



**Central Hudson Gas & Electric
Corporation**

Small and Mid-Sized Commercial Lighting Program

2010-2011 Impact Evaluation · March 2014

Prepared by:

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Executive Summary

Applied Energy Group, Inc. (“AEG”) was retained by Central Hudson Gas & Electric (“Central Hudson” or “Company”) to conduct an impact evaluation of its Small and Mid-Sized Commercial Lighting Program. The program is part of Central Hudson’s effort to help the State of New York meet its goal of reducing statewide electricity usage by 15% by 2015.

Central Hudson is a regulated transmission and distribution utility serving approximately 300,000 electric customers and 75,000 natural gas customers in New York State’s Mid-Hudson River Valley, which extends from the suburbs of metropolitan New York City to the Capital District of Albany.

The Small and Mid-Sized Commercial Lighting Program encourages small and mid-sized commercial customers to replace existing inefficient lighting with energy efficient interior lighting and lighting controls. Launched in 2011, the program includes over 2,000 businesses throughout the Central Hudson service territory.

Participants receive a free energy audit conducted by Alliance Energy Solutions (“Alliance”), the third-party program implementer. Incentives cover up to 70 percent of the equipment and installation costs. A financing program initiated by Central Hudson and approved by the New York Department of Public Service (“DPS”) provides zero percent financing to cover the remaining equipment and installation cost.

Table ES1 shows the net energy and demand savings attributable to the program. The program produced Engineering Analysis savings of 41,841,892 kWh and 12,684 kW.

Table ES1. Net Energy and Demand Savings

Market Segment	kWh Savings		kW Savings	
Small-Size	31,736,097		9,478	
Mid-Size	10,105,795		3,205	
Program Total	41,841,892		12,684	

Table ES2 presents the NTG factor for the program, which was derived from a participant survey conducted by AEG. The program resulted in a free ridership estimate of 17 percent and a spillover estimate of 8 percent. The overall NTG factor for the program is 91 percent.

Table ES2. Program Net-to-Gross Factor

Free Ridership	Spillover	NTG Factor
17%	8%	91%

This impact evaluation describes the methodology used by AEG to determine the energy and demand savings attributable to the Commercial Lighting Program. The impact evaluation reports the results of AEG’s savings analysis and assesses the overall cost-effectiveness of the program.

Introduction

Applied Energy Group, Inc. (“AEG”) was retained by Central Hudson Gas & Electric (“Central Hudson” or “Company”) to conduct an impact evaluation of its Small and Mid-Sized Commercial Lighting Program. The program is part of Central Hudson’s effort to help the State of New York meet its goal of reducing statewide electricity usage by 15% by 2015.

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The goal of this impact evaluation report is to show the net energy and peak demand savings that resulted from the program from 2010 through 2011. AEG determined the program savings using an Engineering Analysis analytic approach.

The purpose of the Engineering Analysis is to estimate the amount of expected savings from the program. This approach features an engineering analysis of program tracking data using algorithms from the *2010 New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs*¹ (“Tech Manual”). The Tech Manual is a public document that is designed to provide a standardized, fair and transparent approach for measuring program energy savings.

AEG conducted a participant survey in order to derive a net-to-gross (“NTG”) factor to estimate the net savings attributable to the program. The survey was designed to capture free ridership and spillover dynamics associated with the program.

Finally, AEG conducted a benefit-cost analysis to determine the cost-effectiveness of the program. This impact evaluation report provides more detail into the methodology and outcomes of AEG’s analysis.

¹ *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs*, Prepared for New York Department of Public Service by TecMarket Works, October 15, 2010.

1. Program Tracking Results

1.1 Data Cleaning and Processing

AEG received program tracking data from two third party implementers, Alliance Energy Solutions and Honeywell.² The data received from the third-party implementers had separate data sets for both the small and mid-size commercial market segments. The data sets were combined to form two distinct sets of data containing both market segments from each of the third party implementers. Most participant information was common to both data sets, including market segment, business name and address, measure quantity, and measure description. However, AEG performed comprehensive data cleaning and processing techniques to normalize the data sets to prepare the data set for analysis. The following sections provide detail on the data processing and cleaning.

Building Type

Building types were taken from the Tech Manual. The Tech Manual characterizes businesses first by facility type and then by a broader building type. The facility type is used to determine the full load operating hours of the facility, while the building type is used to determine the HVAC interactive effects.³ For reference purposes, AEG separated the projects into nine different building types based on the building type categories found in the Tech Manual.

The building types contained in the Alliance tracking data were mainly consistent with the Tech Manual facility types. Honeywell data did not contain any information to characterize facility types, AEG created a facility type field in the Honeywell data using the Alliance data as a guide. Facility types were systematically assigned to the Honeywell data based on the name, address and phone number of each business. The name of the business was the primary data point for assigning the facility type. Those facility types whose name did not sufficiently reveal the nature of the business were identified using an Internet search of the premise address and/or phone number.

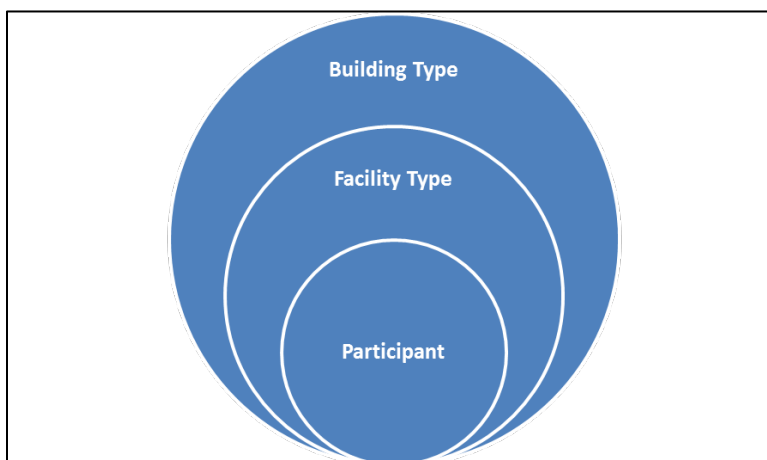
Figure 1 shows the hierarchical relationship between participants, facility types, and building types.⁴

² Honeywell was the implementation contractor from June 2009 to October 2010. Alliance was the implementation contractor from November 2010 to March 2012.

³ HVAC interactive effect multipliers can be found in Appendix D of the Tech Manual.

⁴ A full list of the building and facility types is included in Appendix E of this document.

Figure 1. Participant Classification Hierarchy



The potential loss of precision in estimating the facility type of the Honeywell data is reduced by how the variable factors into the savings equation. The facility type is relevant to the savings equation insofar as it corresponds to a building type, which is used to determine the HVAC interactive effects. According to Appendix D of the NY Tech Manual, the HVAC interactive effects multipliers are assigned based on the building type, which is a broader classification as shown in Figure 1.

Full Load Operating Hours

The full load operating hours (“FLH”) play a crucial role in evaluating the energy savings from lighting fixtures. The FLH represents the total number of hours per year that lighting is used at a given location.

The Tech Manual provides default FLH values for each building type based on the California Database for Energy Efficient Resources (“DEER”).⁵ AEG used the FLH provided by the Tech Manual for each building type to conduct the Engineering Analysis of projected energy savings.

AEG conducted a light logger analysis of program participants to measure the specific FLH values (see Section 2.1). AEG used the actual FLH from the light logger analysis to provide a comparison to Tech Manual EFLH values.

The FLH variable also factors into the energy savings estimates for lighting controls. Lighting controls reduce the lighting energy usage by reducing the total FLH. The efficient FLH (FLH_{ee}) used in estimating the energy savings for lighting controls reflects a 30 percent reduction in annual usage hours, which is considered standard industry practice.

Lighting Fixture Wattage

The difference in lighting wattages from the existing fixture to the more energy efficient measure is a critical component in determining the impacts of the program. The Alliance data contained wattage information for both the replaced fixture and the energy efficient lighting measure. The Honeywell data did not report wattage. Due to the lack of data in the Honeywell database, AEG estimated changes in wattage based on the Alliance data.

⁵ California Database for Energy Efficient Resources available at <http://www.deeresources.com/>

The Honeywell wattage data was estimated in the following manner. First, AEG determined an average wattage multiplier for each facility type in the Alliance data. The equation for determining the average wattage multiplier for any given facility is shown in Equation 1.

Equation 1. Watt Multiplier

$$Watt\ Multiplier = \frac{Watts_{base}}{Watts_{ee}}$$

Table 1 below shows the average wattage multipliers used to determine the existing wattages for each building type in the Honeywell data set. The wattage multipliers are derived from the Alliance program tracking data.

Table 1. Average Alliance Wattage Multiplier by Building Type and Market Segment

Building Type	Small-Size	Mid-Size	Program Total
Office / Retail	3.10	2.85	3.07
Industrial	2.88	2.65	2.83
Automotive	2.78	2.23	2.76
Assembly	3.07	3.13	3.07
School	2.88	2.70	2.82
Healthcare	2.83	2.61	2.78
Other	2.77	2.88	2.79
Food Service	3.40	2.59	3.34
Hotel / Motel	2.87	2.58	2.83
Program Total	2.98	2.74	2.95

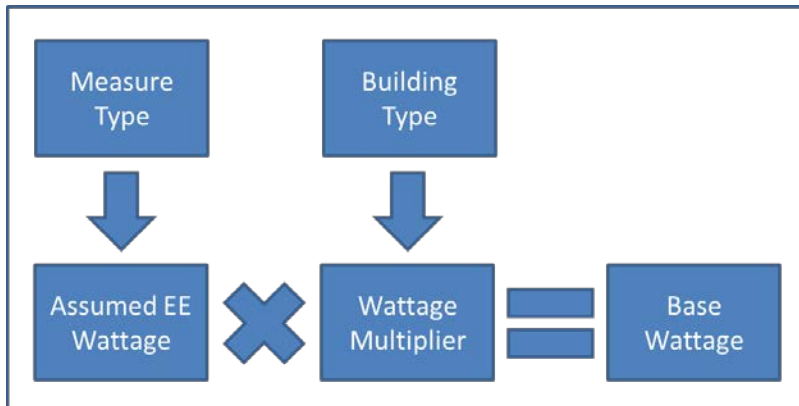
Next, AEG assigned wattages to each of the measures reported in the Honeywell information file based on the standard fixture wattages provided in the Tech Manual. Table 2 summarizes the wattage values utilized for the Honeywell information file. As noted above, AEG used the wattage multiplier to determine the existing wattage before the program was implemented. The assumed wattages were multiplied by the average wattage multiplier corresponding to the facility type. Using this approach accounted for differences in measure types between the two information file.

Table 2. Honeywell Wattage Assumptions

Measure Type	Measure Type	Watts	Source Description
CFL Energy Star Fixture	Lighting	130	Tech Manual App. C. Average W/Fixture, CFL Fixture
High Bay T5 or T8 Fixture	Lighting	66	Tech Manual App. C. Average W/Fixture, T5/T8 Fixture
LED Down-light ESTAR Fixture	Lighting	33	ENERGY STAR Qualified Light Fixtures Product List
LED Exit Sign ESTAR Fixture	Lighting	7	Tech Manual App. C. Average W/Fixture, LED Exit Sign
LPW 40 Pulse Metal Halide Fixture	Lighting	381	Tech Manual App. C. Average W/Fixture, Pulse Metal Halide Fixture
LPW 55 HP Sodium Fixture	Lighting	372	Tech Manual App. C. Average W/Fixture, High Pressure Sodium Fixtures
LPW 75 Pulse Metal Halide Fixture	Lighting	381	Tech Manual App. C. Average W/Fixture, Pulse Metal Halide Fixture
HE T8 Lamp	Lighting	29	Tech Manual App. C. Average W/Lamp, Super T8
T5 Lamp	Lighting	40	Tech Manual App. C. Average W/Lamp, T5
T8 Lamp	Lighting	32	Tech Manual App. C. Average W/Lamp, Standard T8

Figure 2 provides a graphical summary of how the measure and building type are used to determine the base wattage for the Honeywell program tracking data.

Figure 2. Honeywell Wattage Estimation Method



The Honeywell tracking information file indicated that several projects included additional features that increased the efficiency of the lighting measure. In order to capture these additional savings, AEG applied a factor percentage to the overall savings for projects equipped with these features.

The Honeywell information file included separate line items for measure features that are not typically associated with a wattage value (e.g. ballasts, specular reflectors, etc.). According to AEG experience,

the factors are described in Table 3.⁶ The factors are appropriate in this analysis since they represent conservative estimates of the additional savings attributed to the lighting feature.

Table 3. Honeywell Lighting Feature Factors

Lighting Feature	Factor
Specular Reflectors	14%
HE T8 Ballast	5%
T5 Ballast	5%
T8 Ballast	5%

Lighting Controls Wattage

In the absence of primary data for each building regarding the load connected to lighting controls, AEG estimated the connected load of controlled lighting fixtures (*Watts_{ctrl}*) based on the prototypical commercial building types found in Appendix A of the Tech Manual. First, the total lighting wattage of each building type was calculated as the product of the total square feet and the watts per square foot using prototypical building data found in the Tech Manual. AEG estimated that the load connected to the lighting controls was approximately 2 percent of the total lighting wattage for any given building type. Determining the connected load in this way reflects a conservative estimate based on standard industry assumptions. The table below shows the assumptions and values used in the analysis.

Table 4. Lighting Controls Connected Load by Building Type

Building Type	Total Lighting Wattage	Connected Watts
Auto Related	11,330	227
Assembly	114,688	2,294
Elementary School	182,150	3,643
Food Service	10,260	205
Industrial	186,000	3,720
Large Office	525,000	10,500
Small Office	18,500	370
Other	149,704*	2,994

* Average of all building type lighting wattages

1.2 Program Tracking Results

Participation reflects the number of customer sites who completed projects through the program. A “project” is defined as a group of measures of the same type installed at the location of a participating customer. There may be multiple projects installed at a participants’ location with each project consisting of multiple measures.. Figure 2 shows the structure of the program tracking data, which includes participants, projects, and measures.

⁶ Lighting assumptions are based on the judgment of an internal AEG lighting expert with 27 years of experience commercial lighting sector.

Figure 3. Program Tracking Data Hierarchy

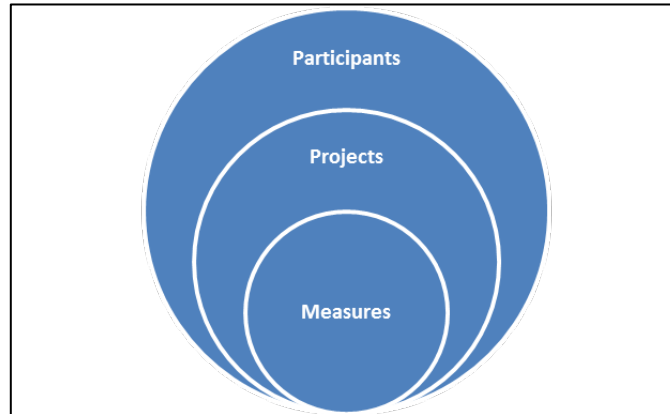


Table 5. Program Tracking Results by Market Segment, 2010-2011

Market Segment	Participants	Projects	Measures
Small-Size	1,879	7,080	111,587
Mid-Size	183	895	41,731
Program Total	2,062	7,975	153,318

Market Segment	Participants	Projects	Measures
Small-Size	91%	89%	73%
Mid-Size	9%	11%	27%
Program Total	100%	100%	100%

Tables 6 through 8 summarize the participants, projects, and measures by building type.

Table 6. Total Participants by Building Type, 2010-2011

Building Type	Small-Size	Mid-Size	Program Total
Office/Retail	648	37	685
Automotive	371	7	378
Industrial	292	52	344
Assembly	210	16	226
Food Service	167	20	187
School	62	28	90
Healthcare	60	11	71
Other	37	7	44
Hotel/Motel	32	5	37
Program Total	1,879	183	2,062

Building Type	Small-Size	Mid-Size	Program Total
Office/Retail	31.4%	1.8%	33.2%
Automotive	18.0%	0.3%	18.3%
Industrial	14.2%	2.5%	16.7%
Assembly	10.2%	0.8%	11.0%
Food Service	8.1%	1.0%	9.1%
School	3.0%	1.4%	4.4%
Healthcare	2.9%	0.5%	3.4%
Other	1.8%	0.3%	2.1%
Hotel/Motel	1.6%	0.2%	1.8%
Program Total	91.1%	8.9%	100.0%

Table 7. Total Projects by Building Type, 2010-2011

Building Type	Small Size	Mid-Size	Program Total
Office/Retail	2,552	252	2,804
Automotive	1,366	49	1,415
Industrial	1,130	279	1,409
Assembly	997	80	1,077
School	260	108	368
Food Service	328	24	352
Hotel/Motel	167	30	197
Healthcare	145	36	181
Other	135	37	172
Program Total	7,080	895	7,975

Building Type	Small Size	Mid-Size	Program Total
Office/Retail	32.0%	3.2%	35.2%
Automotive	17.1%	0.6%	17.7%
Industrial	14.2%	3.5%	17.7%
Assembly	12.5%	1.0%	13.5%
School	3.3%	1.4%	4.6%
Food Service	4.1%	0.3%	4.4%
Hotel/Motel	2.1%	0.4%	2.5%
Healthcare	1.8%	0.5%	2.3%
Other	1.7%	0.5%	2.2%
Program Total	88.8%	11.2%	100.0%

Table 8. Total Measures by Building Type, 2010-2011

Building Type	Small-Size	Mid-Size	Program Total
Office/Retail	38,318	13,375	51,693
Industrial	17,054	11,075	28,129
Assembly	18,891	2,944	21,835
School	9,809	8,012	17,821
Automotive	13,653	535	14,188
Hotel/Motel	4,817	948	5,765
Healthcare	3,063	2,672	5,735
Other	3,520	1,848	5,368
Food Service	2,462	322	2,784
Program Total	111,587	41,731	153,318

Building Type	Small-Size	Mid-Size	Program Total
Office/Retail	25.0%	8.7%	33.7%
Industrial	11.1%	7.2%	18.3%
Assembly	12.3%	1.9%	14.2%
School	6.4%	5.2%	11.6%
Automotive	8.9%	0.3%	9.3%
Hotel/Motel	3.1%	0.6%	3.8%
Healthcare	2.0%	1.7%	3.7%
Other	2.3%	1.2%	3.5%
Food Service	1.6%	0.2%	1.8%
Program Total	72.8%	27.2%	100.0%

The tracking data revealed several different measure types that were included in the program. The miscellaneous category includes lighting measures that could not be identified as belonging to the other categories. Table 9 shows the total number of measures by measure type.

Table 9. Total Measures by Measure Type, 2010-2011

Measure Type	Small-Size	Mid-Size	Program Total
T8	84,170	30,146	114,316
Misc.	13,996	4,512	18,508
CFL	5,636	3,324	8,960
T5	4,459	2,428	6,887
Exit Sign	3,051	1,011	4,062
Controls	265	70	335
Delamping	2	240	242
LED	8	0	8
Program Total	111,587	41,731	153,318

Building Type	Small-Size	Mid-Size	Program Total
T8	54.9%	19.7%	74.6%
Misc.	9.1%	2.9%	12.1%
CFL	3.7%	2.2%	5.8%
T5	2.9%	1.6%	4.5%
Exit Sign	2.0%	0.7%	2.6%
Controls	0.2%	0.0%	0.2%
Delamping	0.0%	0.2%	0.2%
LED	0.0%	0.0%	0.0%
Total	72.8%	27.2%	100.0%

2. Gross Energy and Demand Savings Verification

AEG determined the gross energy and demand savings for the Commercial Lighting Program based on the International Performance Measurement and Verification Protocols (IPMVP) Options A and B. AEG conducted both an Engineering Analysis and Metering Study savings verification analysis to determine the impacts of the Commercial Lighting Program. The Engineering Analysis determines the projected amount of energy savings based on assumptions found in the Tech Manual and calculated using data that reflects the expected outcome of the program. By contrast, the Meter Study directly evaluates the lighting EFLH based on primary participant data.

2.1 Savings Verification Methodology

AEG determined the energy (kWh) and peak demand (kW) savings for the Commercial Lighting Program using algorithms from the 2010 New York Technical Reference Manual (“Tech Manual”). The Tech Manual provides savings algorithms for both measure types, lighting fixtures and lighting controls, offered through the program.

AEG used the following Tech Manual formulae to estimate the energy (kWh) and peak demand (kW) savings for commercial lighting fixtures.

Equation 2. Commercial Interior Lighting Fixtures Savings Algorithms

$$\Delta kW_s = \left[\frac{(Watts \times Units)_{base} - (Watts \times Units)_{ee}}{1000} \right] \times CF \times (1 + HVAC_{d,s})$$

$$\Delta kWh = \left[\frac{(Watts \times Units)_{base} - (Watts \times Units)_{ee}}{1000} \right] \times FLH \times (1 + HVAC_c)$$

Where:

ΔkW_s	= gross summer coincident demand savings
ΔkWh	= gross annual energy savings
$Units$	= number of units installed under the program
$Watts_{ee}$	= connected load of the energy-efficient unit
$Watts_{base}$	= connected load of the baseline unit(s) displaced
FLH	= full-load operating hours
CF	= coincidence factor
$HVAC_{d,s}$	= HVAC system interaction factor at utility summer peak hour
$HVAC_c$	= HVAC system interaction factor for annual energy consumption

AEG utilized the following Tech Manual formulae to estimate the energy (kWh) and peak demand (kW) savings for commercial lighting controls.

Equation 3. Commercial Lighting Controls Savings Algorithms

$$\Delta kW_s = Units \times \left(\frac{Watts_{ctrl}}{1000} \right) \times DSF_s \times (1 + HVAC_{d,s})$$

$$\Delta kWh = Units \times \left(\frac{Watts_{ctrl}}{1000} \right) \times (FLH_{base} - FLH_{ee}) \times (1 + HVAC_c)$$

Where:

ΔkW_s	= gross summer coincident demand savings
ΔkWh	= gross annual energy savings
$Units$	= number of control units installed under the program
$Watts_{ctrl}$	= connected load of controlled lighting fixtures
DSF_s	= coincident demand savings factor
FLH	= full-load operating hours
$HVAC_c$	= HVAC system interaction factor for annual energy consumption
$HVAC_{d,s}$	= HVAC system interaction factor at utility peak hour

2.2 Metering Study Methodology

As noted above, the Metering Study analysis estimates the savings impact of the Commercial Lighting program using primary participant usage data in the savings algorithms. In order to accomplish this task, AEG conducted a study to determine lighting usage patterns among commercial customers in Central Hudson's service territory to support the impact evaluation. The study included a total of twenty (20) participants on a voluntary basis in response to the metering study, who were recruited as part of the net-to-gross survey sample. The light logger results represent the lighting usage patterns of businesses who participated in the Commercial Lighting Program and agreed to participate in the metering portion of the study. As a result, the light logger results are based on a non-probability sample and do not constitute a statistically significant representation of all building types within Central Hudson's service territory. The light logger study was limited to 20 participants based on budget and project timeline. The results of the Metering Study are for information purposes only and should not be used to determine program impacts across all participants. Further study of a representative sample of all building types in the Central Hudson service territory is being discussed as an option for future study. AEG contracted Honeywell to install up to ten (10) light logger devices at the business locations of each participating customer. The light logger devices recorded the lighting usage data at the customer site over a period of approximately one month between February and March of 2013. At the conclusion of the study Honeywell provided the light logger data to AEG for verification and analysis.

Light Logger Data Analysis

Two different brands of logger devices, Sensor Switch® and HOBO®, were used to conduct the study. AEG performed identical data analyses on the data exported from each light logger.⁷ Runtime and date information from each logger device was exported to an Excel spreadsheet to conduct the data analysis.

Using the individual light logger data AEG determined the average weekly hours of use by calculating the average lighting "on" hours for each weekday, Sunday through Saturday. The sum of these daily

⁷ For a more detailed overview of the light logger data analysis refer to Appendix D. Light Logger Data Analysis.

averages reflects the average weekly usage hours for each light logger. Approximately half of the data sets for each participant contained information identifying the location of the logger device (i.e. office, sales floor, hallway, etc.). The average weekly hours for each location were weighted in proportion to the square footage where the logger was located within the facility. Assumptions regarding the square footage of each identified logger area were based on the prototypical building information found in Appendix A of the Tech Manual. The average weekly hours for unidentified loggers was weighted in proportion to the total weekly usage for that facility. Assumptions regarding building specifications and logger locations are based on industry expertise and are not statistically significant. To determine the estimated full load operating hours (FLH) per year, the average weekly usage hours were multiplied by 50.3 weeks per year (353/365, to account for business holidays).⁸ Any seasonal impacts on lighting usage were assumed to be minimal and were not included in the estimation of annual FLH.

The FLH for the various sites were grouped and averaged according to the facility and building types. Overall, light logger participants operated their businesses in eleven unique building types. The full load operating hours from the light logger study compared to the Tech Manual operating hours are shown in Table 10. Overall the light logger FLH results were generally less than those provided by the Tech Manual, with an average difference of approximately 25 percent.

Table 10. Light Logger Results by Building Type

Facility Type	Participants	Average FLH	TRM FLH	Δ%
Office (General Office Types)	2	2,520	3,100	-19%
Retail	2	2,602	4,057	-36%
Multi-Family (Common Areas)	1	7,122	7,665	-7%
Library	1	3,217	3,748	-14%
Manufacturing Facility	1	2,183	2,857	-24%
Nursing Homes	1	6,439	5,840	10%
Office/Retail	2	2,453	3,748	-35%
Workshop	1	2,748	3,750	-27%
Food Stores	1	5,114	4,055	26%
Auto Related	2	2,436	4,056	-40%
Industrial - 1 Shift	1	4,209	2,857	47%
Dining: Bar Lounge/Leisure	1	1,396	4,182	-67%
Police / Fire Stations (24 Hr.)	1	4,593	7,665	-40%
Waste Water Treatment Plant	2	2,106	6,631	-68%
Fire Station (Unmanned)	1	641	1,953	-67%
Total	20	3,319	4,411	-25%

There are several possible reasons that account for the steep variance between the FLH from the Tech Manual and the light logger study. First, participants do not represent a statistical sample of the Central Hudson program participants, nor the entire New York region, as reflected in the Tech Manual FLH values. A potential sampling bias arises insofar as participation in the study was voluntary. Participants in the Commercial Lighting Program may exhibit a greater propensity for saving energy, thus lowering

⁸ AEG estimated that businesses would be closed on 12 days throughout the year to account for ten federal holidays plus an additional 2 days to account for discretionary holidays.

the overall lighting usage of the study. The light logger study reflects primary usage data of participants, but it cannot be reliably applied any customers outside the small sample group.

2.3 Gross Savings Verification Results

AEG determined the Engineering Analysis gross energy and demand savings based on the methodology described in Section 2.1. The following sections present AEG’s findings for the Engineering Analysis savings results.

Gross Energy Savings by Market Segment

Using the methodology described above, AEG determined that the Commercial Lighting Program resulted in a gross Engineering Analysis savings of over 45,923 MWh and over 13.9 MW, with the majority of savings coming from the small commercial market segment. Table 11 summarizes the gross Engineering Analysis savings results for the Commercial Lighting Program.

Table 11. Gross Engineering Analysis Energy (kWh) and Demand (kW) Savings

Market Segment	kWh Savings	kW Savings
Small-Size	34,831,597	10,403
Mid-Size	11,091,501	3,518
Program Total	45,923,098	13,921

Gross Energy Savings by Building Type

Table 12 shows the gross energy savings by building type for the Engineering Analysis. More than half of total program savings came from the combination of office/retail and industrial building types. The next largest savings contributions are assembly and automotive building types.

Table 12. Gross Engineering Analysis Energy (kWh) Savings by Building Type

Building Type	Small-Size	Mid-Size	Program Total
Office/Retail	11,514,091	2,800,962	14,315,053
Industrial	5,463,322	3,743,474	9,206,796
Assembly	6,034,570	1,012,867	7,047,437
Automotive	5,484,254	234,120	5,718,375
School	1,658,014	1,279,144	2,937,158
Healthcare	1,553,637	1,118,679	2,672,316
Other	1,431,022	643,935	2,074,958
Food Service	905,432	85,714	991,146
Hotel/Motel	787,254	172,605	959,859
Program Total	34,831,597	11,091,501	45,923,098

Building Type	Small-Size	Mid-Size	Program Total
Office/Retail	25.1%	6.1%	31.2%
Industrial	11.9%	8.2%	20.0%
Assembly	13.1%	2.2%	15.3%
Automotive	11.9%	0.5%	12.5%
School	3.6%	2.8%	6.4%
Healthcare	3.4%	2.4%	5.8%
Other	3.1%	1.4%	4.5%
Food Service	2.0%	0.2%	2.2%
Hotel/Motel	1.7%	0.4%	2.1%
Program Total	75.8%	24.2%	100.0%

Tables 13 shows the gross Engineering Analysis demand savings by building type, revealing similar patterns in the savings distribution by building type.

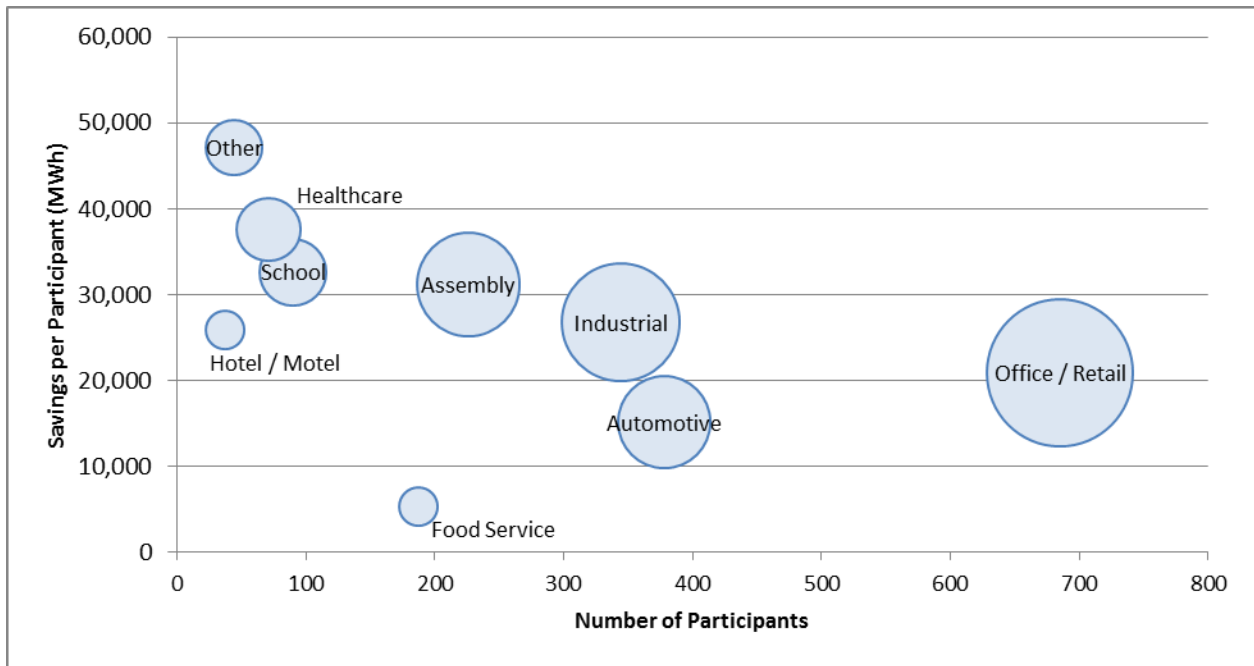
Table 13. Gross Engineering Analysis Demand (kW) Savings by Building Type

Building Type	Small-Size	Mid-Size	Program Total
Office/Retail	3,337	886	4,223
Industrial	1,960	1,331	3,291
Assembly	1,660	209	1,870
Automotive	1,526	63	1,589
School	868	650	1,518
Other	304	122	425
Healthcare	236	170	406
Hotel/Motel	299	62	361
Food Service	213	25	239
Program Total	10,403	3,518	13,921

Building Type	Small-Size	Mid-Size	Program Total
Office/Retail	24.0%	6.4%	30.3%
Industrial	14.1%	9.6%	23.6%
Assembly	11.9%	1.5%	13.4%
Automotive	11.0%	0.5%	11.4%
School	6.2%	4.7%	10.9%
Other	2.2%	0.9%	3.1%
Healthcare	1.7%	1.2%	2.9%
Hotel/Motel	2.1%	0.4%	2.6%
Food Service	1.5%	0.2%	1.7%
Program Total	74.7%	25.3%	100.0%

Figure 4 summarizes the energy savings results by building type according to number of participants (x-axis) and gross Engineering Analysis savings per participant (y-axis). The size of the data points represents the gross savings per participant for each of the nine building types.

Figure 4. Gross Savings by Building Type Summary



Gross Energy Savings by Measure Type

Table 14 summarizes the Engineering Analysis energy savings by measure type for both the small- and mid-sized market segments.

Table 14. Gross Engineering Analysis Energy (kWh) Savings by Building Type

Measure Type	Small-Size	Mid-Size	Program Total	Measure Type	Small-Size	Mid-Size	Program Total
T8	25,119,361	7,060,277	32,179,638	T8	54.7%	15.4%	70.1%
Misc.	4,476,168	1,509,786	5,985,954	Misc.	9.7%	3.3%	13.0%
T5	3,585,198	1,769,668	5,354,866	T5	7.8%	3.9%	11.7%
CFL	1,140,767	472,684	1,613,451	CFL	2.5%	1.0%	3.5%
Controls	347,657	78,024	425,681	Controls	0.8%	0.2%	0.9%
Exit Sign	157,384	61,103	218,487	Exit Sign	0.3%	0.1%	0.5%
Delamping	2,401	139,959	142,360	Delamping	0.0%	0.3%	0.3%
LED	2,661	0	2,661	LED	0.0%	0.0%	0.0%
Program Total	34,831,597	11,091,501	45,923,098	Total	75.8%	24.2%	100.0%

Table 15 summarizes the Engineering Analysis energy savings by measure type for both the small- and mid-sized market segments.

Table 15. Gross Engineering Analysis Demand (kW) Savings by Measure Type

Measure Type	Small-Size	Mid-Size	Program Total	Measure Type	Small-Size	Mid-Size	Program Total
T8	7,377	2,173	9,550	T8	53.0%	15.6%	68.6%
Misc.	1,369	447	1,816	Misc.	9.8%	3.2%	13.0%
T5	1,157	637	1,794	T5	8.3%	4.6%	12.9%
CFL	368	172	540	CFL	2.6%	1.2%	3.9%
Controls	83	20	103	Controls	0.6%	0.1%	0.7%
Exit Sign	47	16	62	Exit Sign	0.3%	0.1%	0.4%
Delamping	1	54	55	Delamping	0.0%	0.4%	0.4%
LED	1	0	1	LED	0.0%	0.0%	0.0%
Total	10,403	3,518	13,921	Total	74.7%	25.3%	100.0%

3. Net Energy and Demand Savings

Net energy and demand savings are the direct savings attributable to the Commercial Lighting Program while accounting for free ridership and spillover impacts. The NTG ratio represents an adjustment of the gross energy and demand savings to account for free ridership impacts and an upward adjustment for spillover impacts. Equation 4 expresses the NTG ratio in mathematical terms.

Equation 4. Net-to-Gross Ratio

$$NTG \text{ Ratio} = 1 - \text{Free Ridership} + \text{Spillover}$$

In October 2012, AEG conducted a survey of 72 Central Hudson customers who participated in the Commercial Lighting Program. The survey results are based on a stratified random sample of program participants. Table 16 shows the number of completed surveys stratified according to building type compared to the actual distribution of the program.⁹ Although the program tracking data cleaning was conducted after the survey was administered, the building type distribution between the program and the sample is comparable.

Table 16. Phone Survey Sample Stratification

Building Type	Program	Sample
Office/Retail	33%	28%
Industrial	17%	14%
Automotive	18%	13%
Assembly	11%	18%
School	4%	10%
Healthcare	3%	6%
Other	2%	N/A
Food Service	9%	8%
Hotel/Motel	2%	4%
Total	100%	100%

Survey results have a margin of error of +/- 10 percent at a 90 percent level of confidence. The survey was designed to capture free ridership and spillover in order to determine the net-to-gross ratio for the program. The following sections describe the methodology for using the survey results to determine the NTG factor and the net savings attributable to the program.

⁹ Note that the stratification and the survey were completed before the data cleaning for the engineering analysis was finalized.

3.1 Free Ridership

Free ridership estimates the energy savings that would have been achieved without the incentives provided through the Commercial Lighting Program. Two survey questions were designed to reveal the portion of savings that are attributed to free ridership. For each question each participant was assigned a value based on the probability that they are a free rider. The weighted mean of the free ridership probabilities provides an estimate of free ridership for the entire Commercial Lighting Program. The following two tables present the participant probability by survey question.

Free Ridership Question 1

QF1a. Were you planning to purchase new lighting with the EXACT SAME EFFICIENCY within three months before or after purchasing this equipment?

Q1 Free Ridership Probability	Min	Max	Est.
Yes	0%	50%	25%
No	0%	0%	0%

Free Ridership Question 2

QF1d. How likely is it that you would have purchased and installed equipment with the EXACT SAME EFFICIENCY within 3 months of when you did participate in the program if the utility had NOT OFFERED the PROGRAM?

Q2 Free Ridership Probability	Min	Max	Est.
Very Unlikely	0%	0%	0%
Somewhat Unlikely	10%	30%	20%
Neither Likely or Unlikely	30%	50%	40%
Somewhat Likely	50%	70%	60%
Very Likely	70%	90%	80%

AEG was able to estimate the amount of free ridership based on the responses to each question. Tables 17-19 show how the survey results were used to determine the free ridership results.

Table 17. Free Ridership Estimate, Question 1

Response	FR Probability	Count	Weight	FR Estimate	Q1 FR Estimate
Yes	25%	11	0.15	0.04	4%
No	0%	61	0.85	0.00	

Table 18. Free Ridership Estimate, Question 2

Response	FR Probability	Count	Weight	FR Estimate	Q2 FR Estimate
Very Unlikely	0%	47	0.66	0.00	13%
Somewhat Unlikely	20%	13	0.18	0.04	
Neither Likely or Unlikely	40%	4	0.06	0.02	
Somewhat Likely	60%	4	0.06	0.03	
Very Likely	80%	3	0.04	0.03	

By combining the free ridership estimates from question 1 and 2, Table 24 shows that 17 percent of energy savings would have been achieved absent the Commercial Lighting Program.

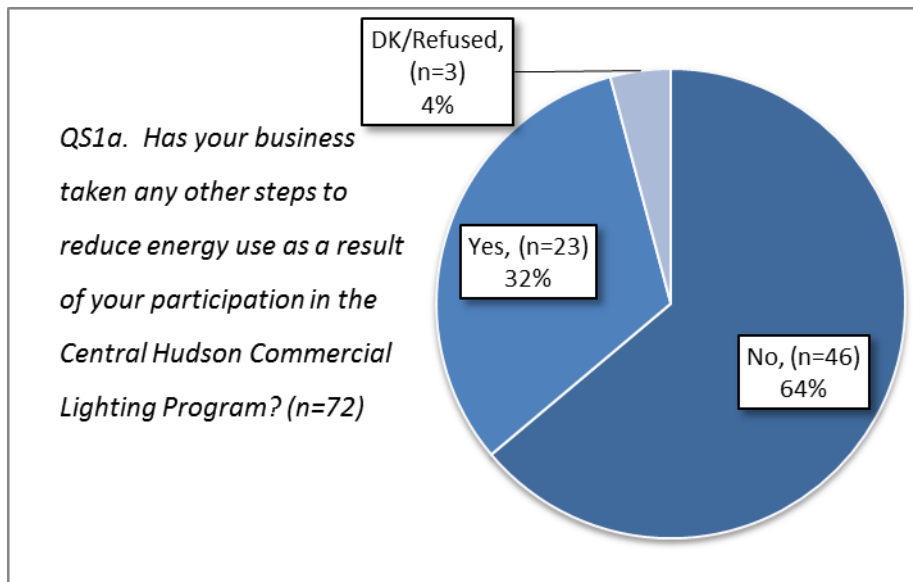
Table 19. Program Free Ridership Estimate

Q1 FR Estimate	Q2 FR Estimate	Total FR Estimate
4%	13%	17%

3.2 Spillover

Spillover represents the estimated portion of energy savings that occurred as a result of the Commercial Lighting Program, but were not directly incentivized through the program. Participants were asked a series of questions to determine the spillover impacts attributable to the program. The questions and scoring method are outlined below.

Spillover Question 1



Spillover Question 2

QS1b. Have you completed any of the following actions at this site as a result of your participation in the program? (Mark all that apply)*

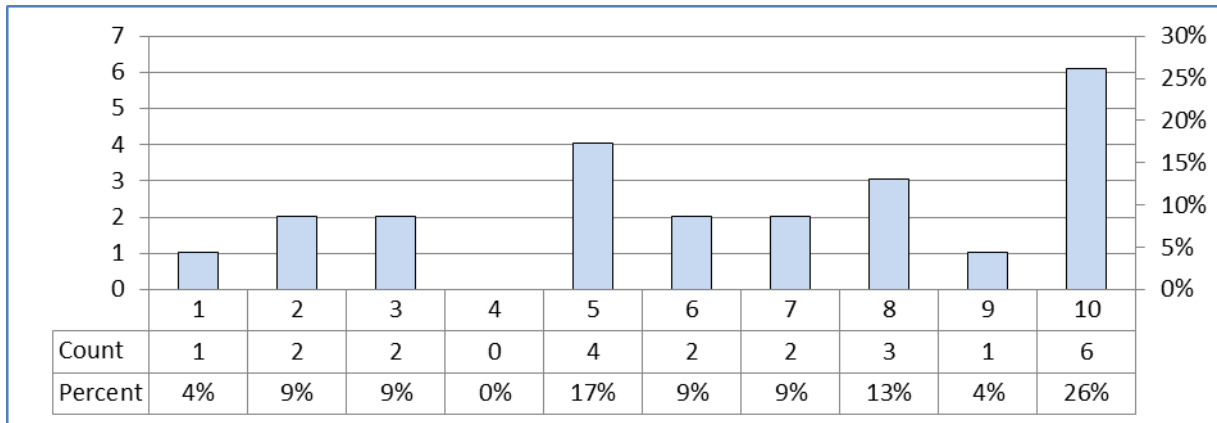
Response	Count	Percent (n=72)
Shared your experience in the Commercial Lighting Program with other business, colleagues, friends, neighbors and/or family members	19	26%
Purchased Energy Star Appliances	11	15%
Recycled a refrigerator or room air conditioner	12	17%
Installed new energy efficient doors and/or windows in part of your business.	6	8%
Installed new energy efficient doors and/or windows in all of your business.	0	0%
Installed / upgraded insulation in your business (walls, ceiling, attic)	7	10%
Insulated your water heater and/or install pipe insulation	2	3%
Can you think of any other energy savings actions you have taken, not mentioned in this list?**	18	25%

* Responses include only those who answered in the affirmative to Spillover Question 1.

**Other actions include energy audits, energy management systems, appliance recycling, etc.

Spillover Question 3

QS1c. On a scale of 1-10 with 10 being very important and 1 meaning little importance, what influence did the program have in your decision to take additional energy efficiency actions in your business?



The spillover questions were designed to capture the additional spillover energy savings achieved as a result of the program. Only those respondents who answered “yes” to Spillover Question 1 were included in the spillover calculations.

Spillover Question 2 captured the spillover energy savings action(s) that each respondent took as a result of participating in the program. The responses to this question only include those respondents who answered in the affirmative to Spillover Question 1. Spillover Question 3 captures how much

influence the program had in a given participant’s decision to engage in additional energy savings actions. Based on the responses to these questions, AEG used Equations 5 and 6 to determine the spillover savings for the program.

Equation 5. Weighted Spillover Score

$$\text{Weighted Spillover Score} = \frac{\text{Spillover Question 3}}{10}$$

Equation 5 converts the score from Spillover Question 3 to a percentage. This percentage shows how much influence the program had in each participant’s decision to engage in additional energy savings actions.

Equation 6. Spillover Measure Savings

$$\begin{aligned} & \text{Spillover Measure Savings}_{(\text{participant } i, \text{measure } j)} \\ &= \text{TRM kWh Savings}_{(\text{measure } j)} \times \text{Weighted Spillover Score}_{(\text{participant } i, \text{measure } j)} \end{aligned}$$

Equation 6 determines the spillover measure savings for each participant based on the specific additional energy action(s) they took as a result of participating in the program. Each participant reported their actions in Spillover Question 2. AEG estimated the spillover measure savings of each participant using the appropriate Tech Manual algorithms from each reported action.

Table 20 shows the energy savings estimate for each action along with a general description of the assumptions used in the Tech Manual calculation. In order to incorporate energy savings in terms of both kWh and therms, spillover savings were converted to mmBTUs using conversion factors found in the Tech Manual.

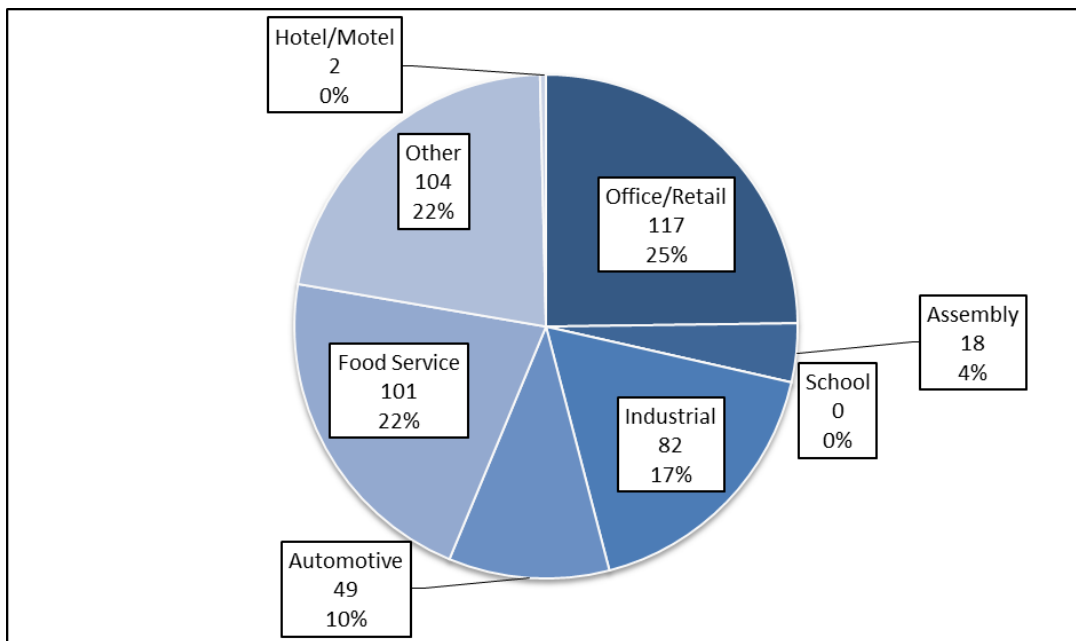
Table 20. Spillover Savings Assumptions

Response	kWh	Therm	mmBTU	Summary
Shared Experience	0	0	0	No additional savings were associated with this action
Purchased Appliance	157	20	3	Tech Manual default savings of average refrigerator, furnace/boiler
Recycled Room AC or Refrigerator	879	0	3	Tech Manual default savings
Windows (part)	312	53	6	Tech Manual default savings for 1 window
Windows (All)	0	0	0	No survey responses in this category (n=0)
Installed / upgraded insulation	228	209	22	Tech Manual default savings of average for roof and wall insulation (1000 SF)
Insulated WH and/or pipes	265	11	2	Tech Manual default savings of average for pipe and water heater insulation
Thermostat	1,437	75	12	Tech Manual default savings
Lighting	636	-159	-14	10 CFL facility, as designated by the Tech Manual
Water Heater	1,175	40	8	Tech Manual default savings
Air-Cooled Condenser	28,934	0	99	Tech Manual default savings

Finally, Equation 7 determines the spillover factor adjustment, which reflects the ratio of all participant spillover measure savings to the total energy savings of all survey respondents. The spillover measure savings is the sum of all the energy savings from each participant as a result of the program. The total kWh savings for all survey respondents includes the spillover measure savings plus the average savings for a Commercial Lighting Program participant (76 mmBTU).

Figure 4 shows the share of net spillover savings attributable to each building type based on the survey responses. The results show that office/retail building types accounted for most spillover savings, followed by food service and other, which includes parking garages, nursing homes, and multi-family building types. Schools, hotel/motels, and healthcare did not report any spillover savings from the program.

Figure 5. Net Spillover Savings (mmBTU) by Building Type



Equation 7. Spillover Factor Adjustment

$$Spillover\ Factor\ Adjustment = \frac{\sum Spillover\ Measure\ Savings_{(participant\ i, measure\ j)}}{\sum Total\ kWh\ Savings\ for\ All\ Survey\ Respondents}$$

Table 21 shows the values that were used to determine the program spillover factor adjustment. AEG estimates that the program achieved approximately 8 percent of additional energy savings. The complete data used for calculation of spillover savings is included in Appendix F of this report.

Table 21. Spillover Estimate, Program Total

Spillover Measure Savings (mmBTU)	Total EE Savings (mmBTU)	Spillover Estimate
473	6,215	8%

3.3 Net-to-Gross Results

This section combines the findings from Sections 3.1 and 3.2 regarding the free ridership and spillover impacts into a composite NTG ratio. As noted above, the NTG ratio represents a downward adjustment of the gross savings to account for free ridership impacts and an upward adjustment for spillover impacts. Using the free ridership and spillover values determined in the previous section the overall NTG factor for the Commercial Lighting Program is 0.91, as shown in Table 22 below. Note that the NTG factor is statistically representative of the program as a whole. However the free ridership and spillover estimates were derived using cross-tabulated results that do not include the entire sample of responses. Therefore, the NTG factor does not carry the same statistical significance as the overall sample.

Table 22. Program Net-to-Gross Factor

Free Ridership	Spillover	NTG Factor
17%	8%	91%

Applying the NTG Ratio to the gross energy and demand savings results yields the net savings attributable to the program.

Table 23. Net Engineering Analysis Energy and Demand Savings

Market Segment	kWh Savings	kW Savings
Small-Size	31,736,097	9,478
Mid-Size	10,105,795	3,205
Program Total	41,841,892	12,684

4. Program Cost Effectiveness

4.1 Cost-effectiveness Methodology

Cost-effectiveness analysis compares the costs and benefits of efficient equipment with those of baseline (non-efficient) equipment. Cost-effectiveness analysis indicates whether the efficient technology(s) improve a customer’s financial position, decrease overall energy costs to ratepayers, or raise society’s well-being. A program is considered cost-effective if the benefit-cost ratio is greater than one (1.0). There are many approaches to performing cost-effectiveness tests and key assumptions regarding critical factors, such as future energy prices, can vary among experts. DPS has not required cost-effectiveness tests as part of EEPS evaluation studies and has not confirmed the assumptions and approaches in this analysis.

AEG analyzed the cost-effectiveness of the Commercial Lighting Program utilizing four standard cost-effectiveness tests taken from the California Standard Practices Manual.¹⁰ Each test analyzes cost-effectiveness from a different perspective and answering a separate question:

- Participant Cost Test: Compares customer costs and benefits of installing the measure. Will the participant benefit over the life of the measure?
- Program Administrator Cost Test (Utility Cost Test): Comparison of program administrator costs to supply-side resource benefits. Will utility costs to save energy be less than utility costs to deliver the same amount of energy?
- Ratepayer Impact Measure: Measures the impact of the DSM program on utility rates if rates were to be adjusted to account for the program. Comparison of utility program costs and bill reductions associated with energy savings to supply-side resource benefits. Will customer rates increase?
- Total Resource Cost Test: Comparison of program administrator and customer costs to utility resource savings. Will the total costs of energy in the utility service territory decrease?

Results from the impact evaluation, following IPMVP best practices, are utilized in the four cost-effectiveness tests taken from the California Standard Practices Manual. The direct participant costs were derived using standard industry assumptions regarding the incremental cost for each measure type. The specific cost assumptions for each measure type are detailed in Table 24.

Table 24. Incremental Costs by Measure Type

Measure Type	T8	T5	EXIT SIGN	DELAMP	CTRL	CFL	MISC	LED
Incremental Cost per Measure	\$100	\$100	\$30	\$30	\$125	\$5	\$85	\$30

The incremental cost of each measure was multiplied by the number of measures to calculate the total direct participant costs of the program. Other program costs including administrative and incentive costs

¹⁰ The California Standard Practices Manual details cost-effectiveness guidelines and procedures for standardized cost-effectiveness evaluations.

reflect costs incurred from January 2010 through December 2011, which were provided by Central Hudson. The avoided cost data used in the cost-effectiveness calculation is included in Appendix G of this report. The data associated with total costs is summarized in Table 25.

Table 25. Cost-Effectiveness Analysis Input Summary

Market Segment	Direct Participant Cost	Admin Costs	Incentive Costs	Total Costs
Small-Size	\$10,205,695	\$1,205,586	\$8,937,679	\$20,348,960
Mid-Size	\$3,703,820	\$310,582	\$4,134,508	\$8,148,910
Program Total	\$13,909,515	\$1,516,168	\$13,072,187	\$28,497,870

4.2 Cost-effectiveness Results

Engineering Analysis Results

Tables 261 through 28 summarize the cost-effectiveness results using the Engineering Analysis savings. The Commercial Lighting program passes each of the tests with a benefit-cost ratio greater than 1, except for the Ratepayer Impact Measure Test, for each market segment and the overall program.

Table 26. Small-Size Cost Effectiveness Results Summary, Engineering Analysis

Test Results	NPV	B/C	Total Costs	Total Benefits
Total Resource Cost Test	\$15,763,788	1.77	\$20,348,960	\$36,112,748
Societal Test	\$18,966,907	1.93	\$20,348,960	\$39,315,867
Participant Test	\$39,206,949	4.84	\$10,205,695	\$49,412,644
Ratepayer Impact Measure Test	(\$14,505,481)	0.71	\$50,618,230	\$36,112,748
Utility Cost Test	\$25,969,483	3.56	\$10,143,265	\$36,112,748

Table 27. Mid-Size Cost Effectiveness Results Summary, Engineering Analysis

Test Results	NPV	B/C	Total Costs	Total Benefits
Total Resource Cost Test	\$3,232,223	1.40	\$8,148,910	\$11,381,133
Societal Test	\$4,241,263	1.52	\$8,148,910	\$12,390,173
Participant Test	\$13,188,611	4.56	\$3,703,820	\$16,892,431
Ratepayer Impact Measure Test	(\$5,821,879)	0.66	\$17,203,013	\$11,381,133
Utility Cost Test	\$6,936,043	2.56	\$4,445,090	\$11,381,133

Table 28. Program Cost Effectiveness Results Summary, Engineering Analysis

Test Results	NPV	B/C	Total Costs	Total Benefits
Total Resource Cost Test	\$18,996,012	1.67	\$28,497,870	\$47,493,882
Societal Test	\$23,208,170	1.81	\$28,497,870	\$51,706,040
Participant Test	\$52,395,559	4.77	\$13,909,515	\$66,305,074
Ratepayer Impact Measure Test	(\$20,327,360)	0.70	\$67,821,242	\$47,493,882
Utility Cost Test	\$32,905,527	3.26	\$14,588,355	\$47,493,882

4.3 Cost-effectiveness Results including Non-Energy Benefits

Non-energy benefits (NEBs) refer to those benefits that accrue to society that are not directly related to energy reduction, including public health and comfort, job creation, reduced emissions, labor productivity, etc. Since these benefits are not readily quantified, they may be incorporated into the cost-effectiveness analysis by applying an adder to the avoided costs.

AEG performed a separate set of cost-effectiveness tests applying a 10 percent adder to the avoided costs to reflect the non-energy benefits.

Engineering Analysis Results including NEBs

Tables 29 through 31 summarize the cost-effectiveness results using the Engineering Analysis savings accounting for non-energy benefits. The Commercial Lighting program passes each of the tests with a benefit-cost ratio greater than 1, except for the Ratepayer Impact Measure Test, for each market segment and the overall program.

Table 29. Small-Size Cost Effectiveness Results Summary, Engineering Analysis, NEBs

Test Results	NPV	B/C	Total Costs	Total Benefits
Total Resource Cost Test	\$19,375,063	1.95	\$20,348,960	\$39,724,023
Societal Test	\$22,578,182	2.11	\$20,348,960	\$42,927,142
Participant Test	\$39,206,949	4.84	\$10,205,695	\$49,412,644
Ratepayer Impact Measure Test	(\$10,894,206)	0.78	\$50,618,230	\$39,724,023
Utility Cost Test	\$29,580,758	3.92	\$10,143,265	\$39,724,023

Table 30. Mid-Size Cost Effectiveness Results Summary, Engineering Analysis, NEBs

Test Results	NPV	B/C	Total Costs	Total Benefits
Total Resource Cost Test	\$4,370,337	1.54	\$8,148,910	\$12,519,247
Societal Test	\$5,379,376	1.66	\$8,148,910	\$13,528,286
Participant Test	\$13,188,611	4.56	\$3,703,820	\$16,892,431
Ratepayer Impact Measure Test	(\$4,683,766)	0.73	\$17,203,013	\$12,519,247
Utility Cost Test	\$8,074,157	2.82	\$4,445,090	\$12,519,247

Table 31. Program Cost Effectiveness Results Summary, Engineering Analysis, NEBs

Test Results	NPV	B/C	Total Costs	Total Benefits
Total Resource Cost Test	\$23,745,400	1.83	\$28,497,870	\$52,243,270
Societal Test	\$27,957,558	1.98	\$28,497,870	\$56,455,428
Participant Test	\$52,395,559	4.77	\$13,909,515	\$66,305,074
Ratepayer Impact Measure Test	(\$15,577,972)	0.77	\$67,821,242	\$52,243,270
Utility Cost Test	\$37,654,915	3.58	\$14,588,355	\$52,243,270

Appendix A. Participant Survey

NOTE: To avoid duplication with interviews conducted in the Phase I Evaluation, check list of names prior to making phone call.

Customer Name	
Customer Phone Number	
Interviewer	

CONTACT RECORD		
Date	Time	Response

Response Codes

1. Busy Signal
2. No Answer
3. Call Back
4. Wrong Number (Cannot be Surveyed)
5. Refused (Cannot be Surveyed)
6. Interview – Incomplete (Cannot be Surveyed)
7. Interview Complete

Hello, I'm _____ with Applied Energy Group. We are conducting a survey for Central Hudson Gas & Electric Company as part of Central Hudson's continual effort to improve its energy efficiency programs. According to our records, your household participated in the "Central Hudson Commercial Lighting" in _____ {List Program Year as being either 2010 or 2011}.

The survey should only take about 10 minutes. The information you provide will be kept strictly confidential and will be used to improve Central Hudson's Energy Savings programs.

May I ask you a few questions about your participation?

1. Yes
2. No *(Determine if they would agree to another date/time: If "No," thank them for their time, and exit.)*

Do you recall participating in the Commercial Lighting Program offered by Central Hudson?

1. Yes
2. No *(The program provides rebates to customers upgrade to energy efficient lighting in their commercial facility. According to our records, your household purchased _____ {List measures rebated}. If they still do not remember, **terminate the Interview.**)*

Participation Process

QP1. Do you recall the main reason you decided to participate? (**DO NOT READ - Mark all that apply**)

1. Contractor recommended it
2. Needed to replace lighting fixtures in building
3. Wanted to save money
4. Seemed like a good deal/offer from the utility
5. Wanted to save energy
6. Other (verbatim)

Customer Satisfaction

QS1. Please rate your satisfaction with the following program components on a five-point scale, where “5” means “Very Satisfied” and “1” means “Very Dissatisfied.” How satisfied are you with the:

	5	4	3	2	1	DK/Refused
a) Enrollment process						
b) Performance of the new equipment obtained through the program, compared to your replaced equipment						
c) Contractor who performed the work						
d) Overall program experience						

Comments (verbatim)

QS2a. Did you finance the equipment you received through the program...

1. Independently
2. With Central Hudson’s financing option (***Skip to QF1***)
3. With both independent and utility financing. (***Skip to QF1***)
4. Other (Please Specify): _____
5. DK/Refused (DO NOT READ)

QS2b. Please rate your overall satisfaction with Central Hudson’s financing option on a scale from one to five where “5” means “Very Satisfied” and “1” means “Very Dissatisfied.”?

	5	4	3	2	1	Don’t Know/Refused
Central Hudson Financing						

Free Ridership

QF1a. Were you planning to purchase new lighting with the EXACT SAME EFFICIENCY within three months before or after purchasing this equipment?

	Yes	No (Skip to QF1d)	Don’t Know/Refused (Skip to QF1d)
Light Fixtures			
Lighting Controls			

QF1b. What factors stopped you from purchasing lighting earlier? (**READ RESPONSES - Mark all that apply**)

1. The financial position of the business.
2. I was not sure how long the business would remain in the same building.
3. I was not sure what type of system or brand to install.
4. I was not convinced I would save more.
5. I did not have a contractor I felt I could trust.
6. Other (verbatim)
7. Don't Know/Refused (**DO NOT READ**)

QF1c. Was one factor most significant?

1. Yes (list which factor)
2. No
3. Don't Know/Refused (**DO NOT READ**)

QF1d. How likely is it that you would have purchased and installed equipment with the EXACT SAME EFFICIENCY within 3 months of when you did participate in the program if the utility had NOT OFFERED the PROGRAM? (**READ RESPONSES**)

1. Very Unlikely
2. Somewhat Unlikely
3. Neither Likely nor Unlikely
4. Somewhat Likely
5. Very Likely
6. Don't Know/Refused (**DO NOT READ**)

	1	2	3	4	5	6
Light Fixtures						
Lighting Controls						

QF1e. On a scale of one to five, with one being very low and five being very high, how would you rate energy efficiency as a priority for your business?

LOW 1 2 3 4 5 HIGH

Program Spillover Impacts

QS1a. Has your business taken any other steps to reduce energy use as a result of your participation in the Central Hudson Commercial Lighting Program?

1. Yes
2. No (*Skip to QS1c*)
3. Don't Know/Refused (**DO NOT READ - Skip to QS1c**)

QS1b. Have you completed any of the following actions at this site as a result of your participation in the program? (**READ RESPONSES - Mark all that apply**)

- Shared your experience in the Commercial Lighting Program with other business, colleagues, friends, neighbors and/or family members
- Purchase Energy Star Appliances
- Recycle a refrigerator or room air conditioner
- Install new energy efficient doors and/or windows in part of your business. If yes, approximately how many?
- Install new energy efficient doors and/or windows in all of your business. If yes, approximately how many?
- Install / upgrade insulation in your business (walls, ceiling, attic)
- Insulate your water heater and/or install pipe insulation
- Can you think of any other energy savings actions you have taken, not mentioned in this list? **VERBATIM**

QS1c. *On a scale of 1-10 with 10 being very important and 1 meaning little importance, what influence did the program have in your decision to take additional energy efficiency actions in your business?*

(RECORD SCORE FROM 1-10)

Business Information

QD1. Does your business own or lease the building where the business is located?

1. Own
2. Lease
3. Own and Lease
4. Other (Please Specify): _____
9. DK/Refused (DO NOT READ)

QD2. Approximately how many square feet of space is the building?

1. [Write-In] _____ ft²
2. DK/Refused (DO NOT READ)

QD3. Approximately how long has your business been at its current location?

1. [Write-In]: _____
9. DK/Refused (DO NOT READ)

QD4. Are you planning to relocate your business in the next year?

1. Yes
2. No
3. DK/Refused (DO NOT READ)

QD5. Is your business open year-round?

1. Yes
2. No (If No, Approximately what percent of the year is it open? _____%)

QD6. Okay, we are almost done. I have one final set of questions to ask you concerning other energy savings actions your business may have taken during the last 1 to 3 years. I am going to read you a list of ways to cut energy use. Please let me know when I list an action that your business has taken to reduce energy use sometime during the last 1 to 3 years: **(Mark all that apply)**

1. Installed / upgraded wall insulation
 2. Installed / upgraded ceiling insulation
 3. Installed new energy efficient doors and/or windows
 4. Purchased Energy Star-Rated Appliances
 5. Replaced incandescent light bulbs w/ compact fluorescent bulbs
 6. Insulated the existing water heater and/or installed pipe insulation
 7. Installed a tankless or solar water heating system
 8. Installed an energy management system
 9. Can you think of any other energy savings actions the business has taken that I haven't mentioned? VERBATIM
-

Thank you for taking the time to respond to this survey. The information you have provided will be kept strictly confidential, and will be combined with information from other program participants to improve Central Hudson's Energy Savings programs.

Central Hudson is conducting a metering study to see how customers use energy for lighting. The study will be used to improve energy efficiency programs in the future.

EQ. Would you like to participate?

1. Yes
2. No. Thank you for taking the time to answer my questions!

Metering Study Supplement

As a participant, Central Hudson will install a light logger in your business for a period of 3-5 weeks free of charge. The logger will record your energy usage in various building types and light fixtures.

*[If they are **hesitant**, probe for reason(s) of reluctance. If concerns about use of data, mention all data is kept confidential.]*

Please answer the following yes/no questions to determine whether you are eligible to participate in the metering study:

- 1) Have there been any significant changes in the building since installation of the lighting measures?
- 2) Are there any areas of the building no longer being used where lighting is installed?
- 3) Do lighting schedules vary based on different areas of the building?
- 4) How many different lighting schedules do you have?
 - a. What are your lighting schedules?
- 5) What usage areas do your building have (hallways, offices, bathrooms, retail space, etc.)?
- 6) What is the ceiling height in your building?

Thank you for answering our questions and for agreeing to participate in the metering study. A customer service representative will be contacting you for set-up and installation. Please provide an email address where we will send you a link to sign up for the program.

Appendix B. Survey Results Summary

Do you recall the main reason you decided to participate?

Response	Count	Percent
Contractor recommended it	0	0%
Needed to replace lighting fixtures in building	22	20%
Wanted to save money	31	28%
Seemed like a good deal/offer from the utility	27	25%
Wanted to save energy	19	17%
Other (please specify)	11	10%
Total	110	100%

Please rate your satisfaction with the following program components using a five-point scale, where “1” means “Very Dissatisfied” and “5” means “Very Satisfied”.

Component	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied	Don't Know
Enrollment process	2	0	4	22	40	4
Performance of the new equipment obtained through the program, compared to your replaced equipment	0	3	8	12	47	2
Contractor who performed the work	4	2	7	14	44	1
Overall program experience	2	2	8	21	38	1
Total	8	7	27	69	169	8

Component	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very Satisfied	Don't Know
Enrollment process	25%	0%	15%	32%	24%	50%
Performance of the new equipment obtained through the program, compared to your replaced equipment	0%	43%	30%	17%	28%	25%
Contractor who performed the work	50%	29%	26%	20%	26%	13%
Overall program experience	25%	29%	30%	30%	22%	13%
Total	3%	2%	9%	24%	59%	3%

Did you finance the equipment you received through the program...

Response	Count	Percent
CHGE Financing Option	58	81%
Independently	5	7%
Both	3	4%
DK/Refused	6	8%
Total	72	100%

How satisfied were you with Central Hudson’s financing option using the same five point scale. (5 is very satisfied and 1 is very dissatisfied)

Response	Count	Percent
Very Dissatisfied	1	1%
Dissatisfied	1	1%
Neutral	3	4%
Satisfied	8	11%
Very Satisfied	43	59%
Don't Know	9	12%
Total	73	100%

Were you planning to purchase new Light Fixtures and/or Lighting Controls with the EXACT SAME EFFICIENCY within three months before or after purchasing this equipment?

Response	Light Fixtures	Lighting Controls
Yes	11	11
No	61	59
DK/Refused	0	1
Total	72	71

Response	Light Fixtures	Lighting Controls
Yes	15%	15%
No	85%	83%
DK/Refused	0%	1%
Total	100%	100%

What factors stopped you from purchasing the equipment earlier?*

Response	Count	Percent
Cost	20	33%
DK/Refused	6	10%
Lack of Awareness/Need	30	49%
Other	3	5%
Skeptical of Savings	2	3%
Total	61	100%

*Coded based on response

Cross tab

		Cost as preventative factor...	
		Yes	No
Planning to purchase light fixtures...	Yes	0	11
	No	12	49

Was one factor most significant for fixtures and/or controls?

Response	Fixtures	Controls
Yes	3	2
No	49	49
DK/Refused	3	3
Total	55	54

Response	Fixtures	Controls
Yes	5%	4%
No	89%	91%
DK/Refused	5%	6%
Total	100%	100%

Which factor was the most significant?

	Fixtures	Controls
Saving Energy	1	0
Lack Of Knowledge	1	1
Solicitation	1	1

On a scale from one to five where “5” means “Very Likely” and “1” means “Very Unlikely, how likely is it that you would have purchased and installed equipment with the EXACT SAME EFFICIENCY within 3 months of when you did participate in the program if the utility had NOT OFFERED the PROGRAM?

Response	Light Fixtures	Lighting Controls
1	47	47
2	13	13
3	4	4
4	4	4
5	3	3
DK/Refused	1	1
Total	72	72

Response	Light Fixtures	Lighting Controls
1	65%	65%
2	18%	18%
3	6%	6%
4	6%	6%
5	4%	4%
DK/Refused	1%	1%
Total	100%	100%

On a scale of one to five, with one being very low and five being very high, how would you rate energy efficiency as a priority for your business?

Response	Count	Percent
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1	1	1%
2	2	3%
3	18	25%
4	23	32%
5	28	39%
Total	72	100%

Has your business taken any other steps to reduce energy use as a result of your participation in the Central Hudson Commercial Lighting Program?

Response	Count	Percent
Yes	23	32%
No	46	64%
DK/Refused	3	4%
Total	72	100%

Have you completed any of the following actions at this site as a result of your participation in the program?

Response	Count	Percent (n=72)
Shared your experience in the Commercial Lighting Program with other business, colleagues, friends, neighbors and/or family members	19	26%
Purchased Energy Star Appliances	11	15%
Recycled a refrigerator or room air conditioner	12	17%
Installed new energy efficient doors and/or windows in part of your business. If yes, approximately how many?	6	8%
Installed new energy efficient doors and/or windows in all of your business. If yes, approximately how many?	0	0%
Installed / upgraded insulation in your business (walls, ceiling, attic)	7	10%
Insulated your water heater and/or install pipe insulation	2	3%
Other	19	26%

On a scale of 1-10 with 10 being very important and 1 meaning little importance, what influence did the program have in your decision to take additional energy efficiency actions in your business?

Response	Count	Percent
1	9	13%
2	7	10%

3	6	8%
4	4	6%
5	16	22%
6	4	6%
7	8	11%
8	9	13%
9	1	1%
10	8	11%
Total	72	100%

Does your business own or lease the building where the business is located?

Response	Count	Percent
Own	60	83%
Lease	12	17%
Total	72	100%

Approximately how many square feet of space is the building?

Quartile	Count	Percent	
1	3,600	14	20%
2	9,000	13	18%
3	26,250	12	17%
4	250,000	13	18%
DK/Refused	19	27%	
Total	71	100%	

Approximately how long has your business been at its current location?

Quartile	Years	Count	Percent
1	11.5	18	25%
2	25	18	25%
3	43	17	24%
4	120	18	25%
DK/Refused		0	0
Total		71	100%

Is your business open year-round?

Response	Count	Percent
Yes	70	97%
No	2	3%
Total	72	100%

I have one final set of questions to ask you concerning other energy savings actions your business may have taken during the last 1 to 3 years. Have you...

Response	Count	Percent (n=72)
Installed / upgraded wall insulation	10	14%
Installed / upgraded ceiling insulation	18	25%
Installed new energy efficient doors and/or windows	21	29%
Purchased Energy Star-Rated Appliances	34	47%
Replaced incandescent light bulbs w/ compact fluorescent bulbs	41	57%
Insulated the existing water heater and/or installed pipe insulation	15	21%
Installed a tankless or solar water heating system	2	3%
Installed an energy management system	6	8%
Other	19	26%

Appendix C. Net-to-Gross Methodology

Memorandum

To: Central Hudson Gas & Electric Company
From: Applied Energy Group
Subject: Commercial Lighting Net-To-Gross Scoring Algorithms
Date: August 15, 2012

Free Ridership

Two survey questions were designed to determine customer free ridership. Each participant was assigned a value based on the probability that they are a free rider. The weighted mean of the participant probabilities provides an estimate of free ridership for the entire Commercial Lighting Program. The following two tables present the participant probability by survey question.

Question 1: Were you planning to purchase a new lighting with the EXACT SAME EFFICIENCY within three months before or after purchasing this equipment?

Q2 Free Ridership Probability	Min	Max	Est.
Yes	0%	50%	25%
No	0%	0%	0%

Question 2: How likely is it that you would have purchased and installed equipment with the EXACT SAME EFFICIENCY within 3-months of when you did participate in the program if the utility had NOT OFFERED the REBATE?

Q1 Free Ridership Probability	Min	Max	Est.
Very Unlikely	0%	0%	0%
Somewhat Unlikely	10%	30%	20%
Neither Likely or Unlikely	30%	50%	40%
Somewhat Likely	50%	70%	60%
Very Likely	70%	90%	80%

Free ridership participant probabilities for question 1 and question 2 were added together to get a free ridership estimate by customer surveyed, bound by 0% and 100%. The free ridership probability estimates are shown in the table below.

$$\text{Free Ridership} = \text{Question 1} + \text{Question 2}$$

Spillover

The following survey questions and scoring methodology is proposed for the calculation of program spill-over impacts.

Question SQ1: Since you participated in the Central Hudson program, have you taken any other actions to reduce energy use in your home? [1=Yes / 0 = No]

Question SQ2: [Ask only If Yes to SQ1]

Can you brief describe what EE measures/actions you took and from the following list I am going to read to you:

Measure/Action Taken (Measure/Action)	How Many?
Shared your experience in the Commercial Lighting Program with other businesses, colleagues, friends, neighbors and/or family members	
Purchase Energy Star appliances	
Recycle a refrigerator or room air conditioner	
Install new energy efficient doors and/or windows in part of your business	
Install new energy efficient doors and/or windows in all of your business	
Install / upgrade insulation in your business (walls, ceiling, attic)	
Insulate your water heater and/or install pipe insulation	
Can you think of any other energy savings actions you have taken, not mentioned in this list?	

Question SQ3: {Only Ask If yes [=1] to Q1}: On a scale of 1-10 with 10 being very important and 1.0 meaning little importance, what influence did the program have in your decision to take additional EE actions in your home?

Scoring Method:

Spillover = If Question 1 is 'No,' then Spillover Score is 0%

Else, If Q1=1, then Weighted Spillover Score =

SQ3 Score/10 (= Weighted (%) Spill-over Score)

We will then estimate kWh savings from spillover actions reported in the table above, for only those measure(s) for which savings estimates are available from the Tech Manual, using the following calculations:

Estimated Weighted, Annualized Energy Savings from Spill-over Measure-j, for each respondent – i:

Spill-over Measure Savings _(participant-i, measure-j) =

Tech Manual kWh Savings _(measure-j) * **Weighted (%) Spill-over Score**_(participant-i, measure-j)

Next, to develop the **Spill-over Factor Adjustment**, we will sum over all estimates of program spill-over savings (measures and participants), and calculate the following ratio:

\sum Spill-over Measure kWh Savings _(participant-i, measure-i)

\sum Total kWh for EE Measures for All Survey Respondents

This ratio we define as, the **Spill-over Adjustment Factor** to be included in the net-to-Gross (NTG) Adjustment to Savings.

Note: This ratio should be a very, very small number (i.e. 1.0 <<<), as only a few respondents will most likely respond Yes (SQ1=1), which will then we weighted down by their 1-10 ranking in SQ3.

Appendix D. Light Logger Data Analysis

Sample Logger Detail

Logger ID	Normalized Weekly Hours
00001F38	38.75
00001BD0	39.06
0000197B	45.05
00001CFD	43.67
00001DAF	38.71
000019FF	43.70
Average Weekly for Site	41.49

Date	Day	Full Day	Hours On
2/27/2013	Wednesday	FALSE	6.93
2/28/2013	Thursday	TRUE	8.57
3/1/2013	Friday	TRUE	8.13
3/2/2013	Saturday	TRUE	0.00
3/3/2013	Sunday	TRUE	0.00
3/4/2013	Monday	TRUE	0.00
3/5/2013	Tuesday	TRUE	8.13
3/6/2013	Wednesday	TRUE	8.30
3/7/2013	Thursday	TRUE	8.27
3/8/2013	Friday	TRUE	8.20
3/9/2013	Saturday	TRUE	0.00
3/10/2013	Sunday	TRUE	0.00
3/11/2013	Monday	TRUE	7.97
3/12/2013	Tuesday	TRUE	8.60
3/13/2013	Wednesday	TRUE	9.37
3/14/2013	Thursday	TRUE	8.23
3/15/2013	Friday	TRUE	8.00
3/16/2013	Saturday	TRUE	0.00
3/17/2013	Sunday	TRUE	0.00
3/18/2013	Monday	TRUE	8.53
3/19/2013	Tuesday	TRUE	8.87
3/20/2013	Wednesday	TRUE	8.00
3/21/2013	Thursday	TRUE	6.20
3/22/2013	Friday	TRUE	8.40
3/23/2013	Saturday	TRUE	0.00
3/24/2013	Sunday	TRUE	0.00
3/25/2013	Monday	TRUE	6.13
3/26/2013	Tuesday	FALSE	0.07

Daily Average	5.30
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Sunday	0.00
Monday	5.66
Tuesday	8.53
Wednesday	8.56
Thursday	7.82
Friday	8.18
Saturday	0.00

Normalized Weekly	38.75
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Total Hours	144.90
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Sample Building Normalized Weekly Average Detail

Site A

Weeks per Year	50.29
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Time Range	Average Weekly for Site	Weighted AVG (Usage)	Weighted AVG (SF)
Weekly	41.49	42.14	42.31
Yearly	2087	2119	2128

Logger ID	Location	Total Weekly Hours
00001F38	Conference Room	38.75
00001BD0	Conference Room	39.06
0000197B	Lobby	45.05
00001CFD	Office	43.67
00001DAF	Office	38.71
000019FF	Office	43.70
Total		248.94

Weighted Average (SF)

Location	Hours	Weight	Weighted Hours
Conference Room	38.90	20%	7.78
Lobby	45.05	30%	13.51
Office	42.03	50%	21.01
Total	125.98	100%	42.31

Weighted Average (Usage)

Location	Hours	Weight	Weighted Hours
Conference Room	38.90	31%	12.01
Lobby	45.05	36%	16.11
Office	42.03	33%	14.02
Total	125.98	100%	42.14

Appendix E. Building and Facility Types

Building Type	Facility Type	Measures
Assembly	Town Hall	4,714
Assembly	Police/Fire Stations (24 Hr.)	4,630
Assembly	Entertainment	3,181
Assembly	Fire Station (Unmanned)	1,858
Assembly	Church	1,680
Assembly	Convention Center	1,565
Assembly	Transportation	1,376
Assembly	Gymnasium	1,312
Assembly	Religious Building	901
Assembly	Sports Arena	570
Assembly	Motion Picture Theatre	28
Assembly	Performing Arts Theatre	15
Assembly	Museum	5
Automotive	Auto Related	8,685
Automotive	Auto Repair	5,503
Food Service	Dining: Family	684
Food Service	Dining: Cafeteria/Fast Food	600
Food Service	Dining: Bar Lounge/Leisure	509
Food Service	Restaurants	440
Food Service	Bakery	429
Food Service	Fast Food Restaurants	122
Hospital	Hospitals/Health Care	4,495
Hospital	Hospitals	1,240
Hotel/Motel	Lodging (Hotels/Motels)	5,537
Hotel/Motel	Motel	228
Industrial	Warehouse (Not Refrigerated)	8,503
Industrial	Manufacturing Facility	5,207
Industrial	Light Manufacturers	4,831
Industrial	Industrial - 1 Shift	4,388
Industrial	Workshop	2,438
Industrial	Waste Water Treatment Plant	1,411
Industrial	Industrial - 2 Shift	833
Industrial	Industrial - 3 Shift	436
Industrial	Pump Stations	82

Building Type	Facility Type	Measures
Office/Retail	Office (General Office Types)	19,121
Office/Retail	Small Retail	9,550
Office/Retail	Large Office	4,795
Office/Retail	Banks	4,067
Office/Retail	Small Services	2,041
Office/Retail	Medical Offices	2,038
Office/Retail	Food Stores	1,945
Office/Retail	Large Retail	1,370
Office/Retail	Office/Retail	1,239
Office/Retail	Convenience Stores	1,237
Office/Retail	Commercial Condos	1,158
Office/Retail	Court House	1,106
Office/Retail	Library	754
Office/Retail	Laundromats	617
Office/Retail	Exercise Center	557
Office/Retail	Mall Concourse	98
Other	Nursing Homes	2,278
Other	Multi-Family (Common Areas)	1,770
Other	Parking Garages	864
Other	Refrigerated Warehouse	456
School	Schools (Jr./Sr. High)	8,975
School	Schools (Preschool/Elementary)	5,725
School	School/University	1,686
School	Schools (Technical/Vocational)	1,432
School	College - Classes/Administrative	3

Appendix F. Spillover Data

Respondent Id	Building Type	So:Q1	Shared Exp.	Purchased Appliance	Recycled Room AC or Refrig	Windows (Part)	Installed / Upgraded Insulation	Insulated WH And/O r Pipes	Tstat	Lighting	Water Heater	Air-Cooled Condenser	So Score	Spillover Measure Savings	Total EE Savings
2168007205	Office/Retail	Dk/Refused	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2343350016	Assembly	Dk/Refused	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2344009965	Assembly	Dk/Refused	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2343234538	Assembly	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2377924666	Office/Retail	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2343558425	School	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2351385051	Industrial	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2351156829	Office/Retail	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2270458650	Industrial	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2351078079	Industrial	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2350773354	Assembly	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2358642851	School	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2351535483	School	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2270244841	Industrial	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2350706724	Automotive	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2301278128	Office/Retail	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2167952638	Office/Retail	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2270052549	Office/Retail	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2343713276	Office/Retail	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2164241169	Automotive	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2301260142	Industrial	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2263619040	Office/Retail	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2165768642	Food Service	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2270418461	Office/Retail	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2167923156	Office/Retail	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2343933918	Assembly	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2263488422	Office/Retail	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2270159506	Industrial	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2351022517	Industrial	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98

Respondent Id	Building Type	So:Q1	Shared Exp.	Purchased Appliance	Recycled Room AC or Refrig	Windows (Part)	Installed / Upgraded Insulation	Insulated WH And/O r Pipes	Tstat	Lighting	Water Heater	Air-Cooled Condenser	So Score	Spillover Measure Savings	Total EE Savings
2164375797	Office/Retail	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2384339053	Office/Retail	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2270298829	Industrial	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2377683216	Other	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2377608990	Industrial	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2262992961	Office/Retail	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2390070030	Automotive	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2165819540	Office/Retail	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2343491108	Office/Retail	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2263666612	Office/Retail	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2373508217	Food Service	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2164044012	Automotive	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2384371040	Industrial	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2167749197	Assembly	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2166036305	Office/Retail	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2163916812	Automotive	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2164323323	Automotive	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2351398563	Industrial	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2358575757	School	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2358610549	School	No	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	0.00	75.98
2390082228	Automotive	Yes	0.00	2.56	3.00	19.10	21.66	2.03	0.00	0.00	0.00	0.00	0.50	24.18	124.34
2164297894	Automotive	Yes	0.00	2.56	3.00	19.10	0.00	0.00	0.00	0.00	0.00	0.00	1.00	24.67	100.65
2167597815	Hotel/Motel	Yes	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	1.80	78.98
2343322762	Other	Yes	0.00	2.56	3.00	76.41	21.66	0.00	0.00	0.00	0.00	0.00	1.00	103.64	179.62
2163994869	Automotive	Yes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	75.98
2393391827	Assembly	Yes	0.00	0.00	0.00	38.21	0.00	0.00	0.00	0.00	0.00	0.00	0.30	11.46	114.19
2270018135	Office/Retail	Yes	0.00	0.00	3.00	12.74	21.66	2.03	0.00	0.00	0.00	0.00	0.80	31.54	115.41
2377660263	Industrial	Yes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.00	75.98
2351258173	Industrial	Yes	0.00	0.00	0.00	0.00	0.00	0.00	12.39	0.00	0.00	0.00	0.90	11.15	88.37
2343787666	Office/Retail	Yes	0.00	0.00	3.00	19.10	21.66	0.00	0.00	0.00	0.00	0.00	0.30	13.13	119.75
2343285170	Industrial	Yes	0.00	0.00	0.00	0.00	0.00	0.00	12.39	0.00	8.02	0.00	1.00	20.41	96.39
2270000455	Office/Retail	Yes	0.00	2.56	0.00	19.10	0.00	0.00	0.00	0.00	0.00	0.00	0.80	17.33	97.65
2358780319	Industrial	Yes	0.00	2.56	3.00	0.00	21.66	0.00	0.00	0.00	0.00	0.00	0.50	13.61	103.21
2343384345	Assembly	Yes	0.00	0.00	0.00	0.00	21.66	0.00	0.00	-13.73	0.00	0.00	0.80	6.34	83.91

Respondent Id	Building Type	So:Q1	Shared Exp.	Purchased Appliance	Recycled Room AC or Refrig	Windows (Part)	Installed / Upgraded Insulation	Insulated WH And/O r Pipes	Tstat	Lighting	Water Heater	Air-Cooled Condenser	So Score	Spillover Measure Savings	Total EE Savings
2167531482	Industrial	Yes	0.00	2.56	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.56	81.54
2396572623	Food Service	Yes	0.00	2.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	98.75	1.00	101.32	177.30
2343906339	Other	Yes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	75.98
2270031228	Office/Retail	Yes	0.00	2.56	3.00	19.10	0.00	0.00	0.00	0.00	0.00	0.00	0.70	17.27	100.65
2271424816	Industrial	Yes	0.00	2.56	3.00	159.19	0.00	0.00	0.00	0.00	0.00	0.00	0.20	32.95	240.74
2393468247	Other	Yes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.60	0.00	75.98
2165721772	Office/Retail	Yes	0.00	0.00	0.00	0.00	21.66	0.00	12.39	0.00	0.00	0.00	1.00	34.05	110.03
2263077163	Office/Retail	Yes	0.00	2.56	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.70	3.89	81.54
2270206041	Industrial	Yes	0.00	2.56	3.00	0.00	0.00	0.00	12.39	0.00	0.00	0.00	0.20	3.59	93.93

Appendix G. Central Hudson Avoided Costs

Year	Wholesale Prices		
	Wholesale Electricity	Electric Capacity	Natural Gas
	\$/kWh	\$/kW-yr	\$/therm
2011	\$0.085	\$94.05	\$1.17
2012	\$0.086	\$100.07	\$1.18
2013	\$0.088	\$109.87	\$1.21
2014	\$0.090	\$114.04	\$1.25
2015	\$0.092	\$115.93	\$1.29
2016	\$0.095	\$128.15	\$1.34
2017	\$0.098	\$143.99	\$1.39
2018	\$0.102	\$151.92	\$1.44
2019	\$0.105	\$159.94	\$1.48
2020	\$0.108	\$168.07	\$1.52
2021	\$0.112	\$176.30	\$1.57
2022	\$0.115	\$181.59	\$1.62
2023	\$0.119	\$187.04	\$1.67
2024	\$0.123	\$192.65	\$1.72
2025	\$0.127	\$198.43	\$1.77
2026	\$0.131	\$204.39	\$1.82
2027	\$0.134	\$210.52	\$1.88
2028	\$0.138	\$216.83	\$1.93
2029	\$0.143	\$223.34	\$1.99
2030	\$0.147	\$230.04	\$2.05
2031	\$0.151	\$236.94	\$2.11
2032	\$0.156	\$244.05	\$2.17
2033	\$0.161	\$251.37	\$2.24
2034	\$0.165	\$258.91	\$2.31
2035	\$0.170	\$266.68	\$2.31
2036	\$0.175	\$274.68	\$2.31
2037	\$0.181	\$282.92	\$2.31
2038	\$0.186	\$291.40	\$2.31
2039	\$0.192	\$300.15	\$2.31
2040	\$0.197	\$309.15	\$2.31