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Massachusetts Electric and Gas Program Administrators

Recommended Methods for Assessing Market Effects of C&I Lighting and Controls Programs (Final)

February 26, 2015

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1.   INTRODUCTION

1.1   OBJECTIVES

This document identifies market effects studies for Massachusetts PA programs that support energy-efficient commercial lighting. The studies could provide significant value to the PAs in terms of estimates of spillover as well as provide guidance for future program design. The October 30, 2014, memo, Cross-Cutting Market Effects Study, Task 5 Final Deliverable: Recommendations for Priority Market/Program Intersections for Remaining Market Effects Methods Work, identified C&I Lighting and Controls as priority markets for conducting market effects research. The Market Effects Cross-cutting Evaluation team determined that C&I Lighting was well suited for a market effects study for the following reasons:

- Lighting measures received considerable program support, resulting in a high volume of volume of measures rebated to a significant number of accounts

- The measures consisted largely of standardized products, which facilitates quantification of market effects and supporting data collection

- The Massachusetts PAs have conducted two market effects studies in separate lighting sub-markets to date, providing a range of data that can be leveraged for additional market effects research

- Work about to be completed for the Existing Buildings Market Characterization (Project 41) and an analysis of equipment recently installed (Project 50) will contain useful detail on lighting products installed and recently purchased to support these analyses.

This document addresses the following two objectives:

1. Identify sub-segments of the C&I lighting and controls market that are suitable for prospective or retrospective market effects studies

2. Outline the recommended methods for conducting market effects studies of each of the identified markets.

1.2   GENERAL APPROACH

Based on previous experience, we determined that any proposed market effects studies would need to meet the following criteria in order to provide value to the PAs:

1. Program efforts in support of the targeted technologies need to be sufficiently large to result in spillover

2. Established methods are available to collect and analyze the data needed to assess the level of spillover

3. Reasonable program and market logic models have been developed by NMR to provide a strong theoretical framework for structuring and interpreting the results of the empirical research.

To identify program efforts that meet the first volume-related criterion, DNV GL reviewed 2011–2013 C&I Lighting and Controls upstream and downstream program tracking records.

Our objective in the review was to assess which, if any, elements of the prescriptive and custom lighting programs was sufficiently large to affect the technology selection decisions and related behaviors of vendors and/or customers outside the program. The records contained information on the number of total participants who installed a given technology,[1] the number of individual projects in which the measure was included, the total number of measures rebated, and the tracking system estimate of savings for that measure. We used this review and our experience in structuring and conducting other lighting-oriented market effects assessments for programs that address commercial lighting to identify candidate studies.

Applying these two criteria, we identified two potential studies:

1. A retrospective assessment of the market effects of programs to support high-efficiency linear fluorescent technology, with a primary focus on low-wattage T8 lamps
2. A baseline (prospective) study of the commercial market for lighting controls.

LEDs and high-bay lighting also received high levels of support from C&I programs. However, the PAs have already conducted a market effects study on high bay lighting and are currently completing a baseline study for market effects for LED programs.

The remainder of this document is structured as follows:

- Section 2 – Presents an analysis of the PAs' program activity in regards to commercial lighting for the years 2011–2013.

- Section 3 – Presents the recommended methods for conducting a retrospective market effects study of the high-performance T8 market and a prospective study of the lighting controls market.

- Section 4 – Presents a preliminary set of market indicators for use in market effects assessments for programs that promote low-wattage T8s and commercial lighting controls.

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[1] We were not able to identify multiple instances of participation by a single customer.

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2. ANALYSIS OF C&I LIGHTING PROGRAM ACTIVITY

DNV GL analyzed commercial program tracking data from 2011–2013 in order to identify individual lighting measures purchased in significant quantities by a large number of customers. As discussed above, we hypothesize that the programs supporting the high-volume measures will have the greatest chance of generating market effects.

Table 2-1 below presents a summary of this analysis. Note that the program tracking records did not provide energy savings estimates for the upstream measures. For purposes of this report we have estimated upstream measures energy savings using average unit savings from the downstream measure records.

Table 2-1. Review of Participation, Measures, Units, and Savings from C&I Lighting and Controls Programs (2011–2013)*

Downstream	Count				Percent of Total			
	Participants	Measures Installed	Quantity Installed	Annual kWh Savings	Participants	Measures Installed	Quantity Installed	kWh Savings
CFL	2,656	5,071	40,973	7,059,983	3.6%	2.9%	1.3%	0.8%
Control & EMS	4,035	15,049	61,860	23,906,662	5.5%	8.7%	1.9%	2.9%
Custom and Design	381	437	607	15,057,695	0.5%	0.3%	0.0%	1.8%
LED Interior fixture	3,356	9,278	87,771	50,676,461	4.6%	5.4%	2.8%	6.0%
LED Exit and Specialty	1,125	1,937	11,796	3,833,328	1.5%	1.1%	0.4%	0.5%
LED Exterior	233	327	841	2,857,873	0.3%	0.2%	0.0%	0.3%
LED Other	8,933	17,474	205,532	61,296,073	12.1%	10.1%	6.5%	7.3%
T5	3,372	25,558	203,772	32,645,833	4.6%	14.8%	6.4%	3.9%
T8 (Low Wattage T8)	11,481	28,729	324,222	57,461,951	15.6%	16.6%	10.2%	6.9%
Other Linear Fluorescent	3,650	14,542	135,464	30,805,813	5.0%	8.4%	4.3%	3.7%
Other	7,566	18,480	382,607	173,228,729	10.3%	10.7%	12.0%	20.7%
Upstream								
LED Other	21,620	28,013	618,139	184,348,390	29.3%	16.2%	19.4%	22.0%
T5	359	478	48,869	7,829,188	0.5%	0.3%	1.5%	0.9%
T8 (Low Wattage T8)	4,914	7,236	1,058,134	187,533,371	6.7%	4.2%	33.3%	22.4%
Unclassed	2	2	108	14,496	0.0%	0.0%	0.0%	0.0%
Total	73,683	172,611	3,180,695	838,555,845	100%	100%	100%	100%
Total Low Wattage T8	16,395	35,965	1,382,356	244,995,322	22.3%	20.8%	43.5%	29.2%

* Other includes measures coded as "induction," "holiday," "unclassified," "metal halide," "other lighting retrofit," and "circline light fluorescent"

2.1 HIGH-PERFORMANCE T8 LINEAR FLUORESCENTS

Our analysis of the tracking system data found that efficient linear T8 products are the largest single category of C&I lighting measures supported by the PAs' programs. Closer examination of the measure names showed that one measure—low-wattage T8 lamps—accounted for a large share of all lighting measures supported during the period. This measure consists of substituting low-wattage lamps (28 W) into existing T8 ballasts and fixtures that previously used 32 W lamps. These products are promoted heavily through the upstream lighting program in both the C&I Retrofit and New Construction programs.

Altogether, we identified 16,395 participants who received support for the low-wattage T8s. This is roughly 5 percent of all the PAs' commercial customers. The count includes multiple

instances of participation by individual customers and facilities, so it is not a perfect measure of program market share. However, even if we reduce the customer total to account for duplicates, the presence of the programs in the market is clearly quite large. Nearly 1.4 million lamps passed through programs over the three years. Viewed in the context of the programs, low-wattage T8s accounted for:

1. 44 percent of units rebated

2. 22 percent of participants

3. 21 percent of measures

4. 29 percent of tracked ex-ante savings.
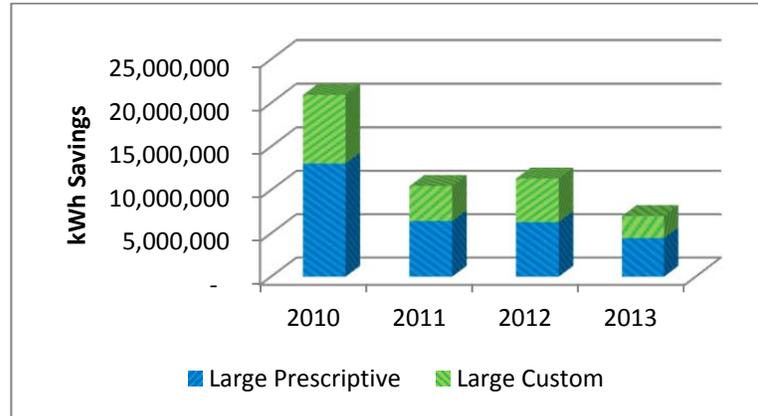
2.2   LIGHTING CONTROLS

According to recent market and technology studies, lighting controls offer considerable untapped potential for cost-effective energy savings in commercial facilities. A recent national commercial lighting market assessment estimated that less than one-third of total lighting energy use in the commercial sector was under automated controls.[2] A meta-analysis of 88 studies on energy savings achieved through installation of automated lighting controls found that the average savings ranged from 24 percent to 38 percent of baseline consumption, depending on the underlying control strategy.[3] The economics of lighting controls have improved considerably since these studies were undertaken due largely to the introduction of wireless and fixture-based technologies.

Despite high savings potential and low baseline saturation, control measures were conspicuous by their relative absence from program records. As Figure 2-1 shows, kWh savings from commercial lighting controls measures decreased significantly over the period 2010–2013. Only slightly more than 4,000 instances of controls installations were recorded relative to a population of roughly 345,000 C&I customers.

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[2] Navigant Consulting, Inc. 2012b. *2010 U.S. Lighting Market Characterization.* Washington D.C.: U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy.

[3] Williams, Alison, Barbara Atkinson, Karina Garbesi PhD, Erik Page, and Francis Rubinstein, "Lighting Controls in Commercial Buildings". *Leokos.* 83:3, January 2012, pp 161 – 180.

Figure 2-1. Retrofit Large C&I Lighting Controls Savings by Year

DNV GL recently completed a study to identify the reasons for the low and declining rate of lighting controls measure implementation in the PAs' programs.[4] The study team conducted interviews with lighting vendors and program administrators and completed a review of recent literature on lighting control technology, installation, and markets. This research identified significant remaining technical and economic potential for lighting controls, but did not develop any strong conclusions regarding the reasons for low and declining adoption of lighting controls through the program.

DNV GL would recommend undertaking a detailed baseline study of the commercial lighting controls market only if the PAs are considering significant redesign of programs and measures to support that technology. The Existing Building Market Characterization Study has collected on-site data on the presence of lighting controls and limited information on control types for a sample of 350 commercial facilities in Massachusetts. A modest effort to complement this information with data on the supply of lighting controls into replacement, retrofit, and new construction projects could be very useful in providing a more comprehensive view of the lighting controls market.

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[4] DNV GL. 2014. *Retrofit Lighting Controls Measures: Summary of Findings*. Massachusetts Energy Efficiency Program Administrators and Advisory Council. October 27, 2014.

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3. METHODS FOR QUANTIFICATION OF MARKET EFFECTS

As described in detail in the Massachusetts document "Methods for Measuring Market Effects of Massachusetts Energy Efficiency Programs,"[5] quantifying net savings from program market effects requires estimating the level of efficient product adoption (or changes in that level over time) for the market as a whole—not just for program participants. It also requires one or more analytic mechanisms by which to estimate the portion of the observed level of adoption that is attributable to the program. There are four general methods of estimating net savings stemming from market effects:

- Supply-side market actor self-reported counterfactual analysis

- Cross-sectional analysis, which may include time-series data

- Forecasting or retrocasting the non-intervention baseline

- Structured expert judgment.

Historical tracing, which relies on case studies, is a qualitative approach to assessing attribution of market effects to programs. It is a subset of theory-based evaluation.

The relative strengths and appropriate applications for each of the attribution methods are discussed at length in "Methods for Measuring Market Effects of Massachusetts Energy Efficiency Programs" and a number of recent methodological papers,[6] and will not be reviewed here. The following sections assess alternatives available for estimating levels of market adoption of low-wattage T8s and lighting controls (Section 3.1) and for assessing the attribution of observed levels of adoption to program operation for such equipment (Section **Error! Reference source not found.**).

3.1 ESTIMATING C&I LIGHTING MARKET SHARE AT THE MARKET LEVEL

The following discussion focuses on T8 technology, but the general observations can also be applied to other lamp technologies and controls. Market share data for low-wattage T8s is defined as the share of total linear fluorescent T8 lamps sold in a given period that is represented by low-wattage models. Information on sales (or purchases) of T8s and low-wattage models in Massachusetts can be developed from a number of sources, including:

- Surveys of lighting equipment distributors

- Compiled sales records maintained by paid panels of distributors

- Surveys of firms "downstream" from distributors, including lighting maintenance contractors, electrical contractors, lighting and general electrical equipment retailers

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[5] NMR Group & Tetra Tech. 2014. "Methods for Measuring Market Effects of Massachusetts Energy Efficiency Programs." Prepared for the Massachusetts Electric and Gas Program Administrators. November 14.

[6] Rosenberg, Mitchell & Lynn Hoefgen, 2009, *Market Effects and Market Transformation: Their Role in Energy Efficiency Program Design and Evaluation.* Prepared for California Institute for Energy and Environment; NMR Group, Inc., 2013, *A Review of Effective Practices for the Planning, Design, Implementation, and Evaluation of Market Transformation Efforts*, Prepared for the California IOUs.

- Surveys of customers and the planned market share assessment study.

In selecting a market share data collection method for a given product or service, we take into account the following:

- Market coverage – How much of the total flow of sales or purchases is a representative sample of the targeted group likely to capture? Analyses of the market for fluorescent lamps generally identify five sets of "events" that trigger lamp purchases—new construction, renovation, system retrofit, fixture replacement, and maintenance (simple lamp replacement). In the case of fluorescent lamps, several important branches of the supply chain skip the distributor. For example, manufacturers sell directly to large installation contractors for new construction, renovation and retrofit projects, and to lighting maintenance and retailers for simple lamp replacement.

- Accuracy – Are the respondents in a position to report accurately on the share of the subject technology they purchased or sold over the past one to two years? That is, can they distinguish between efficient and standard models? Are they likely to have first-hand knowledge of the quantity of sales or purchases? Are there records of the sales or purchases that can be validated independently? Are they likely to know the geographic area in which the equipment they sold was installed? What experience do researchers have with market share data provided by these sources?

- Sample frame and weighting Issues – Firms on the supply side of the market—in particular, distributors and contractors—vary greatly in terms of size, the portion of their business accounted for by lighting sales, and the downstream market segments they most often work with. Therefore, it is very important to estimate and take into account the portion of the total market each of those firms represents when estimating averages such as market share. This generally requires the use of a combination of third-party data, such as number of employees reported by Dun & Bradstreet, and self-reported information on the volume of unit sales for the equipment of interest. Neither of these sources is wholly accurate, so precautions must be taken in data collection and analysis to avoid wildly out-of-range results for individual respondents.

- Survey participation – What was the range of response rates for the survey and willingness to provide sales data? Do these raise concerns about non-response bias?[7]

- Replicability – Can the methods be implemented in a consistent way in different regions (to support cross-sectional analyses) and over time to trace changes in market share? Usually, replication requires that sample frames developed using similar methods be available in the different regions and time periods.

- Cost – Can the data be collected at a reasonable cost per unit? Costs will affect the extent to which desired levels of statistical precision can be achieved at a given budget.

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[7] Response rates for the T-12 phase-out study may help inform participation/response rates.

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Given the nature of the low-wattage T8 measure, surveys of customers are not likely to meet the accuracy criterion.[8] Representatives of small- and mid-size firms with little facility management infrastructure are unlikely to be able to distinguish between low-wattage and other kinds of lamps, and they are also unlikely to have an accurate idea of the volume of lamps purchased.

As end-use customers are unlikely to provide accurate data, supply chain actors may be a better option to provide data. For this decision, market coverage is the primary consideration. Unfortunately, little information is available on the relative volume of linear lamp sales through different channels in the supply chain. A recent study of commercial lighting in the Northwest estimates that 85 to 90 percent of linear lamp sales pass through distributors.[9] However, this report does not describe the method by which this estimate was developed. Moreover, this finding is at odds with the results of the most recent Commercial Market Share Tracking survey conducted by the California Public Utilities Commission, which found that 30 to 40 percent of commercial customers (weighted by consumption) purchased the bulk of their lighting equipment from retailers and other channels other than contractors and distributors.[10] Given these discrepancies and the generally blurry picture of the downstream portion of the fluorescent lamp supply chain, developing credible estimates of the relative size of the distributor and non-distributor channels will be a key first step. Depending on the findings from that step, it may be necessary to survey retailers and contractors to develop reliable estimates of technology shares.

As described below, recent market characterization and market effects studies have shown that it is feasible to collect useful information on T8 technology market share from distributors and contractors. Moreover, we have found that it is possible to replicate some of these methods in different regions and at different times to support cross-sectional and trend analyses. The following paragraphs summarize this experience in regard to specific sets of supply-side market actors.

3.1.1 Distributors

Survey approach. DNV GL (KEMA) used interviews with random samples of distributors to estimate market shares of various high-bay lighting technologies in studies conducted for the Massachusetts PAs and for the California Public Utilities Commission.[11] For the Massachusetts study, we used in-depth interviews with a small number of distributors to

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[8] The ongoing C&I Market Share study is a hybrid approach using onsite inspection to record bulb type, while customers provide additional information (e.g., when replaced, prior equipment type). While such an approach is feasible for the proposed market effects work, it is likely to be costly. However, the C&I Evaluation contractor should utilize data collected through the on-site assessment and Market Share studies to the extent possible.

[9] Navigant Consulting. Non-Residential Lighting Market Characterization. Bonneville Power Authority, January 2013.

[10] Itron, Inc. Final Report: Commercial Saturation and Commercial Market Share Tracking Study: Telephone Survey Findings. California Public Utilities Commission. September 2014.

[11] DNV GL (KEMA). High Bay Lighting Market Effects Study Final Report. Project 1A New Construction Market Characterization. Massachusetts Energy Efficiency Programs' Large Commercial & Industrial Evaluation. Prepared for the Massachusetts Energy Efficiency Program Administrators. June 7, 2011. KEMA, Inc. High Bay Lighting Market Effects Study. California Institute for Energy and Environment. 2010.

corroborate information gained from larger sample surveys of contractors. For the California survey, we conducted CATI surveys of lighting distributors in California (n = 142) and in a comparison area (n = 77). The results were used to develop market share estimates independent of those developed from the contractor survey results. In the California study, we asked distributors to estimate the total numbers of high-bay fixtures they sold in a year and the portion accounted for by competing technologies of higher and lower efficiency. We used this information in combination with sample frame data on number of employees to estimate average market share, using a ratio estimation procedure. The results were consistent with those obtained from customer and contractor surveys.

The strengths of the survey approach were:

- Relative ease of implementation

- Ability to deploy the approach consistently in the program and comparison areas

- Sufficiently large sample to develop statistical precision

- Coverage of the full range of distributor types.

The drawbacks of the survey approach were:

- Relatively low response rate raises the issue of non-response bias

- High level of effort to field the survey and obtain participation limits the opportunity to conduct frequent rounds of the survey

- The survey mode (telephone) does not allow for careful consideration of responses to market share and volume questions

- Only a small range of technologies can be covered without fatiguing or annoying the respondent

- There are no means to validate sales volume and market share responses independently.

Panel approach. A consortium of program administrators in the Northwest has recently commissioned the development of a distributor panel to track lighting equipment sales in the region. Distributors receive a stipend of $500 as well as access to aggregated survey results in return for filling out a detailed report on the number of ballasts and lamps they sold in the past year by technology (linear fluorescent, HID, LED) and types or efficiencies within those categories. The distributors so far have not been asked to provide sales records to validate these data. The most recent study from this effort[12] estimated energy savings resulting from program-induced changes to C&I lighting market shares based primarily on sales volume data obtained through interviews with 11 lighting distributors. (These distributors accounted for 35 to 55 percent of the total market). These data were combined with higher-level data from retailers and manufacturers, and with qualitative responses from distributors not willing

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[12] Navigant. Nonresidential Lighting Market Characterization: Determining the baseline and Estimating Non-programmatic Savings. Prepared for Bonneville Power Administration. January 7, 2013.

to submit sales data, to estimate the volume of sales and market share for efficient equipment.

The advantages of this approach relative to a more conventional survey are as follows:

- The respondents can provide more detailed information on specific products given the nature of the survey mode—filling out an emailed spreadsheet versus responding on the telephone

- It may be possible to request sales record validation of the self-reported data, although this has not proven feasible to date

- The survey can be redeployed more quickly than a CATI-type effort

- There are fewer issues in comparability over time since the same firms remain in the panel (although some attrition and replacement is likely over time)

- The process evaluation of the Bright Opportunities upstream commercial lighting program (KEMA, 2013) identified 50 participating distributors. Given the size of the state, these firms likely account for a very large portion of all distributor channel sales. The relationships established with these firms through the program will likely provide a resource for facilitating the development of a panel.

The disadvantages of the panel approach compared to the more conventional survey are:

- Given the expense and time required to build and maintain the panel, the sample size is too small to support the application of statistical techniques to estimate precision.

- The approach used in the Northwest can best be described as intentional sampling which targeted larger firms. Statistical methods cannot be used to assess representativeness of the sample or to "reweight" for representation of different types of firms.

- Our first impression is that it would be difficult to replicate this approach in a comparison area, given the lack of recognition of the program sponsors outside the Northeast. Perhaps with a very large payment to the distributors it could be possible, but local knowledge would likely be needed to select an appropriate sample.

3.1.2   Contractors

DNV GL has frequently used random sample surveys of contractors to develop estimates of technology shares in commercial lighting. We typically use the ratio estimation procedure described above for distributors to account both for stratum weights and differences between firms in volume of sales or installations of the subject equipment. We have applied this approach in both the high bay lighting studies mentioned above and in LED studies recently completed in California and Massachusetts. The primary advantage of this method, beyond those already described in the distributor section, is that it supports estimates of the relative volumes of products used in the different "event" streams, as well as closer observations of customer response. Its disadvantage in regard to lamps is that contractors likely see a relatively small portion of the total flow of lamps (as opposed to fixtures).

Contractors will likely be the best source of information on the market share of different types of lighting controls since most of those devices are installed by contractors.

3.1.3 Retailers

We are not aware of any studies that have attempted to estimate technology shares of linear fluorescents sold by retailers. Given that retailers do not, to our knowledge, receive incentives or marketing support from C&I programs, it is highly unlikely that they would provide sales data on linear fluorescents. It might be possible to obtain self-reported technology shares from the managers in charge of contractor and bulk sales.

3.1.4 End-use customers

DNV GL has recently completed collecting on-site building and equipment data in a sample of 350 commercial facilities in Massachusetts. As part of the lighting inventory for these facilities, we collected the customer's report of the date of installation for all lighting equipment groups. In 2015, we plan to analyze the details of lighting (and other equipment) of equipment reported installed since 2009. These data will include the basic technologies for linear lighting equipment, as well as narrowly defined efficiency categories for T8 lighting. The latter will be based on direct observation or look-ups of model numbers. We will also be able to develop data on the prevalence of different control types on recently purchased lighting installations.

It will be difficult to develop this level of detail on recently installed lighting from customers without going on site. The report of the recently completed California Commercial Market Share Tracking compared results from a nested sample of respondents who participated in both the telephone and on-site samples. This analysis found that respondents were able to report accurately on the presence of T8 and/or T12 lamps in a large majority of cases. However, the analysis did not report on the ability of customers to accurately identify efficient T8 models.

3.2 MARKET EFFECTS STUDY OF PROGRAMS THAT PROMOTE HIGH PERFORMANCE T8 LAMPS

3.2.1 Overview

DNV GL recommends that the PAs undertake a full retrospective study of the market effects of programs to promote high performance (HP) T8 lamps and ballasts, including quantification of net savings attributable to those programs over the past 2 – 3 years. The study will include the following components:

1. Development of program logic and market models and the definition of market indicators used to characterize market conditions.

2. Characterization of the broad range of program market effects, including changes in market actors' awareness and knowledge of the HP T8s, stocking and promotion of HP T8s in the supply chain, and adoption of the product by end users.

3. Estimation of net sales of HP T8s by Massachusetts commercial and industrial customers that were attributable to the program.

Table 3-1 summarizes the data collection and analysis efforts that we propose be undertaken as part of this analysis. In some cases we will be able to use the results of previous studies to conduct the planned analysis.

Table 3-1. Data Collection Efforts and Key Analytic Applications

* = optional task.
Italicized items represent original primary research for this project.

Data Source or Collection Effort	Product Adoption	Awareness, Knowledge, Business Importance
Analysis of Program Databases	Quantity of HP T8s sold through the program	Distribution of sales by customer size classification and type
Participant Surveys for Previous Evaluations	Free ridership rates for HP T8s	Awareness of HP T8s prior to purchase through the program Understanding of product performance Lighting purchase practices
Existing Building Market Characterization (Project 50) and Analysis of Recent Purchases (Project 41)	Total annual purchases of T8s (via analysis of recent projects and stock adjustment modeling of saturation). Market share of HP T8s	Lighting purchase practices and policies (phone survey)
Massachusetts Distributor Survey or Panel	Total annual sales of T8s Market share of HP T8s Assessment of program influence on HP T8 sales and market share Assessment of other influences on HP T8 sales	Current practices and changes over time regarding stocking, pricing, and promotion of HP T8s v. competing products Assessment of program influence on stocking, pricing, and promotion
Comparison Area Distributor Survey or Panel	Market share of HP T8s Identification of influences on customer T8 purchase decisions	Current practices and changes over time regarding stocking, pricing, and promotion of HP T8s v. competing products Influences on stocking, pricing, and promotion practices
Massachusetts and Comparison Area Retailer Surveys*	Total annual sales of T8s direct to commercial customers and contractors with commercial projects Market share of HP T8s in the customer direct and contractor channels Assessment of program influence on HP T8 Purchases (MA only)	
Secondary Research	Other studies on purchases and sales of T8s	Manufacturer and distributor views on technology and market development for linear fluorescents
Market expert	Backcast of baseline market share	Factors affecting customer

Data Source or Collection Effort	Product Adoption	Awareness, Knowledge, Business Importance
interviews or Delphi Process*	of HP T8s in Massachusetts in the absence of the program	acceptance and supplier promotion of HP T8s.

3.2.2   Development of program logic and market models and market indicators

The first major step in the analysis will be to develop program logic and market models along with conceptual and operational definitions of market indicators to characterize the market conditions and market actor behaviors identified in the models. DNV GL will work closely with PA program and evaluation staff and consultants to develop the program logic and market models in graphic form. We will then elaborate definitions for market indicators. Table 3 in the Appendix summarizes a preliminary set of market indicators. This set of indicators will be revised following the development of the program logic and market indicators.

3.2.3   Assessment of attribution and quantification of market effects

DNV GL's proposed approach to assessing program influence on the market for HP T8s will use the following analytic approaches.

- Compilation and analysis of customer and supply-side market actor reports of program influence on their adoption/promotion of HP T8s.

- Cross-sectional comparison of market indicators of awareness, knowledge, business relevance, and adoption for HP T8s between Massachusetts and a comparison area. The comparison area will comprise a population of businesses that resembles the PA's C&I customer base but that has not been served by public benefit programs to promote HP T8s.

- Expert judging of the effect of the program on the observed level of adoption of HP T8s in Massachusetts. This approach can be developed and fielded quickly if the results of the first two approaches are not conclusive.

Figure 3-1 illustrates the quantities that need to be estimated in order to calculate the net sales of HP T8s attributable to the program. The components of this calculation and the most likely sources of data for those calculations are as follows.

- **Total annual sales of T8 lamps.** The primary source for estimates of total annual sales of T8 lamps will be the analysis of recent lighting installations observed during the onsite inspections carried out for the Existing Buildings Characterization. We will use estimates based on a stock adjustment model populated by observed saturation of T8s to check estimates from the smaller set of observations on recent installations.

- **Market share/total sales of HP T8s in Massachusetts.** The primary source for this estimate will be surveys or sales diaries collected from a sample or panel of distributors. We will use the results of the analysis of recent lighting purchases conducted from Project 50 to check and corroborate the results of the distributor survey.

- **Baseline share of HP T8s sold in Massachusetts.** The market share of HP T8s sold by distributors in the comparison area will serve as a proxy measure for the baseline share in Massachusetts.

Figure 3-1. Relationship of Quantities used to Calculate Net Savings for Efficient Lighting
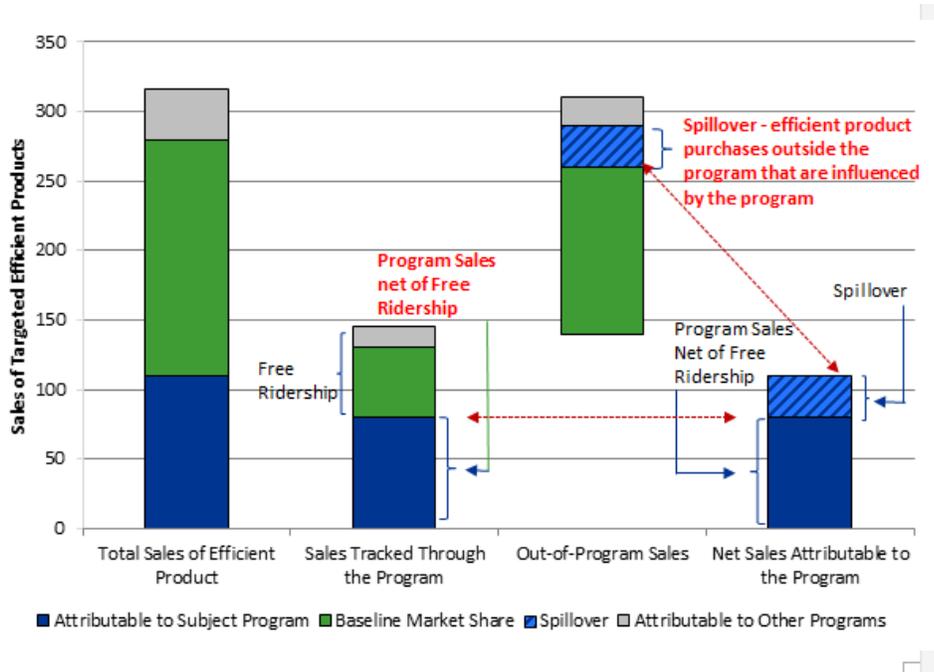
- **Sales of HP T8s through the PAs' programs.** DNV GL will analyze the program databases to calculate the number of HP T8s sold or installed through the various programs, including the Bright Opportunities upstream, the downstream retrofit, new construction, and direct install programs.

- **Free ridership.** We will use the results of the free ridership analyses for the individual program evaluations to estimate the free ridership rate for HP T8s purchased through those programs. These analyses were based on customer self-report surveys on the influence of the program on efficient product purchases.

- **Sales of HP T8s outside the program.** This quantity will be calculated using the results of the estimates of total T8 sales, HP T8 market share, and HP T8s sold through the PA's programs discussed above.

- **Spillover.** The portion of HP T8 sales outside the program attributed to spillover will be established through several steps. First we will subtract the portion of baseline sales not included in program sales from the total sales outside the program. Then we will apportion the remainder between spillover (sales influenced primarily by the PA programs) and other influences based on the results of surveys and in-depth interviews with different groups of market actors. If these steps do not yield conclusive results, additional analyses, such as a Delphi process, may be recommended.

Our rationale for recommending the use of a cross-sectional approach with a comparison area rests on the following observations.

- **Relatively stable market.[13]** Fluorescent lamp technology has been relatively stable over the past several years. This is not a dynamic technology, such as LEDs, which are experiencing rapid uptake even in areas without strong utility programs. Therefore, we believe a one-time, cross-sectional study will yield useful estimates of spillover for an extended period—say from 2011 to present.

- **Availability of comparison areas.** Based on recent work on the LED study, we identified a relatively large number of states that do not currently support efficient commercial lighting at all, or at only negligible levels. We believe it will be possible to find a sufficient number of "non-program" states to develop a comparison area.

- **Relatively low level of threats to validity due to differences between Massachusetts and a comparison area.** For a number of reasons, we believe that differences between Massachusetts and potential control areas on characteristics that may affect adoption rates of efficient equipment will pose less of a threat to validity than they have in other studies. Consider that the metric of interest is the share of T8 lamps represented by low-wattage models. Customers who converted from T12 to T8 technology will already have made the major investments involved. Most of the sales stream will be for simple replacement. Unlike retrofit or renovation events, the customer will generally not be facing a wide range of choices concerning timing, scale, or efficiency level of the purchase. Incremental unit costs are relatively low (about $0.50 per lamp) as are energy savings (8 to 12 kWh/year). Given all these factors, it is likely that a large portion of any observed differences in low-wattage T8 market share will be attributable to the results of program activity.

- **Proven feasibility of approach.** The general cross-sectional approach worked well for the High Bay Lighting studies, which are in many ways analogous.

3.2.4   Additional recommended study details

The following paragraphs provide high-level descriptions of recommended approaches for selected elements of the HP T8 market effects study. Detailed work plans will be developed by the C&I Evaluation team as part of the execution of the respective market effects research initiatives.

1. **Leverage existing research to map the supply chain for low-wattage T8s.** PA-sponsored market and evaluation research recently completed or currently underway should provide the key information needed to develop estimates of product flows through the distributors and other channels. The on-site surveys recently completed for Project 41 will provide accurate estimates of the saturation of T8s in existing commercial facilities and of the market share for HP T8s in recent installations. Combined with population information developed for the sample and information on effective useful life, the C&I evaluation team will attempt to develop a statewide control total for annual sales of T8 lamps for replacement. Surveys conducted for the High Bay Lighting and LED market effects studies will provide information from which totals can be estimated for sales associated with retrofit, fixture replacement, renovation, and new construction events.

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[13] Note EPACT has recently increased the level of activity in this market, manufacturers are introducing EPACT compliant T-12's, and businesses may be are moving to standard T-8s as the new baseline.

Once the control totals are developed, we can use information from preliminary contacts with distributors to determine, roughly, the share of T8 lamps that pass through the distributor channel. If that share falls below a threshold to be determined by the PAs, then it may be necessary to conduct research with retailers, lighting maintenance contractors, and/or electrical contractors.

2. **Identify comparison areas.** The C&I evaluation team will identify candidate states for inclusion in the comparison area using available databases on program activity maintained by ACEEE, DSIRE, and regional energy efficiency organizations. Once candidates are identified, the C&I evaluation team will conduct more detailed research on current program activities and plans as well as market conditions to identify states to be recommended for inclusion in the comparison area.

3. **Explore the feasibility of constructing a distributor panel in Massachusetts and in comparison areas.** The panel approach offers sufficient potential advantages over conventional surveys in terms of detail, breadth of technologies covered, and consistency over time to warrant a serious exploration. For the Massachusetts panel, we recommend undertaking a series of informal interviews with 10 to 15 distributors to assess their interest and capability. The C&I evaluation team can use a reworked version of the Navigant data collection template and participant report format to provide a concrete idea of the kinds of information for which they would be asked and the kinds of market data they would receive in return. Similar interviews would be undertaken with ten distributors in each of the states to be included in the comparison area. These distributors would be identified through commercially available directories. Based on the distributors' response to these interviews, the C&I evaluation team would develop a memorandum to the PAs with a proposal on how to proceed. The options to be weighed will include:

   a. Invest in developing panels in Massachusetts and the comparison area using the data collection and reporting approaches as is or with minor revisions

   b. Invest in developing the panel only in Massachusetts and using a more conventional survey approach in the comparison area

   c. Deploy a conventional survey approach in both Massachusetts and the comparison area.

   The memorandum will present the relative methodological advantages, estimated costs, and schedule for these three approaches or others the PAs may have identified.

   We will work with the PAs and EEAC consultants to coordinate market effects work with ongoing net-to gross studies.

4. **Recruit and initiate panels/conduct surveys.** If the PAs decide to proceed with developing the panel, the C&I evaluation team would develop a sample of participating and nonparticipating distributors and proceed to recruitment. The panel would be requested to keep a diary of technology sales over time, specifically 32 watt and 28 watt T8s and a few other technologies. The data collection form will also elicit broader observations on market trends and market shares prior to the upstream program.

5. **Conduct interviews with a sample of retailers and contractors, if indicated by the results of Step 1.** Conduct interviews with representatives for Home Depot,

Lowes, and other volume retailers who purchase directly from manufacturers, or investigate third-party data of shipments from such retailers. The C&I evaluation team must research the most appropriate means of obtaining sales data from this group of retailers, as they are likely to represent a substantial share of the market.

6. **Compile data required to estimate gross and net savings.** Leverage data from the other market characterization studies to provide estimates of important parameters for estimating savings. The C&I evaluation team would leverage data being collected through the LED market effects study, the existing buildings on-site study, and other relevant studies to obtain parameters such as hours of use, space types, and information needed to scale up to the market level.

7. **Estimate Net Savings.** The approach to estimating spillover savings will be similar to that used for the 2012 high-bay lighting market effects study.

As we have seen in other studies, use of a comparison area raises many issues in regard to comparability between the two regions in terms of factors that might affect adoption of efficient technologies. Given the dynamics of the market and energy efficiency policies, the ability of researchers to ensure comparability is constrained. We therefore will strive to limit any additional differences between regions that may arise due to study methods. First, the suggested method requires only one specific point of comparison between the regions – namely the market share of HP T8s as measured using distributor reports. Second, to the extent possible, the DNV GL team will deploy identical methods to capture information from distributors in Massachusetts and the comparison area. For example, even if it proves too costly or simply infeasible to create a distributor panel in comparison areas, we will use the same data collection methods to the extent possible. Specifically, we will apply the same approach to sampling, use the same data collection instruments, and pay the same incentives even if the costs of creating a distributor panel in the comparison areas are cost prohibitive.

3.3 LIGHTING CONTROLS MARKET EFFECTS STUDY

3.3.1 Baseline study for market effects assessment: lighting controls

The Market Effects Cross-cutting Evaluation team recommends the following steps in developing a baseline study for PA programs that promote lighting controls.

Assess the potential value of developing a baseline study on lighting controls. Given the relatively low level of program activity for controls, it may be best to undertake fairly low-cost research before proceeding to a full-scale study. The elements of this research would include the following:

- Review the results of the recently completed *Retrofit Lighting Controls Measure* study, which, among other things, questioned lighting distributors and contractors regarding the decline in participation and savings for lighting control measures over the period 2010–2013.

- Collect information on trends in sales, customer response, observed program effects, pricing, and performance from Massachusetts distributors in the course of assessing the feasibility of the lighting distributor panel described above. If the market is showing movement in any of those dimensions, it may be useful to move quickly on developing a controls baseline.

- Conduct similar in-depth interviews with a small sample of electrical contractors covering the same topics as the interviews with distributors.

- The C&I evaluation team will present the results of this research to the PAs along with recommendations regarding whether to proceed to a full baseline study and, if so, to develop a high-level work plan and budget.

Monitor market conditions. The evaluation team will continue to monitor program activity and developments in lighting control technology and markets via the distributor panel. If purchases of controls begin to increase through the program, outside the program, or both, we will notify the PAs and seek their views on whether proceed with a baseline study.

Conduct the baseline study. If the PAs decide to proceed to a full baseline study, the C&I evaluation team will develop a detailed work plan. The Market Effects Cross-cutting Evaluation team anticipates that the recommended approach will include the following steps:

- Conduct a series of market actor interviews to obtain additional data necessary for estimating market share and qualitative evidence of market effects

- Combine data from survey research with engineering data to estimate total gross demand and energy savings associated with lighting controls

- Compare gross savings estimates in Massachusetts to the comparison area savings estimates to identify total program-attributable demand and energy savings in Massachusetts

- Use program tracking data to remove program-attributable savings that are currently accounted for by the program

- Assess attribution of untracked energy efficient sales to the PA's energy efficiency programs.

4. INDICATOR TRACKING

Table 4-1 below provides a preliminary set of market indicators for use in market effects assessments for programs that promote low-wattage T8s and commercial lighting controls. These tables will be revised to reflect program logic and market models developed through the evaluation process.

Table 4-1. Preliminary Indicators of Progress toward Outcomes for Commercial Lighting & Controls

Short-Term Outcome	Indicator	Tracking Status	Indicator Source	Who Collects the Data	Source of Tracking Info	Possible Data Collection Issues
C&I customers receive information about program, energy-efficient equipment and lower product costs	Number of contractors who feature the program in their marketing efforts	Tracked - LEDs only	Contractor and end-user surveys	C&I Evaluation Team	End user and contractor surveys for LED and high bay lighting market effects	Surveys only report contractor referral for LEDs and high bay lighting. High bay lighting study data are from 2011. Requires additional data collection for promotion of non-LED and non-high-bay lighting.
Availability of EE equipment at same cost as standard equipment	Percent of products stocked in retail stores	Tracked	Retail shelf survey	C&I Evaluation Team	LED Market Effects study retail shelf survey	Data already collected for MA and comparison area.
Customers receive information about program, energy-efficient equipment and systems	Percentage of tenants/occupants who express awareness of the program	Tracked	End-user surveys	C&I Evaluation Team	Existing buildings customer survey; LED end-u	LED study only reports awareness of LED program. Additional data collection required for awareness of specific lighting programs.
	Percent of lamps specified in the past year by lamp type	Tracked	Lighting designer IDI; Lighting contractor survey	C&I Evaluation Team	LED Market Effects study contractor and distrit	Focuses on projects completed, not recommendations.
Program vendors promote and stock energy-efficient lighting	Percent of lighting projects by lamp type	Tracked	Lighting designer IDI; Lighting contractor survey	C&I Evaluation Team	LED Market Effects study contractor and distrit	

Intermediate-Term Outcome	Indicator	Tracking Status	Indicator Source	Who Collects the Data	Source of Tracking Info	Possible Data Collection Issues
Increased demand for energy-efficient equipment	Number of linear lighting projects	Tracked	Lighting designer IDI; Lighting contractor survey	C&I Evaluation Team	LED Market Effects study contractor and distrit	Data collected in 2014 for LED market effects study can be used to estimate technology shares by lighting type in MA and comparison-area states. Questions regarding specific changes to behavior focus primarily on LEDs. Additional data collection required to capture trends in other lighting types
	Percent of linear lighting projects by lighting type	Tracked	Lighting designer IDI; Lighting contractor survey	C&I Evaluation Team	LED Market Effects study contractor and distrit	
	Increase/decrease in linear lighting systems by fixture type	Tracked	Lighting designer IDI; Lighting contractor survey	C&I Evaluation Team	LED Market Effects study contractor survey and	

Intermediate-Term Outcome	Indicator	Tracking Status	Indicator Source	Who Collects the Data	Source of Tracking Info	Possible Data Collection Issues
Increase promotional activity for energy-efficient lighting and controls	Increased awareness of energy-efficient lighting	Data not collected	Contractor and end user surveys	N/A	N/A	These data were only collected for LEDs and High bay lighting. Additional data collection is required.
	Increased percent of customer request for energy-efficient lighting	Data not collected	Contractor and end user surveys	N/A	N/A	
	Increased percent of contractors promoting energy-efficient lighting	Data not collected	Contractor and end-user surveys	N/A	N/A	
	Increase in product promotional activity at retail stores.	Tracked	Retailer survey	N/A	LED Market Effects study retail shelf survey	Data are available for MA and comparison area.
Information and lower costs to encourage C&I customers to purchase EE equipment	Increase/decrease in linear lighting systems by fixture type	Tracked	Lighting designer IDI; Lighting contractor survey	C&I Evaluation Team	LED Market Effects study contractor survey and	Instrument does not focus on why shares increase or decrease for non-LED projects.
	Change in manufacturer and distributor costs of supplying energy-efficient lighting	Data not collected	Manufacturer and distributor interviews	N/A	N/A	These data were only collected for LEDs and High bay lighting. Additional data collection is required.

Long-Term Outcome	Indicator	Tracking Status	Indicator Source	Who Collects the Data	Source of Tracking Info	Possible Data Collection Issues
Manufacture/production of high efficiency lighting	Percentage of lighting products manufactured for distribution in Massachusetts	Data not collected	Manufacturer and distributor interviews	N/A	N/A	Coordinate with other lighting manufacturer in-depth interviews
Increased market penetration of energy-efficient lighting	Percentage of nonparticipant contractors surveyed who indicate that EE measures & techniques associated with the program are part of their standard practice	Data not collected	Nonparticipant contractor survey	N/A	No tracking information found	Could not find evidence of MF contractor survey.
Estimated program-attributable untracked spillover from energy-efficient lighting	Estimate total market for energy-efficient C&I lighting in MA and comparison area states	Tracked	Market effects model - MA End-user survey - MA Contractor survey - MA Lighting designer IDI	C&I Evaluation Team	LED Market Effects Study	Data were collected on all lighting technologies used in MA and comparison-area states. Use caution to remove market effects already accounted for in LED and High Bay Lighting market effects studies.
	Determine the net program savings	Available	Market effects model - Comparison area end-user survey - Comparison area contractor survey - Comparison area lighting designer IDI	Public information	Assessor's database	
	Removed program tracked savings and free riders	Tracked	PA Program tracking records	Program	Program records	Identify relevant program - remove LEDs.