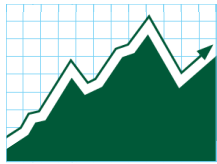


Appendix E
Commercial Lighting Baseline

E-2: State of Commercial & Industrial Lighting in Maine – 2021 Update,
Ridgeline Energy Analytics



To: Laura Martel, Efficiency Maine Trust
 From: David Korn, Ridgeline Energy Analytics
 Cc: Nancy Dickson, Ari Jackson, Will Rambur, Ridgeline Energy Analytics
 Date: July 26, 2021
 Re: State of Commercial & Industrial Lighting in Maine – 2021 Update

Executive Summary

In 2018 The Cadmus Group, (Cadmus) completed a report based on field visits to 75 facilities that examined the potential for future lighting savings. Cadmus estimated a cost-effective potential of 380M kWh/year. After nearly 4 program years of activity since that field work, the Trust wanted to examine the future of lighting conversion to LEDs and revise the potential study. Because FY2020 expenditures and savings were down from FY19, FY18, there was some concern that activity was tailing off and that future opportunities might be harder to find. The Trust asked Ridgeline to update findings of the report. The primary activity was to examine program data for FY 2018 – 2021. We also interviewed various stakeholders to gain understanding of their perception of the remaining potential and barriers to completing additional lighting projects.

Ridgeline adjusted values from the Cadmus report for FY 2016 and 2017 and calculated a new value for FY 2018 – 2021 to produce Table 1.

Table 1. Program Data Summary FY 2016 - 2021

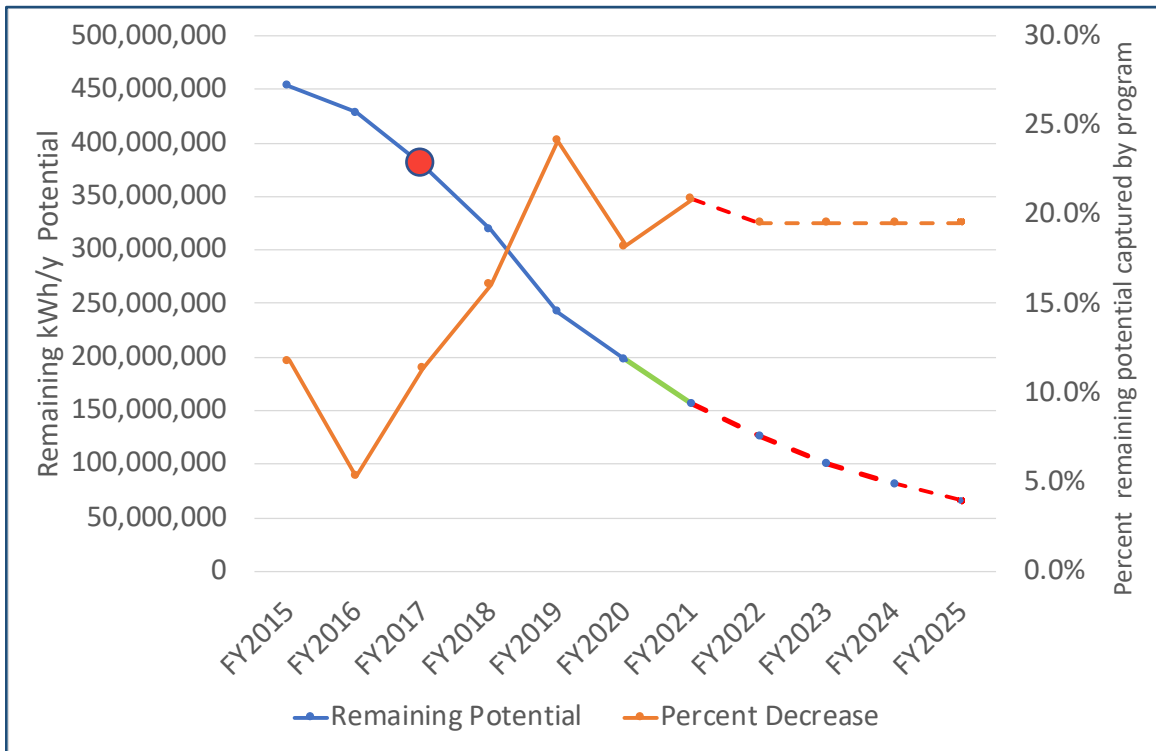
FY	Program Savings (kWh/y)	Remaining Potential (kWh/y)	Program Incentives Paid	Incentive Cost / kWh/y
2016	24,195,572	428,759,192	\$6,350,368	\$0.26
2017	48,759,192	380,000,000 ¹	\$6,138,602	\$0.13
2018	61,002,086	318,997,914	\$11,316,943	\$0.19
2019	77,023,660	241,974,255	\$11,022,398	\$0.14
2020	44,146,081	197,828,174	\$7,370,055	\$0.17
2021	41,242,346	156,585,828	\$7,780,177	\$0.19

Table 1 shows that savings peaked in FY 18 and FY 19, and declined to FY 17 levels in FY 20 and FY21. The incentive cost per kWh saved was stable FY18 – FY21 with a drop in FY19.

¹ 380M kWh was the cost-effective potential value produced by Cadmus based on field work soon after the end of FY17.

Viewing these data in a graphical form, where the red dot equals the cost-effective potential at the end of FY17, we can see that the savings curve starts shallow, steepens, then slackens as the population approaches saturation.

Figure 1. Extrapolated Remaining Potential Based on Fixing Annual Percent Decrease at 19.5% (Red



(Red circle indicates estimated remaining potential at end of FY17)

We interviewed various stakeholders including 3 distributors, 5 contractors, and one manufacturer. They helped us to understand their view of the market and to check whether there were any barriers to achieving the remaining savings. In general, the stakeholders were positive about the Trust and its role, bullish on future conversion to LED activity, and indicated that there is 25 to 50% of building area left to convert to LEDs.

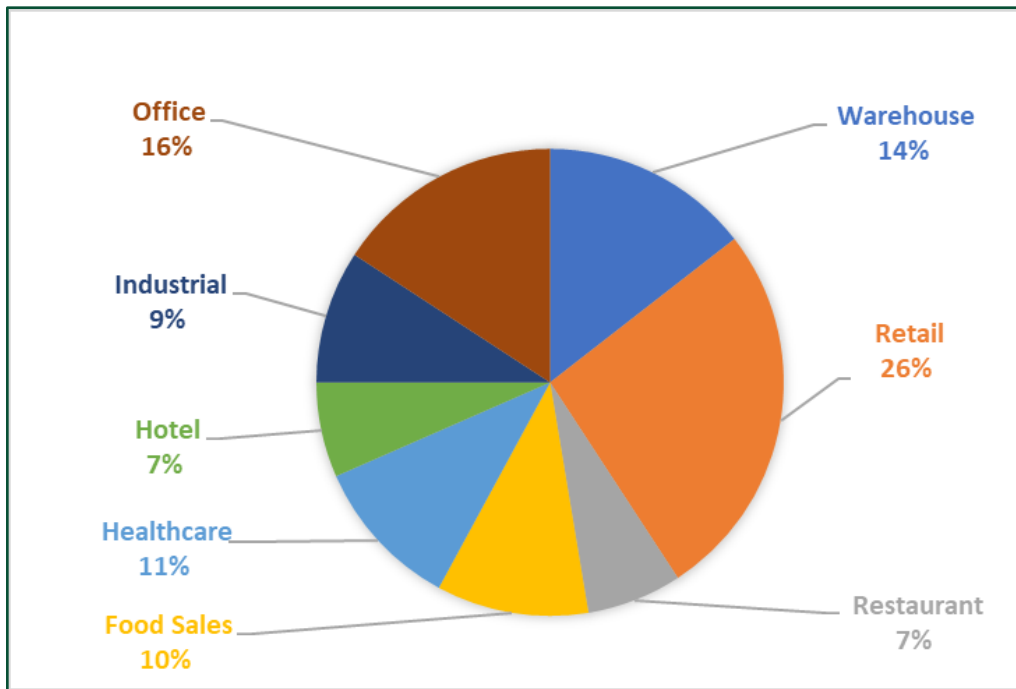
Background

In 2018, The Cadmus Group (Cadmus) completed a report based on field visits to 75 facilities that examined the potential for future lighting savings. Cadmus estimated a cost-effective potential of 380M kWh/year. After nearly 4 program years of activity since that field work, the Trust wanted to examine the future of lighting conversion to LEDs and revise the potential study. Because FY2020 expenditures and savings were down from FY19 and FY18, there was some concern that activity was tailing off and that future opportunities might be harder to find.

The Trust asked Ridgeline to update findings of the report. The primary activity was to examine program data for FY2018 – FY2021. We also interviewed various stakeholders to gain understanding of their perception of the remaining potential and barriers to completing additional lighting projects.

The Cadmus study was based on field visits to 75 facilities. The facilities visited by type are shown in Figure 2. Their staff collected information regarding general facility characteristics including age, square footage, and operating schedules. In all, 7.5 million square feet of facility were visited, and 5.4 million square feet of floor space were directly audited. In addition, Cadmus surveyed roughly 0.6 million square feet of exterior lighting.

Figure 2. Visits by Facility Type



The following charts from the Cadmus report show the simple unweighted percentages of lighting technologies in their sample. LEDs were 11% by installed wattage, 28% by count, and about 25% by floor area. (Figure 3, Figure 4, and Figure 5). Fluorescent and HID fixtures were by far the most numerous non-LED lights.

Figure 3. Installed Lighting Technology by Wattage

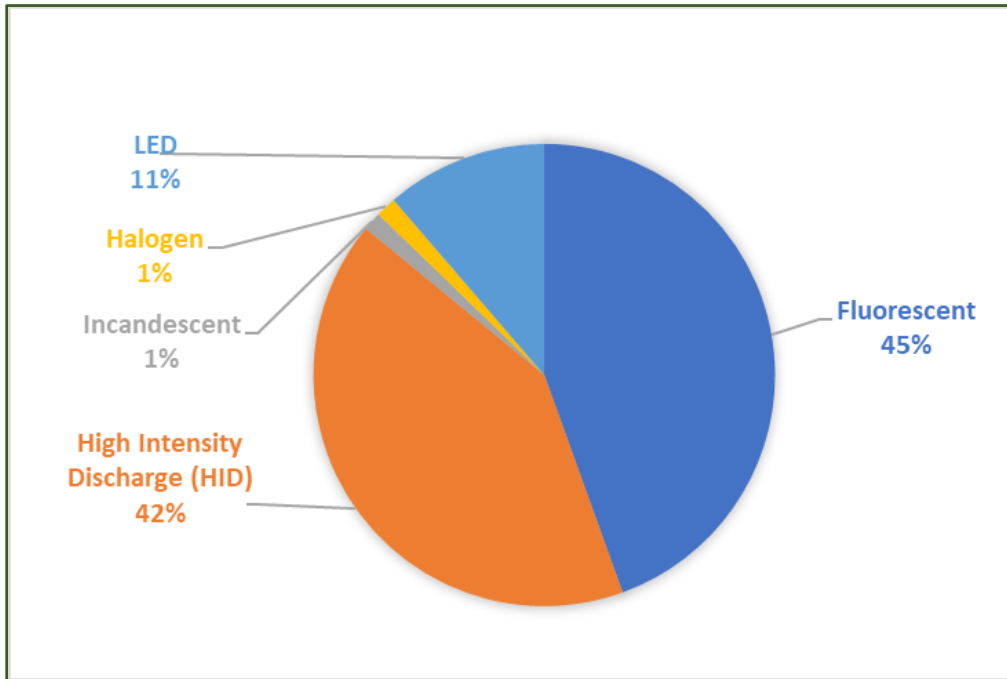


Figure 4. Installed Lighting Technology by Fixture Count

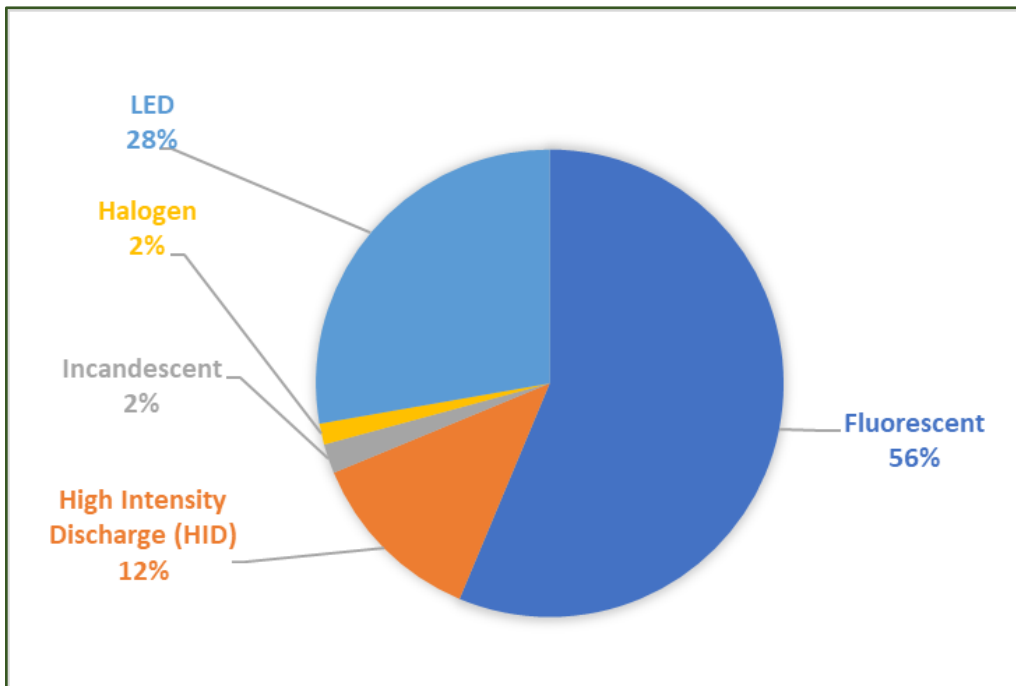
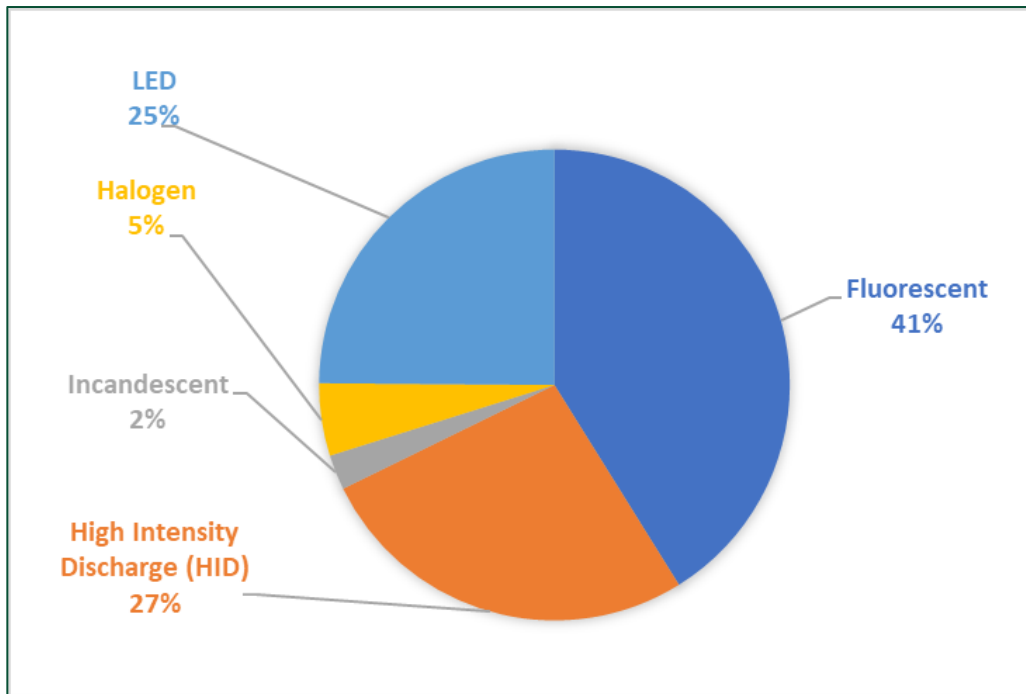


Figure 5. Lighting Technology by Floor Area



Approach

Ridgeline reviewed the Cadmus report and understood that the program activity numbers did not include distributor lighting (DL) and predated several findings from the 2019 evaluation by Demand Side Analytics. We adjusted those historical values and combined them with values for FY2018, FY2019, FY2020, and extrapolated numbers for FY2021. Ridgeline assigned 41% of non-linear lights and 100% of linear lights to the commercial and industrial (C&I) sector. 6.25% of retail lighting (RL) was assigned to the (C&I) sector. We used these combined program numbers from FY2015 to FY2021 to examine patterns and estimate remaining potential.

One concern expressed by the Trust was that remaining potential might not only be small, but it might consist of hard-to-reach populations, small portions of buildings that would not be worthwhile to various market actors to address, or small buildings with projects too small to interest stakeholders.

To bring context to remaining potential we interviewed 9 stakeholders to determine their past and projected activity. They included:

- 5 contractors
- 3 distributors
- 1 manufacturer

For additional insights we interviewed four sites comprising ~6M SF. This was not intended to be a statistically representative sample but rather was a snapshot of the thinking of several sites that were either thought to be active in efficiency or were past participants of the distributor lighting (DL) program.

Program Expenditure and Reported Savings

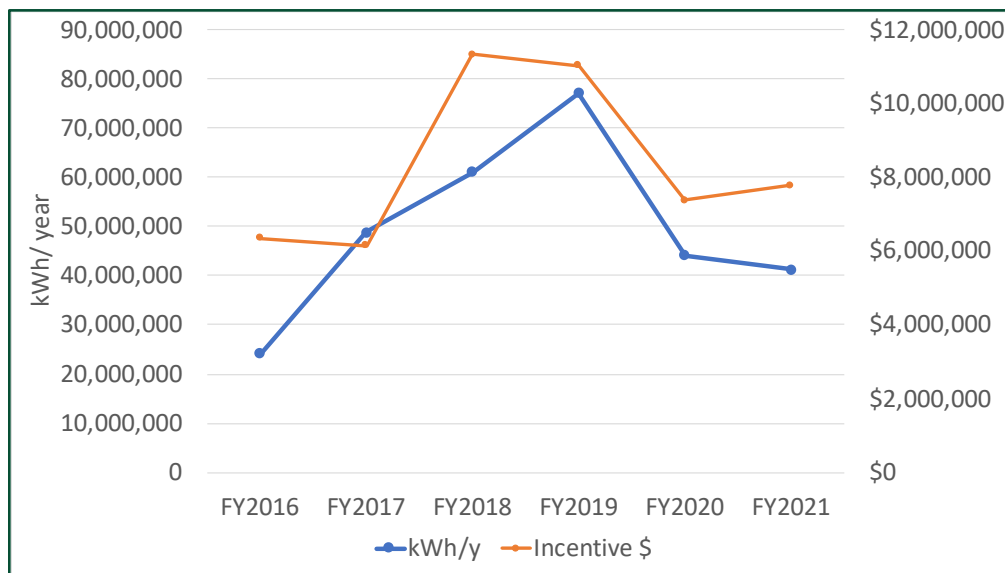
Ridgeline adjusted values from the Cadmus report for FY2016 and FY2017 and calculated a new value for FY2018 based on program data. Ridgeline then processed program data from FY2019 – FY2021 to produce Table 2.

Table 2. Program Data Summary FY 2016 - 2021

FY	Program Savings (kWh/y)	Measure Cost Total	Program Incentives Paid	% Measure Funded	Measure Cost / kWh/y	Incentive Cost / kWh/y
2016	24,195,572	\$11,656,169	\$6,350,368	54%	\$0.48	\$0.26
2017	48,759,192	\$9,571,208	\$6,138,602	64%	\$0.20	\$0.13
2018	61,002,086	\$18,941,624	\$11,316,943	60%	\$0.31	\$0.19
2019	77,023,660	\$20,117,495	\$11,022,398	55%	\$0.26	\$0.14
2020	44,146,081	\$13,225,687	\$7,370,055	56%	\$0.30	\$0.17
2021	41,242,346	\$13,225,672	\$7,780,177	59%	\$0.32	\$0.19

Figure 6 shows a time series of energy savings and incentive expenditures. While FY2020 was a large drop from FY2018 and FY2019, FY2021 appears to show a leveling off in both savings and expenditures. Because COVID impacted the last 4 months of FY2020 and much of FY2021 it is difficult to precisely discern a trend in savings or expenditures. It is clear that there is a drop, but it is hard to answer, absent COVID, questions about rate of decrease or timing. Examining measure cost and incentive costs normalized by kWh/y saved, FY2018, FY2020, and FY2021 are nearly identical with FY2019 an outlier with lower measure and incentive costs.

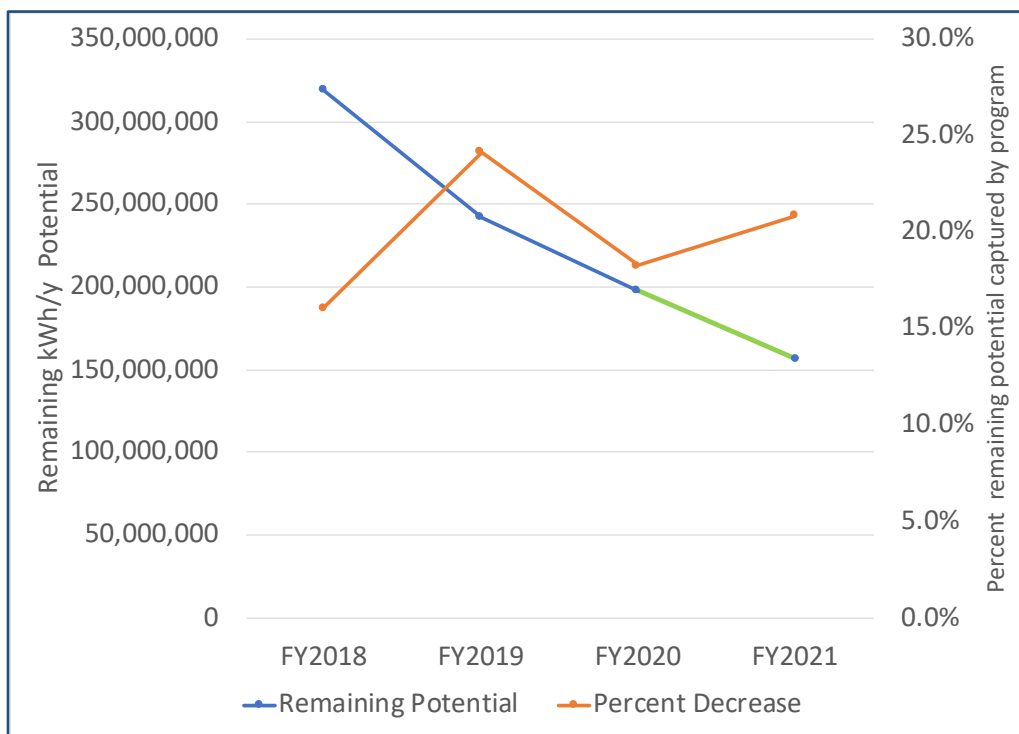
Figure 6. Energy Savings and Incentive Cost FY16 – FY21



We set the potential listed by Cadmus of 380M kWh/y to correspond with the end of FY2017². We then subtracted the reported savings for each fiscal year from the previous end of fiscal year total. For example, with the potential set to 380M at the end of FY2017, we subtracted the 61M kWh/y listed in Table 2 to yield a new potential of 319M kWh/y at the end of FY2018. Figure 7 shows that at the End of FY2020 we calculated a new potential of 200M kWh/y. We then extrapolated the 10 months of available FY2021 data (indicated in green) to yield a potential at the time of this memorandum of roughly 150M kWh/y.

From this potential curve we then calculated the percent of remaining potential addressed each year. This percent decrease varied somewhat year to year and averaged about 20%, with no apparent downward trend.

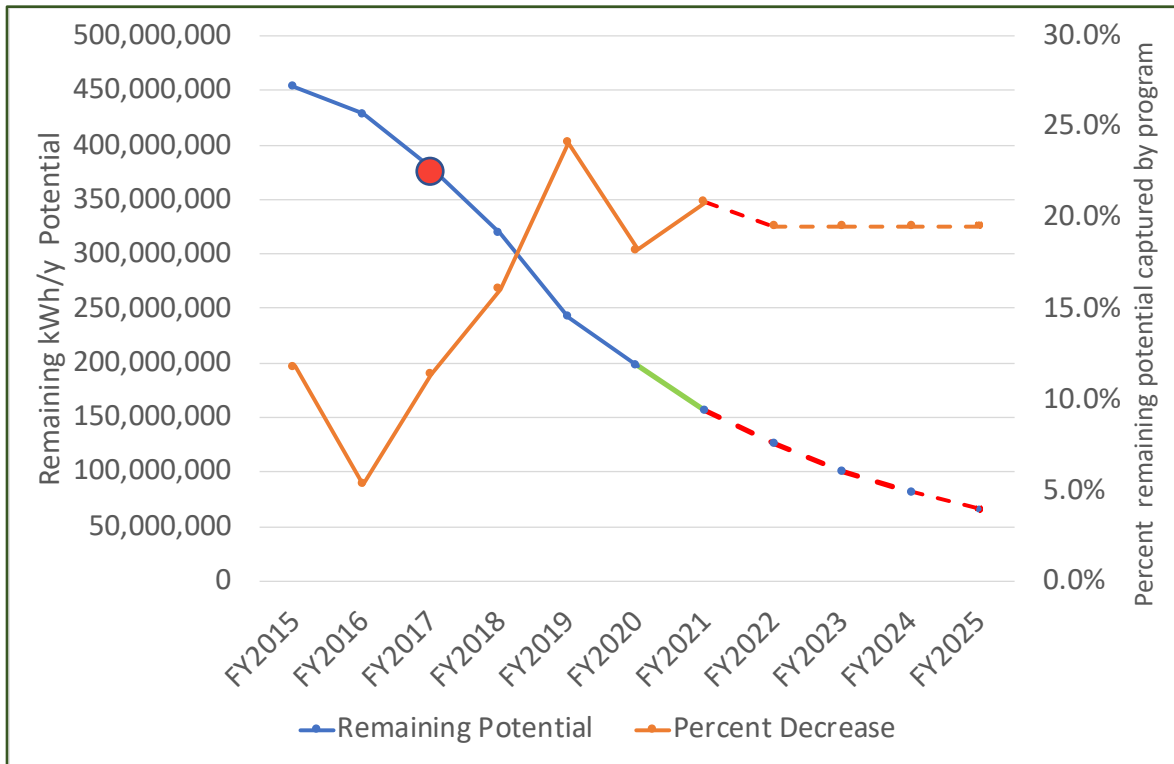
Figure 7. Calculated Remaining Potential and Annual Percent Decrease



We used this average decrease to project FY2022, FY2023, and FY2024 (Figure 8). The resulting potential curve continues to decrease, albeit at a decreasing slope.

² The field work for the study actually took place about 4 months after the end of FY17.

Figure 8. Extrapolated Remaining Potential Based on Fixing Annual Percent Decrease at 19.5%



(Red circle indicates estimated remaining potential at end of FY17)

Program Level Review

The preceding high-level review sets the approximate potential. It is important to know however which programs or measures that potential might come from or if more granular data shows any barriers to continued progress.

To further investigate potential, we reviewed program level and costs for FY2018 to FY2021. We didn't look back further than this because programs and measure types change over time and our view was that this four year look back was sufficient to look for patterns that could impact current programs.

From FY2018 to FY2021, Small Business Initiative (SBI) and the C&I portion of Retail Lighting (RL) were relatively flat, however Commercial and Industrial Prescriptive (CIP) varied greatly with FY2020 and FY2021 less than half of FY2019 (Figure 9). The C&I portion of DL declined steadily over this period. With CIP accounting for nearly 60% of the total lighting savings, CIP activity drives trends in lighting savings.

We also examined trends in incentive cost in \$/kWh/y. All of the programs except for RL rose modestly from FY2020 to FY2021. A sharp increase would indicate that opportunities had become more difficult to find or incent, but the data do not appear to indicate this. Each of the programs have varying costs due to their delivery methods and target audience. SBI offers the most turnkey service and targets small businesses of which a portion are economically challenged. The cost per kWh/y saved is the highest at

about \$0.40 - \$0.45/kWh/y. CIP is lower at about \$0.20/kWh/y and DL and RL are the least at less than \$0.10/kWh/y but also the lowest contributor to savings.

Figure 9. Program Level Savings: FY18 – FY21

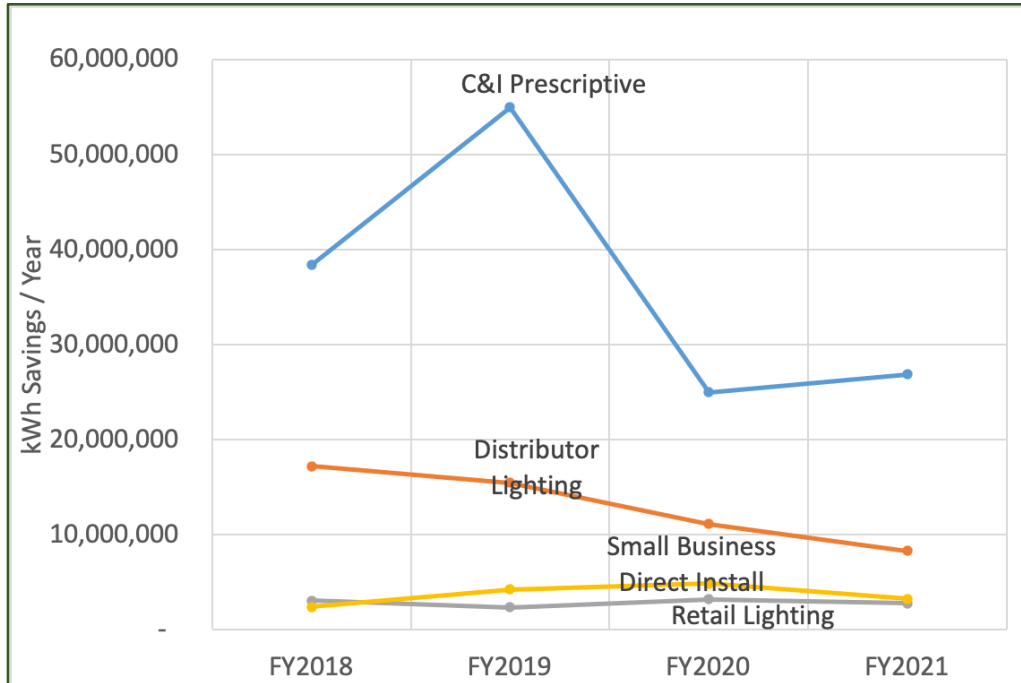
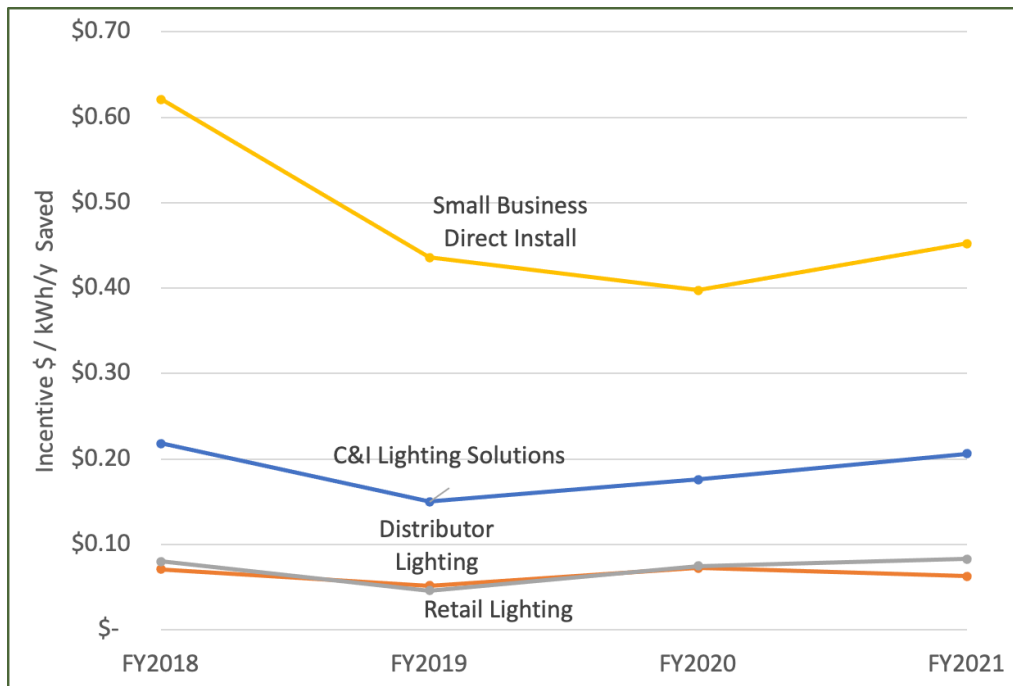


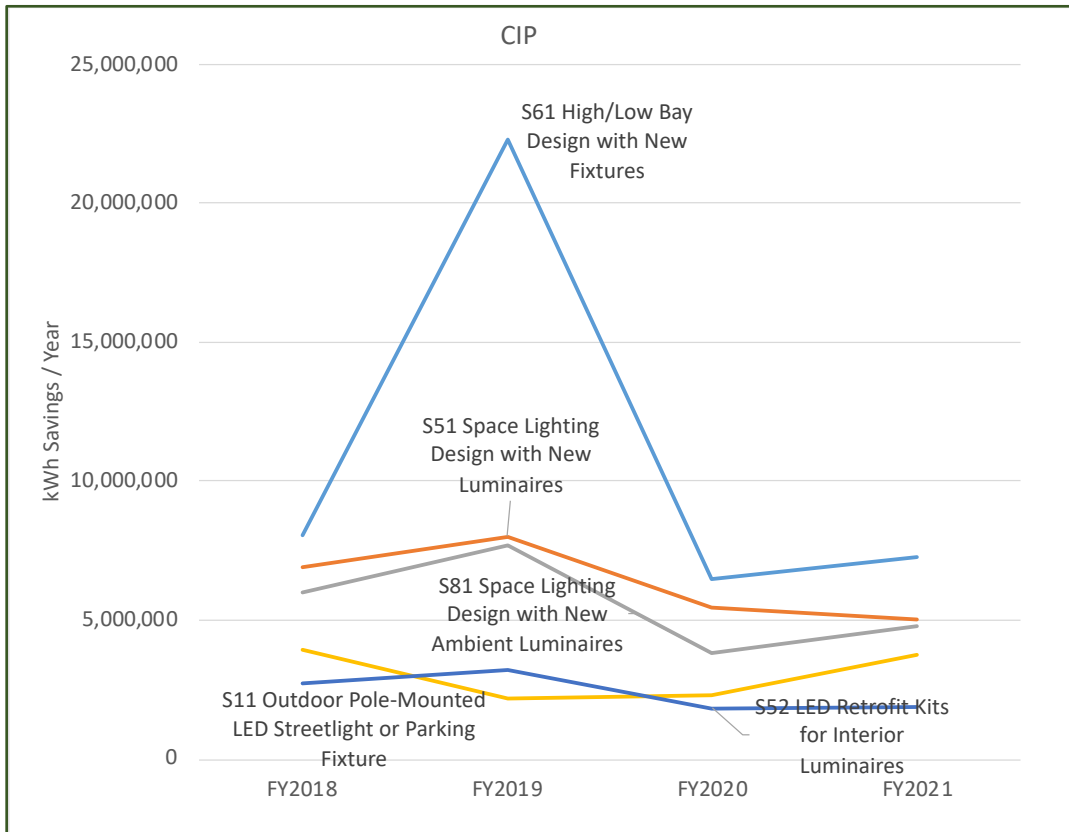
Figure 10. Program Incentive Cost \$/ kWh/y



Measure Level Review

Looking at the measure level for CIP, 4 of the 5 leading measures declined slightly from FY2018 – FY2021. In contrast S61 (high/low bay fixtures) peaked in FY2019 but was otherwise flat (Figure 11). This drives the trend for CIP shown in Figure 9. There was a near doubling of S11, outdoor fixtures, in FY2021 from FY2019.

Figure 11. Five leading Measures Under CIP



Of the five leading measures for SBI, there were modest changes to four, but S52 - LED retrofit kits, increased markedly in FY2019 and FY2020, then returned to FY2018 levels in FY2021 (Figure 12). Total savings for SBI were relatively flat for the four fiscal years.

SBI is a program that is implemented regionally where a location opens up for a set number of months then closes. We examined Regions 5 through 17 where Region 5 first opened in late 2017 and closed March 2018. Region 17 opened in November 2019 and closed in March 2021.

Figure 12. Five leading Measures Under SBI

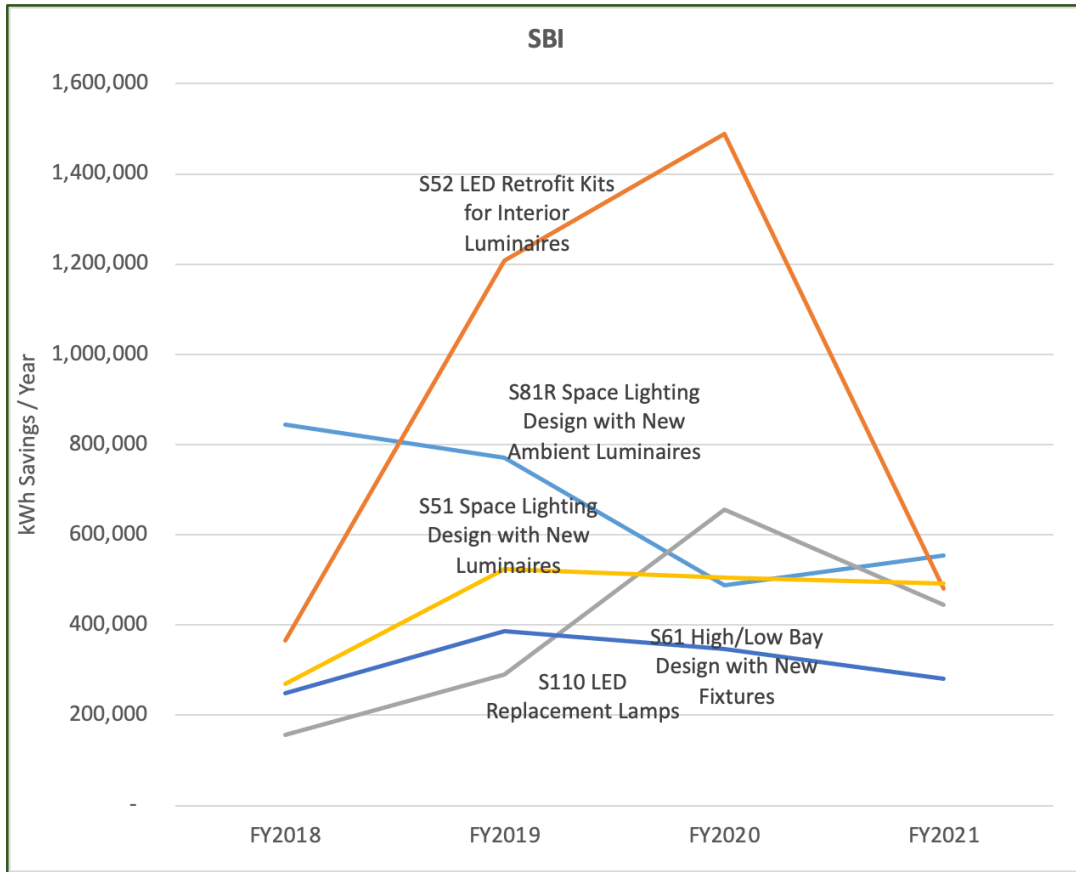


Figure 13 shows ratios of projects to requested audits (~80%), requests per site on target list (~20-70%) and projects per sites on the target list (~10 – 60%). The number of audit requests per site contacted is variable and for some regions quite low. This could be in part because of issues with the lists including duplicate sites, bad addresses, and otherwise ineligible sites. The conversion to projects after requests is high with some projects dropping out due to low opportunities.

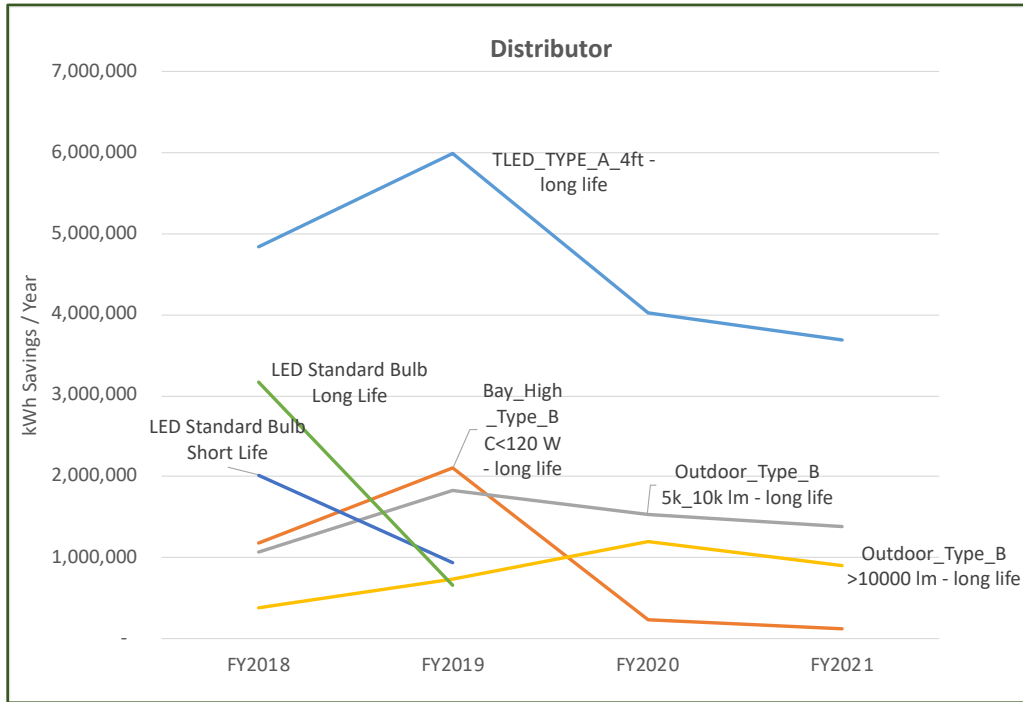
Figure 13. Project Conversion Rates for SBI by Region



Considering that only 41% of non-linear lamps in DL are assigned to the C&I sector, the leading measure by far has been Type A³ Linear LED lamps. Ignoring the relative peak in FY2019, this measure has steadily declined from FY2018 – FY2021 (Figure 14).

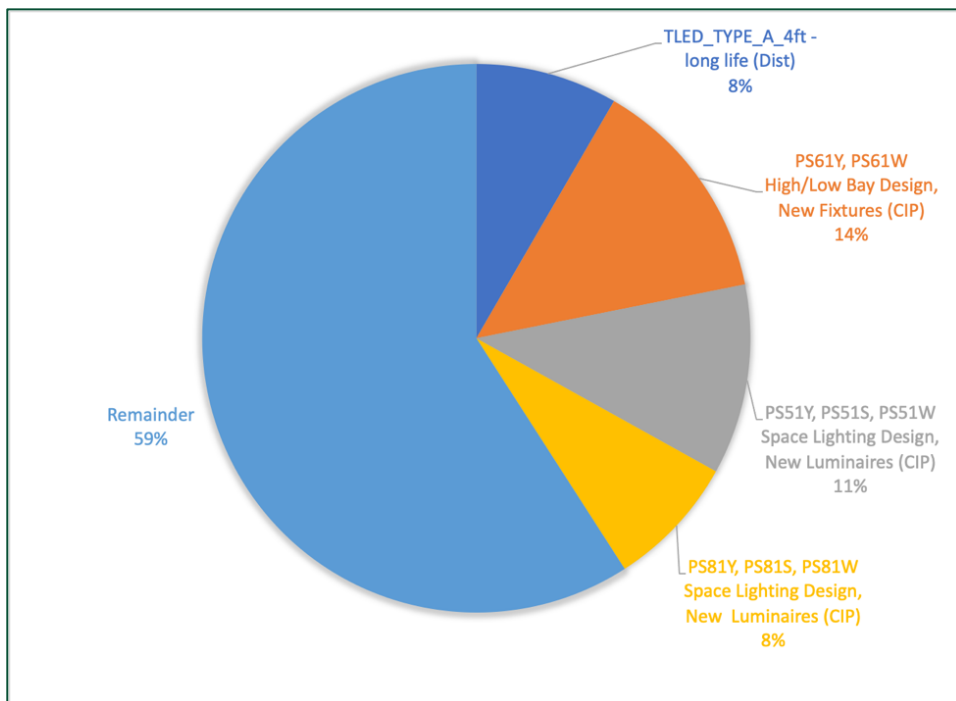
³ Type A LED lamps are those that can replace existing fluorescent lamps with no change to the ballast and no addition of an LED driver. Some makers refer to them as plug and play lamps.

Figure 14. Leading Measures Under DL



Looking across all programs for FY2020, three CIP measures account for over 30% of savings, and Type A linear lamps account for 8% (Figure 15).

Figure 15 Four leading Measures Across All Programs for FY20



Stakeholder Interviews

Conversations with Distributors

We contacted 11 electrical supply distribution firms and offices, and three responded. Table 3 shows details from discussions with those lighting and electrical distributors. All three distributors were very positive about the impact of the Trust’s programs. Each of them thought that much progress had been made but were bullish on future lighting retrofit activities. When asked to estimate the remaining portion of lighting to be converted from a square footage point of view, all three noted that about half remained to be done although they all mentioned that this was a rough estimate. All three also mentioned that while they were enthusiastic participants in the Trust’s programs, they noted that paperwork (forms) was a staff burden and wondered if there wasn’t a way to simplify the work. Other topics brought up by one of more of the distributors included these:

- One distributor noted that sometimes after a job was quoted, a particular fixture would be found to not qualify for an incentive causing issues with customers. The issue appeared to be one of timing between an initial bid and confirming qualification.
- Several stakeholders noted that fixtures with DIP switches allowing for setting wattages could in theory allow them to carry fewer, but more flexible items. The issue they found was that if a fixture would not qualify for all settings, then it would not qualify.
- One distributor noted world-wide material shortages leading to low availability and price increases. One noted up to 10% price increases.
- A distributor (and a contractor) noted that warehouse spaces were one sector that had a good deal of opportunity left.

Table 3. Answers from Distributor Interviews

Firm/ Location	Estimated Percent of non-LEDs Remaining	Notes/ issues	Advice for EMT
A	50%	DIP switches, DLC, self-install	Baseline logging creates burden
B	50%	Warehouses, self-storage, manufacturing left to do, paperwork burden; NC boom is blunting retrofit; margins are lower, SBI is now very small; COVID cut traffic	Paperwork burden
C	50%	3-10% price increases, material shortages: resins, metals, some large current projects, e.g., Hannaford's	Keep programs strong, happy with GDS and ERS; paperwork burden

Conversations with Lighting Contractors

We spoke with five contractors of varying sizes that serviced areas from Caribou down to Portland. Four of the five thought the market remaining was in the 30% to 50% range. The one lower estimate came from a contractor in the County that may be seeing a limited market. While contractors varied in their circumstances and opinions, they were all positive about lighting projects and incentives. Several involved in SBI see potential in revisiting early regions that installed fluorescents, and in opening up the program to the entire state, shifting from the current regional approach. One concern of the Trust is whether remaining potential is in pieces so small that contractors would not be interested. Several of the contractors interviewed worked on jobs less than \$10,000. Contractors that relied on Maine’s program delivery team for leads were happy with those contractors.

Table 4. Answers from Distributor Interviews

Firm	% remaining	Notes/ issues	Advice for EMT
A	30%	Sites call them typically when the rate of burned-out fixtures and ballasts reaches a tipping point	Re-open SBI statewide. There are (many) sites that missed the time frame to participate. Incent exterior lighting.
B	20 - 25%	Lower activity level from 2020 to 2021. Distributors are selling directly to customers, and they are self-installing cutting into electricians’ market. Thinks some remaining buildings are problematic. For example, a local Mall is struggling financially, and while candidate for LEDs, practically they are not.	He perceived a building type focus last year (schools) and thought that it worked well. He thought that an agriculture focus might work although he noted that potato houses had low HOU
C	30%	Less activity today. Declining from 2019 through 2021.	Higher rebates would be nice. Dedicated programs for sectors.
D	50%	Sees refreshing SBI as an opportunity Small retail, auto repair still to be done Sees benefit of no fixtures, costs so low Sees continues demand	Labor rates allowed are too low. Program is \$60, and their std. rate is \$120. Timing important, electricians slammed in the summer.
E	‘substantial’	Seeing same activity in 2021 vs. 2020	

Conversations with a Lighting Manufacturer

We contacted a representative of a leading manufacturer of both lighting projects and an assembler of turnkey projects for municipal clients. The contact was very positive about the Trust’s programs and their role in shifting the market. He still sees a good deal of projects to do and sees about 50% of building area as yet to be converted to LEDs. As an example, he noted a major New England hospital that was still buying T8s and electronic ballasts and a major New England grocery chain that had yet to convert many of its stores. When asked about new products and advances he noted fixtures with controllable wattage and color, and the benefit of controls. He did not see any quantum leaps in lumens per watt but sees continued improvement.

Conversations with Facility Managers

We spoke with four facility managers from sites totaling 6M SF in area:

- 2 colleges
- 1 multi-site retailer
- 1 long term care facility

The contacts were not randomly selected and in fact were sites expected to skew as environmentally motivated. The purpose of these contacts was to examine motivation of sites and see where the progress of motivated sites might be. The two colleges have sustainability goals, and the retailer has completed numerous projects with the Trust. It was therefore interesting that even among this population that 20% to 50% of fixtures remain to be converted to LEDs. This seems to align with estimates of various other stakeholders.

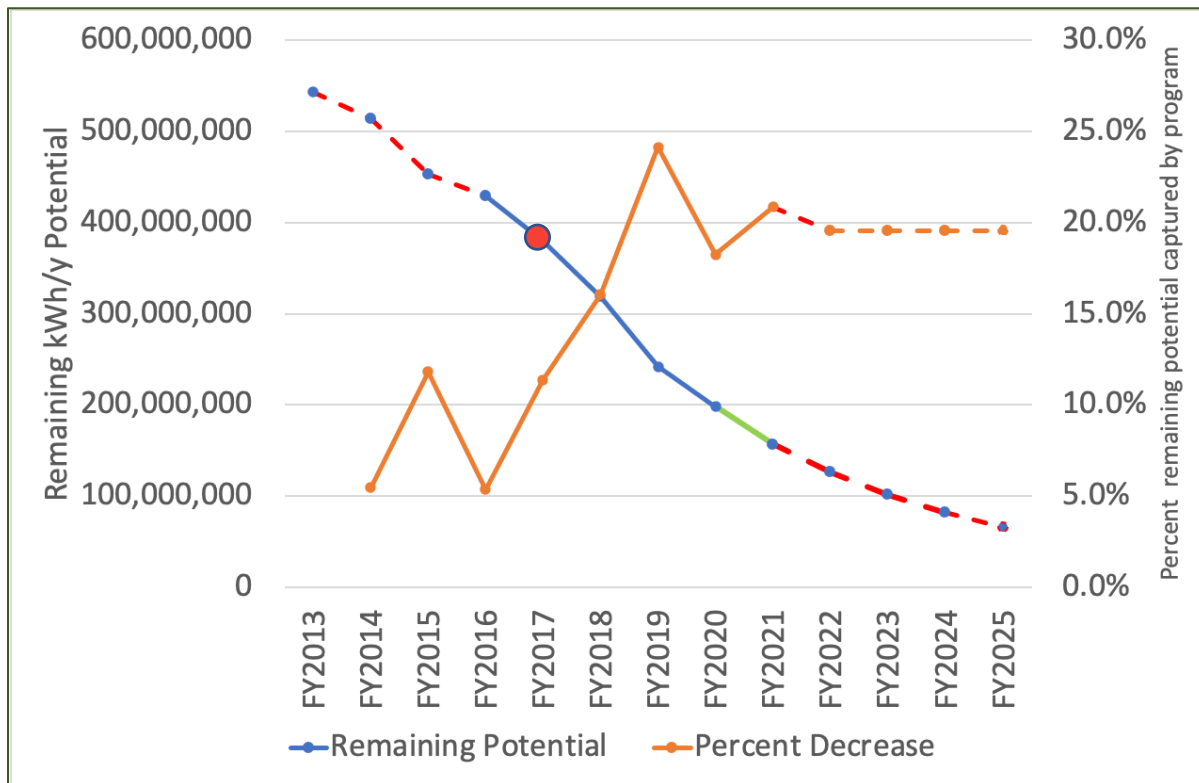
Table 5. Answers from Distributor Interviews

Site	% Remaining	Type of Site	Notes/ issues
A	20%	College	had committed to all LEDs in 2009, remaining projects tend to be small, low HOU
B	40%	College	Limited by sections of lights with high costs, annual budget
C	50%	Retailer	Multi-state firm prioritizes by budgets and apparently by each state's offerings. Some fluorescent installations are recent enough that they want to recover use before retrofit
D	50%	Long Term Care	Slowed by use of in-house labor and need to replace ballasts to accommodate Type A lamps. We understand that Type B lamps are not program eligible.

Aligning Estimates of Remaining Potential

Figure 16 sets the remaining potential to 380M kWh/y at the end of FY2017 (see red dot). The curve "back casts" the potential by adding previous program year's savings to the 380M kWh/y figure. Years prior to FY2016 are noted as a dotted line because programs and accounting may vary from previous practices. Moving forward from FY2017, the program savings for FY2018, FY2019, and FY2020 are subtracted to yield three new potential values. FY2021 was extrapolated for 10 months and is indicated in green. This leaves a remaining potential of 156M kWh/y at the end of FY2021. Using an assumed reduction of 20% of the remaining potential in each year, estimates of potential for FY2022, FY2023, and FY2024 are forecast.

Figure 16. Extending Potential Before and After the FY17 Estimate



(Red circle indicates estimated remaining potential at end of FY17)

Using the techniques described above, the potential at the end of FY2013 would be about 550M kWh/y. Using Figure 16, the remaining potential of 156M kWh/y is a remaining potential of 28%. This number is consistent with, but lower than various stakeholders' rough estimates. There are several explanations for this:

- Estimating cost effective potential is approximate. If the Cadmus estimate was low by say 15% and should have been 437M kWh/y, the remaining potential at the end of FY2021 would then be 213M kWh/y, the FY2013 potential would have been 607M kWh/y, and the remaining potential would be $213M/607M = 35\%$.
- The Cadmus estimate was based on measures that would pass the cost-effective test, and therefore our updated estimates are also cost-effective activities. Stakeholders estimates from their descriptions are for all lighting fixtures regardless of cost-effectiveness of transitioning to LED.
- The contractors, distributors, and contractors gave, at our direction, estimates of remaining potential. These estimates are rough and should be expected to be less accurate than a field-based study and extrapolations from actual program data.

Based on the reasoning above, the extrapolated potential and the market view of the various stakeholders are consistent and indicate that roughly 30 – 35% of the FY2013 C&I Lighting inventory is left to convert to LEDs. This means that there is still substantial work to be done in transforming Maine's facilities to LED lighting.