Appendix D:

State of Commercial and Industrial Lighting
in Maine Study

10/22/2018

CADMUS

2018 State of Commercial & Industrial Lighting in Maine

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Prepared for:

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Table of Contents

Figures

Introduction and Methods

The purpose of this study was to first assess what lighting technologies are currently installed in Maine's commercial and industrial facilities, and then convert those findings into savings potential.

To assess the state of commercial and industrial lighting in Maine Cadmus obtained data from SMR Research[1] on commercial and industrial facilities in Maine. In all, the database contains about 380 million square feet of space. Working with Efficiency Maine, Cadmus focused on ten facility types that account for about 250 million square feet in the SMR database:

- Office
- Retail
- Medical Office
- Hotel
- Restaurant
- Food Sales
- Hospital
- Long Term Care
- Warehouse
- Industrial

Sampling

Cadmus' approach for sampling involved two steps. Cadmus first allocated the number of site visits per facility type, and then selected sites randomly within these facility types. The intent was to balance the desire to target precise estimates of total potential energy savings at the statewide level and at the facility type level. These two estimates serve similar purposes, but the conflict between them can be understood by considering a facility type that contributes little to statewide energy consumption, and as a result, statewide estimates would be improved by allocating site visits into a different category. However, these facility types were specifically identified as being of interest to this study and require some representation. Cadmus' approach serves as a compromise by allocating the number of site visits per facility type proportionally to the expected contribution to statewide potential, and randomly sampling from these types.

Step One

Cadmus allocated the number of site visits per facility-type using a simple weighting of expected total energy savings potential per facility type[2]. The data sources used to calculate energy savings potential are identified in Appendix A. Table 1 shows the percentage of estimated

[1] SMR Research collects and compiles commercial property data including occupant, square footage, property use, and contact information.

[2] Cadmus utilized lighting-related findings regarding lighting densities and technologies from a commercial building stock assessment completed in 2016 to establish a rough estimate of the anticipated savings by facility type. These estimates were used to inform the sampling plan but had no impact on the analysis of sampled data.

statewide savings potential calculated by facility type. The global sample size of 75 sites was allocated to each facility type based on the expected saving potential percentages.

Table 1. Facility Sample by Facility Type

Facility Type	Savings Potential [MWh/facility type]	Expected Statewide Savings Potential [%]	Sample Size
Office	69	13%	10
Retail	151	30%	22
Hotel	31	6%	5
Restaurant	35	7%	5
Food Sales	58	11%	8
Healthcare	19	4%	3
Warehouse	70	14%	10
Industrial	79	15%	12
Total	N/A	100%	75

Step Two

Large sites are expected to contribute disproportionately to estimates of statewide potential as savings potential is expected to be proportional to square footage. The dataset obtained from SMR contains records of facility square footage. These data were used in a sampling technique known as "Probability Proportional to Size (PPS) Sampling" by weighting a site's likelihood of being selected by its square footage. This weighting increased the probability of sampling sites that contribute most to total potential savings. Cadmus used this technique to the extent possible given practical limitations in recruiting sites from each facility type.

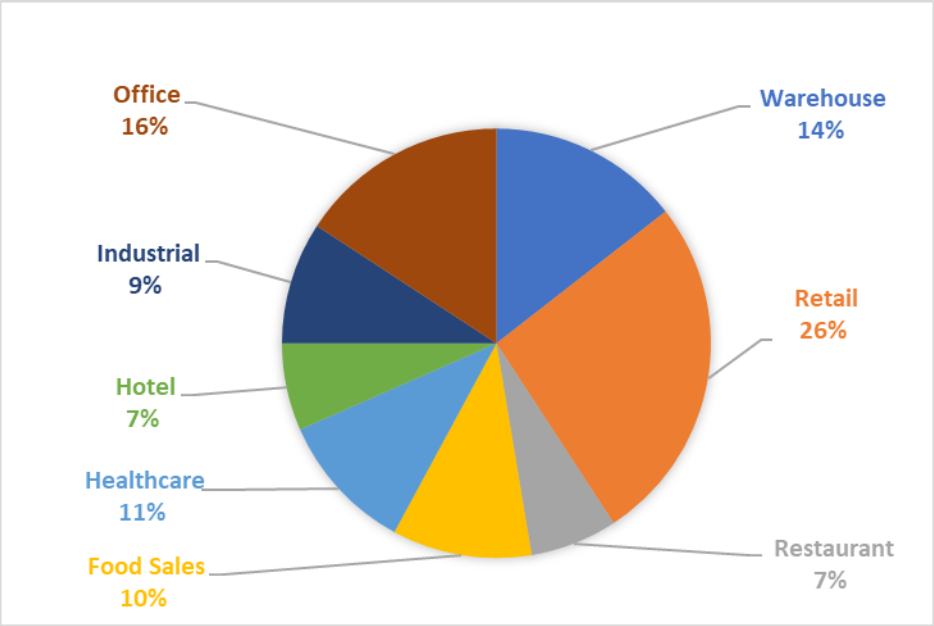
Data Collection Approach

All participants for site visits and telephone surveys were randomly selected according to the PPS method described above.

Site Visits

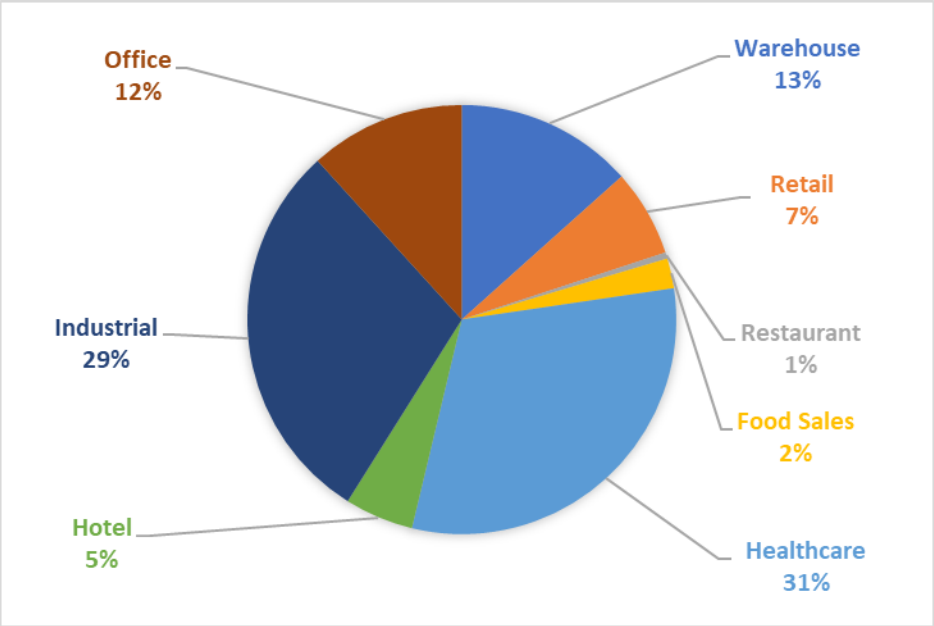
Cadmus visited 75 facilities. In two cases, large complexes with two distinct end uses were counted as two facilities. The number of facilities of each type visited are shown in Figure 1.

Figure 1. Visits by Facility Type



Surveyors collected information regarding general facility characteristics such as age, square footage, and operating schedules. In all, 5.4 million square feet of floor space were directly audited, covering about 7.5 million square feet when in-facility subsampling was extrapolated to whole facilities. In addition, Cadmus surveyed roughly 0.6 million square feet of exterior lighting. The breakdown of the interior space by facility type is shown in Figure 2.

Figure 2. Floor Space Visited by Facility Type



For each space surveyed Cadmus calculated the area of the space and gathered the type, wattage and the counts of the lamps. Ballast data was also gathered where possible. In some cases, this was done through viewing spare ballasts and in other cases through careful removal of cover plates, with the fixture turned off.

Retrofit Scenarios

For each audited item, energy and demand savings and associated costs were calculated for a hypothetical LED replacement. For existing fluorescent fixtures, energy and demand savings and costs were calculated for four LED options: (1) complete fixture replacement with new LED fixtures, (2) fixture conversion using LED retrofit kits, (3) lamp replacement using Type A LED lamps, (4) lamp replacement using Type C LED lamps. For existing high intensity discharge (HID) fixtures, energy and demand savings and costs were calculated for two LED options: (1) complete fixture replacement with new LED fixtures, (2) lamp replacement using LED lamps. For incandescent, halogen and LED[3] baseline fixture types, energy and demand savings and costs were calculated for one LED replacement option. Each LED option was tested for cost effectiveness at the space type level. Only options that passed the TRC test[4] were considered and included in the potential assessment. For fluorescent and HID fixtures where more than one

[3] LED baseline fixtures were included in the analysis for completeness, but none passed the cost-effectiveness screening.

[4] Benefit/cost ratio greater than 1 using the total resource cost test as calculated using the Efficiency Maine developed Potential Study Measure List and Screening C&I Lighting.xlsm workbook.

retrofit option was considered, weighting was applied to all cost-effective options to provide a reasonable mix of retrofit options informed by past program participation.

For fluorescent fixtures the following weighting was applied:
Where all lighting retrofit options are cost effective (TRC ratio >=1), the weighting was as follows:

- Fixture replacement 30%
- Retrofit kit 30%
- Type A lamp replacement 20%
- Type C lamp replacement 20%

Where only the fixture was not cost effective, the weighting was as follows:

- Retrofit kit 42.3%
- Type A lamp replacement 28.6%
- Type C lamp replacement 28.6%

Where only type A and type C lamp replacements are cost effective, the weighting was as follows:

- Type A lamp replacement 50%
- Type C lamp replacement 50%

Where only type A lamp replacements are cost effective, the weighting was as follows:

- Type A lamp replacement 100%

For HID replacements the following weighting was applied:
Where a fixture retrofit and lamp replacement are cost effective, the weighting was as follows:

- Fixture replacement 50%
- Lamp replacement 50%

Where only the lamp replacement was cost effective, the weighting was as follows:

- Lamp replacement 100%

Installation costs for the LED retrofit options were determined based on a combined review of the Efficiency Maine Technical Reference Manual version 2018.4 (table 31), Efficiency Maine CIP Lighting Look Up File 19Q1 R1 (source file for FY19 TRM cost and wattage table), and internal Cadmus research. For facilities where the audit covered a portion of the square footage, the energy and demand savings, and costs were extrapolated to the entire square footage for each facility.

Statewide Extrapolation

The estimates of statewide savings potential by facility type were developed from PPS samples of facilities drawn with probability proportional to area. The potential savings determined for each audited facility were combined with the population data obtained from SRM and used to

calculate total savings potential for the population of commercial buildings. These potentials were calculated using the following equation:

$$\widehat{t_{potential}} = \frac{1}{n}\Sigma_{i=1}^{n}\frac{y_i}{P_i}$$

In this equation, $\widehat{t_{potential}}$ is the estimated savings potential for the population of each facility type, n is the sample size, y_i is the savings potential of audited facility i, and P_i is the probability of facility i getting sampled based on its area and the area of the population. Loosely speaking, the equation corrects for the unequal weights facilities were sampled with. This same equation was used to determine potential kWh, kW, and costs, and in each case one of these quantities was substituted for the variable y_i for each audited facility.

Not all facility types were sampled, and in these cases values of savings potential per square foot were assumed from the most similar facility type included in the sample and multiplied by total area to estimate potential. Statewide potential was then calculated by summing the values of each facility type.

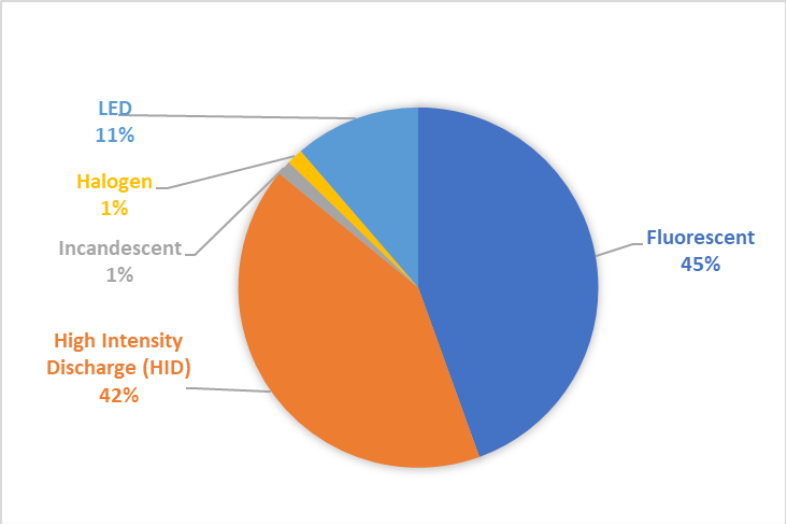
Baseline Findings

The following sections lay out basic findings for the full sample and by facility type.

Full Sample

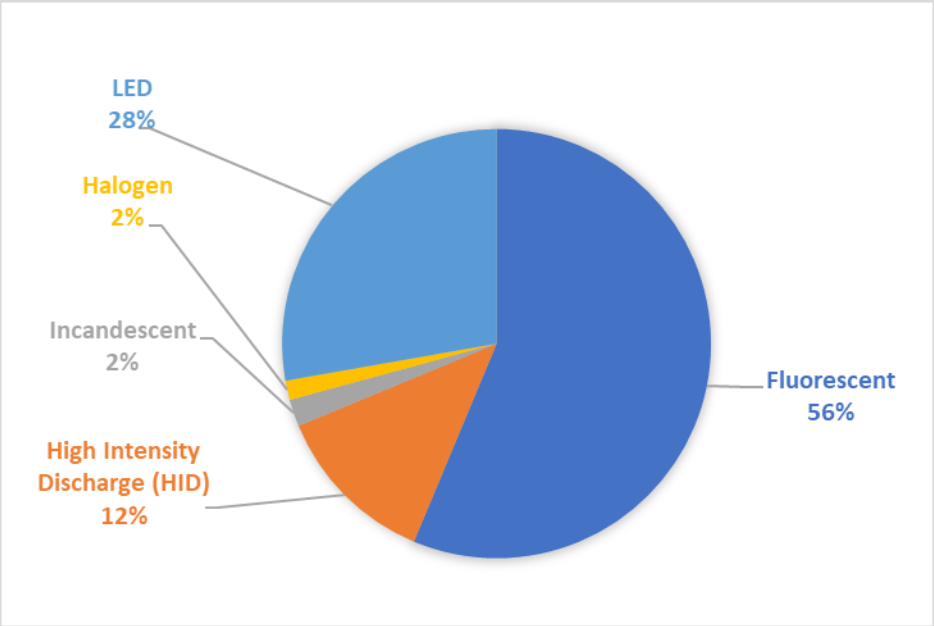
The following charts show the portion of lights made up of various technologies in our sample. The numbers are simple unweighted percentages from the surveyed sites. Later in this report, potential savings and costs are based on weighting. Overall the lighting technologies installed across the sample were dominated by fluorescent and HID fixtures. By installed wattage, about 89% of the lighting can be upgraded to more-efficient lighting from a technology perspective. (Figure 3)

Figure 3. Installed Lighting Technology by Wattage



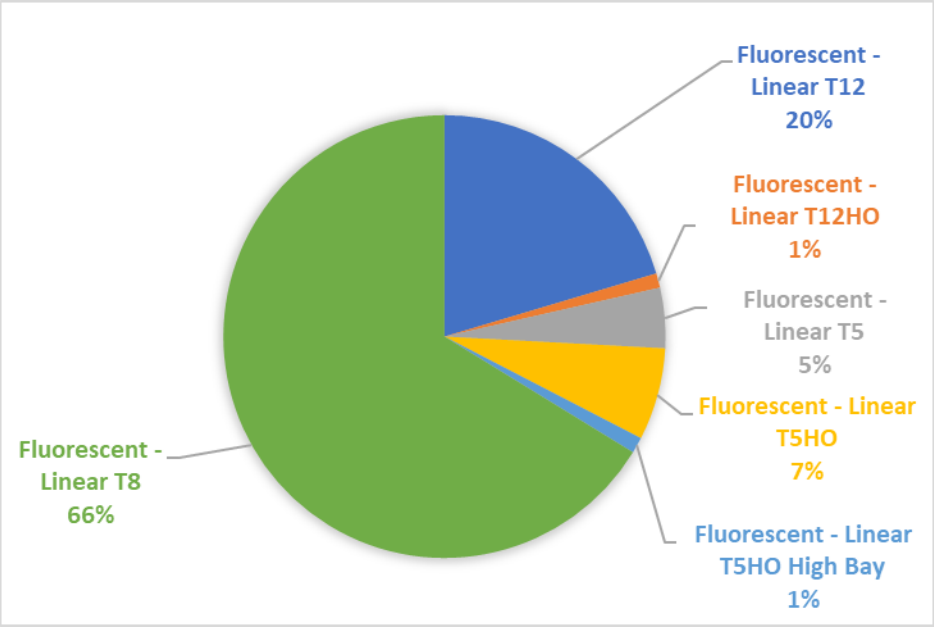
By fixture count, the portion of lighting that can be upgraded from a technical prospective is almost 72%. The primary reason for the by count portion to be lower than the by wattage portion is that HID lighting tends to be higher wattage where most of the HID lights surveyed were 400-watt and 250-watt metal halide fixtures. In addition, LEDs are lower wattage, so they are higher in proportion by fixture count than by wattage.

Figure 4. Installed Lighting Technology by Fixture Count



Looking more closely at the fluorescent fixtures by fixture count, about 20% are T12 technology, 66% are T8, and 14% are T5. (Figure 5) T12 lighting persists in Maine: by count it is 20% of the 56% fluorescent proportion or about 11% of the total lighting installed.

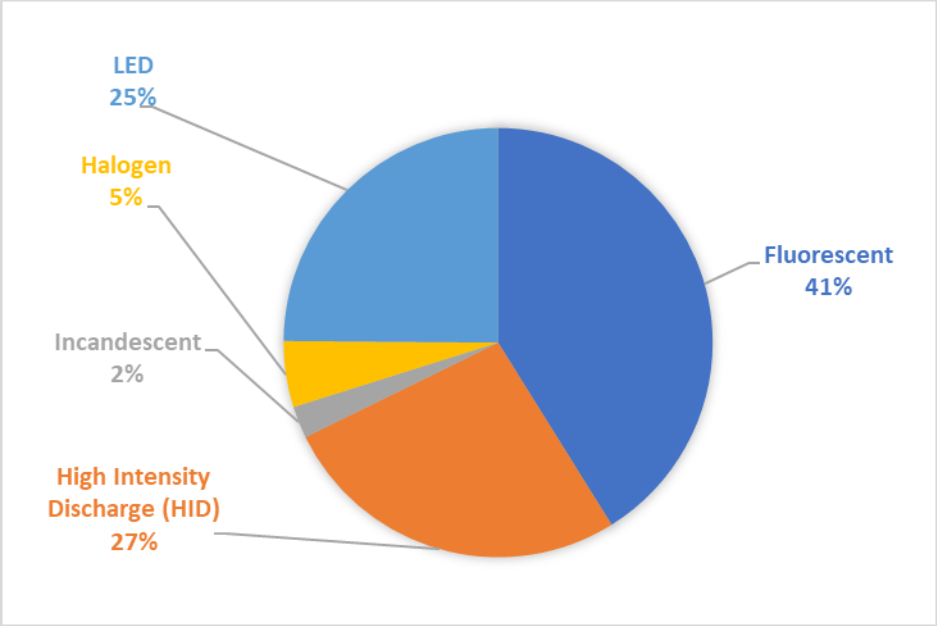
Figure 5. Fluorescent Lighting Technology by Fixture Count



Looking at lighting technology by floor area served yields a value for replaceable lighting between the wattage and fixture count numbers of about 75 percent. This value is instructive, but

not entirely precise because some of the areas within facilities had multiple lamp and technology types in the same space. (Figure 6)

Figure 6. Lighting Technology by Floor Area



By fixture count, the top ten most numerous fixtures found are shown in Figure 7. The most numerous fixtures are two- and three-lamp T8 fixtures. One lamp T12 fixtures are on this list but are relatively low wattage fixtures. By installed wattage and indirectly by savings potential the order changes somewhat. The highest proportion of installed wattage is made up of two sizes of metal halide fixtures with the two- and three-lamp T8 fixtures taking up the next two spots (Figure 8). These technologies are not evenly spread among facility types. Metal halide are found in high bay situations primarily in industrial spaces while other spaces have mostly T8 fixtures. At the facility level lighting power density (LPD) was examined. LPDs have been dropping as lighting has changed from T12 to T8 to T5 and now LED. In high bay applications, lighting has moved from high pressure sodium and metal halide to LED. On average the LPD of the sampled facilities was about 0.83 Watts/SF. This corresponds to most of the lighting being T8 and metal halide. Table 2 shows the LPD by space type examined, which ranges from 1.65 for workshops down to 0.14 for parking garages.

Figure 7. Top 10 Fixture Types in the Survey Sample by Fixture Count

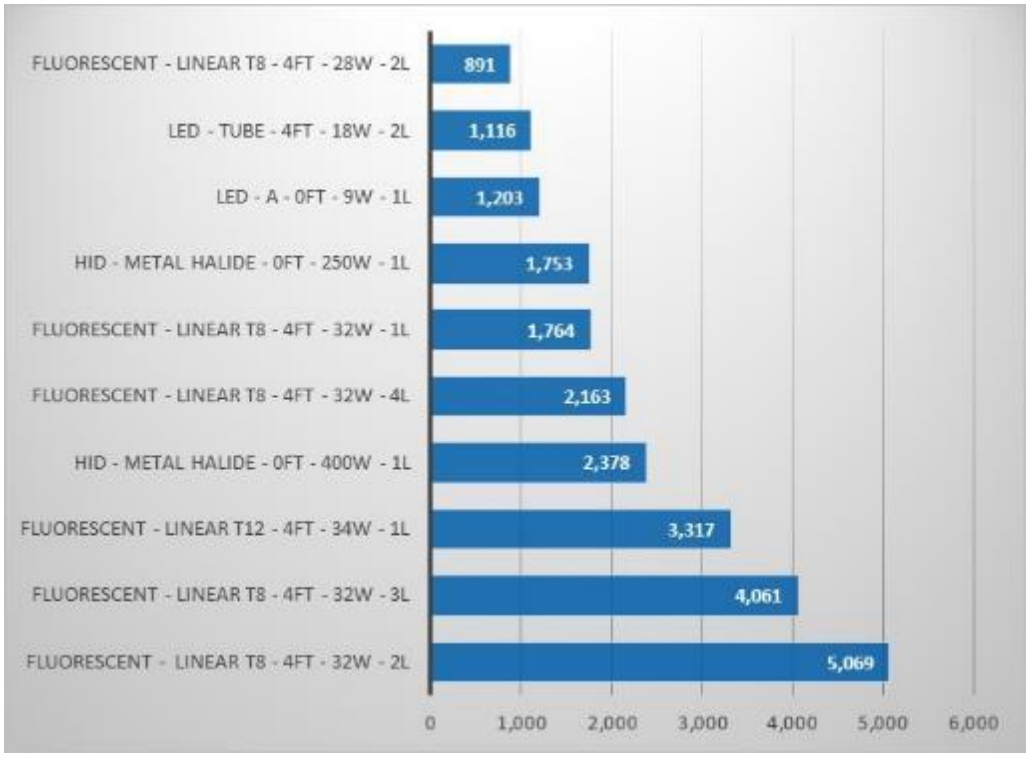


Figure 8. Top 10 Fixture Types in the Survey Sample by Installed Wattage

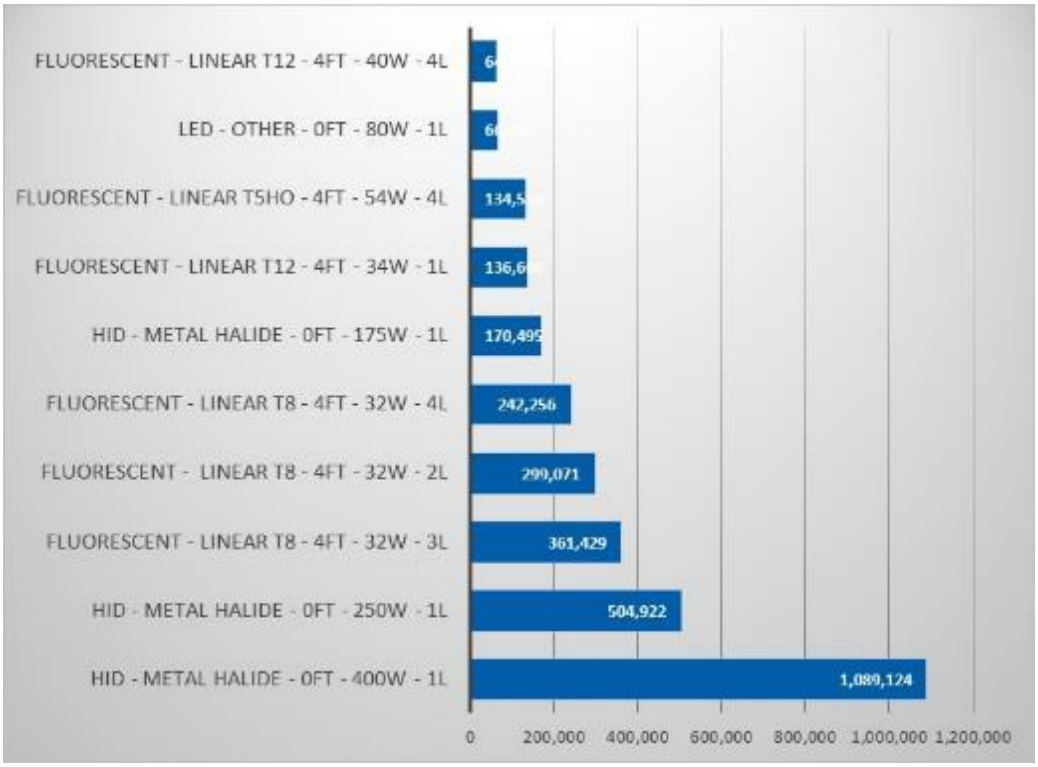


Table 2. LPD for Sampled Spaces

Space Type	SF by Space Type	LPD by Space Type (W/Sqft)
Atrium - first 40 ft in height	28,641	0.89
Classroom/Lecture/Training	7,518	1.08
Conference/Meeting/Multipurpose	70,920	0.95
Corridor/Transition	145,237	0.69
Detailed Manufacturing	1,091,724	0.70
Dining Area	24,092	0.86
Electrical/Mechanical	618,193	0.98
Equipment Room	576	0.33
Exam/Treatment	16,471	1.48
Fine Material Storage	300,315	0.74
Food Preparation	35,949	1.07
High Bay (25–50ft)	58,089	0.84
Hospital—Laundry/Washing	383	0.42
Hotel Guest Rooms	72,773	0.78
Living Quarters	33,140	0.76
Lobby	19,378	0.86
Locker Room	1,830	1.32
Lounge/Recreation	41,848	0.47
Low Bay (<25ft)	2,171	1.33
Medium/Bulky Material Storage	545,722	0.59
Nurses Station	48,607	0.70
Office (enclosed)	310,964	0.88
Office (open plan)	564,287	1.00
Parking Garage—Garage Area	133,580	0.14
Patient Room	83,172	0.81
Physical Therapy	1,733	0.74
Restrooms	20,194	1.11
Sales Area	467,013	1.18
Stairway	10,535	0.38
Storage	328,589	0.31
Workshop	228,095	1.65

See Appendix B for baseline findings by facility type.

Statewide Potential

Energy and Demand Savings

Energy and demand savings are calculated for each baseline fixture type, rolled up to the facility level, and are extrapolated to the state level by facility type. All mention of potential savings

(kWh, kW, or cost) refer to the cost-effective, technical potential of lighting for commercial buildings in Maine. Table 3 shows the facility count, facility floor area, and potential savings for the sample and for Maine, by facility type. Statewide, the savings are roughly 1.0 kWh/y per square foot and the total potential savings are roughly 380 million kWh per year. The simple (non-peak) demand savings are about 132 MW or just over 0.3W/SF. There are two factors that create some uncertainty in the savings estimates:

- The floor area for all facility types in Maine is 381 million square feet whereas the sampled facility types only cover 250 million square feet. For facility types not included in the sampling, results from the most similar sampled facility type were applied, as noted in the table.
- SMR square footage data differs from actual square footage. The square footage listed in the SMR data was much lower than in our sample for industrial and hospital spaces, but slightly higher for other facility types.

Table 3. Statewide Savings by Facility type, Extrapolated from Sample

Facility type	Sample Size	Sample Area SF	Sample kWh/y Potential	Sample kW Potential	Sample kWh/y/ SF	Sample W/SF	Population Size	State Area (SF)	State kWh/y Potential[5]	State kW Potential
Food Sales	8	168,863	359,533	84.9	2.1	0.50	192	1,857,758	3,398,917	818.9
Hospital	1	2,000,000	3,551,288	1,066.8	1.8	0.53	29	6,356,770	11,287,361	3,390.7
Hotel	5	387,925	186,187	57.6	0.5	0.15	5,709	56,862,394	28,438,043	9,310.4
Industrial	7	2,192,076	4,165,045	976.2	1.9	0.45	1,327	50,548,887	77,992,687	16,644.7
Long Term Care	4	200,821	133,089	46.2	0.7	0.23	68	3,361,638	2,419,379	813.0
Medical Office	3	122,333	21,244	6.7	0.2	0.06	245	4,322,660	2,093,765	756.4
Office	12	877,854	401,038	206.7	0.5	0.24	2,733	34,701,981	31,821,133	16,484.4
Restaurant	5	35,241	69,745	16.4	2.0	0.47	1,062	6,453,160	15,728,235	3,644.9
Retail	20	490,027	653,286	166.4	1.3	0.34	4,429	54,392,419	61,095,820	17,575.7
Warehouse	10	991,192	434,640	243.2	0.4	0.25	1,440	30,948,747	11,780,945	5,306.1
Banks & [6]Professional	Non-sampled facility type. Statewide projection based on audited findings from Office facility type.						3,841	15,786,916	14,476,337	4,669.8
Education	Non-sampled facility type. Statewide projection based on audited findings from Office facility type.						1,437	49,482,050	45,374,208	19,727.9
General Commercial	Non-sampled facility type. Statewide projection based on audited findings from Retail facility type.						6,658	33,677,446	37,827,904	16,605.8
Laboratory	Non-sampled facility type. Statewide projection based on audited findings from Hospital facility type.						7	433,978	770,590	338.3
Mining	Non-sampled facility type. Statewide projection based on audited findings from Industrial facility type.						50	634,664	979,233	429.9
Miscellaneous Services	Non-sampled facility type. Statewide projection based on audited findings from Office facility type.						828	6,066,589	5,562,960	2,442.0

[5] **Had this study used simple random sampling to extrapolate statewide values from the audited sites then average kWh/y/sf and kW/sf between the sample and population would be the same but using PPS these values can differ. For example, the facility type Medical Office has a sample kWh/y/sf of 0.2 and a statewide kWh/y/sf of 0.5, looking at the raw data there is a single large facility that had 0.1 kWh/y/sf whereas the other two medium sized sites had higher kWh/y/sf (0.8 and 0.5). Looking at the population data for this site, more areas are closer to the medium sized site with a kWh/y/sf of 0.5, and as a result the statewide kWh/y/sf is as well.**

[6] **For facility types that were not sampled, values of kW/sf were assumed based off a similar facility type that was sampled. This kW/sf was multiplied by the population area to estimate statewide energy savings potential. Energy savings potential was calculated by multiplying the kW/sf by an assumed number of operational hours, these hours do not always correspond the number of hours of the assumed facility type for kW/sf.**

Mixed Use	Non-sampled facility type. Statewide projection based on audited findings from Retail facility type.						2,645	25,221,683	28,330,040	12,436.4
Healthcare-Other	Non-sampled facility type. Statewide projection based on audited findings from Hospital facility type.						442	581,115	1,031,853	275.3
Aggregate	**75**	**7,466,332**	**9,975,094**	**2,871.2**	**1.1**	**0.38**	**33,142**	**381,690,855**	**380,409,411**	**131,671**
Unit Savings/ SF									**1.00**	**0.00034**

Cost

Cadmus examined, at the fixture level, the cost of retrofitting existing fixtures with LED equivalents. Only options that passed the TRC test[7] were considered and included in the potential assessment. Table 4 shows the projected statewide costs for the potential savings. Costs include material and labor of the retrofit options extrapolated by square footage by facility type to the statewide population of facilities.

Table 4. Statewide Costs by Facility Type, Extrapolated from Sample

Building Type	Population Size	State Area	Population Cost
Food Sales	192	1,857,758	$1,173,031
Hospital	29	6,356,770	$6,081,358
Hotel	5,709	56,862,394	$6,254,562
Industrial	1,327	50,548,887	$26,714,241
Long Term Care	68	3,361,638	$957,724
Medical Office	245	4,322,660	$1,245,283
Office	2,733	34,701,981	$20,681,377
Restaurant	1,062	6,453,160	$3,322,478
Retail	4,429	54,392,419	$22,928,983
Warehouse	1,440	30,948,747	$7,801,728
Banks & Professional	3,841	15,786,916	$9,408,545
Education	1,437	49,482,050	$29,489,870
General Commercial	6,658	33,677,446	$14,196,640
Laboratory	7	433,978	$415,176
Mining	50	634,664	$335,409
Miscellaneous Services	828	6,066,589	$3,615,512
Mixed Use	2,645	25,221,683	$10,632,135
Healthcare-Other	442	581,115	$555,938
Total	33,142	381,690,855	$165,809,991
Average Cost/ kWh/y			$ 0.43[8]
Average Cost/ SF			$ 0.43[9]

[7] Benefit/cost ratio greater than 1 using the total resource cost test as calculated using the Efficiency Maine developed Potential Study Measure List and Screening C&I Lighting.xlsm workbook.

[8] Cost per kWh/y are assessed against the annual (or "first year") savings achieved by the lighting retrofit scenarios and is a helpful metric is assessing the cost of the potential savings. Because it does not incorporate the life of the lighting measures it should not be used for cost effectiveness or payback assessments.

[9] Cost per kWh/y and cost per square foot are essentially equal because the average savings are 1 kWh/y / square foot.

Program Participation and Incentive Budget

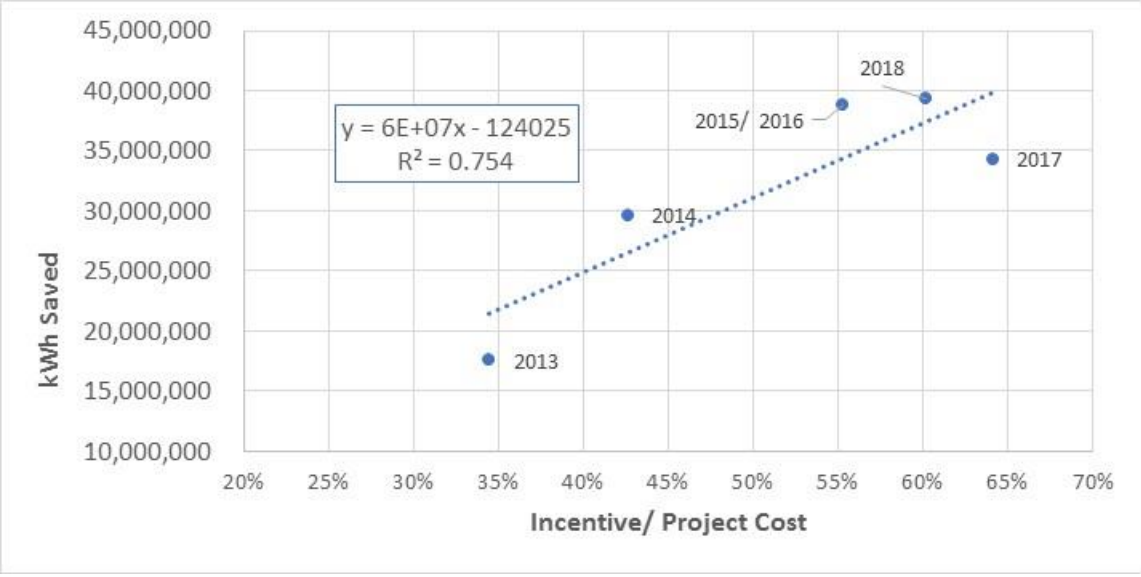
Cadmus reviewed program spending and results for the last 5 program (fiscal) years of the Efficiency Maine Trust C&I lighting programs to inform future potential savings and recommended spending levels. Table 5 shows measures, kWh/y saved, project cost and incentive costs for the last 6 fiscal years.

Table 5. Program Spending and Savings FY 2013 - 2018

FY	Sum of Installed Measure Qty	Sum of kWh/y Total	Sum of Measure Cost Total	Sum of Incentive Total	Funding %
2013	70,878	17,577,644	$6,697,587	$2,311,225	35%
2014	97,585	29,605,640	$9,247,020	$3,942,426	43%
2015	175,644	60,620,262	$30,512,631	$16,975,281	56%
2016	54,723	17,036,596	$11,656,169	$6,350,368	54%
2017	90,145	34,332,342	$9,571,208	$6,138,602	64%
2018	127,851	39,291,437	$15,224,698	$9,169,841	60%
Total	**616,826**	**198,463,920**	**$82,909,314**	**$44,887,744**	**54%**

Figure 9 shows the relationship between kWh/y saved and the portion of project cost funded by incentives (the "funding ratio"). It shows a 60% funding level correlated with approximately 40 million kWh per year savings.

Figure 9. Regression of kWh/y Saved on Funding Ratio: FY 2013 - 2018[10]



[10] An average of FY2015 and FY2016 is shown on the graph because an over subscription in the last quarter of FY2015 forced the program to suspend measures through most of FY2016.

As discussed in this report, the potential savings based on projects passing the TRC is 380 million kWh in annual savings (Table 3). While this represents the total cost-effective opportunity, it is not possible to achieve all the savings in one year or even in the three years of the next Triennial Plan period. There are limitations in the supply chain that require a longer time span to capture the entire opportunity. The most critical of these limitations is the workforce capacity of the installer community, specifically licensed electricians. The Maine economy is at or near full employment, with a strong market for new construction, meaning that there are many competing opportunities for electricians. Furthermore, because this is a retrofit program Efficiency Maine must convince customers to remove functioning equipment and there are limits to customer outreach and adoption rates necessary to capture the entire opportunity. Taking this into consideration, capturing 10% of the opportunity per year in a market-based program is a reasonable goal and consistent with past program performance. Based on a market-based program capturing an average of 10% of the opportunity per year, this is roughly 38 million kWh/y per each year. At an average cost of $0.43/ kWh/y (Table 4), this is $16.3 million per each year. Based on the Trust incenting 60% of this total cost, the incentive budget would then be $9.8 million per each year.

Appendix A: Data Sources

2015 US Lighting Market Characterization Report

Cadmus reviewed the 2015 U.S. Lighting Market Characterization (LMC) draft report released in November 2017. This document identifies a number of characteristics for lighting products operating in the U.S. as of 2015. Cadmus utilized the average wattage per lamp technology (table 4.5, page 54) and average hours of use per facility type (table 4.7, page 58) to determine energy consumption and demand savings per lamp type.

2015 Commercial Building Interval Data Analytics Study

The Commercial Building Interval Data Analytics study released in November 2015 provides valuable insight into energy use within facilities located in Central Maine Power's service territory. Cadmus utilized the lighting intensity (kWh/sqft) per facility type (table 7, page 17) to inform the anticipated lighting energy use per building type when determining potential energy savings.

2016 Vermont Business Sector Market Characterization and Assessment Study

The 2016 Vermont Business Sector Market Characterization and Assessment study provides baseline energy efficiency data for Vermont's business sector facilities as of 2016, largely through primary data collection. Cadmus assumes the distribution of indoor lamps by facility type will be similar between Maine and Vermont. As such, Cadmus utilized the data provided in the distribution of indoor lamps by facility type figure (figure 23, page 42) to inform lighting distribution expectations.

SMR Property Data

Cadmus utilized property data from SMR Research for determining property characteristics associated with commercial and industrial customers in Maine. 33,142 parcel records were utilized to inform the potential energy savings calculations per facility type and sample design.

EMT Mailing List

Cadmus utilized EMT supplied mailing list data of retail sites, to improve the quantity of the food sales category from the SMR property data.

Efficiency Maine Technical Reference Manual version 2018.4, Efficiency Maine CIP Lighting Look Up File 19Q1 R1

Cadmus reviewed the 2018.4 version of the Commercial/Industrial and Multifamily TRM for wattage and cost assumptions. The TRM was superseded by the updated Lighting Look Up File which contains the source data for the FY19 TRM wattage and cost assumption table. This file contains baseline and replacement wattages, costs, labor costs, and hours of use. Cadmus used the baseline wattages checking them against other resources and used much of the cost data, in

some cases substituting industry data. Hours of use for facility and space type were used based on the rational that they were better than the facility level estimates provided by facility operators.

EMT Potential Study Measure List and Screening C&I Lighting.xlsm

This file calculates cost effectiveness at the measure and facility space level using the total resource cost method (TRC). It was provided to Cadmus by the Trust. Space fixture combinations that did not pass the TRC test were excluded from the potential calculations.

Appendix B: Baseline Findings By Facility Type

The following sections show lighting technology and LPDs found by facility types. Lighting technology varies by facility type. This was considered in rolling sample savings up to a state-wide value. The LPDs vary by space type within a facility type reflecting different uses and varying lighting technologies.

Warehouse

Cadmus visited 11 warehouses, finding over 40% of the wattage made up of HID and LED. LPDs varied greatly by space type but the bulk of the space had LPDs of 0.59 and 0.74 (Table 6.

Figure 10. Installed Lighting Technology in Warehouses by Wattage

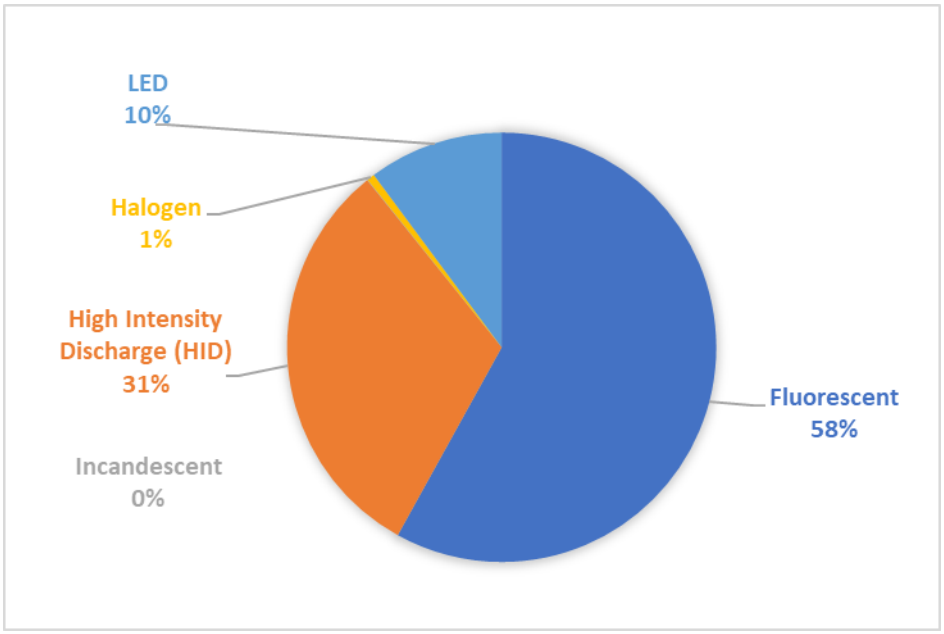


Figure 11. Installed Lighting Technology in Warehouses by Fixture Count

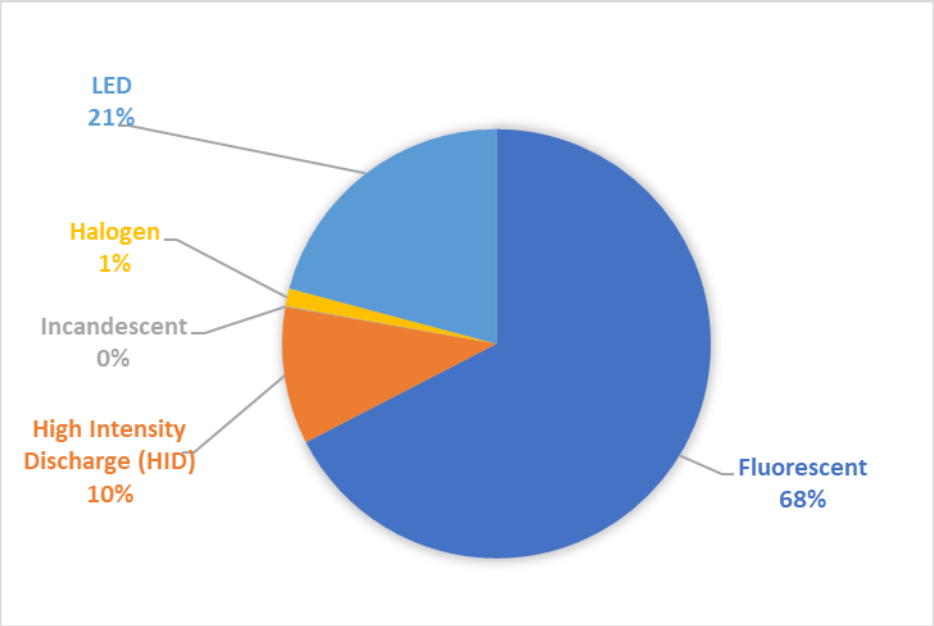


Figure 12. Fluorescents Installed in Warehouse by Wattage

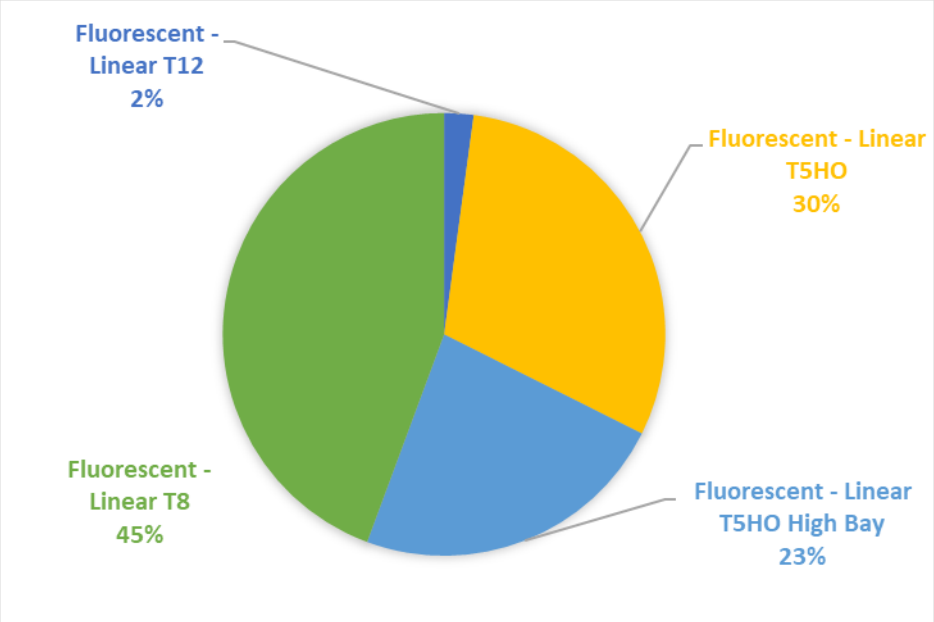


Figure 13. Fluorescents Installed in Warehouse by Fixture Count

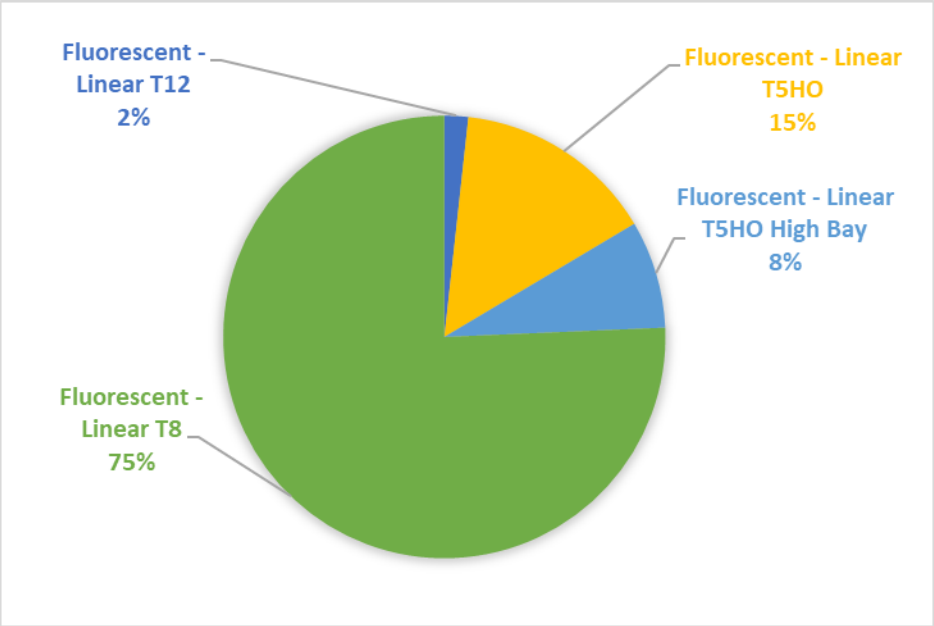


Table 6. LPD for Sampled Spaces in Warehouses

Space Type	SF by Space Type	LPD by Space Type (W/sqft)
Classroom/Lecture/Training	3,040	1.49
Conference/Meeting/Multipurpose	2,409	0.48
Corridor/Transition	1,222	0.79
Electrical/Mechanical	2,390	0.72
Fine Material Storage	300,315	0.74
Medium/Bulky Material Storage	545,722	0.59
Office (enclosed)	8,768	1.66
Office (open plan)	34,376	1.26
Parking Garage—Garage Area	40,000	0.11
Restrooms	5,281	1.39
Sales Area	37,596	0.89
Stairway	399	0.57
Storage	5,579	1.16
Workshop	13,552	1.13

Food Sales

Cadmus visited eight food sale establishments, finding over 80% of the wattage made up of fluorescents. Roughly 6% of fluorescents or nearly 4% of wattage is contributed by T12s. LPDs were relatively high for the bulk of the space surveyed at 1.54 (Table 7).

Figure 14. Installed Lighting Technology in Food Sales by Wattage

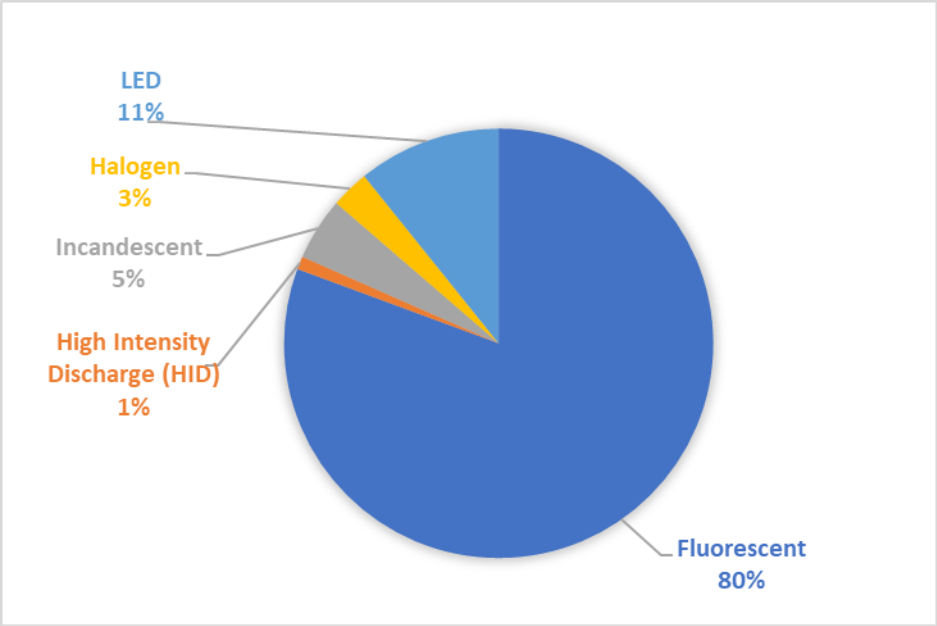


Figure 15. Installed Lighting Technology in Food Sales by Fixture Count

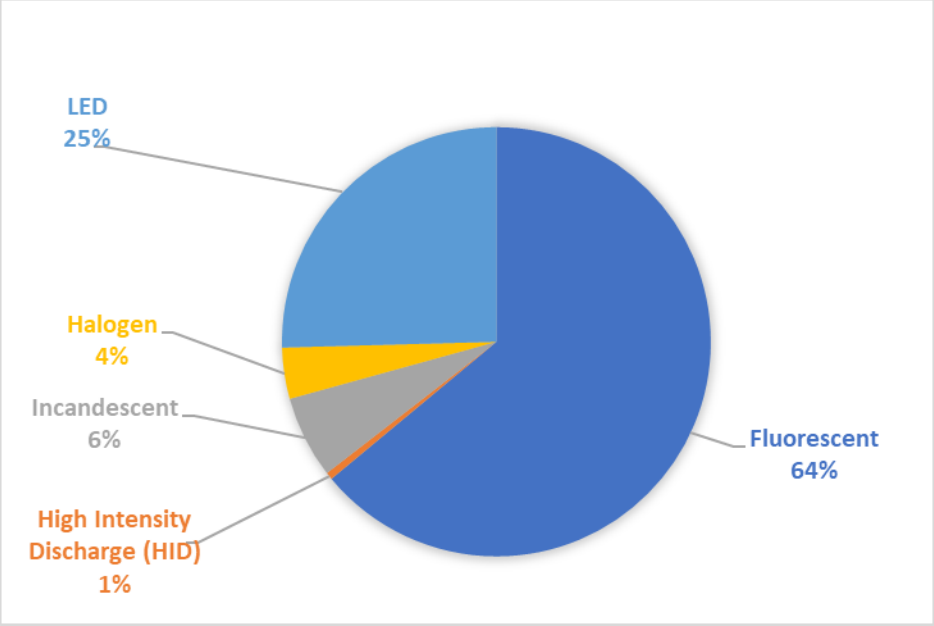


Figure 16. Fluorescents Installed in Food Sales by Wattage

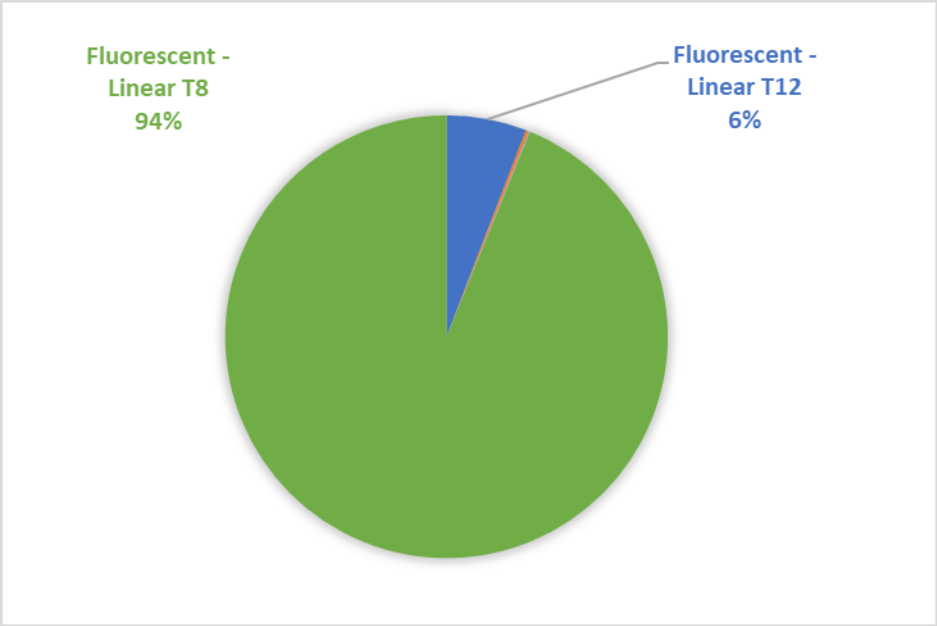


Figure 17. Fluorescents Installed in Food Sales by Fixture Count

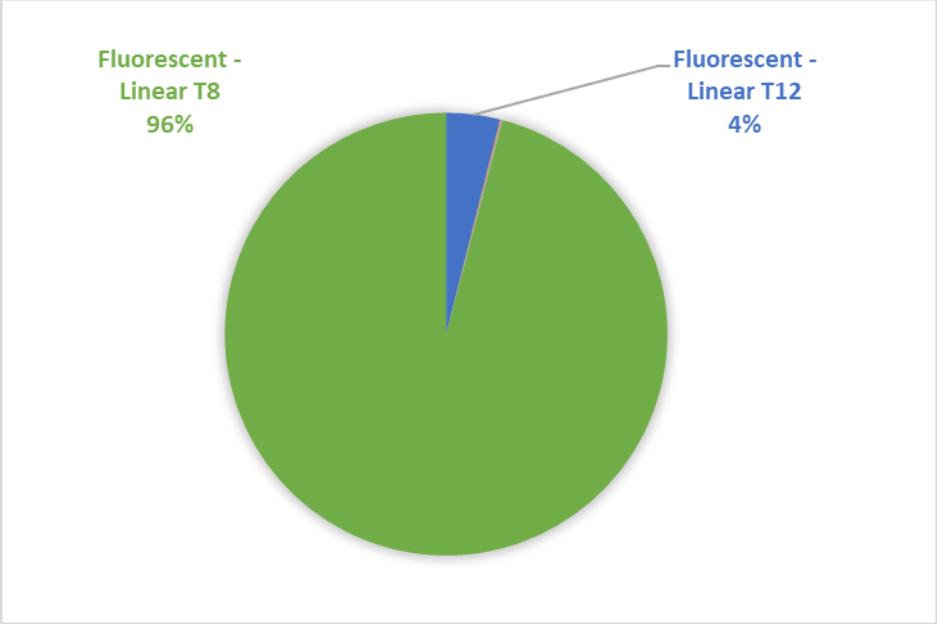


Table 7. LPD for Sampled Spaces in Food Sales Facilities

Space Type	SF by Space Type	LPD by Space Type
Corridor/Transition	534	0.19
Electrical/Mechanical	319	1.81
Food Preparation	4,879	1.43
Office (enclosed)	3,775	1.24
Restrooms	48	0.42

Sales Area	129,265	1.54
Storage	11,378	1.15
Workshop	656	2.32

Healthcare

Cadmus visited eight health care facilities, finding over 88% of the wattage made up of HID and fluorescents, with a small proportion of LEDs compared with other facility types. LPDs varied but were near the overall sample average for the bulk of the spaces surveyed (Table 8).

Figure 18. Installed Lighting Technology in Healthcare by Wattage

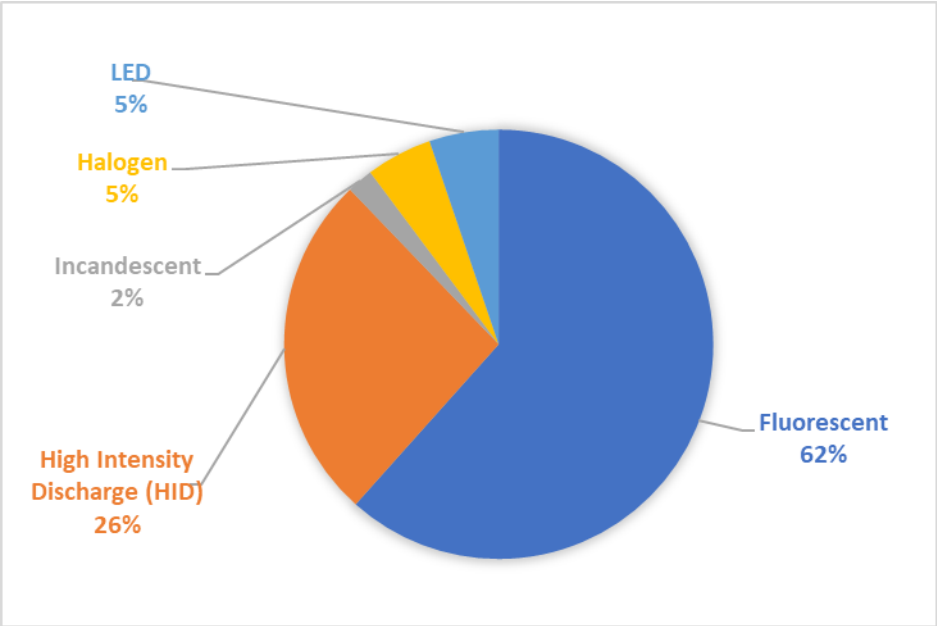


Figure 19. Installed Lighting Technology in Healthcare by Fixture Count

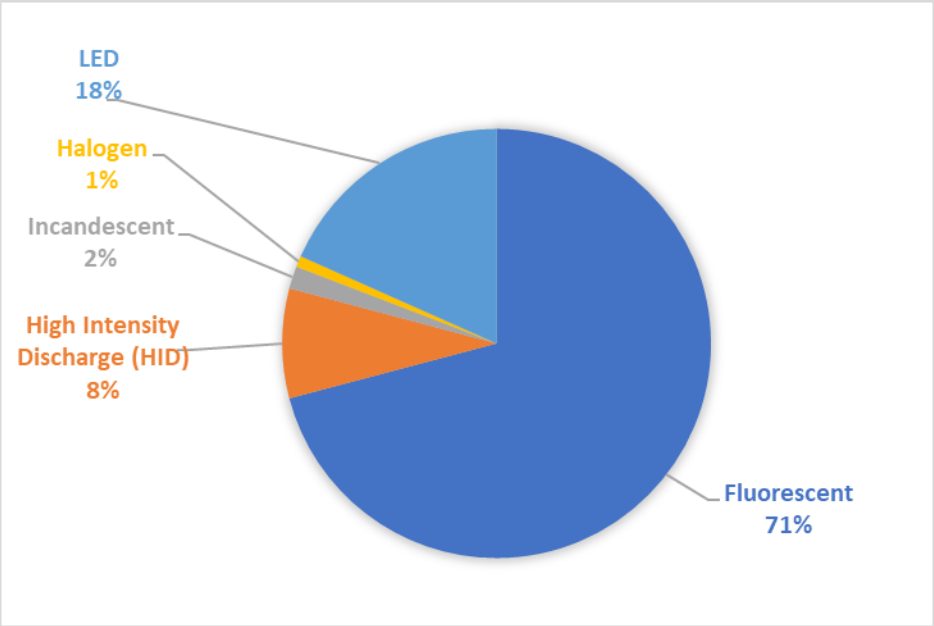


Figure 20. Fluorescents Installed in Healthcare by Wattage

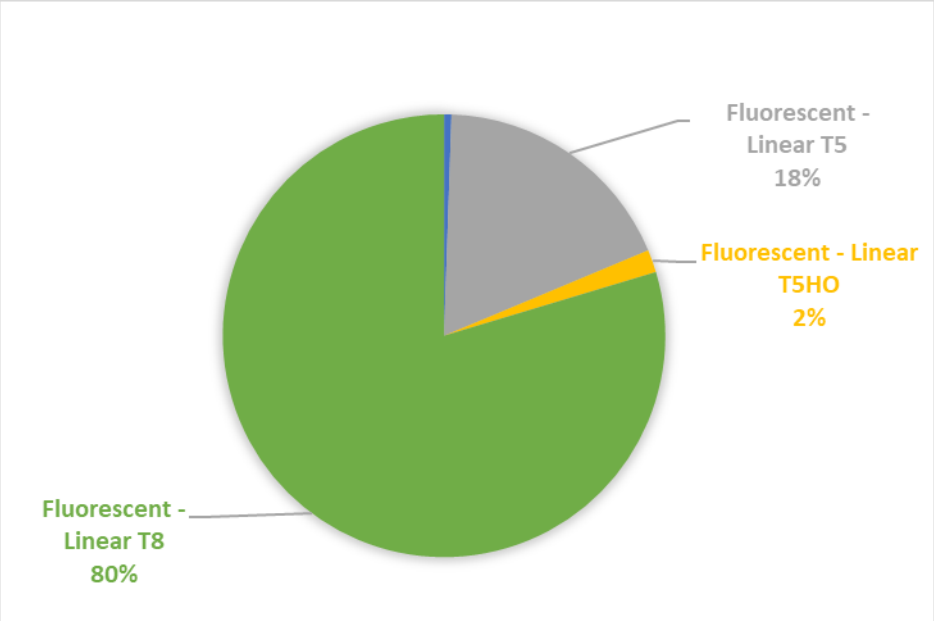


Figure 21. Fluorescents Installed in Healthcare by Fixture Count

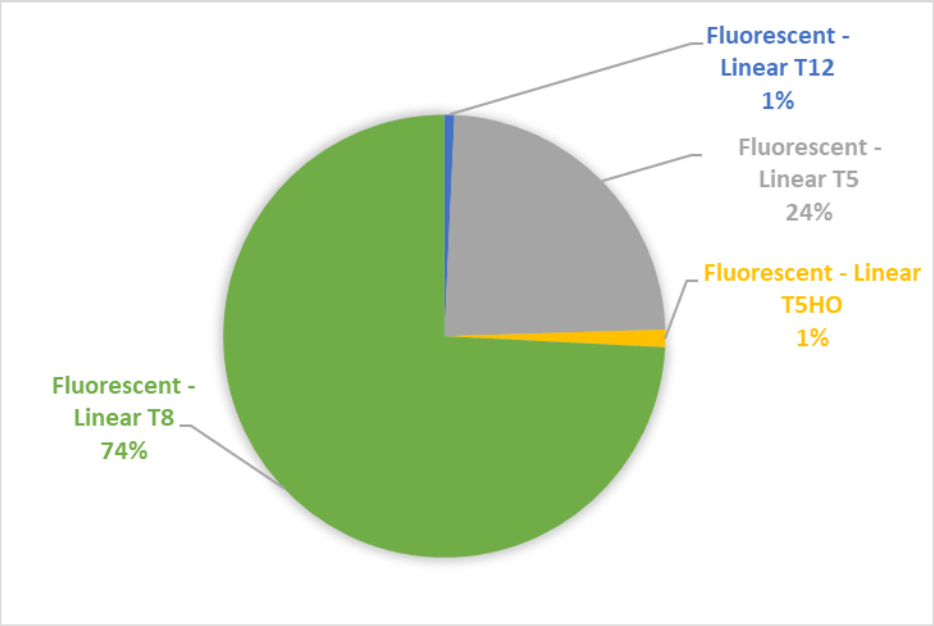


Table 8. LPD for Sampled Spaces in Healthcare Facilities

Space Type	SF by Space Type	LPD by Space Type
Classroom/Lecture/Training	3,358	0.78
Conference/Meeting/Multipurpose	17,059	0.64
Corridor/Transition	87,767	0.71
Dining Area	408	0.71
Electrical/Mechanical	11,502	0.34
Exam/Treatment	16,471	1.48
Food Preparation	12,512	0.69
Hospital—Laundry/Washing	107	0.24
Living Quarters	58,440	0.43
Lobby	7,019	1.33
Locker Room	1,307	1.07
Lounge/Recreation	6,910	0.86
Nurses Station	48,607	0.70
Office (enclosed)	79,860	0.89
Office (open plan)	6,761	1.26
Parking Garage—Garage Area	72,110	0.11
Patient Room	83,172	0.81
Physical Therapy	1,733	0.74
Restrooms	1,539	1.84
Stairway	1,332	1.00
Storage	5,407	0.91

Hotel

Cadmus visited five hotels, finding over 46% of the wattage made up of LEDs and nearly 75% of fixtures were LED, the highest proportions compared with other facility types. LPDs varied but were relatively low for the bulk of the spaces surveyed (Table 9), in part because of the high saturation of LEDs.

Figure 22. Installed Lighting Technology in Hotels by Wattage

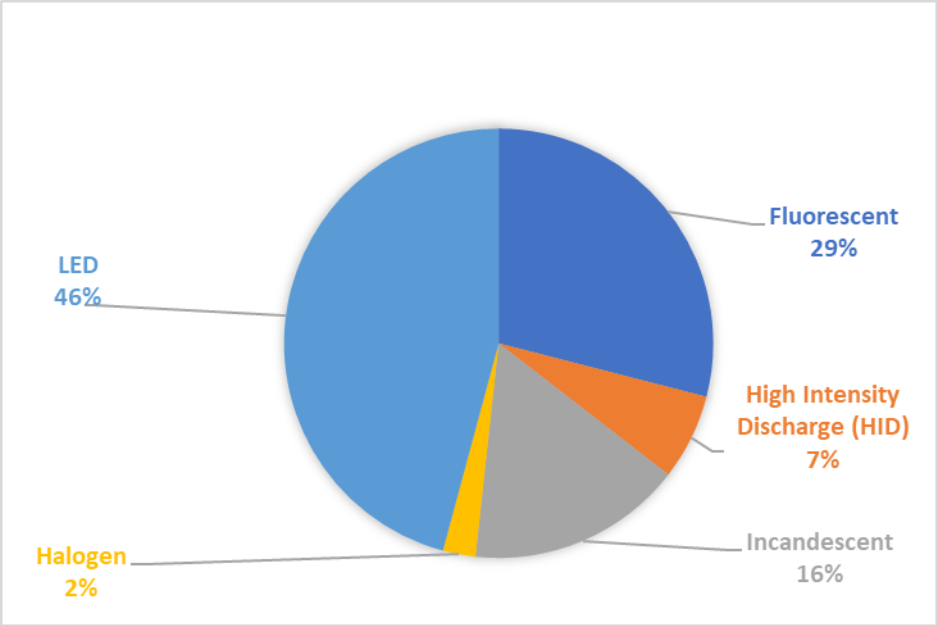


Figure 23. Installed Lighting Technology in Hotels by Fixture Count

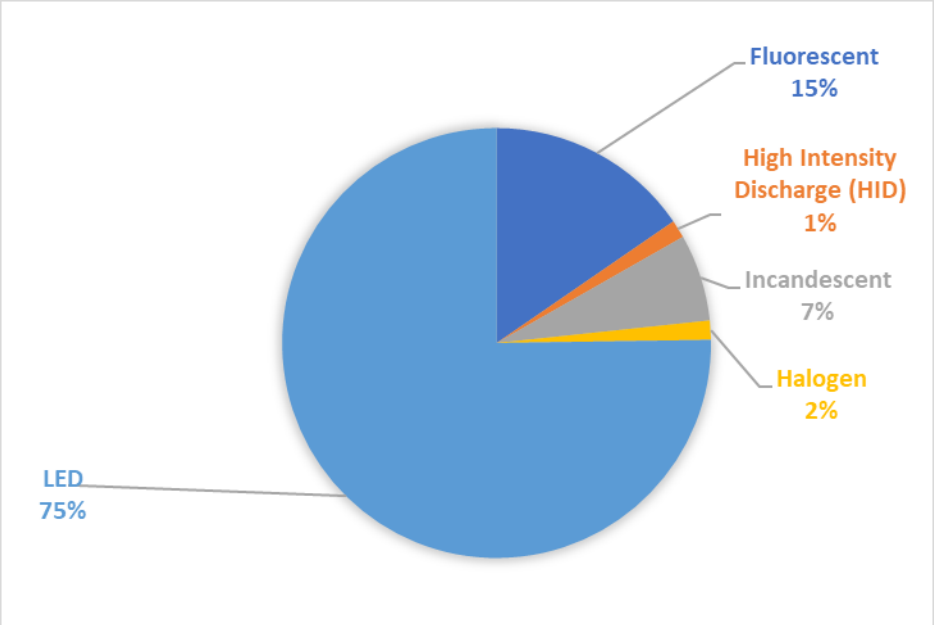


Figure 24. Fluorescents Installed in Hotels by Wattage

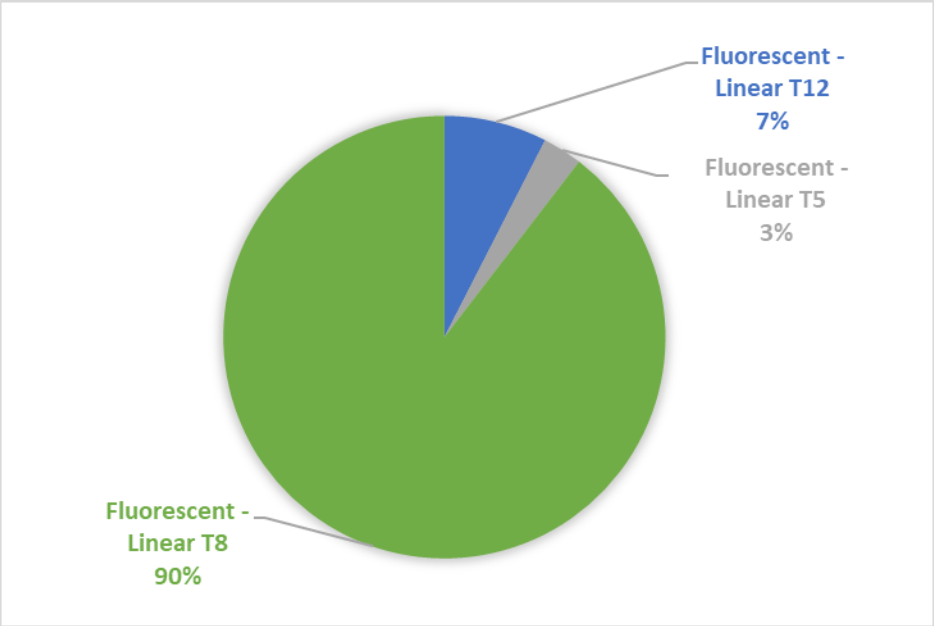


Figure 25. Fluorescents Installed in Hotels by Fixture Count

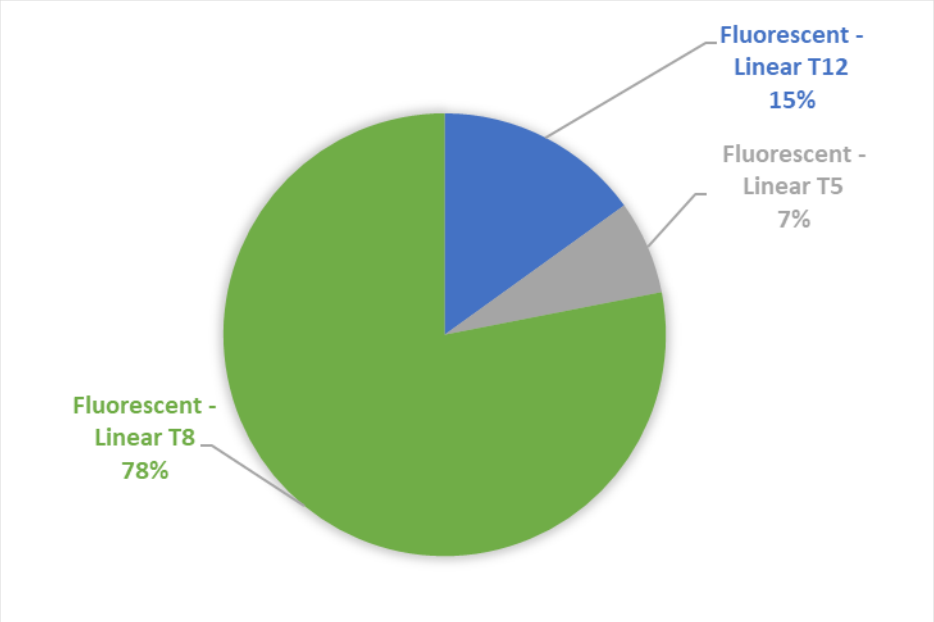


Table 9. LPD for Sampled Spaces in Hotels

Space Type	SF by Space Type	LPD by Space Type
Conference/Meeting/Multipurpose	21,144	1.43
Corridor/Transition	29,123	0.47
Dining Area	809	0.73
Electrical/Mechanical	180	0.22
Laundry/Washing	276	0.49
Hotel Guest Rooms	95,169	0.60
Lobby	10,468	0.50
Lounge/Recreation	2,622	0.30
Office (enclosed)	2,394	0.98
Office (open plan)	108	0.06
Parking Garage—Garage Area	21,470	0.27
Restrooms	1,198	0.88
Stairway	6,735	0.29
Storage	30,453	0.27
Workshop	1,210	0.58

Industrial

In the industrial sector, lighting wattage is dominated by metal halide (HID) lighting. These lights are targets for LED replacements. The LPD for the majority of space is low at 0.70 (Table 10). While T12s are a relatively high proportion of remaining fluorescents, that technology is only 14% of the total wattage.

Figure 26. Installed Lighting Technology in Industrial Facilities by Wattage

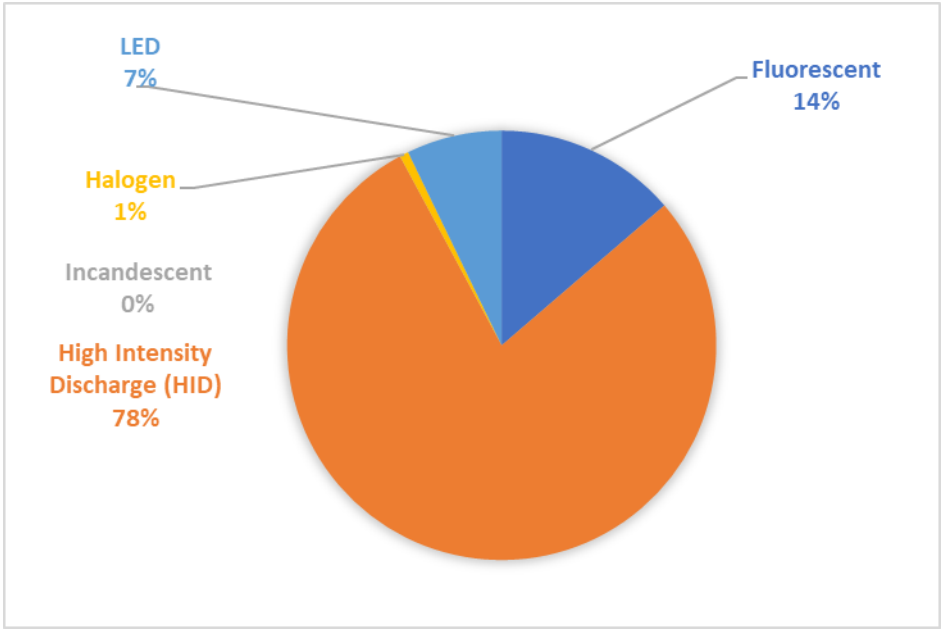


Figure 27. Installed Lighting Technology in Industrial Facilities by Fixture Count

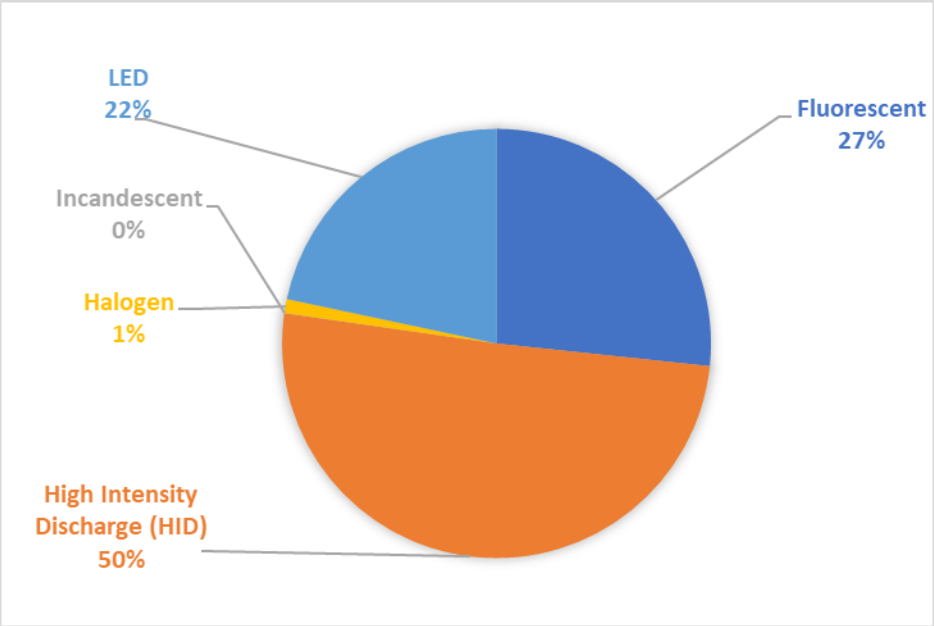


Figure 28. Fluorescents Installed in Industrial Facilities by Wattage

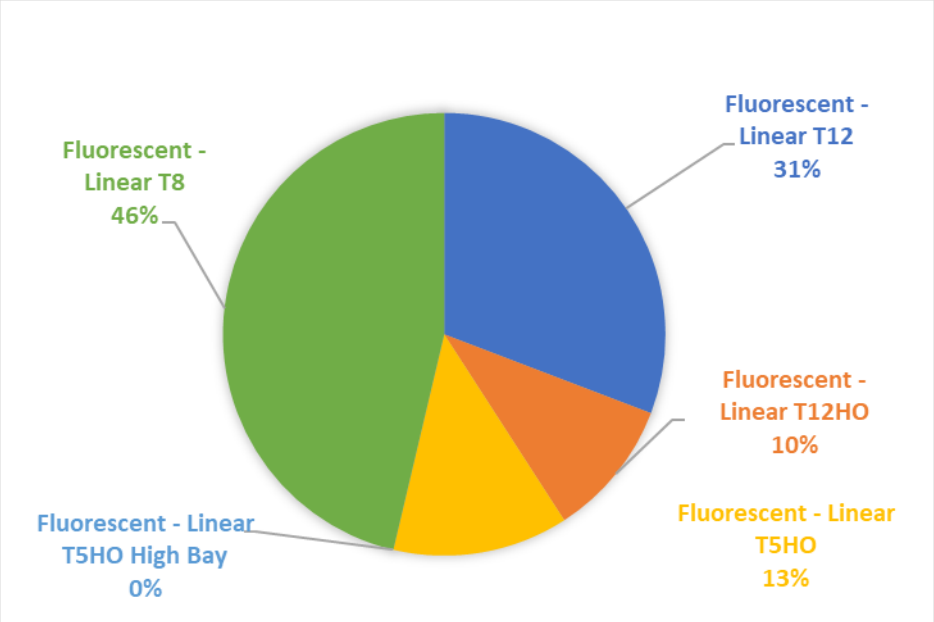
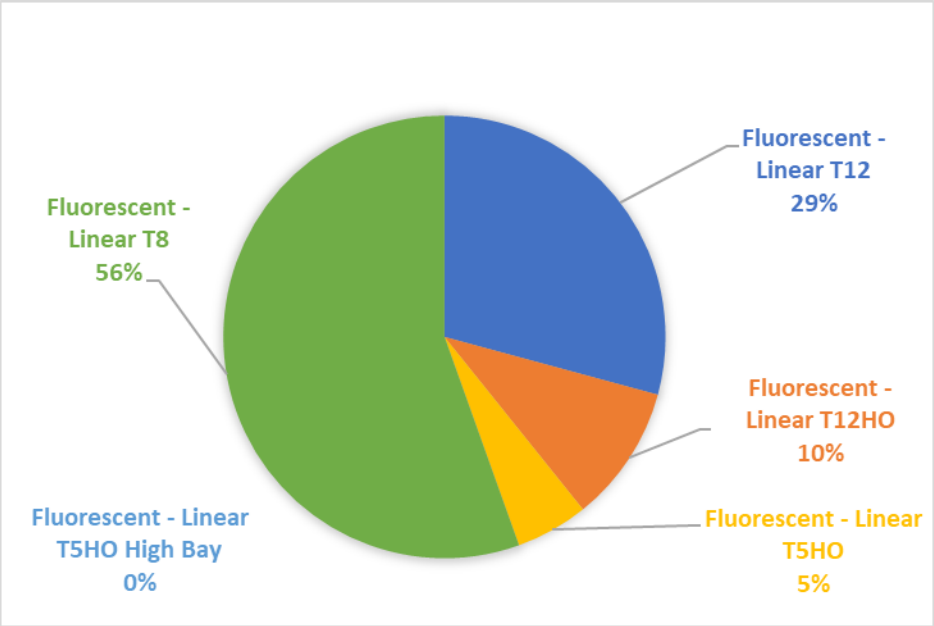


Figure 29. Fluorescents Installed in Industrial Facilities by Fixture Count



LPDs are generally placed high in spaces, although they are also suitable placed low in storage areas.

Table 10. LPD for Sampled Spaces in Industrial Facilities

Space Type	SF by Space Type	LPD by Space Type
Atrium (first 40 ft in height)	900	2.75
Conference/Meeting/Multipurpose	851	1.05
Corridor/Transition	848	3.45
Detailed Manufacturing	1,091,724	0.70
Electrical/Mechanical	596,925	1.00
Equipment Room	576	0.33
High Bay (25–50ft)	58,089	0.84
Lobby	705	1.35
Lounge/Recreation	400	1.03
Low Bay (<25ft)	2,171	1.33
Office (enclosed)	165,066	0.85
Office (open plan)	50,772	0.39
Restrooms	840	1.07
Storage	139,776	0.10
Workshop	101,608	2.80

Office

Offices use fluorescents predominantly 33% of the fluorescents are T12s, or about 25% of the total wattage. The bulk of the space observed had an LPD of 1.0 (Table 11).

Figure 30. Installed Lighting Technology in Offices by Wattage

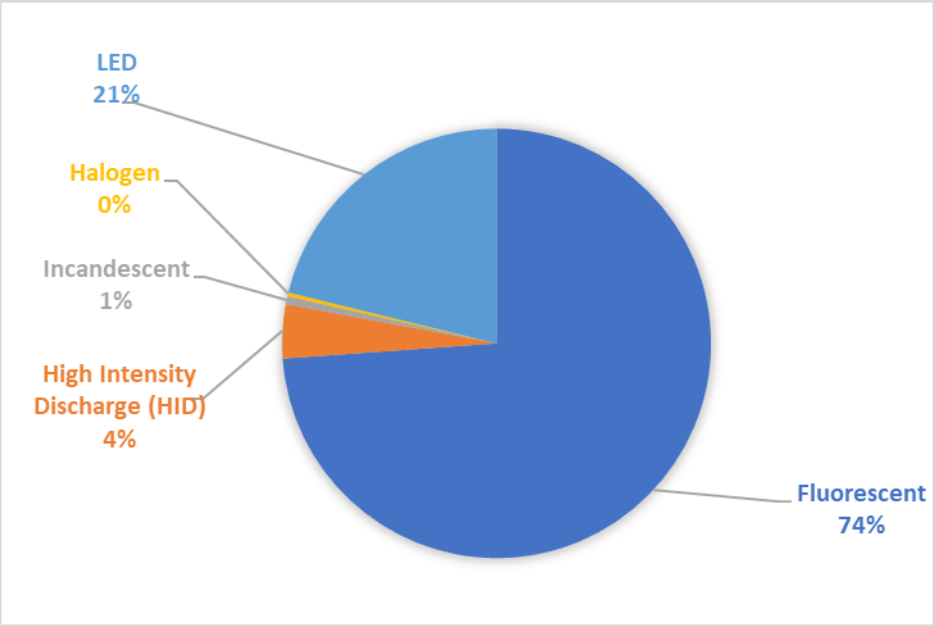


Figure 31. Installed Lighting Technology in Offices by Fixture Count

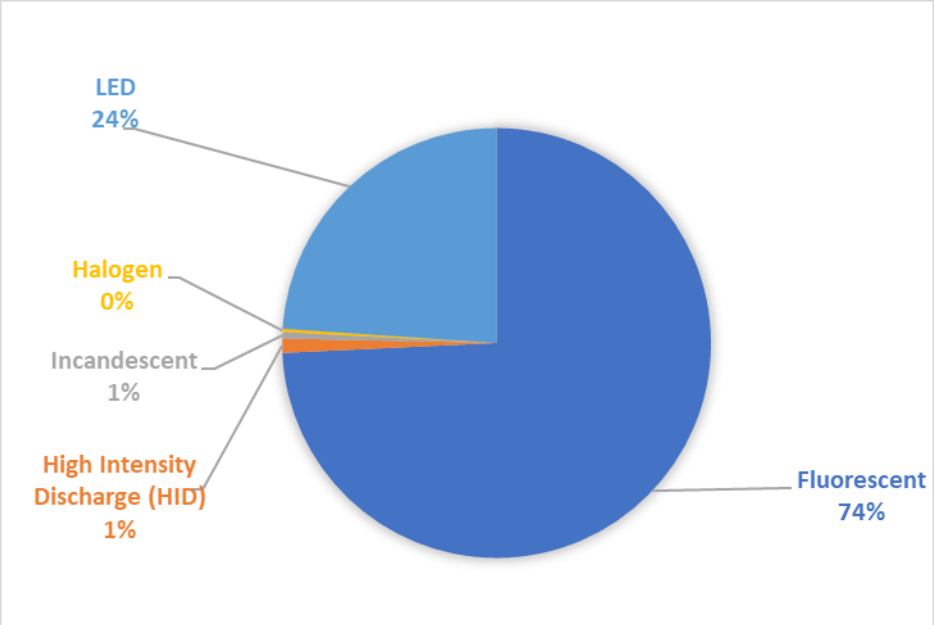


Figure 32. Fluorescents Installed in Restaurants by Wattage

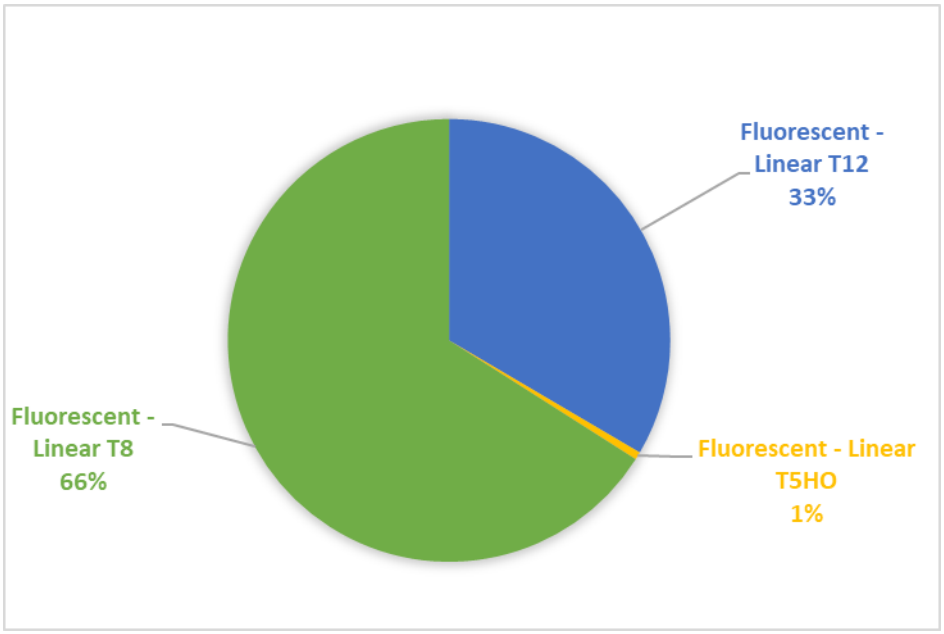


Figure 33. Fluorescents Installed in Restaurants by Fixture Count

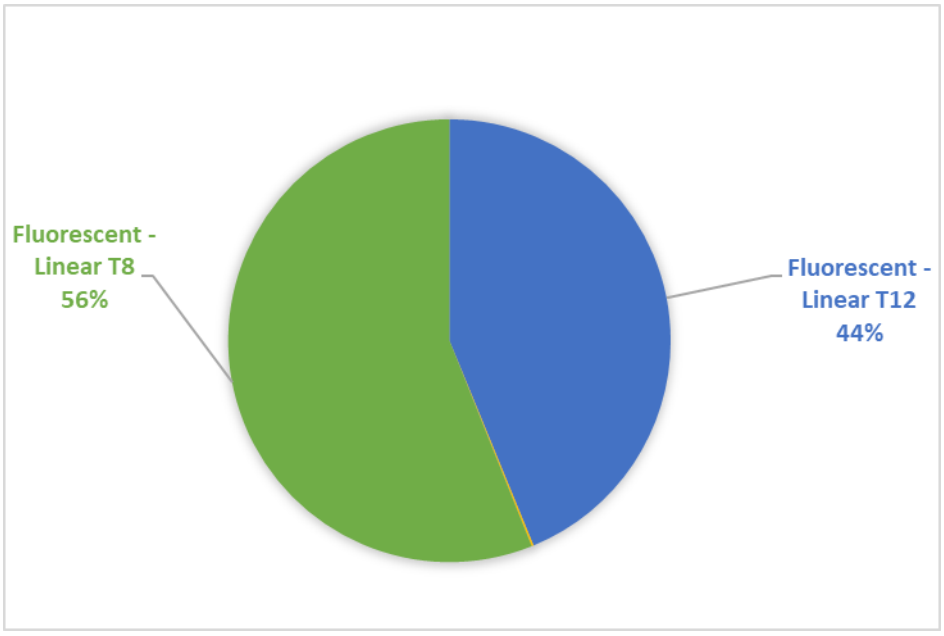


Table 11. LPD for Sampled Spaces in Offices

Space Type	SF by Space Type	LPD by Space Type
Atrium—first 40 ft in height	14,333	0.76
Classroom/Lecture/Training	1,120	0.87
Conference/Meeting/Multipurpose	26,997	0.77
Corridor/Transition	22,429	0.74
Dining Area	3,786	0.59
Electrical/Mechanical	6,600	0.79
Food Preparation	11,900	1.13
Lobby	306	0.25
Locker Room	419	0.83
Lounge/Recreation	34,952	0.36
Office (enclosed)	42,596	0.78
Office (open plan)	470,996	1.04
Restrooms	8,677	0.78
Stairway	1,952	0.16
Storage	5,813	0.81
Workshop	77,330	0.71

Restaurant

Cadmus visited five restaurants, but a relatively small floor area, since most restaurants are relatively small. Fixtures were diverse with the largest portion of halogens among the facility types sampled. LPDs varied but even with low light levels, were relatively high, in part because of the low saturation of LEDs (Table 12).

Figure 34. Installed Lighting Technology in Restaurants by Wattage

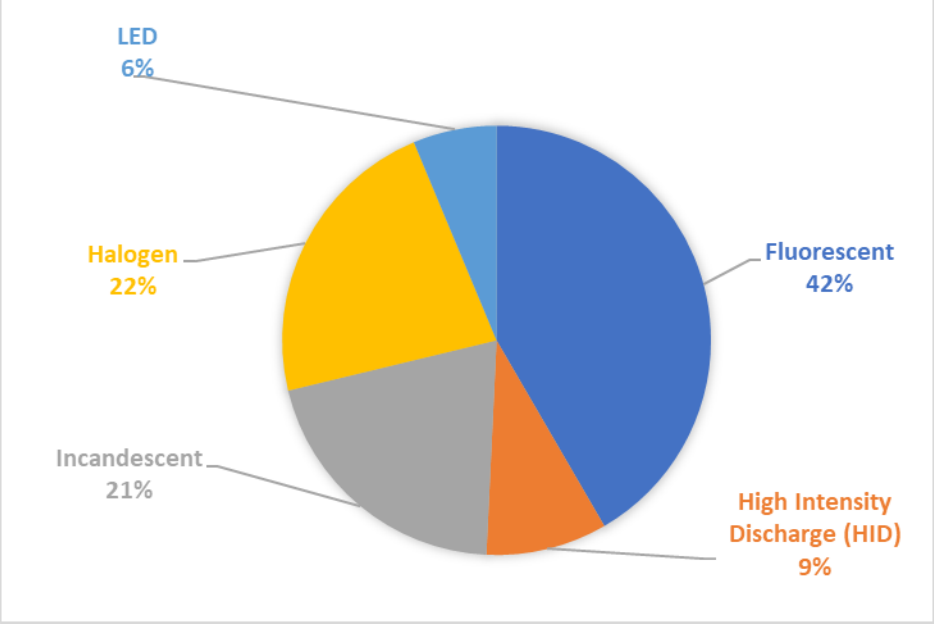


Figure 35. Installed Lighting Technology in Restaurants by Fixture Count

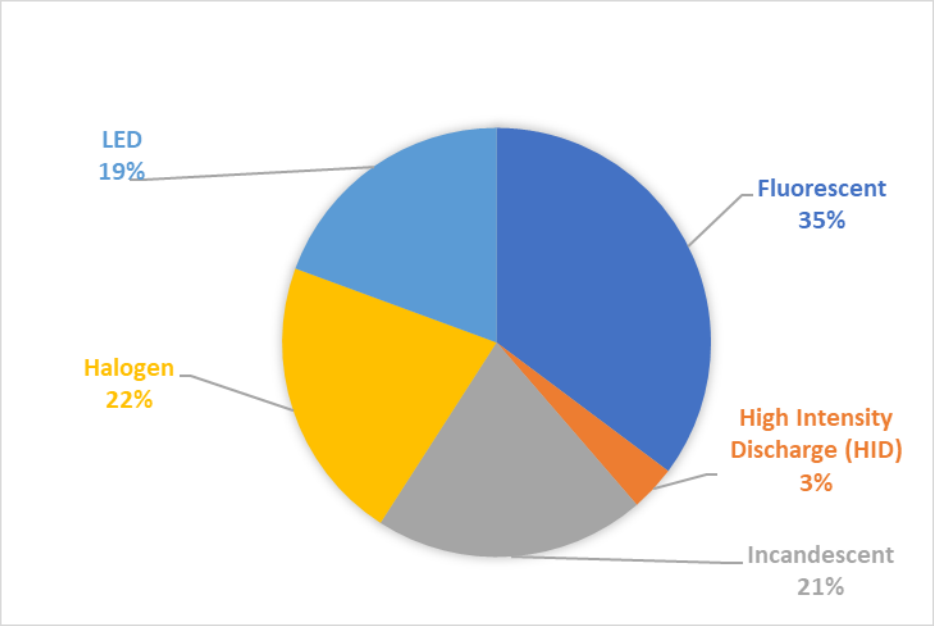


Figure 36. Fluorescents Installed in Restaurants by Wattage

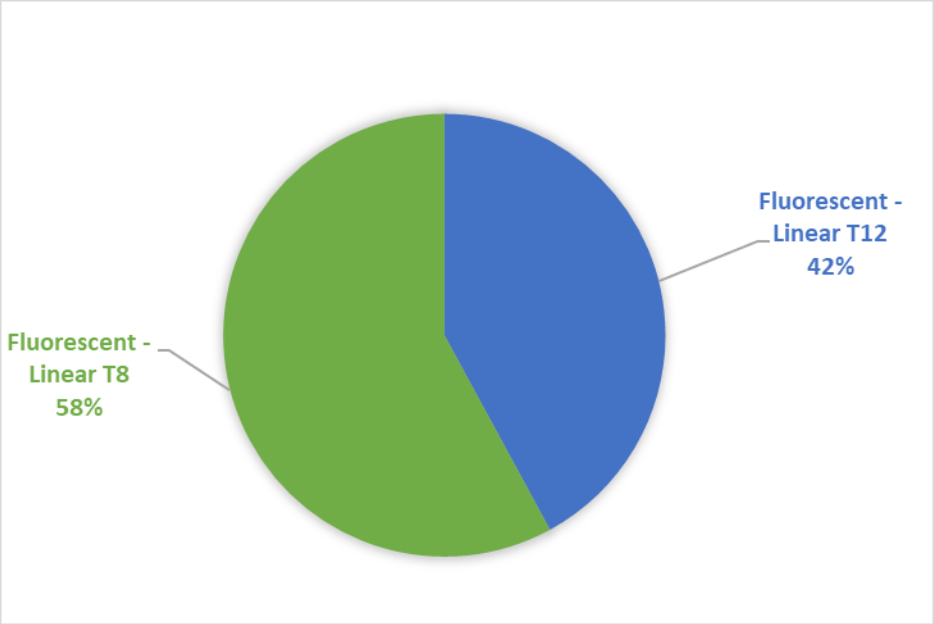


Figure 37. Fluorescents Installed in Restaurants by Fixture Count

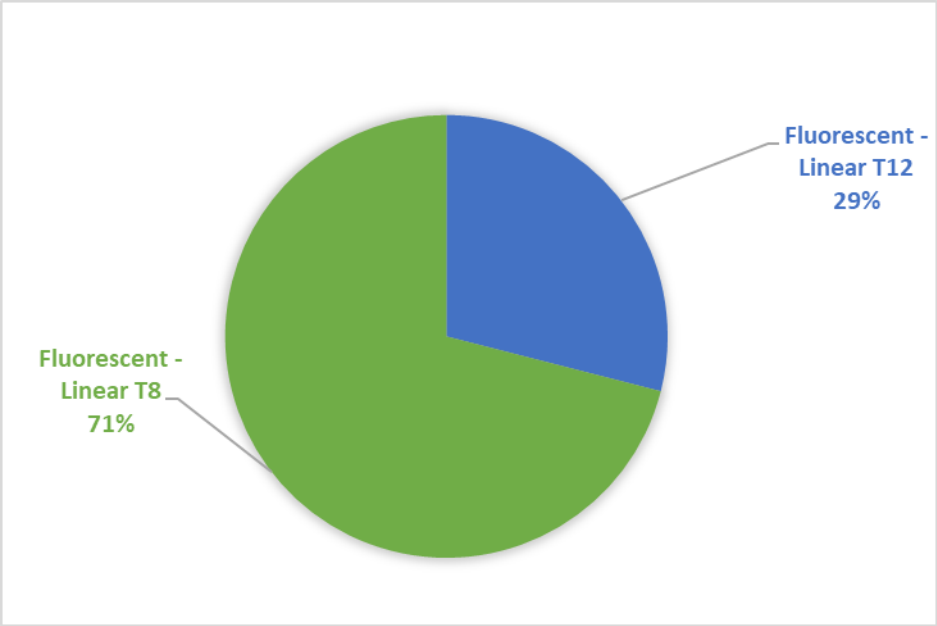


Table 12. LPD for Sampled Spaces in Restaurants

Space Type	SF by Space Type	LPD by Space Type
Corridor/Transition	682	1.36
Dining Area	19,089	0.92
Electrical/Mechanical	205	0.88
Food Preparation	4,259	1.49
Lobby	432	1.27
Locker Room	104	6.46
Office (enclosed)	1,350	0.63
Restrooms	1,346	1.80
Storage	7,884	0.34

Retail

Cadmus visited 20 retail facilities, finding most fluorescents with some LED saturation. LPDs varied but were relatively high (Table 13). Roughly 9% of fluorescents (15% of 61%) or nearly 11% of wattage (14% of 78%) is contributed by T12s.

Figure 38. Installed Lighting Technology in Retail by Wattage

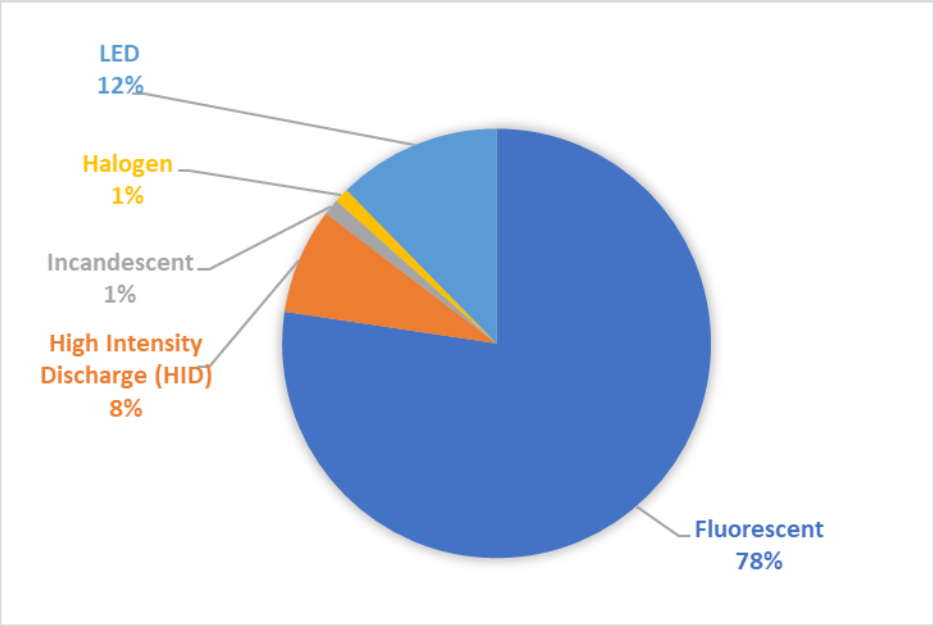


Figure 39. Installed Lighting Technology in Retail by Fixture Count

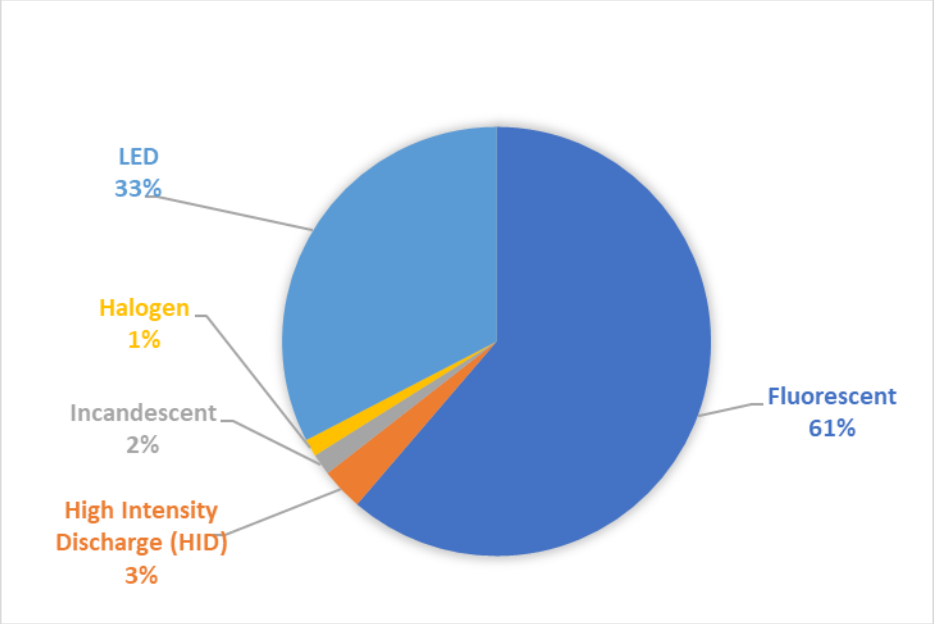


Figure 40. Fluorescents Installed in Retail by Wattage

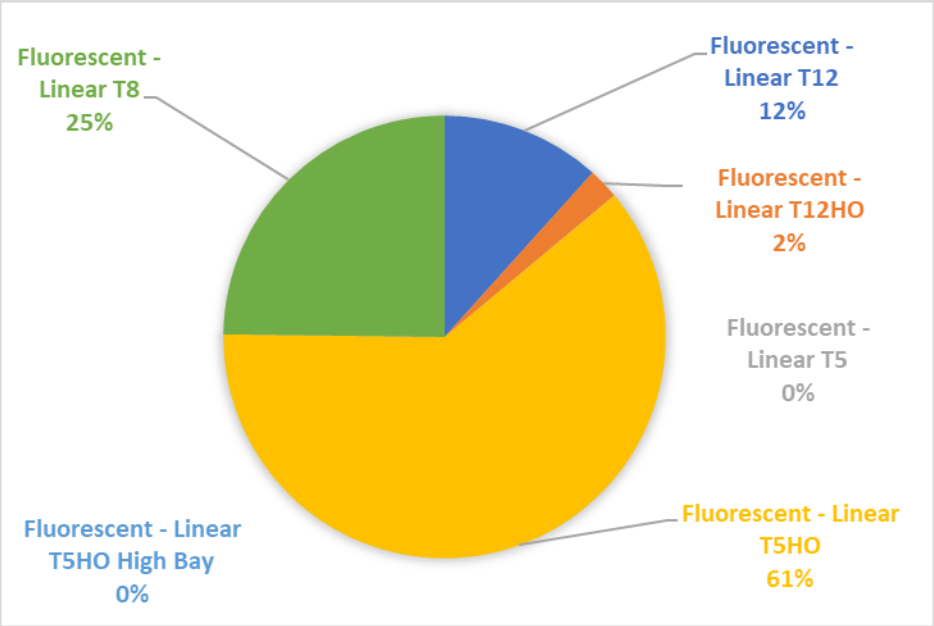


Figure 41. Fluorescents Installed in Retail by Installed Fixtures

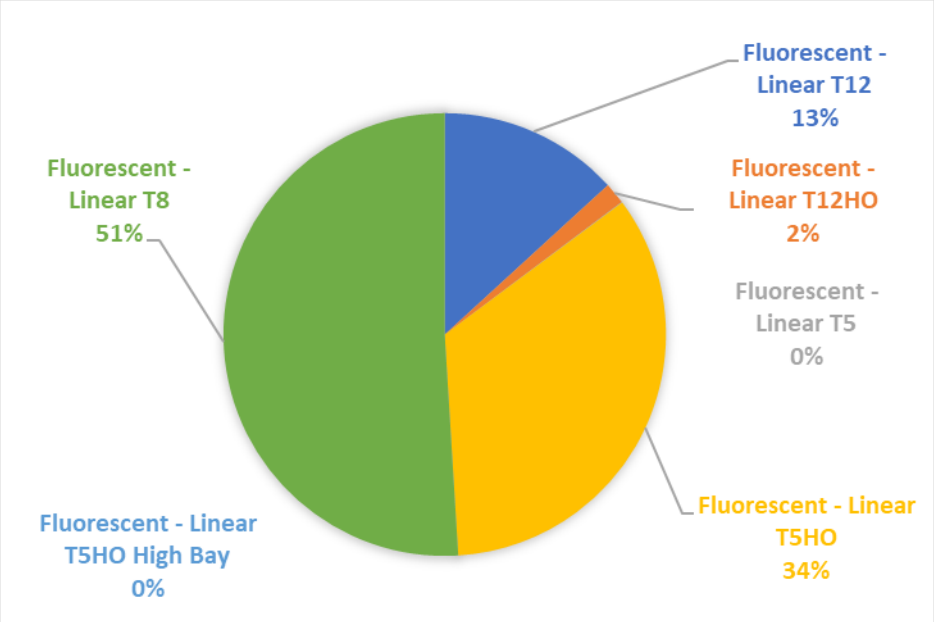


Table 13. LPD for Sampled Spaces in Retail Spaces

Space Type	SF by Space Type	LPD by Space Type
Atrium—first 40 ft in height	13,408	0.90
Conference/Meeting/Multipurpose	2,460	1.27
Corridor/Transition	3,803	0.68
Electrical/Mechanical	72	1.04
Food Preparation	2,029	1.19
Lobby	1,008	0.55
Lounge/Recreation	204	0.87
Office (enclosed)	7,155	0.97
Office (open plan)	1,274	1.16
Restrooms	1,265	0.80
Sales Area	300,152	1.06
Stairway	117	1.01
Storage	122,300	0.40
Workshop	33,739	0.56