

Persistence and Spillover/Market Transformation as Measured for
Boston Edison Company's Energy Efficiency Programs for the Last 7 Years

by

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Introduction and Overview

The Boston Edison Company (BECo) has been offering demand-side management (DSM) programs for over a decade. These programs serve all of BECo's retail customer sectors: commercial, industrial, residential, and multi-family. Such programs have incorporated energy efficiency education, financial incentives in the form of rebates and direct installation, contractor arranging services, and assessments of efficiency potential and cost-effectiveness. BECo invested over \$289 million from 1986 through 1995 in DSM programs to produce estimated savings of over 447 gigawatt hours.

The persistence of DSM program effects basically consists of energy conservation measures (ECMs) remaining in place and operational as they are anticipated to be, as their immediate effects were measured. In other words, the research reported here answers the question of how much do the effects change over the lifetime of the ECMs. This implies that the primary requirement for a persistence study is the determination of what percentage of the program-installed ECMs have persisted. This work provides estimates of annual persistence rates for up to seven years after installation of the ECMs. (Other research, annual and biennial impact evaluations, measure the actual savings obtained immediately after installation as compared to expected savings.)

An additional area of research in this project was measurement of long-term spillover or market transformation for these program participants. There are energy efficiency equipment that appears to be cost-beneficial for individuals and firms to invest in that do not have market acceptance. One of the theories as to this lack of acceptance is that the transaction costs of gathering the information and the risks involved in trying new technology are such that the investment is not made. It is hypothesized that subsidy programs for energy efficiency could overcome these market barriers by providing information and incentives to cover the risk involved in an initial trial. Overcoming this market barrier for these customers in future purchasing is termed long-term spillover or market transformation for these customers.

The research found significant persistence impacts and significant spillover/market transformation impacts.

Methodology

Telephone surveys were the primary data collection technique because they could reach many more participants for a given expenditure as opposed to site visits. This allowed for larger samples for greater disaggregation by particular programs offered by BECo.

Telephone surveys, however, do not offer the objectivity offered by a non-utility site visit. Site visits provide a more objective review of the presence of the equipment and can ascertain its condition and function. A double-check for the telephone survey was provided in this study by the performance of a large number of persistence site visits.¹

Both the telephone surveys and site visits gathered data to answer the primary questions of whether the measure(s) (what proportion of the installations) are still in place and whether those in place are still operational (or what proportion are still operational). A follow-up question for measures that have been removed or replaced concerned the level of efficiency of the replacement equipment as compared to what was installed through the program, and what was there prior to the program. These questions were asked (examined in the site visit) by end-use in order to achieve end-use information and assure accuracy in obtaining the information on the appropriate equipment.

Four telephone surveys were constructed for this project. These were designed for each of the following sectors of customers:

- Commercial/industrial;
- Residential;
- Multi-family; and
- Commercial customers who moved into retrofitted facilities.

Each survey contained many survey loops constructed by end-use. This allowed the survey questions to be specific regarding the measure relevant for each particular participant. The telephone survey sample was selected from program databases with the end-uses annotated that the participant received incentives for within a program year. The amount of data collected from a contacted participant was maximized by inquiring whether the participant had received BECo assistance for other end-uses in other program years. If they had received other assistance, they were also asked the survey loops for those end-uses. This increased the information received, the cost-effectiveness of the persistence survey, and its accuracy concerning participant installation information.

The surveys also contain numerous survey loops within the end-use loops. These were required because of the nested questions within the persistence study. These included the following nested question pattern:

- Is the equipment installed as indicated in the program database?
 - ◆ If not indicated, did they ever receive BECo assistance to install equipment for this end-use?
 - ◆ If so, when was the first year they received BECo assistance for energy efficient equipment for this end-use?
- Is it still in place?
 - ◆ If still in place, is it operational?
 - If not in place and operational, has it been replaced?
 - If replaced, how efficient was the replacement compared to what was installed through the program or what was there prior to the program?
 - ◆ For those in place and operational, how are they used in comparison to how they were used shortly after installation (the one year post-installation usage within the earlier evaluations)?

After persistence of each of the end-uses is examined, the second section of the telephone survey asks the spillover/market transformation questions. There were two types of spillover/market transformation questions asked: general, and end-use specific questions concerning actual post-participation decisions. In other words, did the subsidies offered in the program allow participants to try energy efficiency equipment whereby the participants learned about the benefits of making energy efficiency investments. If this occurred, then participants would increase their investment in energy efficiency in the future without the use of subsidies, and this should be seen in post-participation decisions.

The sampling pools for this study consisted of program databases, or randomly selected program data extracts for the larger program databases, provided by Boston Edison. Numerous databases were provided, with separate databases by program and program year for each BECo DSM program over the last several years. A few of the older databases were not available for this study. However, all programs, sectors, and the program years with the greatest savings were included. Given the diversity within what was available in the databases and their formats², sampling procedures and surveys were designed to accommodate this diversity by simplifying to common denominators. This simplicity was then supplemented and doubled-checked through the telephone survey by inquiring about prior BECo DSM program participation by end-use.

The overall completed samples include over 1,200 telephone surveys, and over 200 site visits. The sampling pools for the telephone surveys consisted of random samples by program and program year³. The site visit sampling pools were randomly selected subsets of the telephone survey sampling pool⁴. The number of telephone surveys and site visits completed by sector and program are given in Table 1.

Findings

A consistent methodology and presentation style was used for estimating persistence across all BECo programs. Five tables were produced for each program displaying the results of the research for that program. The first table in each was derived from the persistence analysis of the telephone survey results. The second table presented the persistence analysis from the site visit data. The third table examines by end-use the level of replacements that occur and the efficiency of those replacements. The fourth table assesses the responses to the specific end-use questions regarding installation decisions as they relate to self-reported spillover/market transformation effects from prior program participation. The fifth table summarized the final persistence factor estimates for that program. A similar process and presentation was used to examine end-uses across residential, and again across commercial and industrial programs.

The telephone survey results were considered the primary persistence results, as these had the larger sample sizes. The persistence findings were compared to those found for 1995 as the survey was in 1996 and the initial persistence factor was already incorporated in the annual impact evaluations. (Double-counting would occur if an immediate persistence loss, i.e., for non-installation or immediate removal, if counted in both the annual impact evaluation and in this mid-term persistence study.) The next step was in developing a trend estimate based upon the by-year findings after comparison to the findings for 1995 participants. This process assumes that the differences across participants will counter-balance one another and that the persistence rates for participants from prior years reflects the persistence rates expected for its time since program participation. In other words, this analysis assumes they are no cohort effects.

The preliminary persistence estimate was a combination of the findings from the telephone survey and site visits, with the greatest weight given to the telephone survey results.

The spillover effects were a combination of the percentage that have made subsequent energy equipment decisions, the self-reported program effect on these decisions, and the combination of these responses across end-uses. This estimate was approximated as a percentage of expected savings so as to be combined with the persistence factor for a final long-term persistence factor.

Table 1 Telephone and Site Visit Samples

| | Telephone Surveys | Site Visits |
|--|----------------------|----------------|
| Multi-Family Programs (Measured by contacts/complexes, many customers served per complex) | 22 | 11 |
| Residential Programs | | |
| High Use Program 1991 - 1993 | 202 | 11 |
| High Use Program 1994 - 1995 | 135 | 34 |
| Home Energy Rebate (HER), 1994-1995 | 59 | 12 |
| HVAC Rebate Program 1993-1994 | 42 | 25 |
| Energy Eff. Lighting 1990-1993 | 99 | * |
| Energy Eff. Lighting 1994-1995 | 53 | * |
| RESIDENTIAL TOTALS | 590 | 82 |
| Large Commercial & Industrial, New Construction, Remodeling, Equipment Replacement | | |
| Large C/I 1990-1993 | 30 | 15 |
| Large C/I 1994-1995 | 26 | 22 |
| Equipment Replacement, 1993-1995 | 6 | 5 |
| New Construction 1992-1995 | 9 | 7 |
| Remodeling 1994 - 1995 | 3 | 2 |
| C&I (Non-small) Totals | 74 | 48 |
| Small C/I | | |
| Small C/I 1990-1993 | 294 | 50 |
| Small C/I 1994-1996 | 243 | 28 |
| Small C/I Totals | 537 | 78 |
| Commercial customers that moved into retrofitted facilities | 24 | |
| COMMERCIAL TOTALS | 635 | 126 |
| TOTALS | 1,247 | 219 |

* Customers voiced resentment when asked for site visits for simple lamps & CFL rebates.
Therefore, priority placed elsewhere given this and their smaller energy savings per site.

As an example for this paper, the findings for one of the ten program areas are presented. These are the results for the Small Commercial/Industrial Retrofit Program results.

There were 537 Small Commercial/Industrial Retrofit Program participants who responded to the telephone survey. Participants were initially asked about measures installed and if other end-uses had measures installed in other program years. This maximized the information we could easily obtain from the participant.

Persistence questions on the survey were asked by end-use. The responses for these were then aggregated. The telephone survey persistence results for the Small Commercial/Industrial Retrofit Program are presented in Table 2.

The program level estimates are 98% for 1995 participants, 91% for 1994 participants, 84% for 1993 participants, 86% for 1992 participants, 85% for 1991 and 1990 participants, and 80% for 1989 participants. Given this, the trend and persistence estimate compared to the 1995 results are 93% in 1994 and decline to 82% in 1989.

Table 2 Small C/I Retrofit Telephone Survey Persistence Findings

| Program Year | N* | Overall | Trend Comp. to 1995 |
|--------------|-----|---------|---------------------|
| 1995 | 170 | 98% | NA |
| 1994 | 186 | 91% | 93% |
| 1993 | 22 | 84% | 89% |
| 1992 | 146 | 86% | 88% |
| 1991 | 62 | 85% | 87% |
| 1990 | 64 | 85% | 87% |
| 1989 | 24 | 80% | 82% |

* Sample size is sum of counts of participants by end-use, as persistence is calculated. With multiple end-use and multiple year participation, sample size can be greater than number of participants surveyed.

There are 78 site visits for this program. Of course, the sample size for any one year is still relatively small. The persistence findings from the site visits are higher than those found in the telephone survey except for one year, 1989, for which they are significantly lower. These results are presented in Table 3.

Table 3 Small C/I Retrofit Site Visit Persistence Findings

| Program Year | N* | Overall | Trend Comp. to 1995 |
|--------------|----|---------|---------------------|
| 1996 | 10 | 90% | NA |
| 1995 | 21 | 90% | NA |
| 1994 | 7 | 100% | 100% |
| 1993 | 12 | 94% | 100% |
| 1992 | 21 | 99% | 100% |
| 1991 | 9 | 92% | 100% |
| 1990 | 17 | 56% | 75% |

* Sample size is the sum of the counts of participants by end-use, as persistence is calculated. With multiple end-use and multiple year participation, the sample size can be greater than number of participants surveyed.

The telephone survey's replacement examination for the Small Commercial/Industrial Retrofit Program is found in Table 4. As shown there, over one-quarter (30%) of participants by end-use have made replacements. (Recognize that a replacement could be many lamps or only one out of ten or 100.) However, there are no persistence effects of these replacements due to the fact that over 80% of these replacements are at least as efficient as the equipment installed through the program. Additionally, there is almost an equal balancing number of replacements that are more efficient than was installed through the program compared to the number of replacements where the efficiency fell back to what was there prior to the program. From this, it was concluded that there were no effects from replacement of program installed equipment.

The examination of subsequent energy equipment purchasing decisions for this program is presented in Table 5. Only a very small percentage of customers make energy equipment decisions in any year. Therefore, the percentage of customers with subsequent decisions in only up to seven years after program participation is also small. As would be expected, the percentage is smaller for those end-uses having equipment with longer expected lives.

Table 4 Small C/I Retrofit Telephone Survey Replacement Examination

| | Total | Replaced | More Efficient | Same Efficiency as Program | Less Efficient than Program | Same as before the Program |
|----------------|------------|--------------|----------------|----------------------------|-----------------------------|----------------------------|
| CFL | 156 | 40 | 5 | 22 | | 2 |
| LAMPS | 387 | 128 | 12 | 73 | 2 | 15 |
| AC | 30 | 3 | | 1 | | 1 |
| HEAT | 4 | | | | | |
| MINWTR | 14 | 2 | 1 | | 1 | |
| BLDG | 2 | | | | | |
| BALLAST | 177 | 60 | 4 | 43 | 2 | 8 |
| MOTORS | 3 | 1 | | | 1 | |
| VSD | 1 | | | | | |
| EMS | 6 | 2 | | 1 | | 1 |
| CUSTOM | 7 | 1 | | | 1 | |
| TOTALS | 787 | 237 | 22 | 140 | 7 | 27 |
| PERCENT | | 30.1% | 2.8% | 17.8% | 0.9% | 3.4% |

Table 5 Small C/I Retrofit Responses for Subsequent Energy Equipment Decisions (Spillover)

| End-Use | Decision since Part. # Yes | % Yes | More Efficient Earlier | More Efficient Same Time | Same Efficiency Earlier | Same Efficiency Same Time | Same Efficiency Later | Less Efficient Same Time | Less Efficient Later | No Effect |
|---------------|----------------------------|-------|------------------------|--------------------------|-------------------------|---------------------------|-----------------------|--------------------------|----------------------|-----------|
| Lighting | 68 | 14% | 24% | 21% | 5% | 2% | 2% | | 2% | 45% |
| AC | 25 | 5% | 27% | 9% | 5% | | | | 5% | 55% |
| Heating Water | 18 | 4% | 33% | 17% | | | 6% | | | 44% |
| Heating | 14 | 3% | 8% | 15% | | | | | | 77% |
| Motors | 13 | 3% | 15% | 23% | 8% | | | | 8% | 46% |
| Process | 4 | 1% | 25% | 50% | | | | | | 25% |
| EMS | 13 | 3% | 23% | 8% | 8% | 8% | 8% | 8% | | 23% |
| Other | 14 | 3% | 42% | | | | 8% | | | 50% |

* "Do not know" not included.

The effects of the program on subsequent energy equipment decisions was smallest for customers in the Small Commercial/Industrial Retrofit Program than for any other BECo program. This is not unexpected as small commercial and industrial customers are more often those where immediate cash flow issues may outweigh longer-term benefit/cost investment decisions.

The final long-term net persistence factors for BECo's Small Commercial/Industrial Retrofit Program are 97% in 1994 and fall to 86% in 1989. These include a spillover/market transformation effect of four percent. This program has contained primarily lighting measures: lamps, ballasts, and CFLs, and serves many smaller businesses. Given this, these persistence factors, though lower than that found in most of the other BECo programs examined, are still quite positive. The persistence factors are presented in Table 6.

Table 6 Results for the Small C/I Retrofit Program

| Program Year | Preliminary Persistence | Spillover* | Final Long-Term Net |
|--------------|-------------------------|------------|---------------------|
| 1994 | 93% | 4% | 97% |
| 1993 | 89% | 4% | 93% |
| 1992 | 88% | 4% | 92% |
| 1991 | 87% | 4% | 91% |
| 1990 | 87% | 4% | 91% |
| 1989 | 82% | 4% | 86% |

* Overall estimate, not performed on an annual basis.

Boston Edison Company's (BECO's) long-term net persistence factors found in this study for each of their DSM programs are presented in Table 7. These net persistence factors are quite strong, with and without the spillover/market transformation impacts seen from these participants during this medium-term follow-up. The net persistence factors vary in the out-years from a low of 86 percent for the Small C/I Retrofit Program to a high of 112% for the C/I Remodeling Program.

Table 7 Final Long-Term Net Persistence Factor Results for Boston Edison Company's DSM Programs

| Program -- Years post-participation | 1994 2 years | 1993 3 years | 1992 4 years | 1991 5 years | 1990 6 years | 1989 7 years |
|---|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Large C/I Retrofit | 110% | 110% | 110% | 110% | 110% | 110% |
| C/I Remodeling | 112% | 112% | 112% | 112% | 112% | 112% |
| C/I New Construction | 103% | 103% | 103% | | | |
| C/I Equipment Replacement | 102% | 102% | 102% | 102% | 102% | 102% |
| Small C/I Retrofit | 97% | 93% | 92% | 91% | 91% | 86% |
| High Use Program (Residential) | 100% | 100% | 95% | 95% | 90% | 90% |
| Home Energy Rebate (HER) Program | 101% | 101% | 101% | 101% | 101% | 101% |
| HVAC Rebate Program (Residential) | 101% | 101% | 101% | | | |
| Energy Efficient Lighting (Residential) | 96% | 96% | 96% | 96% | 96% | 96% |
| Multi-Family Programs (Multi-Family, Boston Housing Authority (BHA), and Public Housing Authority (PHA) Programs) | 99% | 99% | 99% | | | |

The out-year net estimates for C/I end-uses seven years after program participation (1989 participation) range from a low of 61% for hot water conservation measures (such as water heater tank wraps and low flow showerheads) to a high

of 102% for heating equipment and VSDs. There are four end-uses in the C/I sector with persistence losses by the sixth and seventh years that are significant enough to be examined as part of future program planning and integrated resource management efforts. These are: water conservation measures, 61%; energy management systems, 77%; lamps, 83%; and compact fluorescent lamps, 86%.

The out-year net estimates for residential end-uses four to seven years after program participation (1989 - 1992 participation) range from a low of 61% for water conservation measures to a high of 104% and 105% for heating equipment and lamps, respectively. There are three end-uses in the residential sector with persistence losses by the out-years that are significant enough to be examined as part of future program planning and integrated resource management efforts. These are: water conservation measures, 61%; water heating, 67%; and compact fluorescent lamps, 79%.

Significant out-year persistence losses are found in water conservation measures and compact fluorescent lamps cross both the C/I and residential sectors. The smaller potential savings per measure and their ease of removal make these measures more vulnerable to persistence loss. The highest persistence for compact fluorescent lamps is within the Energy Efficient Lighting Program. This suggests that customers whose participation is guided by a desire for these types of lamps, rather than their being a "side-sale" as part of a larger program, may have better persistence results.

Generally, there are still small proportions of customers that have additional energy equipment decisions even as much as six years after program participation. This substantiates that the eligible population for any equipment decision is a small percentage of the total customer population.

Of those participants making subsequent equipment decisions, overall more than half report installing more efficient equipment due to their earlier participation in BECo's DSM programs. This may be one of the first long-term examinations of spillover/market transformation among prior participants. We have found significant program spillover/market transformation occurring.

As would be expected, spillover/market transformation is lower for end-uses not addressed within the participant's prior participation. For example, the Energy Efficient Lighting Program obtained significant spillover among lighting but not for heating equipment or other non-lighting equipment. Similarly, these participants have the lowest reporting that the program taught them about energy conservation opportunities they were unaware of before participating in the program. This is also consistent with the targeted nature of the program.

In summary, there appear to be both advantages and disadvantages to having end-use targeted programs. A targeted program appears to obtain greater measure persistence but also obtains less spillover.

In an innovative inquiry of customers that moved into facilities retrofitted by prior occupants (through BECo's DSM programs) found very high persistence of these measures. This finding is much better than we generally believed would be true. Most of the firms that moved into these retrofitted facilities had moved from elsewhere in the BECo service territory. Any customer moving into this facility would receive the benefits from these efficiency investments, and by moving there would be BECo customers. Yet, the fact that all of those moving in were previously BECo customers means that these new beneficiaries were previously part of the non-participant customers that subsidized this investment through their prior utility bills. This adds another level of benefits to "non-participants" than had previously been considered in standard DSM benefit/cost analyses. That is, the participant bill savings are shared between current participants residing at the facility and those non-participants who would move into the facility later.

Endnotes

1. The telephone survey and site visit numbers are orders of magnitude larger than the sample sizes commonly used in annual DSM evaluations at BECo and most US utilities.
2. Databases were in D-Base, Excel, Paradox, multiple spreadsheets, differing files by program year, different fields by program year, and other complications.
3. The random samples were for participants with what appeared to be valid telephone numbers. Statistical difference of means tests were performed by program that verified that participants with valid telephone numbers and participants without valid telephone numbers did not differ significantly in their expected savings.
4. Site visit personnel were instructed that many customers would be receiving both a telephone survey and a site visit. They were given instructions on how to explain why both were occurring and that the site visit was very brief for the purpose of examining the equipment on-site, and see its usage and application.