sometimes included pre-loading responses that were already known. Because it was posited that the MAR might not plateau (no new measure implementation) for as many as 7 years after study completion, the evaluation team had to survey customers who received studies as long as 8 years after study completion. Prior FlexTech evaluation surveys completed in 2005 and 2007 and a third smaller study completed in 2008 included MAR data from some of these same participants (Osei-Antwi and Gowans, 2005 and Gogte and Gowans, 2007). This evaluation's engineers used the previously determined MARs where appropriate to avoid re-interviewing study recipients regarding information already provided to prior callers. Specifically, engineers completed the relevant sections of the questionnaire in advance for all measures that were definitively resolved.

In the case of studies that included more than fifteen recommended measures, prior to the interview, the interviewers grouped measures that represented more than 80% of the savings, creating a manageable list of measures to investigate. According to the interviewers, fewer than ten measures or groups of

[3] There were two studies in the sample for which the MAR results were already known for all measures, for a total of 303 completed MAR questionnaires.
[4] The firm of Dr. Lori Lewis. Megdal & Associates employs experts on social science research including energy efficiency program attribution and other fields that require telephone-based data collection. Megdal & Associates also was the prime contractor for the portfolio of programs subject to impact evaluation.

measures per interview were manageable for a 30-minute interview. In the case of studies that had a majority of its measures of equal or similar magnitude savings (all converted to MMBtu), a random sampling tool was used to select ten measures for query.

Telephone MAR Survey Execution

The initial MAR telephone survey required 3 months to complete the desired number of surveys. The interviews and subsequent MAR analysis focused on recommended measures as opposed those measures that were studied but not recommended and those measures recommended for further investigation.

The interviewers did not use a traditional computer-assisted telephone interviewing (CATI) system. They entered results directly into a professional contact management system that was used to store contact information, track attempts, and manage data. Some interviewers chose to write responses on paper and later transcribe them. Several respondents chose to answer questions through email exchanges, which added preparation and tabulation time but gathered quality data.

For each measure the survey engineer inquired about measure status (fully, partially, or not installed), collected sufficient data to quantify the measure as “partially installed” if necessary, and categorized the measure by equipment type (verifying program tracking system data) and primary type of energy saved (electricity, fossil fuel). Estimated date of installation was important to collect as well. Other categorizations (upstate versus downstate, electric utility provider, etc.), were made outside of the interview process.

The prospect of partial implementation was one of the reasons evaluators chose to use engineers to administer the survey. The concept of partial implementation is straightforward and easy to quantify for some technologies and applications. With lighting, for example, it is easy to ascertain if the customer installed fixtures on three of the recommended four floors of a regular building. But the concept also could get complicated quickly, even with lighting. The interviewer could not simply ask “How many of the recommended 9,843 fixtures actually were replaced?” The floors in the aforementioned example might have had different areas, there could be a mixture of one-for-one and two-for-one replacements, or different blends of technologies installed than recommended (standard versus high performance T8s, bi-level switching but not dimming, installing three-lamp instead of two-lamp fixtures, etc.). With boilers, for example, a study might have recommended that the customer upgrade three boilers from 80% efficient to 96% efficient condensing boilers. But, if the customer chose to upgrade only two of the boilers and chose 92% efficient units, then the engineer assigned a MAR of 50% (two-thirds of boilers × 75% of recommended efficiency gain). For complex technologies such as reciprocating engine CHP, the ability of the facility to capture the several different waste heat streams was variable. In all cases, the engineer endeavored to quantify the percentage of the measure’s installation as designed, without regard to actual day-to-day loading, hours of use, or other factors that are part of a savings realization rate calculation. Evaluators found that 12% of the installed measures were partially installed.

During the initial 3-month survey each measure was classified as unresolved or definitively resolved. If the contact reported that the measure was installed, never going to be installed, or was partially installed and not going to be further installed, the measure outcome was classified as “definitively resolved.” A follow-up survey was conducted about a year after the initial survey on all unresolved measures. This survey did not reveal material differences or enhancements compared to the original survey. Future evaluations are not expected to include a follow-up survey.

On-Site Follow-Up

Telephone response accuracy was a concern, especially in those instances where the interviewer talked with somebody other than the original study recipient. Another weakness of the telephone survey was that respondents were asked about measures recommended in studies conducted as many as 8 years prior to the call. To address these concerns and assess MAR response quality, the engineers also performed site visits for a subsample of MAR respondents. Inspections and in-person interviews revealed that a material proportion of the MARs reported by respondents in the telephone survey were incorrect. It is believed that the complexity of the questions caused the discrepancies and that the erroneous responses would have been even greater without technical interviewers. Furthermore, having the same engineer conduct the interview and visit the site enabled coherent interpretation and correction of responses when necessary. It also is possible that fewer of the discrepancies would have been discovered had different evaluation team personnel conducted the phone and on-site data collection.

Analysis

The study-level MAR represents the percent of energy savings of measures recommended in completed studies that have been installed. A MAR of 1.0 or 100% indicates that a customer installed all recommended measures in their FlexTech study. This factor does not consider actual realized savings relative to projections.

Analysts aggregated the MAR results in two distinctly different ways. The first method of analysis estimated MAR as a function of time elapsed (in years) since study completion. This paper focuses on the first method. This information is powerful because it enables analysts to review the results over a long period of time and to combine the results from multiple study years into a single result, which tempers any boom or recession effects that may influence the implementation rate associated with particular calendar years. It also focused the analysis on market activity over multiple program administration cycles. Analysts used the sample design's expansion weight associated with the study multiplied by the source equivalent energy savings to represent the relative influence of each measure on the results. Results are separable by upstate/downstate, energy efficiency, measure technology category, and on-site generation.

The second method of aggregation uses the same data but combines it differently, aggregating results using the sampling units and stratification basis in the sample design. The unit of classification regarding time is the study completion year, not elapsed time. The result of the second method is an estimate of the MAR for each program year's studies at the time of evaluation. This second method of analysis is important because study year is a parameter that was identifiable in advance of the research and a basis of sampling. The second method allowed the evaluation team to report on the confidence and relative precision of the responses and variance of the data.

The final step in MAR analysis was to develop a correction factor based on the observed / telephone interview-based adoption rates in the savings realization rate sample. The correction factor was calculated based on the weighted average percentage of source-based savings that was corrected in the SRR sample. This correction factor was kept distinct from the savings realization rate analysis.

Results

Respondents were able to report the condition associated with more than 97% of measures. The site measurement & verification visits revealed that the telephone-based MAR responses were not always accurate, however. Engineers identified forty-seven incorrectly reported measure statuses out of 151 measures in the on-site subsample through on-site inspection, follow-up in-person interviews, and spot metering. About half of the incorrectly reported MARs were binary, meaning a measure declared during the phone interview to be installed (1.00 MAR) was not installed at all (0.00 MAR) or, in one case, the reverse. The other half required adjustments to the percentages of the measures that were installed. Four adjustments increased the MAR, and forty-three reduced it. After weighting and combining natural gas and electricity savings measures using the common source-based Btu factor, the net overall site-based MAR adjustment factor was a downward 7%. The telephone-based MAR results were multiplied by 0.93 to account for this correction.

Figure 1 shows the program overall adoption rate as a function of time elapsed since study completion. The dashed line is the percentage of recommended savings adopted each year after study completion; the solid line depicts the cumulative percentage adopted.

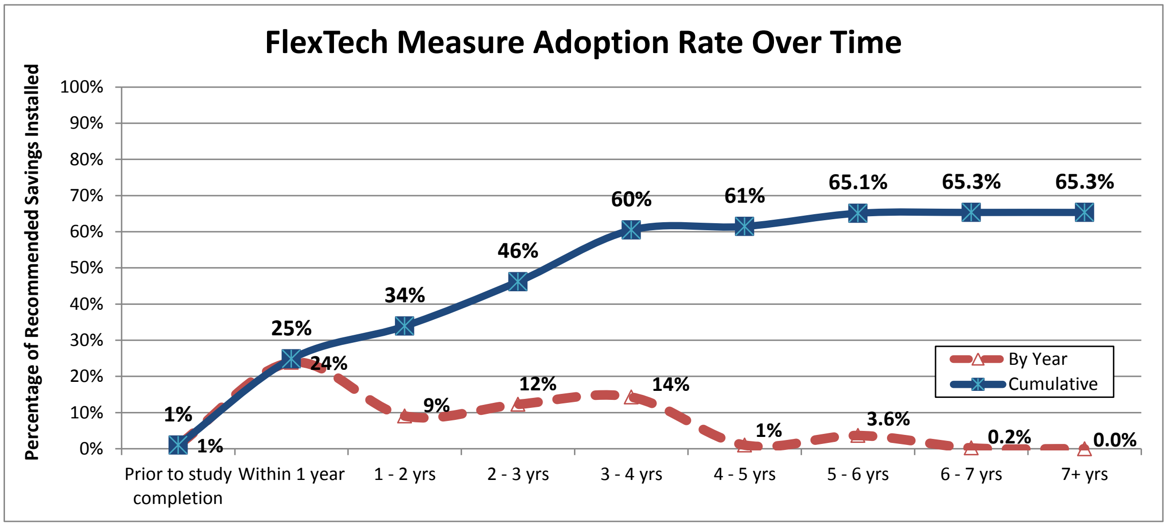

Figure 1. Measure Adoption Rate Over Time, All Measures

About 38% (25% MAR out of a total MAR of 65.3%) of the adopted measures were installed within 1 year of study completion. The average time to adopt was 1.5 years, and 70% of adopted measures were installed within 3 years. Measures continue to be adopted even in the 6th year after study completion before plateauing. The exception to this is CHP. As Figure 2 illustrates, most CHP studies required 2 to 3 years to implement. Two large CHP projects in the sample required 3 and 6 years to complete. In the legends of Figures 2 through 4, "n" refers to the number of unique measures for which interviewers gathered adoption data.

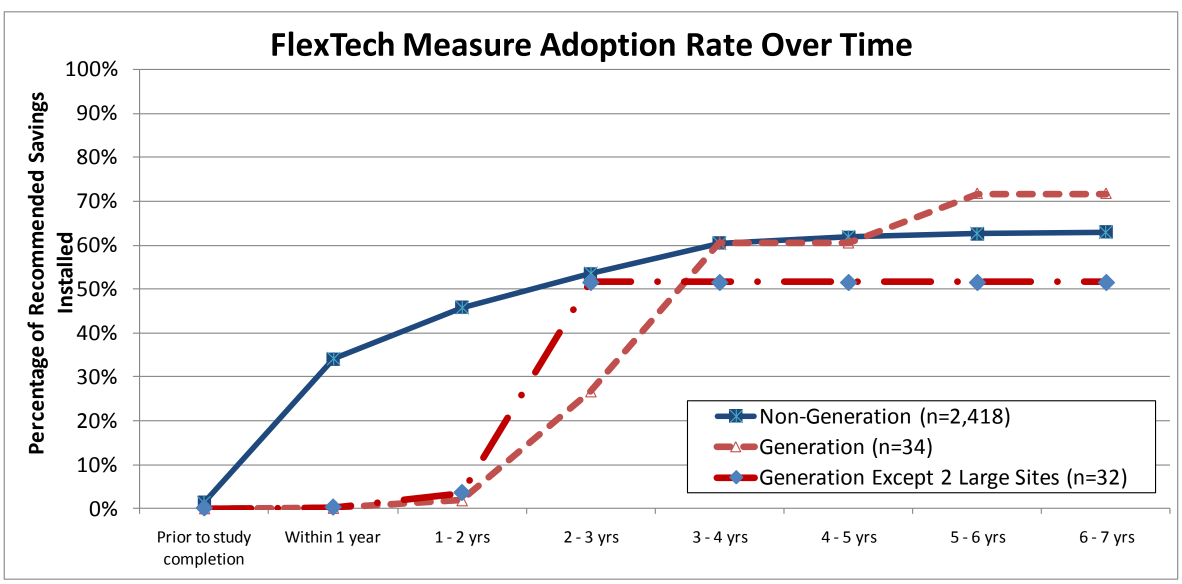

Figure 2. Measure Adoption Rate Over Time, Separate for Generation and Non-Generation Technologies

Figure 3 further disaggregates the measure adoption rates by the technology for non-generation measures. Controls savings were by far the most frequently adopted measure type by study recipients. More than 25% more controls measures were adopted than the next most readily adopted technology, lighting.

Furthermore, study authors recommended controls measures 25% of the time for non-generation measures, which is more than any other technology. This high controls adoption rate is an interesting finding, as lighting often is perceived as the most common and readily adopted opportunity due to low uncertainty and lack of complexity. The pattern can likely be explained by the relatively low cost and fast payback time of many controls measures, but it also indicates customer willingness to implement measures that tend to be more complex. Envelope measures were the least adopted.

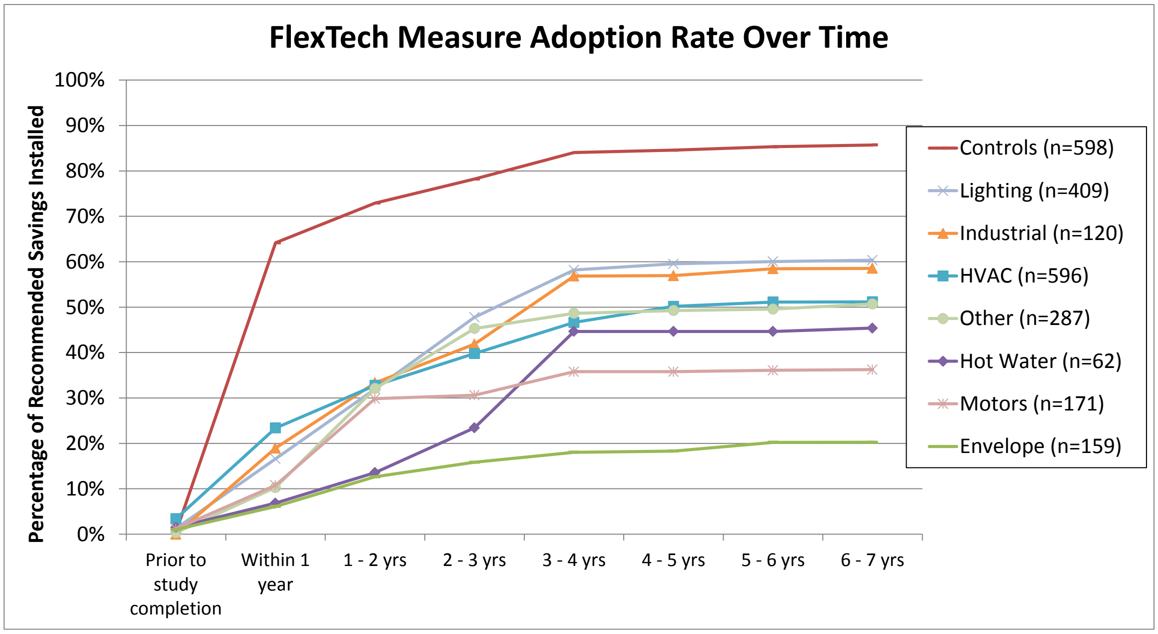

Figure 3. Program MAR Over Time, Separately for Type of Non-Generation Technologies

Figure 4 shows the adoption rates separately for measures that had electric energy savings and those that did not. For tabulation purposes, any measure that reported electric savings was classified as such; the other 559 measures saved only fossil fuel energy, according to study authors. There was substantial divergence in the ultimate MAR for these two categories. Historically, natural gas efficiency measures have received less attention and incentive funding but this is gradually changing in New York state and elsewhere.

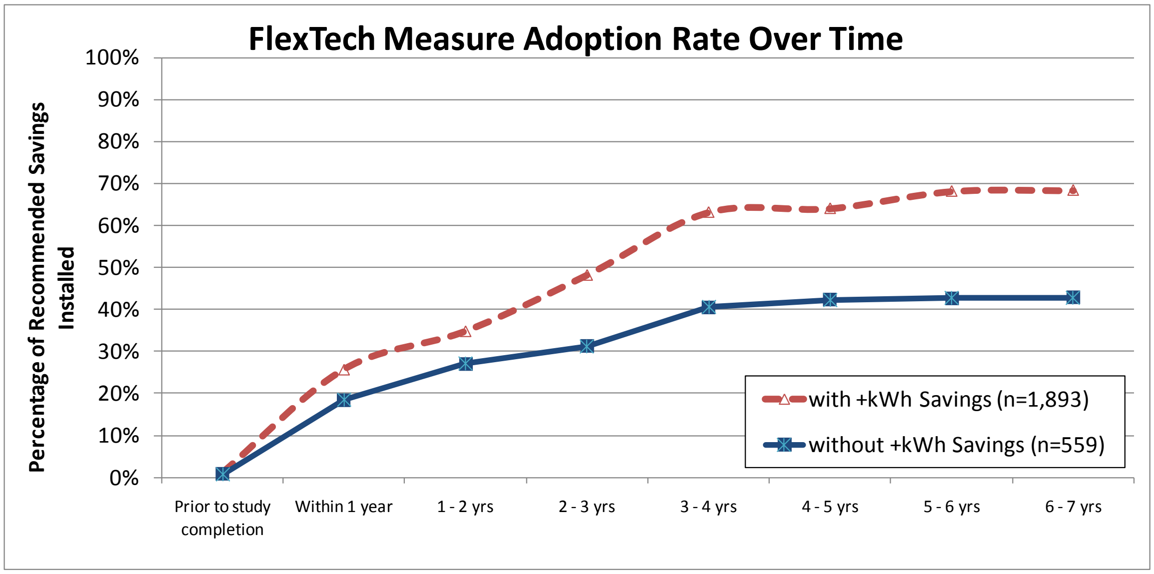

Figure 4. Program MAR Over Time, Separately for Measures with and without Electricity Savings

Table 1 summarizes the projected long-term MARs from the prior figures.

Table 1. FlexTech Projected Long-Term Measure Adoption Rates

Measure Type	**Long-Term Projected Measure Adoption Rate**
Electric energy efficiency	0.68
Non-electric energy efficiency	0.43
On-site generation	0.72
Overall	0.65

The results had little sampling error, as might be expected for a survey that completed 303 interviews out of 411 attempts in a population of 432 studies. Relative precision was less than 4% at the 90% confidence level for each of upstate and downstate samples on electric energy measures, downstate natural gas, and statewide on-site generation. The relative precision for natural gas upstate, and consequently the statewide natural gas relative precision, exceeded 10%, predominantly because of low MAR. Table 2 shows the results associated with the second method of analysis that allowed the statistics calculations.

Table 2. Measure Adoption Rates at Time of Survey and Sampling Statistics

Parameter	Electric Energy			Natural Gas			On-Site Generation Electricity Only	Total Excluding Natural Gas Generation
	Upstate	Down-state	Total	Upstate	Down-state	Total		
MAR as of summer 2010	0.64	0.60	0.63	0.26	0.60	0.31	0.72	0.56
Number of studies in frame	506	149	655	298	60	358	41	655
Total sample	236	67	303	141	25	166	31	303
Standard error	0.017	0.026	0.014	0.029	0.004	0.025	0.015	0.014
Relative precision at 90% confidence	4.07%	6.64%	3.48%	17.58%	1.03%	12.44%	3.15%	3.73%
Coefficient of variation	0.380	0.330	0.369	1.269	0.031	0.975	0.106	0.485

Comparison of Findings

The overall long-term MAR of 65% is high compared to the industry norm. "Energy audits are widely promoted by energy solution providers as well as utility, university, and government programs. Nevertheless, the implementation rate for energy saving programs based on energy audits remains discouragingly low. While the very best programs may achieve 50% implementation, rates in the 20%-30% range are more typical."[5] Table 3 summarizes published MARs from other research.

Table 3. Measure Adoption Rates in North America

Location	Audit Program Type	Measure Adoption Rate
Wisconsin Public Service[6]	Small Business	12% to 39%
California Public Utility Company [7]	Nonresidential	14% to 30%
Xcel Colorado[8]	Small Business	15%
Public Service New Hampshire[9]	Large Commercial and Industrial	25% implemented through incentive programs 40% overall estimated
California PG&E[10]	Agricultural Energy Management Services	±30% approximate
Ontario, Enbridge Gas Distribution[11]	Industrial Steam Traps	42%
National, Industrial Assessment Centers[12]	Small-Medium Industrial	53%

[5] Promotional material for AEE-sponsored real-time distance learning seminar *Converting Energy Audits to Business Plans*. Viewed 3/27/13 and 6/22/11. http://www.aeeprograms.com/realtime/EABP/.
[6] Carroll, Xavier, and Kumar, 2010, 4-26.
[7] ERS internal data.
[8] Carroll, Xavier, and Kumar, 2010, 4-27.
[9] Moray, 2011.
[10] "More than 20% (±3%)" of audit participants had a pump retrofit or adjustment after receiving an audit; 15% went on to participate in PG&E's equipment incentive programs in the 2 years after receiving the study. "Approximately 20% (±3%)" adopted a capital intensive measure after receiving an audit and outside the equipment incentive programs. The paper does not indicate percentage of savings of all recommended measures that were implemented. Mancuso and Dimit, 1996.
[11] Griffin and Johnson, 2006, 7 as cited in Thumann, Younger, and Niehus 2009, 436.

These other studies used different methodologies than the FlexTech evaluation. None of them are known to include the site-based correction factor adjustment, nor did they make the MAR calls so long after study completion. The program designs, target markets, and goals differ. For example, a small business audit program is unlikely to have as high a MAR as large business program. Still, the differences are instructive.

Conclusions – Can the Adoption Rate Be That High? If So, Why?

The fact that this evaluation found so much more measure adoption than other studies of audit programs begs the question: What explains the difference—is it the evaluation method or is it the program design and execution? The authors believe that both factors contribute.

We are not aware of other MAR-type studies that have surveyed recipients as late as 8 years after study completion. One might expect that after 2 or 3 years the study would be shelved. This evaluation showed that such an assumption is definitely not the case for the FlexTech program. The novel technique used of tracking elapsed time between study completion and installation reveals MAR curves that steadily increase over a long period of time with a clear pattern of adoption. The pattern holds for thousands of measures. It does so for every stratification of measure characterization attempted, which is strong evidence that the phenomenon is real and not an anomaly. The adoption rate curves show that if the survey had been conducted nominally two or three years after studies were completed, the findings would have been a significantly lower realization rate. We therefore are confident that evaluation method contributes to the disparity in results between this and other known studies.

If this characterization holds true for other programs then the disparagement that has been heaped on audit programs as expensive marketing tools without much impact is flawed and substantive unrecognized real savings might have been left on the table throughout North America. When adjusted for overlap with direct incentive programs,[13] FlexTech remains a substantial direct cost-effective contributor to NYSERDA's energy savings portfolio and will continue to be so even if the overlap factor increases due to increased program-funded installation activity in New York state.

NYSERDA's program design and execution may offer lessons for other program administrators that aspire to higher adoption rates as well. First and foremost, the program requires 50% cost-sharing for most studies. This requirement has the powerful effect of screening out customers that are "just curious" and at the same time screening out free rider customers who already are certain to implement measures. Cost-sharing also means that there are no free audits thrown at customers to placate high bill complaints or to burnish a customer-friendly image. The program explicitly targets larger customers, who may be more financially sophisticated or likely to have funds to invest. There is no single audit service provider that has a goal to complete a certain number of audits. The pool of providers is seasoned, and applicants can bring in their own firm. The evaluation engineers generally found the audit quality to be high. Collectively, the program design seems oriented to finding customers who need help and giving them the help they need in a market-driven fashion. Overall it is likely that program design also contributed to the disparity in results between FlexTech and other programs' MAR.

---

[12] Anderson and Newell, 2003, 11 and 31.

[13] The majority of the measures recommended in the FlexTech studies were implemented without further funding from NYSERDA or other incentive programs. NYSERDA credits all such savings to the FlexTech program. Some measures did receive installation incentive funding. To avoid double counting of savings in multiple programs NYSERDA funded research to quantify measure and savings overlap. This investigation is not in the scope of the research of work addressed in this paper. For readers' interest however, the authors note that the overlap research found that 19.3% of FlexTech's energy efficiency measure savings ultimately received incentives from NYSERDA core energy efficiency installation incentive programs. Parlin and Megdal, 2008.

Subjecting other audit programs to a similar evaluation as the one FlexTech received would reveal and we suspect confirm that program design contributed to the disparity in results.

Summary and Recommendations

This evaluation examined adoption rates as a function of time, over an extended period of time—up to more than 7 years after study completion—and with follow-up site visits to validate telephone survey data. The evaluators found an overall long term adoption rate of 65% for all measures recommended in the energy studies. Controls measures were both the most commonly recommended measure type and were by far the most likely to be adopted. Unsurprisingly, envelope measures were least implemented.

The authors recommend that the energy efficiency program design community reconsider energy audits as viable sources of energy savings for program administrators, especially those who require cost-sharing and focus on larger customers.

For those types of audit programs, we recommend that evaluators measure program adoption rates over a long period of time, especially if the program provides studies that include a material number of large capital-intensive projects for which the incubation period is likely to be long. The evaluation found marked implementation more than 3 years after study completion for combined heat and power, water heating, and industrial measures.

Acknowledgements

The authors would like to acknowledge the leadership of Jennifer Meissner, NYSERDA Evaluation Systems Program Manager; Lori Lewis, Impact Evaluation Team prime contract program manager; Kathryn Parlin for sample design; and NYSERDA FlexTech program management and staff Brian Platt, Jaime Ritchey, and Mark Gundrum for their support. We also gratefully acknowledge the time and shared by study recipients.

References

Anderson, Soren T., and Richard G. Newell, 2003. *Information Programs for Technology Adoption: The Case of Energy-Efficiency Audits*, University of Michigan, for IACs

Carroll, Ed, Mark Brown, Francis Xavier, and Cody Kumar, 2010. Franklin Energy Services, LLC, *Small and Medium Sized Business Customers: Proactive Services to Increase the Installation Rate of Efficiency Upgrades,* ACEEE Summer Study on Energy Efficiency in Buildings.

Gogte, Salil, and Dakers Gowans, 2007. Nexant , *M&V Evaluation: Technical Assistance Program Final Report*, prepared for The New York State Energy Research and Development Authority, June.

Griffin, Bob, Daniel Johnson, 2006. Enbridge Gas Distribution Inc., *The Enbridge "Steam Saver" Program Steam Boiler Plant Efficiency-Update To Year End, 2005,* Proceedings of the Twenty-Eighth Industrial Energy Technology Conference, New Orleans, LA, May 9–12, 2006.

Mancuso, Joan, Quantum Consulting Inc. and Mary Dimit, 1997. Pacific Gas and Electric Co., *Are Energy Audits Worth It? Teasing Apart the Role of Audits in Driving Customer Efficiency Actions,* ACEEE Summer Study, June 1997.

Moray, Satyen, 2011. Energy & Resource Solutions, Inc., conversation with Public Service of New Hampshire staff, January 2011.

Osei-Antwi, Daniel, and Dakers Gowans, 2005. *M&V Evaluation: Technical Assistance Program Final Report*, prepared for The New York State Energy Research and Development Authority, June.

Parlin, Kathryn, 2008. West Hill Energy & Computing, and Lori Lewis Megdal, Megdal & Associates, Memorandum to Cherie Gregoire, NYSERDA, *Supporting Documentation for the Estimate of Overlapping Savings for the Technical Assistance Program*, September 9, 2008.

Thumann, Albert, William Younger, and Terry Niehus, 2009. *Handbook of Energy Audits*, 2009 for Enbridge 2006 results.