People. Power. Possibilities.
Central Hudson
A FORTIS COMPANY

RESIDENTIAL RETAIL LIGHTING IMPACT EVALUATION FINAL REPORT

PREPARED FOR CENTRAL HUDSON

APRIL 21, 2022

CADMUS

Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS

Contents

Executive Summary
- Key Findings
- Evaluation Objectives
- EM&V Methods
- Savings Comparison

Introduction
- Program Description
- Program Contributions
- Program Participation
- Key Research Questions

Methodology
- Research Approach by Impact Factor

Evaluation Results
- Impact Factors
- Gross Savings & Verified Gross Savings
- Realization Rates

Conclusions & Recommendations
- Key Drivers
- Recommendations

Appendices
- Lighting Market Snapshot
- Glossary of Key Terms
- Detailed Methodology
  - In Service Rate
  - Percent Interior
  - Baseline Wattage
  - Interactive Effects – Residential
  - Interactive Effects – Commercial
  - Cross-Sector Sales
- Low-to Moderate-Income Analysis
- References

Executive Summary

Program: Residential Retail Lighting

Program Period: Program Year 2021

Key Findings:

Verified gross savings tended to be larger than gross savings.

The same factors that drove this difference were the same as in 2020.

- Cross-sector sales assumption used by the evaluation team (6.2%). The gross savings values assumed all bulbs were installed in residential sockets.
    - Commercial sockets have higher hours of use and coincidence factors, which resulted in higher evaluated gross energy and demand savings.
- The evaluation team assumed 11.5% of bulbs were installed in exterior sockets – these have a higher hours of use than interior sockets (2,117 hours compared to 986 hours per the New York Technical Resource Manual [NYS TRM] v8.0).
- The evaluation team identified bulbs that qualified for EISA exempt baseline wattages. This increased the baseline wattage for EISA exempt bulbs resulting in a higher impact for those bulbs.

Realization Rates – 2021		
Bulb Type	**Energy (MWh)**	**Demand (MW)**
Standard	107%	135%
Reflector	106%	135%
Globe	128%	162%
Decorative	136%	172%
3-Way	107%	135%
Fixtures	238%	302%
Overall	**110%**	**139%**

Executive Summary

Evaluation Objectives:

1. Assess if tracking data adequately and consistently captures lighting product details (watts, style, application, base, and lumen output)
2. Assess if gross savings was calculated in accordance with the New York State Technical Resource Manual (NYS TRM)
3. Determine if incented bulbs can be mapped back to the ENERGY STAR Qualified Products List
4. Identify regionally-specific adjustments to the HVAC Interaction factors to reflect Central Hudson's service territory
5. Calculate program level verified gross savings (VGS) and VGS realization rates

EM&V Methods:

1. Review of program tracking data for all bulbs involved in this program
2. Calculate interior/exterior installations, cross-sector sales, in-service rates, and interactive effects based on data from secondary research

Savings Comparison:

Gross Savings

Type	Count (Bulbs)	MWh	kW
Standard	613,531	23,011	1,754
Reflector	127,350	6,917	527
Decorative	82,431	2,569	196
Globe	42,830	1,421	108
Fixture	736	26	2
Three-Way	453	19	1
Total	**867,331**	**33,961**	**2,589**

Verified Gross Savings

Type	Count (Bulbs)	MWh	kW	MMBtu*
Standard	613,531	24,521	2,369	-23,154
Reflector	127,350	7,364	711	-6,953
Decorative	82,431	3,483	336	-3,289
Globe	42,830	1,815	175	-1,714
Fixture	736	62	6	-59
Three-Way	453	20	2	-19
Total	**867,331**	**37,265**	**3,600**	**-35,187**

*Fossil Fuel impacts are not calculated in the gross savings. Considering New York's increased interest in "MMBtu at site" performance, the evaluation team chose to include them in their verification process.

The same EM&V Team performed an impact evaluation of Central Hudson's Residential Retail Lighting program from 2018 to 2019 and 2020 and found similar results.[1, 2]

Introduction

Program Description

The **Residential Retail Lighting** program provides customers with at-the-register discounts on LED lighting products at a variety of stores within Central Hudson's service territory.

- Residential Retail Lighting is part of the Residential Retail Lighting and Efficient Products program. This evaluation focuses on Retail Lighting, which contributes 99% of the program savings.
- The Residential Retail Lighting program supports a variety of lamp shapes and sizes.
- Fixtures were added to the program in 2021

Standard (A-line): these bulbs work well for a variety of applications such as table or floor lamps, wall sconces, pendant and ceiling fixtures.

Decorative (Candelabra): these bulbs can be used in chandeliers, wall sconces, pendant lights, night lights, decorative light strands, holiday lights and other decorative home lighting applications.

Globes: these bulbs are used in wall sconces, pendant fixtures, bathroom vanities and other specialty fixtures

Reflectors: these bulbs are used in many areas such as perimeters of houses, decks, landscapes, patios, recessed cans, track lighting, and ceiling fans.

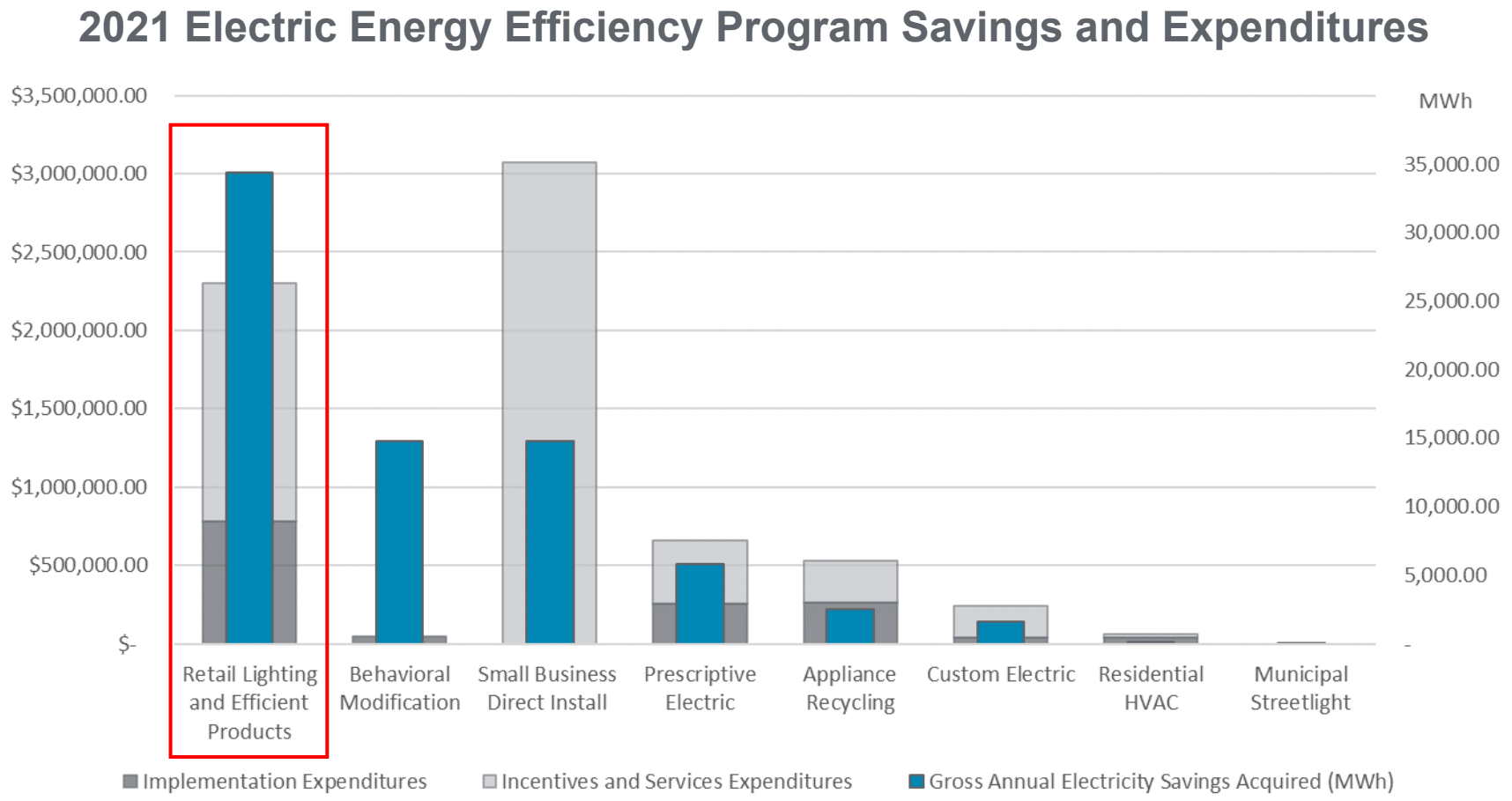
Three-way: these bulbs look like the standard bulb, but have the ability to give three levels of illumination

Fixture: these products are wired directly to the wall or ceiling and have integrated diodes rather than a traditional socket.

Introduction

Program Contributions

- Retail Lighting contributed 99% of electric savings for the Residential Retail Lighting and Efficient Products program in 2021.
- Residential Retail Lighting and Efficient Products contributed 46% of electric portfolio savings and 33% of electric portfolio expenditures in 2021.



CADMUS Demand Side Analytics DATA DRIVEN RESEARCH AND INSIGHTS

Introduction

Program Participation

Home Depot, Lowe's, Sam's Club, BJs, and Walmart account for 90% of the volume, but discounts are provided at several other stores as well.

Distribution of Program Bulbs by Bulb Type and Retailer								
Retailer	**Decorative**	**Fixture**	**Globe**	**Reflector**	**Standard**	**Three Way**	**Total**	**% of Total**
The Home Depot	27,764	-	22,917	52,144	164,916	453	268,193	30.84%
Lowe's	16,941	-	6,875	26,495	119,066	-	169,378	19.55%
Walmart	22,190	271	9,846	26,663	99,565	-	158,536	18.30%
Sam's Club	3,633	-	-	4,514	138,461	-	146,608	16.92%
BJs Wholesale	3,447	465	-	7,668	32,005	-	43,585	5.03%
Dollar Tree	3,146	-	1,131	2,673	16,852	-	23,802	2.75%
Target	1,380	-	467	901	16,996	-	19,744	2.28%
Duchess County Fair	-	-	-	-	13,023	-	13,023	1.50%
Ace Hardware	3,445	-	1,382	3,794	4,328	-	12,949	1.49%
Hannaford	138	-	193	539	4,312	-	5,182	0.60%
Ulster County HFH	263	-	18	203	592	-	1,077	0.12%
Emmanuel's Market Place	-	-	-	481	346	-	827	0.10%
Welcome Oriental Grocery	48	-	-	583	68	-	699	0.08%
Do It Best	-	-	-	-	682	-	682	0.08%
Sam's Food Mart	-	-	-	174	466	-	639	0.07%
IGA	36	-	-	-	582	-	618	0.07%
True Value	-	-	-	-	459	-	459	0.05%
Duchess County Restore HFH	-	-	-	220	231	-	452	0.05%
Salvation Army	-	-	-	-	395	-	395	0.05%
El Mercadito	-	-	-	297	44	-	341	0.04%
.Dollar General	-	-	-	-	142	-	142	0.02%
Total	**82,431**	**736**	**42,830**	**127,350**	**613,531**	**453**	**867,331**	**100%**

Introduction

Key Research Questions

- Are energy, peak demand, and fossil fuel impacts being calculated in accordance with the NYS TRM?[3]

Annual Electric Energy Savings

$$\Delta kWh = units \times \frac{(W_{baseline} - W_{ee})}{1{,}000} \times hrs \times (1 + HVAC_c)$$

Summer Peak Coincident Demand Savings

$$\Delta kW = units \times \frac{(W_{baseline} - W_{ee})}{1{,}000} \times (1 + HVAC_d) \times CF$$

Annual Fuel Energy Savings

$$\Delta MMBtu = units \times \frac{(W_{baseline} - W_{ee})}{1{,}000} \times hrs \times HVAC_{ff}$$

- Can the incented bulbs be mapped back to the ENERGY STAR Qualified Products List?[4]
  - Is the correct efficient wattage being used in savings calculations?
- How can the HVAC Interaction factors be updated to more accurately reflect Central Hudson's service territory?
  - Existing NYS TRM HVAC interaction factors have not been updated since at least 2010 and may not reflect current housing stock and HVAC efficiency levels.

Methodology

Calculation Approach by Parameter

Impact Factor	Approach
ΔWatts ($W_{baseline}$ and W_{ee})	Census review of program-supported LEDs on the ENERGY STAR Qualified Products List or manufacturer cut sheets (W_{ee}). Mapping of LED products to appropriate baseline wattage using style, application, base, and lumen output, per the NYS TRM and EISA standards ($W_{baseline}$).
Hours of Use (Hrs)	NYS TRM v8.0 – 986 interior lamps and 2,117 exterior lamps
Summer CF	NYS TRM v8.0 – 8.2% interior and 0% for exterior
% Interior	Percent interior was estimated using onsite survey data from NYSERDA's 2018 Residential Building Stock Assessment.[5]
Interactive Effects	The Evaluation Team calculated Central Hudson-specific HVAC interaction effects using the same modeling approach implemented for PSEG-LI, Georgia Power, and Efficiency Maine. This approach was selected because it combines a transparent calculation method, reliance on an empirical approach, and the ability to easily update underlying data.
Cross-Sector Sales (%COMM)	Perform a structured literature review of cross-sector sales studies in other jurisdictions. Here, the Evaluation Team referenced similar research done for program administrators in Massachusetts.[6] Using these findings, the team developed a weighted average value to apply in the evaluation. For non-residential HOU and CF, the team reviewed other state technical resource manuals (TRMs) like Pennsylvania that include default parameters for cross-sector sales.[7]
In-service Rate (ISR)	Like cross-sector sales, reviewed in-service rate research that has been performed in other jurisdictions.
Realization Rates	Ratio of verified gross savings to gross savings.

Evaluation Results

Impact Factors

The table to the right shows the impact factors used in calculating verified gross savings values.

- The values for residential HOU and CF were drawn directly from the NYS TRM v8.0. The commercial HOU and CF values were drawn from the 2021 Pennsylvania TRM.[7]
- Derivation of the other factors (Residential HVAC interaction effects, ISR, Cross-sector, and percent interior) is discussed in greater detail in the appendix.

Factor	Residential		Commercial
	Interior	Exterior	
ISR	0.92	0.92	0.92
HOU	986	2,117	2,500
CF	0.082	0	0.60
$HVAC_c$	0.0261	0	0.066
$HVAC_d$	0.129	0	0.175
$HVAC_{ff}$	-0.00093	0	-0.002
% Interior	88.5%		100%
Cross-sector sales	6.2%		

Evaluation Results

Gross Savings

- We found that gross savings calculations followed the algorithms in the NYS TRM for interior lamps.
  - Gross savings calculations assumed 100% of bulbs end up in residential sockets.
  - An in-service rate of 0.92 was included in the algorithm.
  - Coincidence factor, hours of use, and interactive effect inputs were sourced from the NYS TRM v8.0.
- Almost all bulbs could be mapped back to the ENERGY STAR Qualified Products List.

Type		Count	MWh	kW
Standard	A-line	613,531	23,011	1,754
Specialty	Reflector	127,350	6,917	527
	Decorative	82,431	2,569	196
	Globe	42,830	1,421	108
	Fixture	736	26	2
	Three-Way	453	19	1
Total:		**867,331**	**33,961**	**2,589**

Evaluation Results

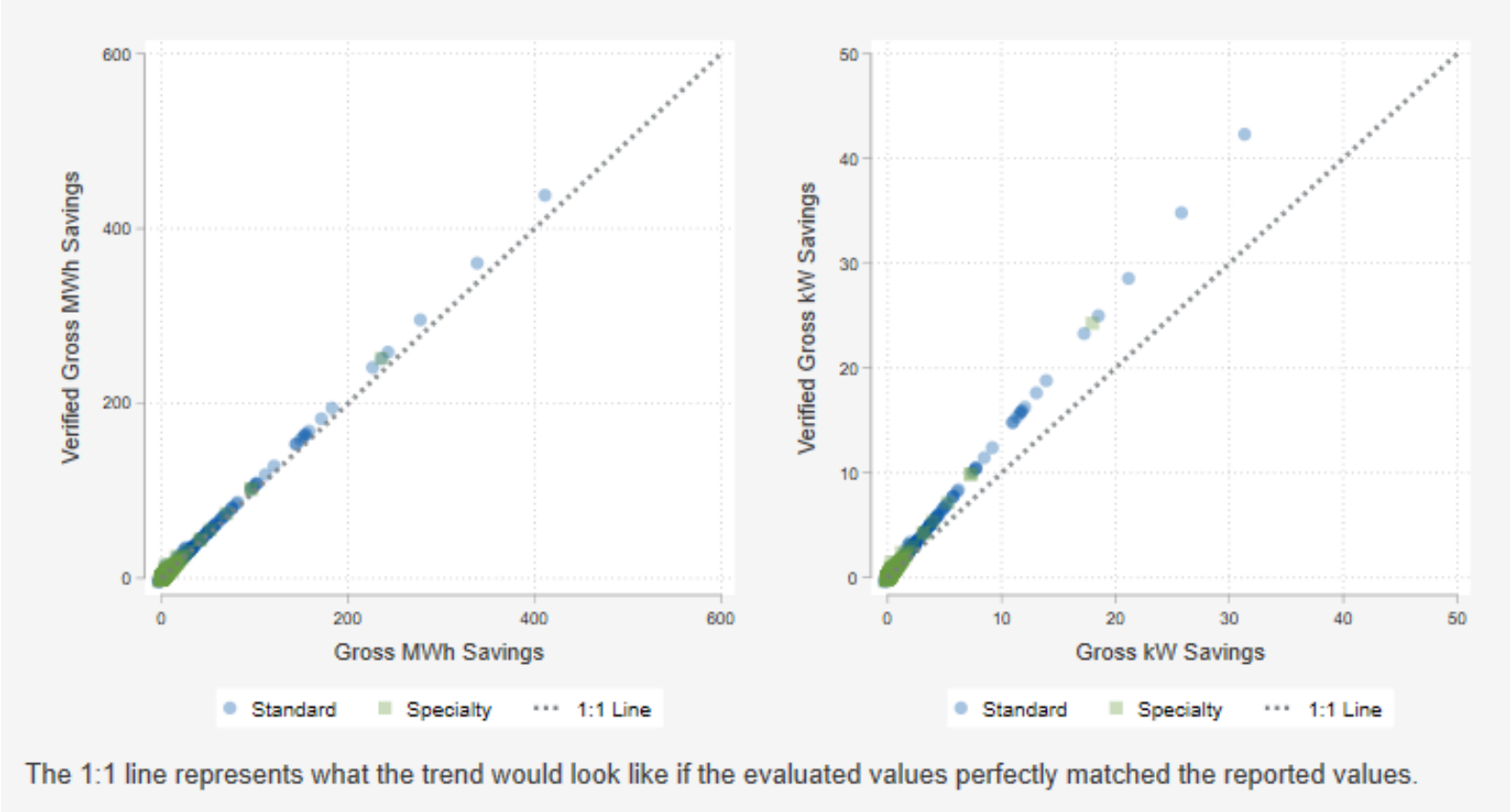
Verified Gross Savings

Type		Count	MWh	kW	MMBtu
Standard	Standard	613,531	24,521	2,369	-23,154
Specialty	Reflector	127,350	7,364	711	-6,953
	Decorative	82,431	3,483	336	-3,289
	Globe	42,830	1,815	175	-1,714
	Fixture	736	62	6	-59
	Three-Way	453	20	2	-19
Total:		**867,331**	**37,265**	**3,600**	**-35,187**

Evaluation Results

Comparison of Gross Savings and Verified Gross Savings

- Each point in the figure below represents a unique tracking data record.
- Most points are above the line, indicating that verified gross savings (y-axis) tend to be larger than gross savings (x-axis).
- Specialty bulbs includes Reflectors, Globes, Candelabras/Decorative, Fixtures and Three-Way.



The 1:1 line represents what the trend would look like if the evaluated values perfectly matched the reported values.

CADMUS Demand Side Analytics DATA DRIVEN RESEARCH AND INSIGHTS

Evaluation Results

Realization Rates

Metric	Standard	Reflector	Globe	Decorative	Fixture	3-Way
Energy (kWh)	107%	106%	128%	136%	238%	107%
Demand (kW)	135%	135%	162%	172%	302%	135%

- Decorative and Globe bulbs are more likely to qualify for EISA-exempt baselines leading to the higher realization rates.
- Gross savings do not account for the variation in size amongst fixtures. In 2021, there were 466 Shop Lights with a light output of 4,000 lumens. VGS savings uses lumens to compute baseline wattage so these fixtures have large per-unit savings that inflate the realization rate.
- The evaluation team incorporated cross-sector savings assumptions into the savings calculations leading to higher savings estimates and increasing realization rates across all categories.

Conclusions and Recommendations

The VGS realization rates have been stable for three consecutive evaluations

Key Drivers of Results	Recommendations
Cross-sector sales – all tracking data records assume installation in residential sockets. The evaluation team used a cross-sector sales rate of 6.2%. Commercial HOU and CF are higher than residential, leading to higher savings.	Consider adjusting gross savings algorithms to account for cross-sector sales, exterior socket installations, and Central Hudson specific waste heat factors.
Exterior sockets – all tracking data records assume installation in interior sockets. The evaluation team assumed 11.5% of bulbs would be installed in exterior sockets, where the HOU is greater.	
Interactive effects – tracking data records assume all bulbs are installed in single-family homes with AC and gas heat. The evaluation team calculated updated waste heat factors using assumptions specific to Central Hudson's service territory.	Consider using Central Hudson-specific Interactive Effect assumptions calculated by the Evaluation team.
EISA Exempt Bulbs – some bulbs reported in the tracking data qualified for EISA exemption. If EISA exempt, the baseline wattage estimates were changed to pre-EISA standards. This increased baseline wattages for these bulbs resulting in an increase in estimated savings.	Adjust baseline wattage assumptions for bulbs that are considered EISA exempt.

APPENDICES

Appendix A – Lighting Market Snapshot

Appendix B – Glossary of Key Terms

Appendix C – Detailed Methodology

Appendix D – Low-to Moderate-Income Analysis

Appendix E – References

CADMUS

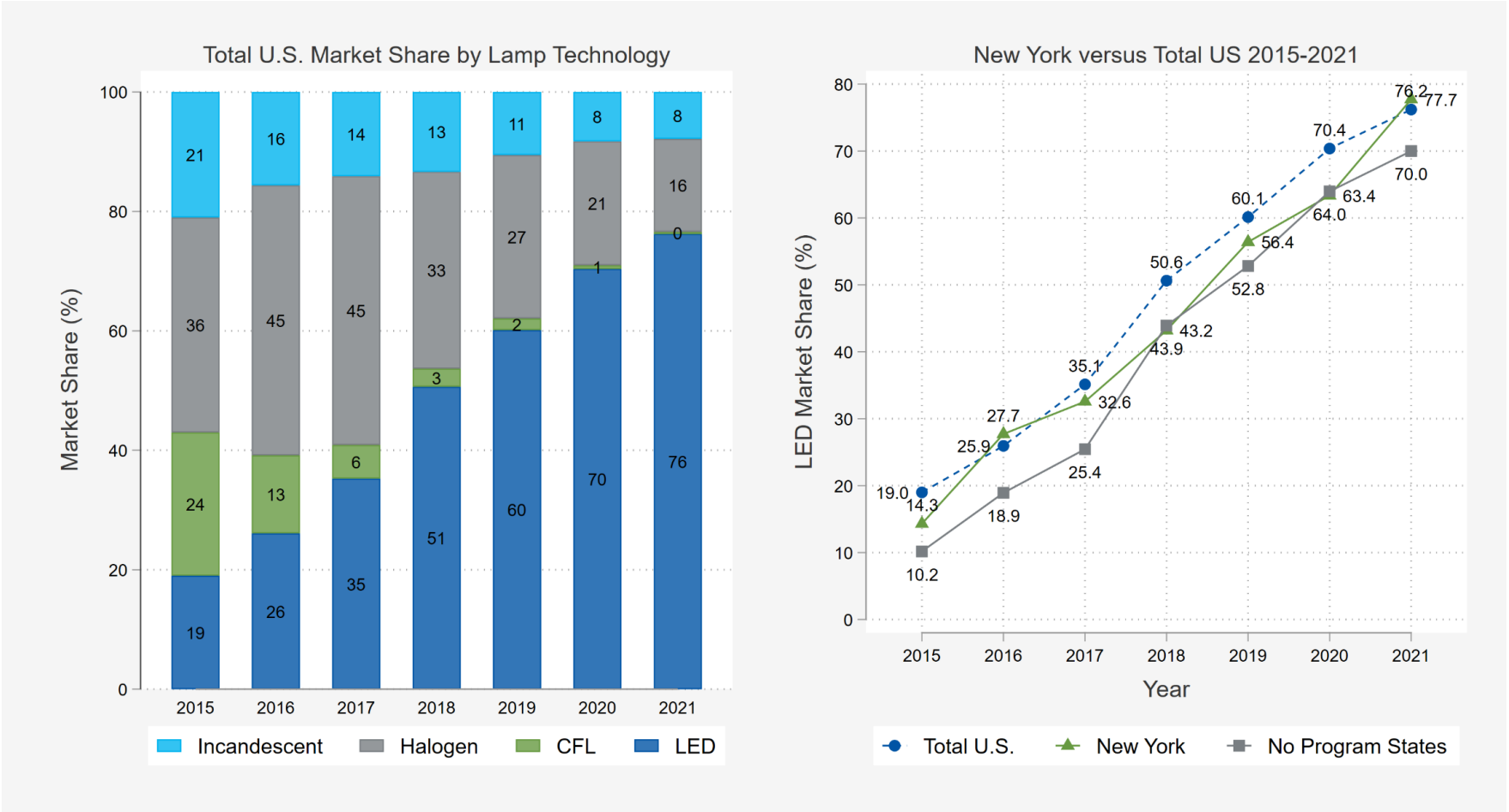
Demand Side Analytics

DATA DRIVEN RESEARCH AND INSIGHTS

Lighting Market Snapshot

LED Market Share Growth

In 2021, New York State showed a higher LED market share than the United States as a whole for the first time since 2016. New York's LED market share was 7.7% higher than states without retail lighting programs in 2021.[8]



CADMUS Demand Side Analytics DATA DRIVEN RESEARCH AND INSIGHTS

Glossary of Key Terms

- **Coincidence Factor (CF):** A ratio with the numerator being the simultaneous demand of a similar group of electrical appliances (measures) within a specified period, to the sum of their individual maximum demands within the same period.*
- **Cross-Sector Sales:** The percentage of measures counted through a residential program that are installed in commercial applications, or vice versa.
- **Gross Savings (GS):** Energy savings that result directly from program-related actions taken by participants in an energy efficiency program, regardless of why they participated and unadjusted by any significant factors. This is sometimes referred to as program-reported savings and may include some level of refinement such as modeling or adjustments for QA/QC to address sources of uncertainties in Planned Savings, including baseline assumptions or deemed values. Gross Savings is determined prior to an independent evaluation.§
- **Hours of Use (HOU):** The hours over a prescribed period which the measure is on and using energy.
- **HVAC Interactive Effects:** The extent to which the measure increases or decreases the demand on a buildings HVAC systems. For instance, LED lighting produces less heat than incandescent lighting, so upgrading an incandescent lamp to an LED lamp will increase HVAC system demand in the heating season and decrease AC demand in the cooling season.
- **In-service Rate:** The percentage of measures counted through the program that are still installed after a given period of time.
- **Verified Gross Savings (VGS):** VGS is the value reported by an independent evaluator as energy efficiency program activities and Gross Savings Analysis are complete. VGS is distinct from GS in two ways: 1) it is the product of a complete gross savings analysis using methods consistent with industry standard best practices, and 2) it is produced by an independent evaluator, not by the program administrator.§
- **VGS Realization Rate (VGS RR):** The ratio of VGS to GS, expressed as a decimal; indicates the performance of a program's reported GS relative to actual realized savings.§

*Source: NYS TRM[1]
§Source: CE-08 Gross Savings Verification Guidance[8]

Detailed Methodology

In Service Rate

- Though not stipulated in the TRM, an in-service rate of 92% was factored into the savings values for tracking data records.
- During the 2018/2019 evaluation, our team reviewed some recent in-service rate research to determine whether or not this input should be adjusted.
- A recent residential appliance saturation survey in Rhode Island found a 93% in-service rate for standard bulbs and 94% for reflectors and specialty bulbs.[9]
- A 2016 PSEG Long Island Residential Lighting, Pool Pump, and Dehumidifier Study calculated ISR by bulb type from 144 in-home surveys. The study estimated a first-year ISR of 89% for LEDs and a long-run ISR of 97%.
- Given that these values do not differ greatly from the 92% ISR factor currently in use, our team aligned with Central Hudson and used 92% throughout our calculations.

Detailed Methodology

Percent Interior

- To develop an assumption regarding the percentage of residential light bulbs that end up in interior light sockets, our team reviewed NYSERDA's 2018 Residential Building Stock Assessment.
- On site surveys in counties served by Central Hudson returned a weighted total of 13,628,259 light bulbs inside homes and 1,779,234 bulbs outdoors. Percent interior was therefore calculated as:

$$\%\ Interior = \frac{13{,}628{,}259}{13{,}628{,}259 + 1{,}779{,}234} * 100\% = 88.5\%$$

- This implies 11.5% of residential bulbs end up in exterior sockets.
- On the commercial side, our team assumed that 100% of bulbs are installed in interior sockets.

Detailed Methodology

Baseline Wattage – EISA Exempt

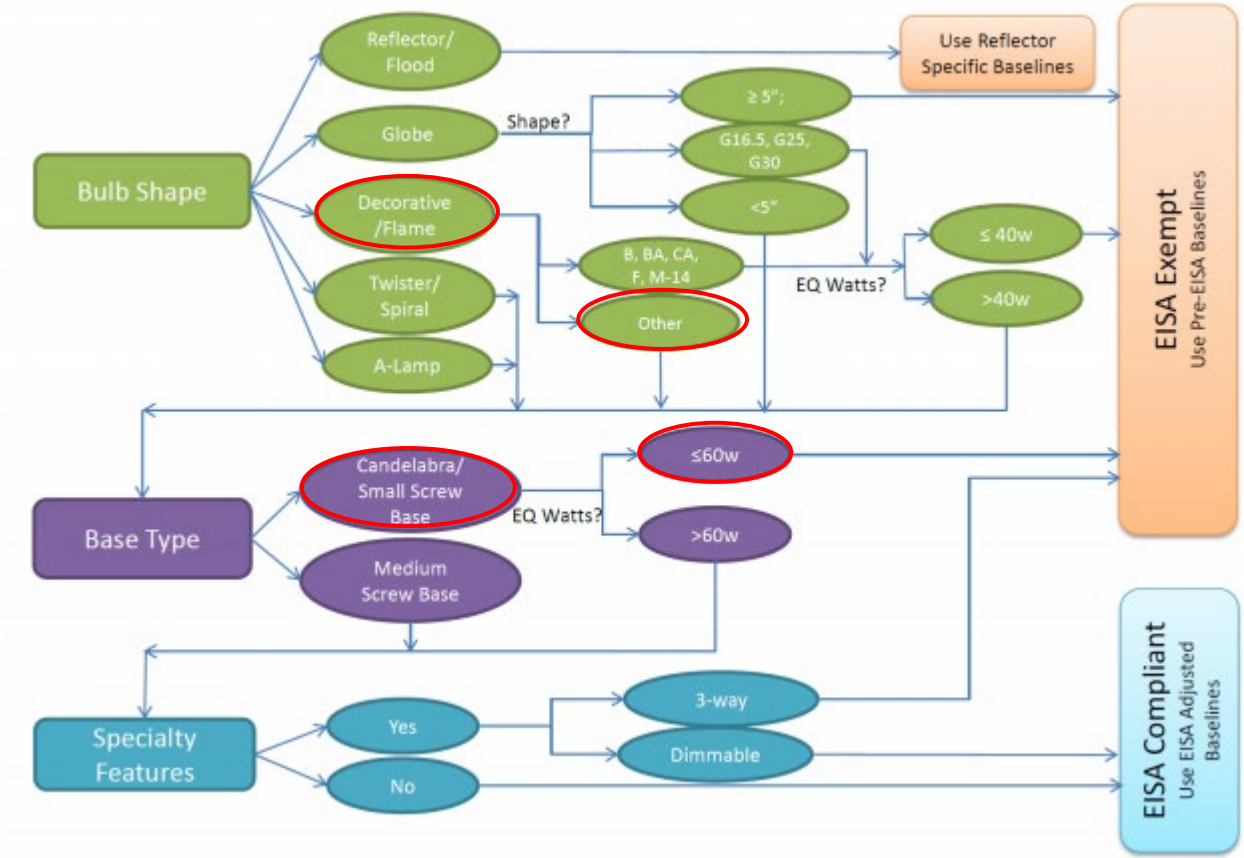
- The NYS TRM provides baseline wattages for both Post-EISA (halogen) standards as well as EISA-Exempt bulbs. If a bulb is EISA exempt, then the baseline wattages would reflect the incandescent equivalent wattage.
  - The NYS TRM does not provide guidance on how to determine if a given lamp is EISA-exempt or not.
- The evaluation team reviewed reported bulbs and updated baseline wattages for those that were considered EISA exempt.

Lumen Range (decorative) (a)	Lumen Range (globe) (b)	Post-EISA 2007 Incandescent Equivalent $W_{baseline}$ (c)	EISA-Exempt Incandescent Equivalent $W_{baseline}$ (d)
70 – 89		10	10
90 – 149		15	15
150 – 299	250 – 349	25	25
300 – 499	350 – 499	29	40
500 – 699	500 – 574	43	60
	575 – 649	53	75
	650 – 1,099	72	100
	1,100 – 1,300	72	150

Detailed Methodology

Baseline Wattage – EISA Exempt

- For example, tracking data reported a baseline wattage of 29 for Decorative (Candelabra) bulb with an E-12 base, a wattage equivalency less than or equal to 60 watts, and lumens at 350.
- However, as shown in the logic in the flowchart below, under EISA guidelines this bulb would be EISA exempt and have a baseline wattage of 40.



Detailed Methodology

Interactive Effects – Residential

- Residential Interactive Effects were calculated by the evaluation team using the modeling approach implemented in the Efficiency Maine TRM with adjustments for CHGE specific inputs. The methodology can be referenced in the 2020 Residential Retail Lighting Impact Evaluation report.[2]
- Below are the algorithms used to determine each interaction effect:

$$HVAC_d = 1 + \frac{IGC \times \%A \times C}{Eff_{HVAC}}$$

$$HVAC_e = 1 + \frac{IGC \times \%A \times C}{Eff_{HVAC}} \times \%Electric$$

$$HVAC_{ff} = -\frac{IGC \times \%A \times C}{Eff_{HVAC}} \times 0.003412 \frac{MMBtu}{kWh} \times \%Fossil$$

- Where:
  - Internal Gain Contribution, IGC (%): the percent of waste heat that remains inside the building, contributing to the increased or decreased need for heating or cooling from the HVAC system.
  - Applicability, %A (%): the percentage of lighting that is installed in spaces that are heated or cooled by the HVAC system.
  - Concurrency, C (%): the percent of time that both lighting and HVAC systems are operating concurrently.
  - HVAC Efficiency, Eff_{HVAC} (%): efficiency of the HVAC system
  - % Fossil & % Electric are the shares of each fuel type in CHGE's territory. Results from NYSERDA's RBSA indicated 12.3% of residential customers had electric heat and the other 87.7% fossil fuel.

Detailed Methodology

Interactive Effects – Residential

- Applying the algorithms results in an $HVAC_c$ value of **0.0261**, an $HVAC_d$ value of **0.129**, and an $HVAC_{ff}$ value of **-0.00093**.
- HVAC fossil fuel interaction factors were converted from Therms to MMBtu in NYS TRM v8.0. For this evaluation, $HVAC_{ff}$ interaction factors in terms of MMBtu were used.

Interaction Factor Value Comparison			
Source	$HVAC_c$	$HVAC_{ff}$	$HVAC_d$
NYS TRM (AC with Fuel)	0.0600	-0.00250	0.079
NYS TRM Weighted Avg. from 2018/2019 Evaluation	0.0060	-0.00210	0.087
DSA/Cadmus Calculated	**0.0261**	**-0.00093**	**0.129**

Detailed Methodology

Interactive Effects – Commercial

- For commercial interactive effects multipliers, we keyed off of the NYS TRM v8.0 Default Values for Poughkeepsie, shown below.
  - According to the NYS TRM, these values are weighted averages of the Small & Large Commercial Building Types with typical HVAC systems.
- DSA is modeling Central Hudson-specific commercial interactive effects as part of the SBDI and Commercial Prescriptive scope. These values will be incorporated into the 2021-2022 evaluation.

DEFAULT VALUES

City	HVACc	HVACd	HVACff
Albany	0.054	0.174	-0.002
Binghamton	0.046	0.173	-0.002
Buffalo	0.049	0.174	-0.002
Massena	0.042	0.174	-0.002
Poughkeepsie	0.066	0.175	-0.002
Syracuse	0.057	0.174	-0.002
NYC	0.080	0.175	-0.002

Detailed Methodology

Cross-Sector Sales Literature Review

- Some fraction of the program-supported lamps are installed in commercial sockets.
  - Commercial Sockets have higher hours of use and coincidence factor.
  - Some utilities also adjust cost recovery.
- NYS TRM and the implementation contractor assume all lamps are installed in a residential setting.
- We reviewed 24 cross-sector sales studies conducted in across the US.
- The studies we reviewed covered multiple geographic regions and a time period of 2010 to 2019. The studies of interest used several different measurement methods.
  - In-store intercept surveys
  - Phone surveys
  - Internet surveys

Study Mode	Average	Count
Phone Survey	6.6%	5
Intercept Survey	6.0%	11
Multiple	7.1%	5
Mobile Device Survey	3.5%	2
Online Survey	7.1%	1
Average of All 24 Studies	**6.2%**	**24**

Low-to Moderate-Income Analysis

Policy Background

- To date Central Hudson has not claimed any Low-to Moderate-Income (LMI) savings for the Residential Lighting and Efficient Products program.
  - The “upstream” nature of the Residential Lighting component does not allow for income validation of participants.
- NYSERDA implemented a plan in 2020 to create a more holistic and coordinated approach to deliver energy efficiency to LMI customers and communities in New York.
  - This push is supported by an overarching advance from New York's clean energy initiative.
  - The LMI Implementation plan spans across New York State, 2020-2025, with goals of 7,559,707 MWh, and gas savings of 151,063,530 MMBtu at the state level and 1,579 MWh and 19,666 MMBTU for Central Hudson.[10]
- New York State’s LMI customer market is more than 3.5 million households (40% of the State’s households) qualifying as LMI.
  - Low-income households are defined as those with annual incomes at or below 60% of the State Median Income.
  - Moderate Income households have an annual income between 60% and 80% of the State Median Income or the Area Median Income, whichever is greater.
- Given the LMI emphasis in New York and the inevitability that a portion of Residential Lighting participants are LMI, there is interest in exploring LMI allocation methods.

Low-to Moderate-Income Analysis

NYSERDA Definitions and Thresholds

- NYSERDA defines Low-to Moderate-Income (LMI) as households at 80% or less than median income for the region or state – whichever is higher.
- NYSERDA uses The New York State Affordable Housing Corporation's estimates of median income.[11]
- The LMI threshold for a 4-person household in the Mid-Hudson region is less than $76,585 annual household income.
- Mid-Hudson region includes Central Hudson's counties as well as Westchester county.
  - Westchester county has a very high median income, $128,000, and is outside Central Hudson service territory.
  - For this evaluation, we estimate a Central Hudson specific threshold.

NYSERDA 80% of Median Income Thresholds

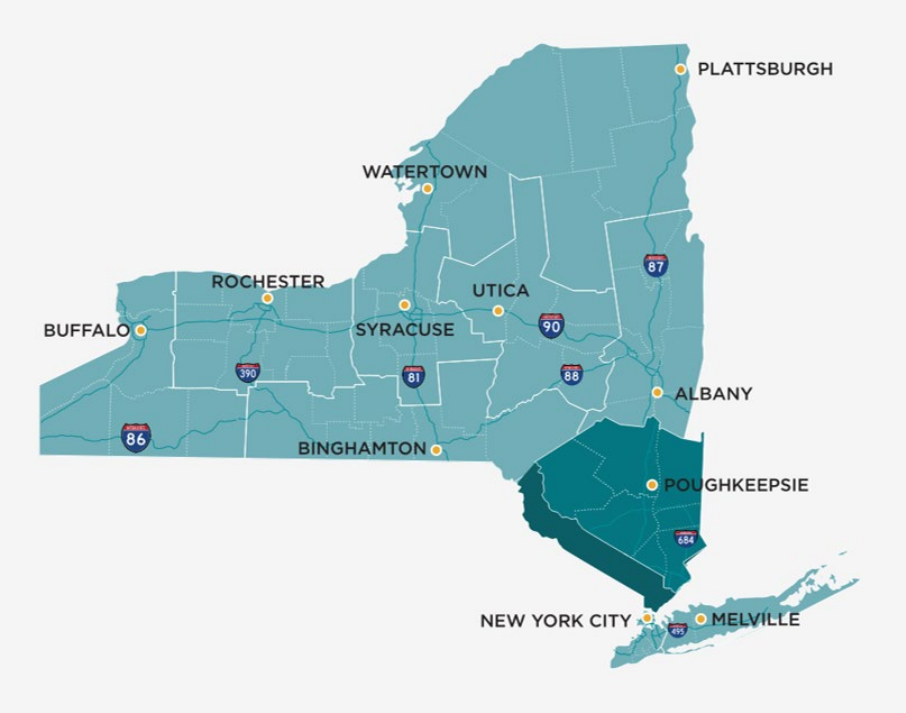
NYS Region	80% of Area Median Income (AMI)[1]							
	1 person households	2 person households	3 person households	4 person households	5 person households	6 person households	7 person households	8 person households
Capital District AMI	$44,058	$50,299	$56,645	$62,926	$67,989	$73,052	$78,053	$83,111
Central New York AMI	$38,404	$43,867	$49,338	$54,796	$59,231	$63,587	$68,014	$72,378
Finger Lakes AMI	$37,973	$43,434	$48,830	$54,220	$58,583	$62,941	$67,294	$71,586
Long Island AMI	$59,520	$68,000	$76,480	$84,960	$91,760	$98,560	$105,360	$112,160
Mid-Hudson AMI	$53,647	$61,303	$68,972	$76,585	$82,756	$88,877	$95,012	$101,103
Mohawk Valley AMI	$34,426	$39,343	$44,259	$49,111	$53,064	$57,000	$60,930	$64,856
New York City AMI	$50,800	$58,000	$65,280	$72,480	$78,320	$84,080	$89,920	$95,680
North Country AMI	$34,426	$39,341	$44,258	$49,116	$53,084	$57,017	$60,950	$64,861
Southern Tier AMI	$35,551	$40,626	$45,700	$50,718	$54,833	$58,893	$62,940	$66,990
Western New York AMI	$36,902	$42,146	$47,389	$52,618	$56,851	$61,069	$65,288	$69,506
State Median Income (80%)[2]	$35,907	$46,956	$58,004	$69,053	$80,101	$91,150	$93,221	$95,293

Low-to Moderate-Income Analysis

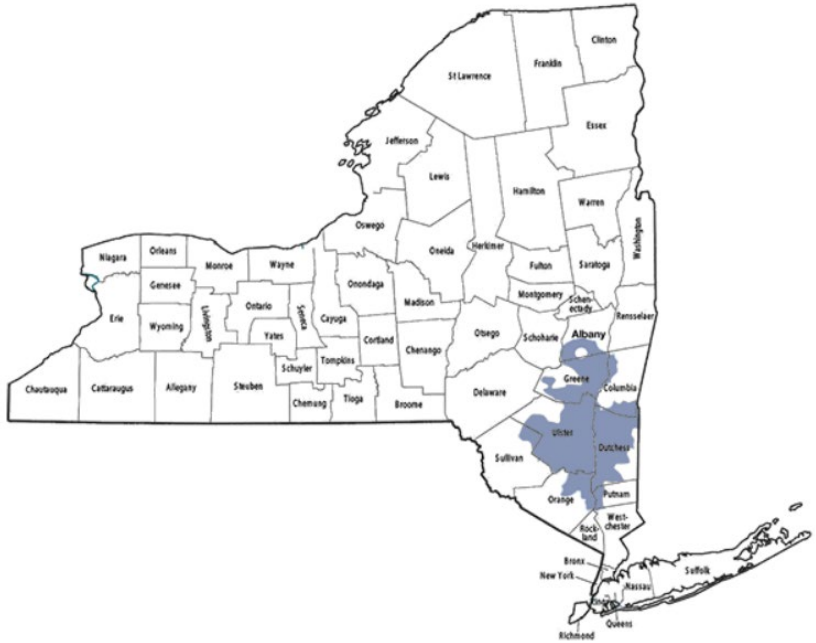
Regional Data vs. Service Territory

Central Hudson territory is entirely within the mid-Hudson economic region but does not include most of Orange, Rockland, Westchester counties.

Mid-Hudson Region



Central Hudson Service Territory



CADMUS Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS

Low-to Moderate-Income Analysis

Census Data

- United States Median Household Income Census provides number of households in multiple income ranges from $0 to over $200,000.[12] These are grouped by blocks.
  - The Census data is derived from a 2019 National Survey.
  - Group: B19001; Income by Household in the last 12 Month
- A block is a range of space that maps out a geographical region in the United States.[13] Each Census Block has an epicenter with longitude and latitude coordinates.
- All Census data was publicly available and pulled directly from Census.gov.
- Census data was used to create an estimate of LMI consumers around each store. The assumption is that no store solely sells light bulbs to Non-LMI or LMI customers. We use the income distribution of the population around a store to estimate the share of light bulbs LMI customers purchase.

Low-to Moderate-Income Analysis

Residential LMI Threshold Calculation

- Using Census blocks that are located in Central Hudson service territory and aggregating all homes by income group creates an income distribution.
  - The four largest counties of Central Hudson, Dutchess, Orange, Greene, Ulster, are used as a proxy for the entire region.
- With the median income of CHGE service territory and NYSERDA's definition of LMI, we calculate the LMI threshold as:
  - $LMI\ Threshold = Median\ Income\ * 0.80$
  - $LMI\ Threshold = \$75{,}000 * 0.80 = \$60{,}000$

County	Less than $10,000	Less than $15,000	Less than $20,000	Less than $25,000	Less than $30,000	Less than $35,000	Less than $40,000	Less than $45,000	Less than $50,000	Less than $60,000	Less than $75,000	Less than $100,000	Less than $125,000	Less than $150,000	Less than $200,000
Dutchess County	4%	8%	11%	14%	18%	22%	25%	28%	31%	38%	47%	60%	71%	79%	89%
Greene County	6%	13%	18%	23%	30%	35%	39%	43%	47%	55%	64%	78%	86%	91%	96%
Orange County	5%	8%	12%	15%	19%	22%	26%	29%	32%	39%	47%	60%	71%	79%	90%
Ulster County	5%	10%	14%	19%	23%	27%	32%	35%	39%	47%	57%	70%	79%	86%	93%
Overall	**5%**	**9%**	**13%**	**16%**	**20%**	**24%**	**28%**	**31%**	**34%**	**41%**	**50%**	**63%**	**73%**	**81%**	**91%**

*Household shares are cumulative

Low-to Moderate-Income Analysis

Residential Income by Store Calculations

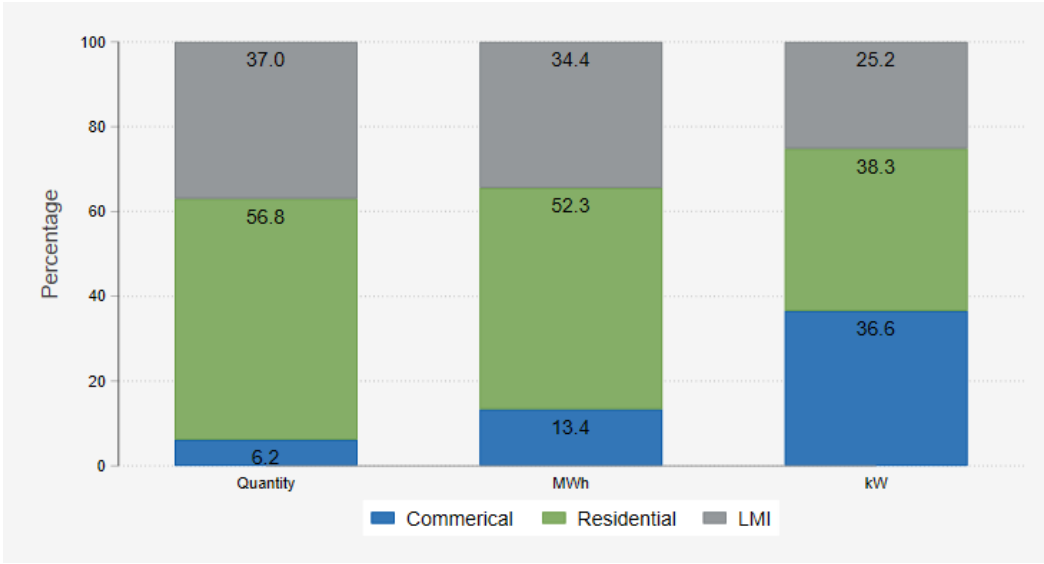
- The evaluation team geocoded each storefront and then calculated the distance between each store and Census Block.
- Stores service multiple census blocks. To find those blocks a radius was created around each store to include those block groups that represent possible customers at the store.
  - Grocery and Dollar stores were given a radius of 5 miles due to their frequency and distance between each other.
  - All other stores were given a 15-mile radius as customer are more likely to drive to these stores.
- Summing all homes by income group that are in the respective circles of each store leads to an estimate of income distribution of the customers that may shop at that store.
- The percentage of homes that are under our LMI threshold of $60,000 is our estimate of LMI shoppers at a given store front.
- We use the estimated share of LMI shoppers as a proxy for LMI LED purchases.
- LMI savings are first calculated at the store level after removing commercial sales.
  - 6.2% of the total bulbs are removed based on the results of the cross-sector sales analysis.
  - The store-specific LMI percentage is applied to all remaining 2021 program-supported LED products.

Low-to Moderate-Income Analysis

Summary of Findings

- Our results suggest that 39.2% of residential LEDs are purchased by LMI households
- After accounting for the 6.2% cross-sector sales rate, we estimate the following LMI shares:
  - 37.0% of all 2021 *bulbs*
  - 34.4% of all 2021 *MWh*
  - 25.2% of all 2021 *kW*

Share of Bulbs and Savings



Estimated 2021 LMI Savings

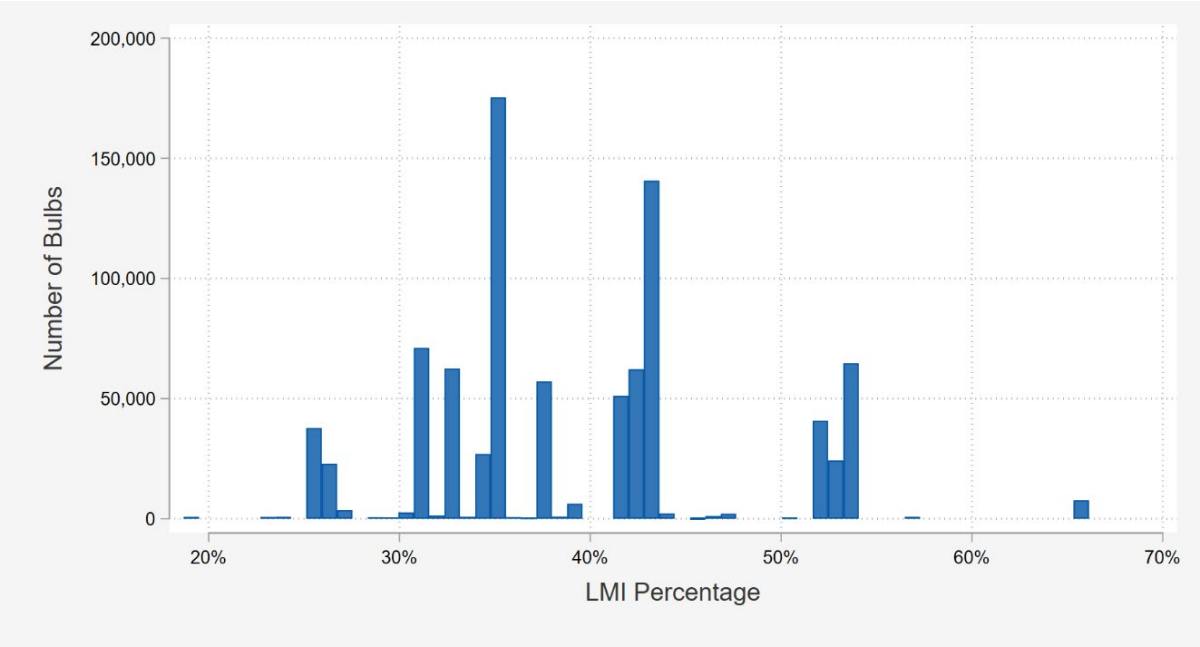
Type*	Count (Bulbs)	MWh	kW	MMBtu
Standard	225,289	8,339	590	-6,676
Reflector	49,357	2,670	189	-2,138
Decorative	30,827	1,202	85	-962
Globe	14,879	578	41	-462
Fixture	234	17	1	-14
Three-Way	175	7	0	-6
Total	**320,761**	**12,813**	**906**	**-10,258**

Low-to Moderate-Income Analysis

Conclusions and Recommendations

Key Drivers of Results	Recommendations
LMI Threshold – Instead of relying on NYSERDA's Mid-Hudson's LMI threshold of $76,585, the Evaluation Team's estimated LMI threshold for the CHGE portion of the Mid-Hudson region is $60,000.	Consider adjusting to a more conservative estimate of LMI since the Mid-Hudson region includes counties outside of Central Hudson's scope. These counties tend to be wealthier which raise the LMI threshold.
Income by Stores – The Evaluation team estimated share of LMI shoppers and savings for each retailer to get a granular estimate of LMI savings.	Consider estimating share of LMI bulbs on the individual store level. This method acknowledges the fact that no store services exclusively Non-LMI or LMI consumers. As seen below the majority of bulbs are from stores with 35-45% LMI customers.

Distribution of 2021 Lamps by Estimated Storefront LMI Share



CADMUS Demand Side Analytics DATA DRIVEN RESEARCH AND INSIGHTS

Low-to Moderate-Income Analysis

Stores: Dollar & Grocery

Dollar General	LMI
330 Route 212, Saugerties, NY, 12477-5122	50.7%
423 Broadway, Newburgh, NY, 12550-5332	45.2%
88 N Plank Rd, Newburgh, NY, 12550-1739	45.3%

Dollar Tree	LMI
1379 Ulster Ave , Kingston , NY, 12401	46.9%
340 West Bridge St , Catskill , NY, 12414	66.1%
16 N Main St, Ellenville , NY, 12428	56.8%
738 Rte 9, Fishkill , NY, 12524	30.3%
3999 Albany Post Rd , Hyde Park , NY, 12538	31.6%
39 Northplank Rd , Newburgh , NY, 12550	42.3%
1431 Rte 300 , Newburgh , NY, 12550	36.2%
115 Temple Hill Rd , New Windsor , NY, 12553	30.3%
Us 9 4A , Wappingers Falls , NY, 12590	38.4%
2585 South Rd , Poughkeepsie , NY, 12601	41.6%
1925 South Rd , Poughkeepsie , NY, 12601	27.1%
47 Burnett Blvd , Poughkeepsie , NY, 12603	44.2%

Welcome Oriental Grocery	LMI
1820 NY 376 , Poughkeepsie, NY, 12603	19.3%

El Mercadito	LMI
344 Broadway, Kingston, NY, 12401	47.0%

IGA	LMI
4099 Route 28 , Boiceville , NY, 12412	18.7%
32 Front St , Millbrook , NY, 12545	29.6%

Emmanuel's Market Place	LMI
3853 Main St, Stone Ridge, NY, 12484	24.1%

Hannaford	LMI
100 Plaza Road, Kingston, NY, 12401	45.5%
1261 Ulster Ave, Kingston, NY, 12401	47.2%
223 Main St, Cairo, NY, 12413	47.0%
3650 Us Highway 9W, Highland, NY, 12528	51.7%
2066 State Route 32, Modena, NY, 12548	33.8%
2636 Route 32, New Windsor, NY, 12553	30.0%
31 Ted Dr, Pine Bush, NY, 12566	30.2%
35 Hannaford Dr, Red Hook, NY, 12571	36.9%
1490 Route 9, Wappingers Falls, NY, 12590	29.0%

Low-to Moderate-Income Analysis

Stores: Hardware

Lowes	LMI
901 Frank Sottile Blvd , Kingston , NY, 12401	43.9%
60 Catskill Commons , Catskill , NY, 12414	53.8%
650 Ny 299 , Highland , NY, 12528	41.4%
1239 Rte 300 , Newburgh , NY, 12550	34.8%
1941 South Rd , Poughkeepsie , NY, 12601	34.0%

Home Depot	LMI
1122 Ulster Ave , Kingston , NY, 12401	42.0%
450 State Rte 9 , Fishkill , NY, 12524	31.1%
1220 Rte 300 , Newburgh , NY, 12550	34.9%
1570 Rte 9 , Wappingers Falls , NY, 12590	25.9%
695 Rte 23B , Leeds , NY, 12451	53.2%
3470 North Rd , Poughkeepsie , NY, 12601	37.9%

True Value	LMI
4 Mill Hill Rd , Woodstock , NY, 12498	33.4%

Do It Best	LMI
Rt 209 Box 5000 , Accord , NY, 12404	37.3%

Ace Hardware	LMI
140 S Main St, Ellenville, NY, 12428	50.2%
317 Kyserike Rd , High Falls , NY, 12440	37.4%
34 Bloomer Rd , Tannersville , NY, 12485	44.4%
908 Route 82 , Hopewell Junction , NY, 12533	23.1%
2424 Rte 44 , Pleasant Valley , NY, 12569	27.0%
9-11 E Market St , Red Hook , NY, 12571	39.1%
6760 Rte 9 , Rhinebeck , NY, 12572	42.9%

Low-to Moderate-Income Analysis

Stores: Non-Profit & Big Box & Wholesale

Target	LMI
1300 Ulster Ave , Kingston , NY, 12401	42.8%
50 Rte 17K , Newburgh , NY, 12550	34.9%
2001 South Rd , Poughkeepsie , NY, 12601	34.9%

Walmart	LMI
601 Frank Stottile Blvd , Kingston , NY, 12401	43.0%
30 Catskill Commons , Catskill , NY, 12414	53.8%
7500 Rte 209 , Napanoch , NY, 12458	52.0%
26 W Merritt Blvd , Fishkill , NY, 12524	31.3%
1201 Rte 300 , Newburgh , NY, 12550	34.8%

Sam's Club	LMI
801 Frank Sottile Blvd , Kingston , NY, 12401	43.0%
56 W Merritt Blvd , Fishkill , NY, 12524	32.8%
6 Hooker Ave, Poughkeepsie, NY, 12601	36.2%

BJs Wholesale	LMI
401 Auto Park Pl, Newburgh, NY, 12550	35.2%
1404 Route 9 , Wappingers Falls, NY, 12590	26.6%

Duchess County Fair	LMI
6282 U.S. 9, Rhinebeck, NY, 12572	42.4%

Duchess County Restore HFH	LMI
1822 South , Wappingers Falls , NY, 12590	31.2%

Salvation Army	LMI
884 Ulster Ave , Kingston , NY, 12401	41.4%

Ulster County Hfh	LMI
406 Onteora Trl , Kingston , NY, 12401	42.9%

References

1. Central Hudson 2018-2019 Residential Retail Lighting and Efficient Products Impact Evaluation Report, July 1, 2021. Available at https://documents.dps.ny.gov/public/MatterManagement/MatterFilingItem.aspx?FilingSeq=269721&MatterSeq=48057
2. Central Hudson Residential 2020 Retail Lighting Impact Evaluation Final Report, December 2021. Available at https://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={7C502F20-E804-401B-9C03-8A52A21D945F}
3. New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Residential, Multi-Family, and Commercial/Industrial Measures. Version 8. January 2021. Available at https://www3.dps.ny.gov/W/PSCWeb.nsf/96f0fec0b45a3c6485257688006a701a/72c23decff52920a85257f1100671bdd/$FILE/NYS%20TRM%20V8.pdf
4. ENERGY STAR Certified Light Bulbs Version 2.0. Available at https://data.energystar.gov/Active-Specifications/ENERGY-STAR-Certified-Light-Bulbs-Version-2-0/ebgj-qsf7/data
5. Cadmus Group LLC. Residential Building Stock Assessment. Prepared for New York State Energy Research And Development Authority (NYSERDA). October 2019. Available at https://www.nyserda.ny.gov/-/media/Files/Publications/building-stock-potential-studies/2019-residential-building-stock-assessment-report.pdf
6. Massachusetts Residential Lighting Cross-Sector Sales Research. NMR Group, Inc. and Cadmus. Prepared for Massachusetts Program Administrators and Energy Efficiency Advisory Council. March 2015. Available at https://ma-eeac.org/wp-content/uploads/Residential-Lighting-Cross-Sector-Sales-Research-Memo.pdf
7. 2021 Technical Reference Manual, Volume 2 – Commercial and Industrial Measures. August 2019. See Table 3-20. Available at https://www.puc.pa.gov/pcdocs/1692531.docx
8. CREED LightTracker National and State-Level Sales Data Reports. https://www.creedlighttracker.com/
9. NMR Group, Inc. RI2311 National Grid Rhode Island Lighting Market Assessment. July 2018. Reported prepared for National Grid Rhode Island. Available at http://rieermc.ri.gov/wp-content/uploads/2019/04/ri2311-rass-lighting-report-final-27july2018.pdf
10. Statewide Low- and Moderate-Income Portfolio Implementation Plan, July 2020, See Table 3.1 Available at https://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7B51100786-2EFC-49AD-8ED3-8D836FC2A8B9%7D
11. NYSERDA Low-To Moderate Market Characterization Study Special Topic Report – INCOME STATUS FOR LMI, HOUSEHOLDS Guidelines . October 2017. See Table 3.1. Available at http://www.appriseinc.org/wp-content/uploads/2017/10/LMI-Special-Topic-Rpt-Income-Guidelines.pdf
12. American Census Survey 2019 Data. 2019. See S1903, Group B19001. Available at http://api.census.gov/data/2019/acs/acs5/subject/groups/.html?msclkid=ce448063b03e11ec9f4e55f03b4deec9
13. United States Census 2010 TIGER/Line® Shapefiles. 2010. See 2010, New York. Available at https://www.census.gov/cgi-bin/geo/shapefiles/index.php?year=2010&layergroup=Block+Groups

CONTACTS

Jesse Smith | Partner
Demand Side Analytics
jsmith@demandsideanalytics.com

Akhil Jonnalagadda | Senior Quantitative Analyst
Demand Side Analytics
akhil@demandsideanalytics.com

CADMUS

Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS