Memo to:
Massachusetts Program Administrators
Massachusetts EEAC Consultants

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Massachusetts C&I Custom CDA Results Memo

This memo presents the results of the re-analysis of the 2018 Custom Comprehensive Design Approach (CDA) energy and peak demand savings realization rates using new standard lighting power densities (LPD) derived from the recent new construction baseline market characterization study. The analysis also includes adjustments for other non-lighting industry standard practice (ISP) impacts. The results from this study are expected to be applied retrospectively only to custom CDA projects completed in PY2020.

1 INTRODUCTION

Custom CDA is an energy efficiency track within the custom C&I New Construction energy efficiency programs offered in Massachusetts intended to encourage a comprehensive, integrated, whole-building approach. CDA projects are typically initiated at the beginning of the new building or at a major renovation design stage to yield cost-effective energy efficiency opportunities and significant energy use reductions relative to state building code and/or common practice. The most recent impact evaluation of this program track was completed in 2018 for the Massachusetts Program Administrators (PAs) under the guidance of the Massachusetts Energy Efficiency Advisory Council (EEAC) Consultants.[1] Among the results of this study was an electric annual energy savings realization rate of 57%.

A key driver of the low electric energy savings realization rate was the application of the lighting industry standard practice (ISP) from the MA code compliance study (P24)[2]. This study found that the standard practice for lighting in new buildings was 0.78 of allowable LPD under IECC 2009 code. The impact of this baseline change was a reduction in CDA electric program savings of approximately 20%. A secondary driver of the result was a 9% reduction in savings due to the application of an ISP baseline for fan coil units with EC motors. Since 2019, the PAs have been applying the MA Baseline Repository, which includes the fan coil unit ISP baseline.

2 METHODOLOGY

This study used the same sampled CDA projects as the 2018 study to recalculate electric savings realization rates . As noted above, the lighting ISP that was developed as part of the 2015 code compliance study was 0.78 of allowable LPD under IECC 2009 code. The prior impact evaluation sample consisted of buildings that were completed in 2014. For most projects in the impact evaluation sample, ex-ante baselines were defined in accordance with the 8th edition of the Massachusetts Energy Code,[3] which from August 2010 through July 2013 references IECC 2009 and ASHRAE 90.1 2007 with state-specific amendments, and from August 2013 through December 2014 references IECC 2012 and ASHRAE 90.1-2010 with state-specific amendments. Given the overlap between the research study time frames, the ex-post baselines in the prior impact evaluation used the 0.78 LPD adjustment to code.

In 2020, a new NRNC Market Characterization study was conducted to assess a new LPD adjustment factor based on buildings permitted under the IECC 2015 code, among other objectives. The finding from the NRNC study was that current lighting practice is 0.6 of IECC 2015 code. This analysis recalculated the custom electric CDA gross annual savings realization rate by applying the new LPD adjustment factor of 0.6 from the current NRNC project to the sample of sites from the prior impact evaluation. To do this, the team completed the following three steps:

[1] DNV GL, Massachusetts Commercial and Industrial Impact Evaluation of 2014 Custom CDA Installations, April 25, 2018. https://ma-eeac.org/wp-content/uploads/MA_CIEC_Stage5_Report_P56_Custom_CDA_Final-Report_180514.pdf

[2] Energy and Resource Solutions, Inc., P24 – Massachusetts Commercial New Construction Energy Code Compliance Follow-up Study, July 22, 2015

[3] http://www.mass.gov/eea/energy-utilities-clean-tech/energy-efficiency/policies-regs-for-ee/building-energy-codes.html

1. Converted site-level ex-ante LPDs from the 2018 impact evaluation study to equivalent values consistent with current program rules. The DNV team collected feedback from implementation engineering staff familiar with program requirements to fully understand the adjustments the program is already making to code for current ex-ante lighting baselines.
2. Converted site-level evaluation baseline LPDs from 2018 impact evaluation study using new LPD adjustment of 0.6 from NRNC study.
3. Recalculated the gross energy savings realization rate using adjusted LPD values calculated in 1 and 2 above.
4. Recalculated the gross summer and winter on-peak demand savings realization rates using the ratio of the new CDA energy savings realization rate from step 3 above to the 2018 CDA realization rate (57%).

Finally, the impact of the FCU ISP was removed from the CDA RRs following the LPD recalculation as this ISP has been incorporated into new projects through PA use of the MA Baseline Repository.

3 FINDINGS

3.1 Current CDA design requirements

DNV worked with PA engineering staff to first understand how the current program offering handles lighting baselines. For current CDA projects, as well as other performance lighting projects, the lighting baseline depends on the permitting code. For projects permitted under IECC 2015/ASHRAE 90.1-2013, the PAs use a baseline that is 0.8 of code LPD. For projects permitted under IECC 2018/ASHRAE 90.1-2016, the PAs use the Massachusetts Amendments to code. These requirements are documented each year in the MassSave Baseline Document. The MassSave Baseline Document also provides the tables of program allowable LPDs for both the Building Area Method and the Space-by-Space Method with the appropriate adjustments.

DNV also requested newer technical assistance (TA) studies from the PAs to attempt to verify the use of the adjusted LPDs noted above. We received a selection of TA studies from both Eversource and National Grid. A review of these TA studies found that the lighting baselines did reference the MassSave Baseline Document but some were applying a 10% reduction to IECC 2015 code LPDs and some used 20%, which is the current stated practice. It is unclear which version of the MassSave document was in place at the time these projects were permitted. It is possible that even though the PAs began using the 20% baseline adjustment in 2019, some of these projects were initiated prior to 2019 and may have used an older 10% adjustment.

For the purposes of this study, DNV used the 0.8 LPD adjustment to IECC 2015 to re-estimate tracking lighting baselines for the 2018 CDA sample of projects, since the NRNC study focused on this code year and the PAs stated that 0.8 LPD is the current practice for this code year.

3.2 Analysis

DNV used the sample of 11 CDA projects that were evaluated as part of the 2018 Custom CDA impact evaluation in this analysis. The original evaluation estimates produced in 2018 were done using eQuest building simulation modeling software. The evaluation baseline models assumed a 0.78 LPD adjustment to code, which at the time was either IECC 2009 or IECC 2012, depending on the permit year of each application. Energy and peak demand savings were estimated by computing the difference between the baseline model and as-found models, calibrated to energy bills. It is important to note that the CDA projects that were evaluated typically included other non-lighting measures as well. Fortunately, eQuest produces end-use-level energy consumption outputs that allow us to approximate the amount of the total project savings that represents lighting. Site-level tracking and evaluated savings from the original 2018 CDA impact evaluation, including the portion attributable to lighting, are shown in Table 3-1.

Table 3-1. 2018 CDA impact evaluation results

		Tracking IECC 2009/2012		Evaluation IECC 2009/2012 (w/ 0.78 LPD Adj.)		
Application ID	**Program Administrator**	**Annual Energy (kWh) Savings**	**Annual Lighting kWh Savings (approx.)**	**Annual Energy (kWh) Savings**	**Annual Lighting kWh Savings (approx.)**	**Realization Rate w/ LPD Adjustment (kWh)**
CS9571	Eversource	753,182	25,179	137,010	5,495	18%
3575485	National Grid	290,359	57,850	120,720	0	42%
2508881	National Grid	637,285	523,602	594,710	209,257	93%
NC140603	Eversource	217,550	123,090	279,041	190,379	128%
2508878	National Grid	3,934,277	1,659,084	1,074,107	753,807	27%
NC140292	Eversource	378,626	48,219	509,096	54,428	134%
NC140204	Eversource	42,373	19,562	80,790	8,158	191%
3549519	National Grid	1,319,740	790,935	80,742	91,436	6%
976238	National Grid	1,642,375	689,667	732,083	595,131	45%
3575521	National Grid	671,340	481,241	335,271	187,738	50%
NC140176	Eversource	1,138,303	183,455	523,252	17,980	46%
	Total kWh	11,025,410	4,601,884	4,466,821	2,113,808	41%
Total Weighted kWh and RR		26,353,809	9,225,576	14,905,484	5,105,511	57%

For this study, the original models were not re-run with the new baseline LPDs. Instead, we leveraged the prior results and the eQuest end-use-level outputs to recalculate lighting savings using the updated baseline LPDs. To re-estimate both tracking and evaluated savings, DNV reviewed each site to identify key parameters from the original CDA study for both tracking and the evaluation, including:

- Building type
- Building square footage
- Total site savings
- Lighting savings
- Baseline LPD
- Proposed/as-found LPD
- Lighting hours

Using these parameters, DNV was able to isolate and re-calculate revised tracking lighting estimates assuming the use of IECC 2015 and a 0.8 adjustment factor as described as current practice by the PAs. We also calculated revised evaluation lighting savings by applying the 0.6 adjustment factor to the evaluation lighting baseline as found by the

NRNC study. DNV also adjusted the proposed/as-built LPDs using the ratio of original base LPD to proposed/as-found LPD. This assumes some level of lighting design improvement since these projects were completed in 2013 or 2014. Table 3-2 provides an example of one site in the analysis, including the key savings parameters, which show how we arrived at the revised tracking and evaluated savings.

Table 3-2. Example calculation (site 3575521, school/university – 278,000 sq. ft.)

Site ID	Original Tracking	Original Evaluated	Revised Tracking	Revised Evaluated
Lighting Hours	3,266	2,568	3,266	2,568
Total Site Savings	671,340	335,271	381,006	171,857
Site RR		50%		45%
Code	IECC2009	IECC2009	IECC2015	IECC2015
Code LPD (W/SqFt)	1.2	1.2	0.9	0.9
Code Adjustment	None	0.78	0.80	0.60
Baseline LPD (W/SqFt)	1.20	0.94	0.70	0.52
Proposed/As-found LPD (W/SqFt)	0.67	0.67	0.49	0.49
LPD Savings	0.53	0.26	0.21	0.03
Lighting kW Savings	147	73	58	9
Lighting kWh Savings	481,241	187,738	190,907	24,324

3.3 Results

DNV completed a detailed analysis for each site in the sample using the same methods. Table 3-3 presents a summary of the site-level results. As shown in Table 3-3, the resulting program-level realization rate, which is the weighted result using the original sample design case weights, is 48% for annual electric energy savings. This is reduced from the 57% realization rate from the prior CDA impact evaluation. However, the removal of the FCU ISP baseline from the revised RR brings the result back to 57%.

Table 3-3. Revised CDA results

		Tracking IECC 2015 (w/ 0.8 LPD Adj.)		Evaluation IECC 2015 (w/ 0.6 LPD Adj.)		
Application ID	Program Administrator	Annual Energy (kWh) Savings	Annual Lighting kWh Savings (approx.)	Annual Energy (kWh) Savings	Annual Lighting kWh Savings (approx.)	Realization Rate w/ LPD Adjustment (kWh)
CS9571	Eversource	728,003	0	131,515	0	18%
3575485	National Grid	232,509	0	118,338	0	51%
2508881	National Grid	325,819	212,136	433,463	48,010	133%
NC140603	Eversource	262,358	167,898	142,500	53,944	54%
2508878	National Grid	2,806,679	531,486	320,300	0	11%
NC140292	Eversource	344,437	14,030	454,668	0	132%
NC140204	Eversource	22,811	0	72,632	0	318%
3549519	National Grid	1,245,362	716,560	-9,133	1,561	-1%
976238	National Grid	1,500,476	547,768	309,119	172,167	21%
3575521	National Grid	381,006	190,907	171,857	24,324	45%
NC140176	Eversource	957,028	2,180	472,908	0	49%
	Total kWh	8,806,488	2,382,965	2,618,167	300,006	30%
	Total Weighted kWh and RR with LPD adjustment	21,977,157	4,848,927	10,582,277	957,142	**48%**
				Updated kWh RR with FCU ISP Baseline removed		**57%**

Given the limitations of this analysis, summer and winter on-peak demand savings could not be calculated in the same manner as annual energy savings. However, we know that this difference in baseline LPD would impact the peak demand savings in the same direction as it did the annual energy savings since the overall potential for kW savings resulting from lighting has been reduced. Therefore, DNV applied the same ratio of annual energy savings realization rates between the old study and this study to re-calculate summer and winter on-peak demand savings. Table 3-4 presents the revised peak demand savings estimates after performing this adjustment.

Table 3-4. Updated summer and winter on-peak demand savings realization rates

	Summer On-Peak Demand Savings (kW)	Winter On-Peak Demand Savings (kW)
2018 CDA Study	57%	43%
RR Adjustment (57.3%/57.2%)	101%	101%

	Summer On-Peak Demand Savings (kW)	Winter On-Peak Demand Savings (kW)
Revised RR	58%	44%

4 CONCLUSIONS AND RECOMMENDATIONS

This study found that lighting savings were significantly impacted because of the use of the new LPD adjustment factor and by the appropriate application of current baseline practices to the older CDA study results. As shown in Table 3-1 and Table 3-3, the opportunity for lighting savings given these new requirements has decreased. In the original study, lighting savings accounted for approximately 35% of total weighted CDA savings. The application of the PA stated baseline of 0.8 of IECC 2015 resulted in revised tracking estimates of which lighting only makes up 22% of total weighted CDA savings. Lastly, the application of the evaluation baseline of 0.6 of IECC 2015 only produced 20% of the new tracking lighting savings. In total, only 5 of the 11 sites in the sample still had some lighting savings following this analysis.

Recommendation 1. Use RRs from this study to apply retrospectively to CDA projects completed in 2020:

- Gross annual electric kWh savings RR: 57%
- Gross summer on-peak kW reduction RR: 58%
- Gross winter on-peak kW reduction RR: 44%

Recommendation 2. Lighting baselines for new CDA studies should adopt the new LPD adjustment of 0.6 of IECC 2015 code. The immediate application of this baseline finding to projects starting in 2021 would reduce potential lighting savings relative to the current practice of using IECC with MA Amendments but would also limit the risk of lower CDA realization rates in the future.

Recommendation 3. Upon finalization of the NRNC study, incorporate any other non-lighting baseline findings to new construction projects going forward. Further, real-time and continuous application of new baseline findings would limit the risk of lower CDA realization rates in the future.

Consideration 1. Consider a follow-up CDA impact evaluation for prospective use following implementation of any new measure baselines. A follow-up study could include a standalone impact evaluation with full M&V, incorporation of CDA into the current custom rolling impact evaluation framework, or a desk review assessment of measure baselines and application of historical operation adjustments. A decision on the scope and rigor would include several factors such as the number of CDA projects and their savings magnitude, timing and type of changes made to the program, and cost.