Top Down and Bottom Up:
Market Effects and Program Attribution in the C&I Market

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ABSTRACT

Efficiency programs run by utilities or government agencies may have impacts that go beyond those individuals who directly participate in the programs. Nonparticipant spillover occurs as information about efficiency becomes more common and efficient products are more readily accessible to those who do not directly participate in efficiency programs.

This paper describes an impact evaluation designed to estimate savings from nonparticipant spillover (NPSO) and market effects in the C&I existing facilities market. The unusual aspect of this evaluation is that it had both bottom up and top down components: 1) estimating the NPSO through telephone surveys of nonparticipating building owners and contractors, and 2) assessing market effects for one specific technology, i.e., high bay lighting (HBL), through a cross state comparison. In addition, the cross state study was designed to be consistent with two previous studies in the HBL market, allowing for a longitudinal analysis of the HBL market in the comparison states over a five year period.

This paper covers the following aspects of the evaluation:

- A description of the methods used to estimate NPSO from self reports and market effects from the cross state survey
- A discussion of the strengths and weaknesses of the top down and bottom up approaches
- A brief discussion of the results from the two strategies
- An exploration of the various issues that could be creating the discrepancies between the findings and options for future research to address these issues

Introduction

The U.S. and EU have often taken different approaches to improving energy efficiency for buildings and equipment. While the EU approach tends to be based more on governmental regulation and energy codes, many efficiency programs in the U.S. are designed for resource acquisition and are based on providing direct incentives the homeowners and businesses to install efficiency measures. Accordingly, the impact evaluation strategies developed in the U.S. were initially designed for resource acquisition programs. The bottom up method is to evaluate a sample of individual projects and the results are expanded to the program population to estimate the evaluated gross program impacts. However, this approach led to a conundrum, in that the programs can affect the overall market well beyond the direct program participants.

The solution to this situation was the adoption of the net-to-gross construct, in which savings from naturally occurring efficiency (free riders) would be removed from the program savings, and savings from market based improvements in efficiency due to the program but not claimed by the program (spillover) would be added, resulting in net evaluated program savings. Thus, many U.S. impact evaluations include the estimation of the free riders and spillover.

This approach can be seen in contrast to a top down impact evaluation that may be more appropriate for market transformation programs and governmental regulation, where the goal is to change how the market operates. Top down impact evaluation may be based on changes in market share of efficient equipment or comparisons between geographic regions with and without the market intervention. Sometimes the bottom-up and the top-down approaches provide dramatically different pictures of the same efficiency market.

This paper discusses an evaluation that was designed to estimate nonparticipant spillover in the C&I existing facilities market. This study was designed to quantify changes in efficiency measure adoption by nonparticipating owners and vendors due to the presence of the NYSERDA Commercial and Industrial (C&I) programs operating in the existing facilities sector. NYSERDA recognizes these indirect effects of its market transformation and resource acquisition programs and has been periodically measuring the influence of its programs on nonparticipants.

Due to concerns about potential bias introduced by the inherent difficulty in asking survey respondents about what they would have done without the program, a cross state study for one specific technology was added to that evaluation study. The bottom up and top down methods resulted in different outcomes and the two different pictures of the market provided insights for future program implementation.

The following sections cover background and context, evaluation methods, strengths and weakness of the NPSO and market effects approaches, results and recommendations.

Background and Context

The New York State Energy and Research Development Authority (NYSERDA) has been operating a wide range of energy efficiency programs for over 15 years, including initiatives aimed at end users, trade allies and other market actors. As a result of these activities, NYSERDA's programs have become one of many influences in the market place. The two largest programs operating during the analysis period for this study (2007 through 2010) were FlexTech and the Existing Facilities (EFP) programs. FlexTech provides incentives for C&I facilities to conduct feasibility studies to assess the energy efficiency potential for a wide range of applications, from industrial processes to retro-commissioning. Participants are directed to other NYSERDA programs, such as EFP, for assistance with measure installations. EFP promotes energy efficiency and demand management by providing direct incentives for installation of energy efficiency and demand reduction measures.

Nonparticipant spillover occurs as information about efficiency becomes more common and efficient products are more readily accessible to those who do not directly participate in efficiency programs. Information, training, and incentive levels can raise awareness and increase impacts across the targeted market sectors. This effect is often the result of networking between participants and nonparticipants, the education of vendors and end users, or, less directly, market changes occurring due to NYSERDA's programs, e.g., nonparticipating vendors may wish to stay competitive in a market that is changing due to the program efforts.

Previous NPSO studies were conducted by NYSERDA in 2005 and 2007.[1] The NPSO component of this evaluation is based on these earlier efforts, using an enhanced self-report approach and covering all end uses. In addition, a cross-state comparison was implemented as part of this study to estimate the market effects of NYSERDA's programs for high bay lighting only.

[1] The results of this work are reported in the Commercial and Industrial Market Effects Evaluation, prepared for NYSERDA by Summit Blue Consulting, October 2007.

This section covers definitions, market influences, measurement approaches and a comparison of the bottom up and top down approaches.

Definitions

Market transformation is "a reduction in market barriers resulting from a market intervention, as evidenced by a set of market effects, that lasts after the intervention has been withdrawn, reduced or changed." (Framework 2004) Programs that are focused on achieving market transformation are likely to include interventions targeted toward a variety of market actors. Strategies for assessing market effects often include measurement of market share, market behavior and knowledge over time.

In contrast, resource acquisition programs tend to offer specific and direct inventions to achieve a more limited objective, e.g., offering a rebate to encourage purchases of efficient equipment. The net load impact reflecting the savings that would have occurred in the absence of the program are estimated by application of a net-to-gross ratio that accounts for free riders (naturally occurring efficiency) and spillover (efficiency that occurs outside of the program but due to program influences). An example of a resource acquisition program is a residential audit program with direct incentives to cover the incremental cost of specific efficiency measures.

Spillover is defined as energy savings due to the energy efficiency programs from actions taken outside the program. Nonparticipant spillover (NSPO) occurs as information about efficiency becomes more common and efficient products are more readily accessible to those who do not directly participate in efficiency programs.

Measurement Approaches

From its beginning in 1998, NYSERDA operated with a philosophy of market transformation, as was clearly delineated in the chapters of the early annual reports. Discussion of the philosophy of linking market-based energy efficiency programs with economic growth and sustainable development is summarized in a 1998 ACEEE paper (Smith, et. al, 1998). This perspective is also incorporated into the intermediate and long-term outcomes in the current program logic models. At the same time, NYSERDA has always reported savings using the net-to-gross ratio (NTGR) model, effectively assuming that net savings are equal to the net evaluated savings incorporating free riders and spillover. The key differences between net savings and market effects are briefly discussed below and summarized in Table 1.

An example of the difference in perspective is that high free rider rates could actually be caused through market transformation. Over time, the program's work with a variety of trade allies and other market actors may improve the efficiency practices of nonparticipants, and those nonparticipants may later decide to take advantage of NYSERDA's program offerings. However, using the net savings model, these savings would be considered to be free riders, although the former nonparticipant was actually affected by the program (Megdal, et. al., 1997).

Table 1. Comparison of Approaches to Measuring Net Savings and Market Effects

Factor	Net Savings (Bottom Up)	Market Effects (Top Down)
Type of program	Initially conceptualized for resource acquisition programs	Motivated by assessing impacts of market transformation programs
Timing	Focused on specific period	Assessing efficiency improvements over time
Approach	Bottom up estimates constructed from surveys of market actors	Top down using broader indicators such as change in market share
Types of effects	Free riders, spillover	All market influences related to program activities
Issues	Relying on self-reports may lead to bias	Estimates of savings include both program effects and other market influences.

Top Down v Bottom Up

To date, there is little direct experience with reconciling the two approaches. The top-down nature of comparing markets can offer a vastly different measurement of program-induced efficiency gains. A pilot market effects study was conducted as part of the NYSERDA New Construction Program Impact Evaluation concluded that there were possibly substantial program-induced savings that were not captured by the traditional NTG evaluation methods (NCP, 2012).

A reality check for the magnitude of the NPSO is to assess whether the total market effects are larger than the NPSO. A cross-state study was added to this study to provide such a reality check by comparing the market in New York State (NYS) to comparison states that have not had statewide energy efficiency programs. The conceptual underpinning of a cross-state study is the idea that efficiency levels in states with no efficiency programs provide a good indication of the NYS efficiency levels if no NYSERDA programs had been implemented. This comparison effectively incorporates all market effects, including SO, FR, and possibly other nonprogram effects. This approach was recently used in California and Massachusetts to compare efficiency levels in one specific market, *i.e.*, high bay lighting (HBL).

Methods

Nonparticipant Spillover

The NPSO study was based on enhanced self reports, relying on methods that have been refined over many years and are used in numerous jurisdictions in the US. This study investigated aspects of the market that affect energy efficiency upgrades during the years of 2007 to 2010, including the following:

- End user decision-making with respect to energy related facility investments
- End user interactions with contractors and acceptance of contractor's recommendations
- Contractor's recommendation of high efficiency equipment
- NYSERDA influence on end users' and contractors' decisions to install high efficiency equipment

The NPSO survey covered all types of measures, including lighting, HVAC, motors, building envelope improvements and energy management systems. The final estimate of NPSO incorporated program impacts identified by both building owners and by contractors, with extensive efforts to minimize the possibility of double counting.

NPSO savings can be defined as the combination of the NYSERDA influence level, the savings per unit (kWh per square foot), and the quantity (nonparticipant remodeled C&I area in square feet). Figure 2 shows the data sources, inputs and evaluation outputs for the end user component of the NPSO.

The enhanced self report survey was designed to represent all New York contractors, including those who may have participated in NYSERDA's programs during the analysis period as participation occurs at the project level and participation status may change over time. Participant outside spillover (OSO) occurs when participating contractors promote and install efficiency measures in nonparticipating programs. Due to the methods used in this study, OSO could be a subset of the NPSO estimated from the contractor activity. To avoid double counting, the NPSO rate was calculated and then adjusted by subtracting out the estimated OSO from NYSERDA's two largest programs in the C&I existing facilities market.

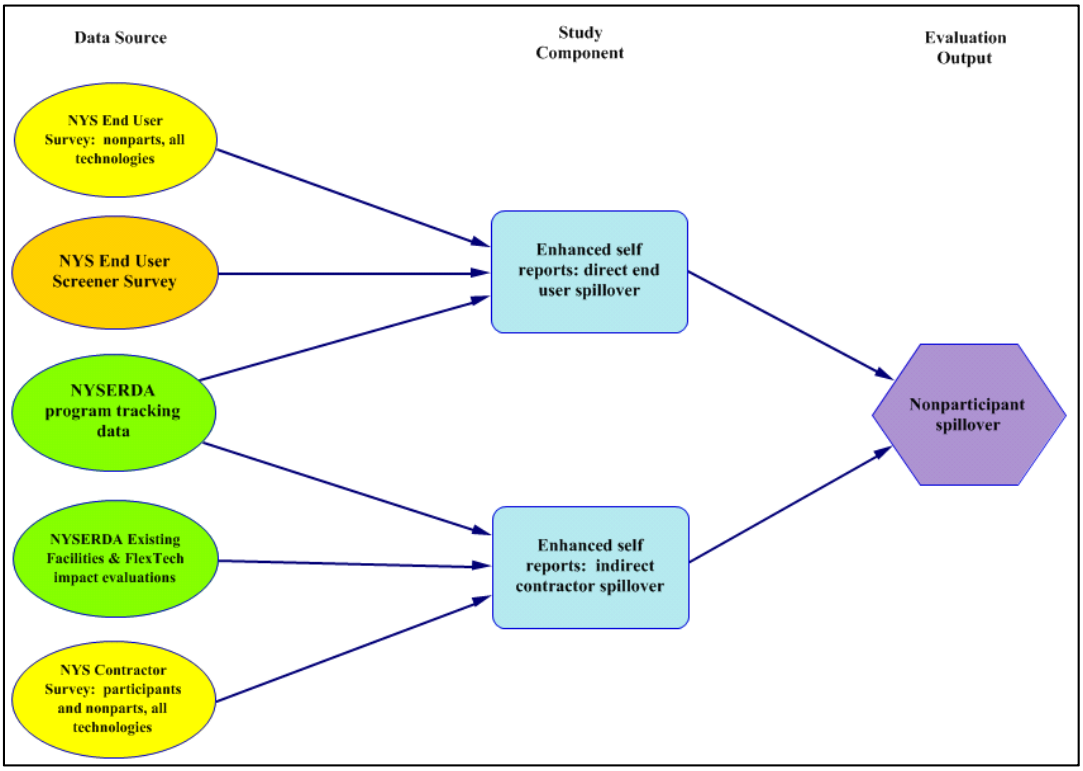

Figure 2: Data Sources, Inputs and Evaluation Outputs for the End User NPSO

Cross State Study

The cross state component of the study was based on the assumption that market effects can be measured by comparing areas of the US where no efficiency programs have been implemented to the jurisdiction under evaluation. This part of the study was designed to replicate the methods used in two previous cross state studies, including using the same comparison states. In contrast to the NPSO component, the cross state study was limited to a single technology, high

bay lighting. The limited scope is necessary to be able to draw meaningful comparisons between the two regions.

This comparison effectively incorporates all market effects and mirrors the approach recently used in California and Massachusetts to compare efficiency levels for HBL. The comparison was based on primary research through surveys of end users and contractors in NYS and the comparison states. Table 3 summarizes the data sources for the three cross state evaluations.

Table 3. Comparison of California, Massachusetts, and New York Cross State Evaluation Data Sources

	Time Period Covered in Evaluation State Survey	Data Source for Evaluation State Survey	Time Period Covered in Comparison Area Survey	Data Source for Evaluation State Survey	HBL Market
California	2006 to 2008	Primary data collection	2006 to 2008	Primary data collection	Existing buildings
Massachusetts	2007 to 2010	Primary data collection	2006 to 2008	Data collected in California study	New construction
NYS	2007 to 2010	Primary data collection	2007 to 2010	Primary data collection	Existing buildings

There are two primary components to estimating market effects through the cross state study:

1. The difference between the efficiency of HBL in NYS as compared to the baseline (the comparison area)
2. The size of the NYS HBL market

The difference in the efficiency of HBL equipment sales (lumens per watt) between the two areas is the basis for the savings due to market interventions. Secondary data was used to estimate the efficiency levels of the HBL products. The percentage of penetration for each technology type was determined from the contractor surveys, and the weighted average of the efficiency for HBL as a whole was calculated for NYS and the comparison area. These results were then compared to assess whether the differences were statistically significant.

Surveys

Five surveys were conducted to provide data for the NPSO and the cross state study, as described in Table 4 below.

Table 4. Telephone Survey Descriptions

Evaluation Activity	Sample	Study Component	Purpose
Screener survey of NYS end users	2,578	ESR and cross state	Estimate incidence of remodeling, C&I space remodeled and difficulty of obtaining required sample sizes for evaluation components; compare sample frames
Survey of NYS end users	570	ESR and cross state	Obtain data required for ESR and cross-state analyses
Survey of NYS contractors	225	ESR and cross state	Obtain data required for ESR and cross-state analyses
Survey of comparison state end users	121	Cross state	Obtain data required for cross-state analysis
Survey of comparison state contractors	72	Cross state	Obtain data required for cross-state analysis

The purpose of the screener survey was to identify businesses that conducted remodeling during the study period. This study formed the basis for the sample frame for the New York End User Survey used for the enhanced self report and high bay lighting cross state study. The Impact Team created lists of buildings that had remodeled and those with high bay lighting (HBL) purchases from the screener component of this survey to determine quotas for each target population. The NYS contractor survey did not distinguish between participating and nonparticipating contractors, as participation occurs at the project level and contractors are likely to be engaged in a variety of projects, some of which may be enrolled in NYSERDA programs and others completed outside of the program.

Strengths and Weaknesses

Each method has its own strengths and weaknesses. A common criticism leveled against self reports for estimating spillover is concerns that survey respondents have difficulty accurately reporting what they would have done without the program. This issue raises questions about construct validity and the potential for bias.[2] To try to mitigate these issues, questions were asked from multiple perspectives and both end users and contractors were surveyed. For the cross state study, the key underlying issue is whether there are other fundamental differences between New York State and the comparison states that affect the acceptance of the energy efficient products and could confound the results of the study. The method of estimating savings using both approaches assumes that we are able to estimate the size of the C&I existing facilities remodeling market. This in itself is a nontrivial task and can have a substantial degree of uncertainty associated with it. The bottom up and top down approaches and implications for some of the critical aspects of the evaluation are summarized in Table 3.

[2] Framework, 2004, pp. 145-156.

Table 3: Comparison of Top Down and Bottom Up Approaches

Issue	NPSO/ ESR (Bottom Up)	Market Effects/ Cross State Study (Top Down)
End users unaware of NYSERDA influence	Spillover due to contractor influence was added.	Includes all market effects, both program- and nonprogram-related.
Changing market conditions over time	NPSO can only be calculated for a specific period. Surveys covered same period as program implementation under evaluation (2007 to 2010).	Incorporates all changes over time; surveys covered same period as program implementation (2007 to 2010).
Complexity of questions	Influence questions are a critical input and can be difficult to answer.	Contractors asked about share of specific lighting products installed with percentages to add to 100%.
Range of end uses	ESR survey included full range of end uses.	Cross state study was only for one technology, high bay lighting.
Self reports	NPSO based on end users' and contractors' reports of NYSERDA influence.	Market effects based on contractors' reports of the share of specific lighting products.
Source of site level savings	Site level savings were based on the kWh/sq foot achieved through the program, with some adjustments.	Market effect saving are based only on the differences in efficacy due to the distribution of efficient lighting products.
Causality	Surveys ask directly about NYSERDA influence. A high level of influence was assumed to equate to causality.	Confounding factors that could affect a comparison between New York and other states, making it difficult or impossible to establish causality.
Size of market	Overall NPSO savings were estimated for the entire C&I existing facility market, which is difficult to estimate.	Market effects were estimated for the entire C&I existing facility lighting market, which is difficult to estimate.

Results

This section covers the results from the two studies. For clarity, the results section is divided into three sections: nonparticipant spillover, the cross state study and integration of results.

Nonparticipant Spillover

The NPSO surveys demonstrated the complex interactions between NYSERDA, contractors, and end users in the market. The critical insights into the decision-making process are summarized below.

- There is a low assessment of NYSERDA influence among end users, as 86% of NYS end users were either unfamiliar with NYSERDA or reported no NYSERDA influence.
- The vast majority of contractors recognizes and works with NYSERDA on some level, with 80% of contractors reporting involvement with NYSERDA.

- Contractors estimate that 80% of NYS end users rely on contractors to recommend equipment, either accepting the contractor's assessment entirely or engaging in a discussion on selecting the appropriate equipment.
- Eight-six percent of contractors report that they recommend energy efficient equipment either always or most of the time.

About half of the contractors stated that NYSERDA influenced the way they work. These contractors were asked about the NYSERDA's influence on four areas of their work. The responses are shown in
Table .

Table 4. Influence of NYSERDA Programs on New York State Contractors

NYSERDA influenced . . .	% Contractors Reporting No/Low Influence[1]	% Contractors Reporting High Influence[1]
Efficiency levels of equipment recommended to customers	59%	29%
How the benefits of energy efficient equipment are explained to customers	61%	26%
Methods or techniques used	67%	17%
Manufacturers and distributors to stock higher efficiency equipment	73%	19%

[1] "No/low" influence indicates the contractor selected "1" or "2" or reported that they were unaware of NYSERDA prior to the survey. "High" influence indicates the contractor selected "4" or "5." The percentages will not add to 100% as contractors who responded "3" were omitted from this table.

The NPSO rate for existing buildings was found to be 25% with a relative precision of 15% at the 90% confidence level. The direct NPSO rate reported by the end users is estimated at 23%, and the indirect spillover from contractors, when the OSO from NYSERDA's main C&I programs is removed, contributes the remaining 2%. Program savings are increased by the NPSO rate of 25% to account for these program related impacts.

Cross State Study

The results of the cross-state study did not demonstrate that there are market effects from NYSERDA's efforts on the HBL market. Unlike the recent studies conducted for Massachusetts and California, the efficiency of the HBL market in NYS and the comparison states was very similar. This outcome was a combination of a substantial increase in the efficiency of the HBL market in the comparison area and the determination that the efficiency of the NYS HBL market is lower than the efficiency levels found in Massachusetts and California. The distribution of HBL lighting for the three cross state studies and the two surveys in the comparison areas are shown in Table 5 below.

Table 5. Comparison of Technology Shares from California, Massachusetts, and NYSERDA High Bay Lighting Market Effects Studies

Technology	Weighted Average Percentage of Fixtures Installed in HBL Applications				
	NYS, 2007 to 2010a (n=70)	Comparison Area, 2007 to 2010a (n=72)	Massachusetts, 2007 to 2010	California, 2006 to 2008	Comparison Area, 2006 to 2008
Fluorescent tube: T5 high output	30%	33%	64%	65%	29%
Fluorescent tube: high performance, reduced wattage, or super T8	15%	11%	13%b	14%b	16%b
Fluorescent tube: standard T8	14%	15%			
Fluorescent tube: T12	2%	1%	1%	1%	11%
HID: pulse start metal halide	16%	17%	3%	14%	31%
HID: probe start metal halide	3%	4%	1%	1%	3%
HID: high pressure sodium	7%	4%	1%	3%	8%
LED	10%	8%	17%b	2%b	2%b
Other: technologies such as induction	1%	5%			

[a] Low pressure sodium and mercury vapor fixtures were omitted due to the low frequency of installation.

[b] The California and Massachusetts evaluation reports did not differentiate between super and standard T8s or between LED and other lighting technologies.

These results reflect the specific time period covered in the survey and are affected by a wide range of influences on the market that are not fully understood. Some specific differences among the three studies include the following:

- Some states in the comparison area, California and Massachusetts all had code updates that went into effect during the time period of the study. During this same period, NYS code requirements lagged behind the other areas in terms of efficiency.
- Both Massachusetts and California had a dramatically higher technology share in the HBL market for high output T5s. This single factor is the largest contributor to the higher efficiency HBL lighting in these two states as compared to New York.
- The increase in T8s in the comparison area is accompanied by a decrease in technology share for the less efficient metal halide figures. These two changes make the greatest contribution to the increase in efficiency in the comparison area between the two study periods.
- The market share for inefficient T12s dropped in the comparison area from 11% in the earlier survey to 1% in the recent survey. This finding is most likely due to the change in federal standards designed to phase out T12s.

In aggregate, this analysis suggests a major improvement in efficiency of the HBL market in the comparison states from the 2006 to 2008 analysis period to the more recent surveys covering 2007 to 2010, and also that NYS lags California and Massachusetts in the overall efficiency of the HBL market.

Integration of Results

The estimate of NPSO is 25% and yet the cross-state study did not find market effects for HBL. Given that NPSO would be expected to be a subset of market effects, these findings appear to be contradictory. However, it appears that other market influences have confounded our ability to identify and quantify the market effects through the cross state study. Initial research suggests that there are two major factors that have propelled the comparison states to near the same efficiency level as New York for high bay lighting:

1. The adoption and strengthening of codes in several of the comparison states resulted in the higher minimum efficiency than in NYS during a portion of the study period. Not only were code efficiencies more stringent, but contractors also reported a stronger influence from the codes in the comparison area (23%) as opposed to NYS (14%).

2. Many corporations have policies regarding sustainability, affecting up to 40% of the market. These policies cut across state lines and tend to raise the average efficiency in the market, regardless of state codes or policies. For corporate entities that use a chain or franchise model, contractors in both NYS and the comparison area reported that over 90% had efficient lighting requirements.

In contrast, a higher percentage of NYS contractors reported influence by efficiency programs regarding the recommendation, acceptance, and installation of efficient HBL. NYS contractors also identified NYSERDA incentives as a driving force in the market. These are clear indications that the NYSERDA programs are a positive influence on the adoption of efficient lighting in NYS.

Conclusions

While the NPSO component of the study shows that contractors report NYSERDA's influence over key aspects of their installations, the cross state study indicates that the efficiency levels in the New York and the comparison states are similar for high bay lighting. These two seemingly contradictory results provide some insights into how the efficiency markets operate and specific areas that could use more attention. Together, these separate endeavors provide a more comprehensive picture of the efficiency market.

One clear finding from the cross state study is that the lighting efficiency in the comparison states dramatically increased from the first contractor survey covering the years of 2006 to 2008 to the more recent one covering 2007 to 2010. Additional research suggests that the implementation and updating state energy codes may partially explain the difference. A second potential factor may be the prevalence of regional and national chains with internal energy efficiency standards. As this is an observational study, it is not possible to demonstrate causality, but these are two areas where New York and the comparison states are different.

Another key finding is that the efficiency of high bay lighting in New York State lags Massachusetts and California, particularly in the market share of T5 high output fixtures. This outcome provides some guidance for program staff in the design and implementation of the C&I existing facility program.

Given that the high bay lighting market is limited to specific technologies and also certain types of applications and businesses, the cross state study addresses only one small aspect of NYSERDA's overall efforts in the C&I market and should not be construed to minimize the effects of its intervention in other aspects of the efficiency market.

From a broader perspective, the cross state study calls into question the concept of finding a comparison area that is free from interference in the efficiency market. National and regional efforts to promote energy efficiency are raising awareness across the board. Distributors and manufacturers respond to demand for energy efficiency from outside state boundaries. NYSERDA and many others have been supporting these regional and national efforts for many years with the goal of widespread acceptance of energy efficiency.

These findings emphasize the importance of baseline studies. For example, ignoring the higher efficiency baseline for national or regional chains could result in the overestimation of program savings. Conducting research at the national level in this area could be an important step toward addressing this issue, and can provide context for the more detailed results obtained from the bottom-up evaluation.

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