Memo to: Electric PAs and EEAC Consultants **From:** Chad Telarico, Chris Dyson, and Jessi Taffel, DNV GL

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MA C&I UPSTREAM LIGHTING IN-SERVICE RATE (ISR) ANALYSIS SUMMARY

This memorandum summarizes the recommendations and considerations from the In-Service Rate (ISR) Analysis. This analysis was part of Project 81: Process Evaluation and Site Visits for the C&I Upstream Lighting Initiative. DNV GL conducted this analysis following the most recent (PY2015) impact evaluation[1] since the electric Program Administrators (PAs) have recently (2016-2018) have been making improvements to the Initiative. The objective of the ISR analysis was to calculate installation rate alternatives from the prior impact evaluation for use by the PAs in the 2019-2021 Three Year Plan. The ISR analysis reviewed both QC contractor[2] inspection data and evaluation on-site data as discussed below. In June and July 2018, DNV GL completed 23[3] site visits to 2018 Q1 Initiative participants as part of this effort.

ISR Analysis Recommendations

Use the revised lighting installation rate of 76.2% and savings factors presented in this memo for 2019-2021 Three Year Planning. DNV GL analyzed PY2015 and 2018 Q1 QC contractor inspection data received in 2018 for this ISR analysis. The DNV GL team conducted site visits from July 2016 to May 2017 visiting PY2015 participants as part of the PY2015 impact evaluation; and in June and July 2018 visited 2018 Q1 Initiative participants as part of this ISR analysis. All calculated in-service rates are included in the full report, which is being finalized in the Fall of 2018. Table 1. Proposed new energy savings factors for three-year planning includes the final agreed upon result (76%) to be used by the PAs in their three-year planning, this represents an increase from the overall PY2015 installation rate (65%). Recommended savings factors to be used in three-year planning are shown in Table 1 - Table 7.

Build upon the initial July 2018 site visits with "rolling" data collection. The site visits and calculated rates completed as part of the ISR analysis were used in consensus group discussion with the PAs and EEAC Consultants to provide early insight into the effectiveness of Initiative changes made in 2016 and 2017, as well as contribute to an overall installation rate assumption (76%) to be used by the PAs in their 2019-2021 Three-Year Plan. The next phase of the study will involve "rolling" data collection, so that the PAs can replace prospective (PY2018 and beyond) results recommended as part of the PY2015 impact evaluation to reflect Initiative changes made since the PY2015 impact evaluation.

ISR Analysis Consideration

Target a more representative sample of sites for QC inspection. The distribution of QC sites by measure category makes it difficult to use current QC results along with some adjustment to represent the population. The PAs could consider potential changes to QC site selection (i.e., stratify by measure category in addition to size). Also, the PAs could consider requiring the QC contractor to visit sites from each distributor monthly, which is the protocol mentioned in Initiative's Distributor Handbook.

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[1] DNV GL. *Impact Evaluation of PY2015 Massachusetts Commercial and Industrial Upstream Lighting Initiative (P58)* Final Report. Massachusetts Program Administrators and Energy Efficiency Advisory Council, 2017. PY2015 site visits had an overall installation rate of 65 percent for all measure categories.

[2] The contractor retained by the electric PAs to perform inspections of incentivized products as part of the Quality Assurance (QA) and Quality Control (QC) plan.

[3] The number of cases was constrained by time, a target of 25 sites was planned in order to have results ready in time for the 2019-2021 Three-Year Plan.

List of tables

Table 1. Proposed new energy savings factors for three-year planning

Product type	Category	Installation Rate	kW Saved per Unit	HOU	HVAC Interactive Effect (kWh)	Annual Savings per Unit (kWh)
G24 LED	5	76%	0.0153	5,673	102%	68
A-line, 40/60w	4	76%	0.0217	2,400	103%	41
A-line, 75/100w	4	76%	0.0305	2,400	103%	58
Decoratives	4	76%	0.0136	2,400	103%	26
LED Retrofit kit, <25W	3	76%	0.0384	3,281	103%	99
LED Retrofit kit, >25W	3	76%	0.0566	3,281	103%	146
MR16	3	76%	0.0221	3,281	103%	57
PAR20	3	76%	0.0281	3,281	103%	73
PAR30	3	76%	0.0381	3,281	103%	99
PAR38	3	76%	0.0442	3,281	103%	114
Stairwell Kit, 2ft w/sensor	2	76%	0.0413	7,633	100%	240
Stairwell Kit, 4ft w/sensor	2	76%	0.0356	7,633	100%	207
TLED, 2ft	1	76%	0.0069	4,426	102%	24
TLED, 4ft	1	76%	0.0138	4,426	102%	47

Table 2. Summary of category 1 savings factors for three-year planning

Savings Parameter	Category 1		
	Value	Precision at 90% Confidence	Precision at 80% Confidence
Installation Rate (Quantity Adjustment - kW) - with in-storage adj	76.2%	±24.6%	±18.9%
Delta Watts (Technology Adjustment - kW)	161.6%	±9.5%	±7.4%
Connected kW Realization Rate	123.1%	-	-
Hours of Use estimate	4,426	-	-
Summer Coincidence Factor			
On Peak Hours	72.1%	±14.3%	±11.1%
Winter Coincidence Factor			
On Peak Hours	65.9%	±16.9%	±13.1%
Summer kW HVAC Interactive Effect			
On Peak Hours	115.4%	±4.8%	±3.7%
Winter kW HVAC Interactive Effect			
On Peak Hours	98.9%	±1.9%	±1.5%
kWh Factors			
kWh HVAC Interactive Effect	101.9%	±1.2%	±1.0%
Hours of Use Realization Rate	129.8%	±21.0%	±16.4%
% On Peak kWh	77.9%	±5.2%	±4.1%
Non-Electric			

Savings Parameter	Category 1		
	Value	Precision at 90% Confidence	Precision at 80% Confidence
Heating HVAC Interaction Effect (MMBtu/kWh)	-0.000162279		

Table 3. Summary of category 2 savings factors for three-year planning

Savings Parameter	Category 2		
	Value	Precision at 90% Confidence	Precision at 80% Confidence
Installation Rate (Quantity Adjustment - kW) - with in-storage adj	76.2%	±24.6%	±18.9%
Delta Watts (Technology Adjustment - kW)	77.3%	±11.9%	±9.3%
Connected kW Realization Rate	58.9%	-	-
Hours of Use estimate	7,633	-	-
Summer Coincidence Factor			
On Peak Hours	81.0%	±9.7%	±7.5%
Winter Coincidence Factor			
On Peak Hours	82.3%	±9.9%	±7.7%
Summer kW HVAC Interactive Effect			
On Peak Hours	101.6%	±1.6%	±1.2%
Winter kW HVAC Interactive Effect			
On Peak Hours	100.0%	±0.0%	±0.0%
kWh Factors			
kWh HVAC Interactive Effect	100.0%	±0.0%	±0.0%
Hours of Use Realization Rate	87.1%	±9.2%	±7.2%
% On Peak kWh	64.0%	±1.6%	±1.3%
Non-Electric			
Heating HVAC Interaction Effect (MMBtu/kWh)	0.0000000000		

Table 4. Summary of category 3 savings factors for three-year planning

Savings Parameter	Category 3		
	Value	Precision at 90% Confidence	Precision at 80% Confidence
Installation Rate (Quantity Adjustment - kW) - with in-storage adj	76.2%	±24.6%	±18.9%
Delta Watts (Technology Adjustment - kW)	94.4%	±10.6%	±8.3%
Connected kW Realization Rate	71.9%	-	-
Hours of Use estimate	3,281	-	-
Summer Coincidence Factor			
On Peak Hours	66.2%	±14.7%	±11.5%
Winter Coincidence Factor			
On Peak Hours	56.4%	±17.5%	±13.6%
Summer kW HVAC Interactive Effect			
On Peak Hours	120.9%	±2.5%	±1.9%
Winter kW HVAC Interactive Effect			
On Peak Hours	91.9%	±6.7%	±5.2%
kWh Factors			
kWh HVAC Interactive Effect	103.5%	±2.2%	±1.7%
Hours of Use Realization Rate	84.1%	±19.5%	±15.2%
% On Peak kWh	84.4%	±7.0%	±5.4%
Non-Electric			
Heating HVAC Interaction Effect (MMBtu/kWh)		-0.0005049520	

Table 5. Summary of category 4 savings factors for three-year planning

Savings Parameter	Category 4		
	Value	Precision at 90% Confidence	Precision at 80% Confidence
Installation Rate (Quantity Adjustment - kW) - with in-storage adj	76.2%	±24.6%	±18.9%
Delta Watts (Technology Adjustment - kW)	64.8%	±18.6%	±14.5%
Connected kW Realization Rate	49.3%	-	-
Hours of Use estimate	2,400	-	-
Summer Coincidence Factor			
On Peak Hours	37.5%	±22.0%	±17.1%
Winter Coincidence Factor			
On Peak Hours	31.5%	±25.6%	±19.9%
Summer kW HVAC Interactive Effect			
On Peak Hours	118.7%	±2.4%	±1.9%

Savings Parameter	Category 4		
	Value	Precision at 90% Confidence	Precision at 80% Confidence
Winter kW HVAC Interactive Effect			
On Peak Hours	92.0%	±5.5%	±4.3%
kWh Factors			
kWh HVAC Interactive Effect	103.1%	±1.5%	±1.1%
Hours of Use Realization Rate	61.5%	±22.1%	±17.2%
% On Peak kWh	79.0%	±7.1%	±5.5%
Non-Electric			
Heating HVAC Interaction Effect (MMBtu/kWh)		-0.0000682070	

Table 6. Summary of category 5 savings factors for three-year planning

Savings Parameter	Category 5		
	Value	Precision at 90% Confidence	Precision at 80% Confidence
Installation Rate (Quantity Adjustment - kW) - with in-storage adj	76.2%	±24.6%	±18.9%
Delta Watts (Technology Adjustment - kW)	119.5%	±6.0%	±4.7%
Connected kW Realization Rate	91.0%	-	-
Hours of Use estimate	5,673	-	-
Summer Coincidence Factor			
On Peak Hours	81.5%	±6.4%	±5.0%
Winter Coincidence Factor			
On Peak Hours	80.9%	±5.8%	±4.6%
Summer kW HVAC Interactive Effect			
On Peak Hours	112.9%	±1.8%	±1.4%
Winter kW HVAC Interactive Effect			
On Peak Hours	100.0%	±0.0%	±0.0%
kWh Factors			
kWh HVAC Interactive Effect	102.3%	±1.3%	±1.0%
Hours of Use Realization Rate	145.4%	±9.1%	±7.1%
% On Peak kWh	73.7%	±3.7%	±2.9%
Non-Electric			
Heating HVAC Interaction Effect (MMBtu/kWh)		-0.0006027575	

Table 7. Summary of combined category 3, 4, and 5 savings factors for planning

Savings Parameter	Categories 3,4,5		
	Value	Precision at 90% Confidence	Precision at 80% Confidence
Installation Rate (Quantity Adjustment - kW) - with in-storage adj	76.2%	±24.6%	±18.9%
Delta Watts (Technology Adjustment - kW)	84.7%	±9.1%	±7.1%
Connected kW Realization Rate	64.5%	-	-
Hours of Use estimate	3,394	-	-
Summer Coincidence Factor			
On Peak Hours	59.0%	±11.1%	±8.7%
Winter Coincidence Factor			
On Peak Hours	52.1%	±12.8%	±10.0%
Summer kW HVAC Interactive Effect			
On Peak Hours	118.5%	±1.6%	±1.3%
Winter kW HVAC Interactive Effect			
On Peak Hours	94.1%	±3.6%	±2.8%
kWh Factors			
kWh HVAC Interactive Effect	103.1%	±1.2%	±0.9%
Hours of Use Realization Rate	87.0%	±12.4%	±9.7%
% On Peak kWh	80.0%	±3.9%	±3.0%
Non-Electric			
Heating HVAC Interaction Effect (MMBtu/kWh)	-0.0003286551		