



## Delta Watt Update (MA19R09-E)

Final

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SUBMITTED TO:

Massachusetts Electric Program Administrators and  
Energy Efficiency Advisory Council Consultants

SUBMITTED BY:

NMR Group, Inc.

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## Executive Summary

This evaluation was conducted on behalf of the Massachusetts Program Administrators (PAs) to update some of the inputs used to calculate LED delta watts in the RLPNC 17-6 Lighting Market Adoption Models (MAMs). The equivalent wattage of bulbs with similar lumen output and the sales weights based on program tracking data tie delta watts directly to program sales. The PAs and EEAC Consultants updated these equivalent wattage bins and sales weights in 2018, and this study repeats that process for data covering January through October of 2019. They study also updates delta watts for linear fixtures sold through the program over the same time period.

Implementation Contractor TRC provided these data, which TRC had obtained from EFI, the fulfillment contractor. However, the 2018 update and this current 2019 update retain the estimated future market share values for screw-based bulbs from the 2017 MAMs (RLPNC 17-6). The decision to keep the same future market share estimates reflected the continued market uncertainty related to federal standards, which existed when the estimates were developed in 2017. Although the nature of the uncertainty has changed, the future of LED market share still remains subject to debate. For this reason, the PAs and EEAC consultants agreed not to update the market share within the MAMs for 2019, but they have used the MAM as a tool to explore assumptions about changing market share on lighting impact factors in efforts external to this delta watts update.

## METHODS

NMR reviewed and cleaned the partial 2019 upstream program sales data obtained from EFI. In total, the data contained sales records for 10,811,487 LEDs. After cleaning, NMR grouped LEDs into three types: General Service (GSL) (63%), reflector (23%), and specialty (14%). As the EFI data do not include equivalent incandescent wattage, after categorizing LEDs by type, NMR leveraged web scraping and shelf stocking data from Massachusetts and Rhode Island to look up manufacturer-specified equivalent incandescent wattage. A statistical model provided predictions of halogen reflector and specialty equivalents, as the variety of bulbs among these shapes do not lend themselves to simple rules of thumb about wattage equivalence. The resulting equivalent incandescent wattages across all bulb shapes and technologies were used to assign LEDs to the appropriate 2017 MAM equivalent wattage bins. After binning LEDs, we updated sales weights, which are equivalent to the proportions of 2019 program-supported bulbs in each wattage bin.

NMR also expanded on a previous planning effort to estimate delta watts for tubular (linear) LEDs.<sup>1</sup> However, the tracking data indicated that the program only sold linear fixtures between January through October of 2019. The 350,925 fixtures collectively contained 536,086 lamps, which NMR binned by length (24", 36", 48" 96"). Using the planning assumptions for binned delta

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<sup>1</sup> NMR Group., Inc. 2018. *Memorandum: RLPNC 18-7: TLED Product Impact Factor Estimation*. Delivered to the Massachusetts Program Administrators and Energy Efficiency Advisory Council Consultants on August 3, 2018.

watts for T8 linear lamps with a ballast bypass (the most comparable to the linear fixtures sold through the program), NMR produced sales weighted estimates of delta watts for 2019.

## FINDINGS

Updating the wattage by bulb type and upstream sales share based on actual 2019 LED sales resulted in increased delta watts for GSL and decreased delta watts for reflectors and specialties (Table 1). These changes are based on differences in the lumen output of bulbs purchased through the program in 2019 versus 2018 as well as improved prediction of reflector and specialty halogen wattage equivalence. Generally, relative to 2018, through the upstream program, consumers purchased a higher proportion of high equivalent wattage LEDs in the GSL categories, moderate equivalent wattage LEDs in the reflector category, and lower equivalent wattage LEDs in the specialty category (Table 3 in the body of this report). Net delta watts are presented in Table 8 and direct install delta watts in Table 9 in the body of this report. Table 2 presents the updated delta watts for linear fixtures.

**Table 1: MAM Upstream Gross Delta Watt Comparison 2017 – 2019**

Bulb Type and MAM Year	Delta Watts <sup>1</sup>						
	2019	2020	2021	2022	2023	2024	2025
GSL 2017	33	34	34	34	34	34	35
GSL 2018	36	38	38	38	38	38	38
GSL 2019	38	38	40	40	40	40	40
Reflector 2017	46	46	47	47	47	47	47
Reflector 2018	45	45	46	46	46	46	46
Reflector 2019	43	43	43	43	44	44	44
Specialty 2017	37	37	38	39	39	40	40
Specialty 2018	40	41	41	42	42	42	43
Specialty 2019	34	34	35	35	36	36	36

<sup>1</sup> Note: All values rounded to nearest watt. Values are not rounded in the attached MAM Excel files.

**Table 2: Linear Fixture Weighted Average Delta Watts**

Length	Output	Ballast	Planning Delta Watts	2019 Sales
24"	Standard	Bypass	7.4	13,385
36"	Standard	Bypass	13.6	19,828
48"	Standard	Bypass	19.7	529,839
96"	Standard	Bypass	26.4	34
Total Sales				563,086
<b>T8 Weighted Average Delta Watts</b>			<b>17.9</b>	<b>19.2</b>

**RECOMMENDATIONS**

This study does not make any recommendations, nor does it provide considerations or guidance.

## Section 1 Introduction

This evaluation was developed for the Massachusetts Program Administrators (PAs) to update the inputs used to calculate LED delta watts in the RLPNC 17-6 Lighting Market Adoption Models (MAMs). The study also provides updated delta watts for linear fixtures sold through the program in 2019.

For the 2019 Annual Report, the PAs and EEAC consultants agreed to pursue a partial update to the MAM, focusing on updating equivalent wattage and sales weights based on 2019 upstream program tracking data, which ties the delta watts directly to program sales, while keeping the market share values from the 2017 MAMs (RLPNC 17-6).<sup>2,3</sup> Due to difficulties stemming from an update to their data tracking systems, the fulfillment contractor EFI was unable to provide program tracking data to NMR Group, Inc. (NMR), the evaluation contractor, in time for meeting the PAs' annual reporting deadlines. Instead, NMR relied on data spanning January to October of 2019 provided by TRC, the implementation contractor. These data originated with EFI.<sup>4</sup>

The MAM nomenclature and timing are as follows. In Q1 of a given year, evaluation produces annual report MAMs that calculate delta watts based on the most recently completed program year. Thus, in Q1 2017 we delivered the 2016 Annual Report MAMs and in Q1 2018, we delivered the 2017 Annual Report MAMs. Historically, NMR would produce a special MAM for three-year planning, but recent changes to the MAM inputs and structure mean that the 2017 Annual Report MAMs also doubled as the 2019 to 2021 three-year planning MAMs. This evaluation provides the results of updates to some of the 2017 Annual Report MAM inputs (wattage bins and sales weights), producing new delta watt values that could inform the 2019 Annual Report, dependent on PA and EEAC consultant decisions about their usage. We suggest referring to this study's deliverables as the 2019 Annual Report Partial MAMs to avoid any future confusion with the 2017 Annual Report MAMs and the 2018 Annual Report Partial MAMs or giving the impression that this effort represents fully updated MAMs.

The PAs also asked NMR to update delta watts for tubular LEDs (TLEDs), using the planning assumptions developed in study *RLPNC 18-7: TLED Product Impact Factor Estimation* as a guide.<sup>5</sup> According to the program data, the PAs sold linear fixtures in 2019. Linear fixtures are

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<sup>2</sup> To fully update a MAM, the PAs have typically used market share estimates from supplier interviews, sales data analysis, and on-site saturation data and supplemented them with up-to-date market intelligence. The evaluation contractor then facilitated an iterative process in which the PAs, EEAC Consultants, and evaluators reviewed the available information, submitted market share predictions through 2025, discussed them, and then revised the estimates. The final market share predictions included in the MAM reflected the equally weighted market shares of each of the three groups. The PAs decided against the iterative market share prediction process, given the continued market uncertainty and substantial efforts involved in annual reporting in 2016 and annual reporting and three-year planning in 2017.

<sup>3</sup> NMR Group., Inc. 2018. *RLPNC 17-6 Market Adoption Model Findings*. [http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC\\_176\\_MAMMEMO\\_24APR2018.pdf](http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_176_MAMMEMO_24APR2018.pdf)

<sup>4</sup> DNV-GL, the Data Management Consultant, continues to work with EFI to resolve persistent shortcomings of the current data tracking systems for upstream lighting and other programs and products.

<sup>5</sup> NMR Group., Inc. 2018. *RLPNC 18-7*.

most similar to TLEDs using ballast bypass (as opposed to plug and play models).<sup>6</sup> Therefore, NMR used the delta watts assumptions for ballast bypass TLEDs, weighting by sales by tube length and the number of lamps built into the fixture (many fixtures had two or more tubes).

## 1.1 METHODS

To update the program sales weights and lumen bins for screw-based bulbs, NMR reviewed and cleaned the January to October 2019 upstream sales data obtained from TRC, which originated with EFI. As these data did not include equivalent incandescent wattages, after categorizing LEDs by bulb shape, NMR leveraged web scraping and shelf stocking data (collected by TRC in Massachusetts and Rhode Island) to look up manufacturer-specified equivalent incandescent wattages. We additionally created a regression model to predict equivalent wattages for reflector and specialty halogens, as the diversity of sizes and shapes among these bulb shapes preclude the use of simple rules of thumb about wattage equivalence by lumen bins. In total, we were able to assign equivalent incandescent wattages for 85% of total LEDs sold in 2019. These equivalent incandescent wattages were used to assign LEDs to the appropriate 2017 MAM equivalent wattage bins. After binning LEDs, we updated sales weights, which are equivalent to the proportions of 2019 program-supported bulbs in each wattage bin.

For linear fixtures, NMR updated the planning delta watts based on program sales data provided by TRC described above. In updating the delta watts, NMR made the following decisions:

- Most fixtures held lamps that fit into the 24-, 36-, 48-, and 96-inch binning scheme used in the RLPNC 18-7 memo, but a few fell between 36 and 48 inches. We binned lengths 37 to 42 inches as 36 inches and those 43 to 47 inches as 48 inches.
- Some of the fixtures comprise two or more linear tubes. Although the original memo assumed replacement of individual TLEDs, NMR accounted for the full number of bulbs in the fixtures when estimating sales by length-bin.
- The information available on each fixture was not sufficient to determine whether the bulb was more similar to a T5, T8, or fully integrated LED. We assumed T8s for this effort.

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<sup>6</sup> For fixtures, the PAs use the lighting impact factors for the most similar LED bulb type.

## Section 2 Updates to 2017 MAM and Linear Fixtures

In this section, we discuss the updates that were made to the 2017 MAMs based on a review of the 2019 sales data. The impact of adjusting sales shares and wattage equivalence was to increase 2019 GSL delta watts over both the original 2017 MAM estimates as well the 2018 updates, but decrease the delta watts for reflectors and specialty bulbs.

	<b>GSL</b>	<b>Reflector</b>	<b>Specialty</b>
• Gross delta watts	<b>Increased 6</b>	<b>Decreased 7</b>	<b>Decreased 7</b>
• Net delta watts	<b>Increased 6</b>	<b>Decreased 7</b>	<b>Decreased 7</b>

### 2.1 UPDATED SALES SHARES

Table 3 provides a comparison of the upstream program sales weights (proportion of LEDs sold) in 2017 and 2019. Based on our analysis, program sales gravitated toward higher wattage GSLs, moderate wattage reflectors, and lower wattage specialties in 2019 compared to 2018. This may reflect shifts in program emphasis stemming from the start of the 2019 to 2021 program cycle that de-emphasize 60W GSLs. Table 4 shows the breakdown of linear program sales by the number of bulbs contained within the fixture; 48-inch bulbs made up 94% of sales while 36-inch bulbs made up 4%, 24-inch 2%.

**Table 3: Program Sales by MAM Wattage Bins 2017 – 2019**

Equivalent Wattage Category	2017	2018	2019	Change since 2018
<b>General Service LEDs (GSL)</b>				
100 W	1%	11%	21%	+10%
75 W	4%	4%	10%	+6
60W	78%	76%	57%	-19%
40W	17%	9%	12%	+3%
<b>Reflectors</b>				
125 W	8%	7%	6%	-1%
65 W	86%	72%	83%	+11%
45 W	6%	21%	11%	-10%
<b>Specialty</b>				
75 W	1%	17%	6%	-11%
60 W	33%	24%	26%	+2%
40 W	66%	59%	68%	+9%



**Table 4: T8 Program Sales by Length and Number of Bulbs in Fixture**

Inches	Bulbs	Total	% of Sales
24"	1	6,541	2%
	2	6,844	
36"	2	19,828	4%
48"	1	129,489	94%
	2	393,566	
	4	6,784	
96"	2	34	0%
Total		563,086	100%

## 2.2 UPDATED WATTAGE BIN BY TYPE

Table 5 provides an overview of the lumens included in the incandescent wattage equivalence for each technology. The overlap in lumens covered by the 45W and 65W reflector wattage bins results from the numerous sizes and styles of reflectors, which lead to variations in the lumens per watt for this category. Note that NMR did not update wattage bins for linear fixtures, but used the assumed wattages as listed in the *RLPNC 18-7* memo.

**Table 5: Lumen Range for Each Wattage Equivalence Category**

Wattage Category	Minimum Lumens	Mean Lumens	Max Lumens
<b>General Service LEDs (GSL)</b>			
100 W	1600	1608	2000
75 W	1100	1108	1150
60 W	800	803	910
40 W	450	464	620
<b>Reflectors</b>			
125 W	1000	1279	3000
65 W	385	772	1350
45 W	250	472	1000
<b>Specialty</b>			
75 W	120	306	500
60 W	500	503	800
40 W	800	1641	2200

Table 6 maps out the average wattage for each bulb type by lumen bin. For LEDs, we used the observed average wattage. For halogens, we matched to available products with the same equivalent wattages and lumen outputs, by type, found in web scraping and shelf stocking data—identifying halogen or incandescent bulbs by lumen-class bin for each of the LEDs sold. Additionally, for reflectors and specialty lamps, we created a regression model to predict the halogen equivalence due to the diversity of product sizes and shapes for these bulb types. For GSL LEDs, we have assumed an increase in efficiency in 2020, which yields two estimates. The 2018-19 GSL LED values are based on the average wattage observed in the 2018 sales data, and the 2020-2025 values assume a decrease in LED wattage. Finally, we did not update CFL wattages this year due to their anticipate small market share, which means they have almost no impact on delta watts.

The table identifies wattages that were changed from 2018 as **white text with green background**. Wattages of GSL and reflector LEDs nudged upwards slightly across categories, while halogen reflectors and specialties saw mixed changes from 2018, largely stemming from what NMR believes is an improved predictive model drawing on a larger number of bulbs used to predict wattage equivalence in 2019 compared to 2018.

Table 6: Updated MAM Wattage by Bulb Type, 2017 to 2019

Equivalent Incand. Wattage Category	LEDs			CFLs <sup>2</sup>			Halogen <sup>3</sup>			Incand <sup>3</sup>		
	2017	2018	2019	2017	2018	2019	2017	2018	2019	2017	2018	2019
General Service LEDs (GSL)												
100 W	15	16	17	23	23	23	72				100	
	13	14	15									
75 W	10	11	13	18	20	20	53				75	
	9	10	11									
60 W	9	9	9	13	14	14	43				60	
	8	8	8									
40 W	6	6	6	9	11	11	29				40	
	5	5	5									
Reflectors												
125 W	13	16	18	19	23	23	56	64	92		125	
65 W	10	10	13	15	15	15	55	55	53		65	
45 W	5	6	8	11	11	11	20	41	36		45	
Specialty												
75 W	10	16	16	14	26	26	43	88	78	75	100	100
60 W	6	5	5	9	10	10	51	40	43	60	60	60
40 W	4	4	4	7	6	6	39	32	26	39	39	39

<sup>1</sup> Multiple values for GSL LEDs reflect assumed greater efficiency in 2020-2025

<sup>2</sup> Did not update CFL wattage due to small anticipated market share

<sup>3</sup> Retained industry accepted GSL wattage equivalents for halogen and incandescent, and for incandescent reflectors, which is consistent with practice in prior years

## 2.3 UPDATED SALES SHARE AND WATTAGE

NMR applied the changes in sales shares and wattage equivalence to the 2017 MAM spreadsheets and market shares to update the delta watts. Gross delta watts (Table 7) for GSL increased, while delta watts for reflectors and specialty decreased relative to 2018. This stems largely from the changes in wattage equivalence for reflectors, but also somewhat for LEDs. Table 8 and Table 9 summarize to upstream net delta watts and to direct install delta watts. These follow similar patterns to upstream gross delta watts.

Table 10 details the calculation of updated linear fixtures delta watts. The average weighted delta watts of 19.2 based on 2019 sales, an increase from the planning assumption of 17.9. This increase reflects the fact that 94% of program sales fall into the 48-inch bin, which has an assumed delta watts of 19.7 per lamp.

**Table 7: MAM Gross Delta Watt Comparison 2017 – 2019**

Bulb Type and MAM Year	Delta Watts <sup>1</sup>						
	2019	2020	2021	2022	2023	2024	2025
GSL 2017	33	34	34	34	34	34	35
GSL 2018	36	38	38	38	38	38	38
GSL 2019	38	38	40	40	40	40	40
Reflector 2017	46	46	47	47	47	47	47
Reflector 2018	45	45	46	46	46	46	46
Reflector 2019	43	43	43	43	44	44	44
Specialty 2017	37	37	38	39	39	40	40
Specialty 2018	40	41	41	42	42	42	43
Specialty 2019	34	34	35	35	36	36	36

<sup>1</sup> Note: All values rounded to nearest watt. Values are not rounded in the attached MAM Excel files.

**Table 8: MAM Net Delta Watt Comparison 2017 – 2019**

Bulb Type and MAM Year	Delta Watts						
	2019	2020	2021	2022	2023	2024	2025
GSL 2017	19	18	17	15	13	11	9
GSL 2018	21	20	18	16	14	12	10
GSL 2019	22	21	19	17	15	13	10
Reflector 2017	30	29	27	25	23	21	18
Reflector 2018	27	26	25	23	21	19	17
Reflector 2019	26	25	24	22	20	18	16
Specialty 2017	25	24	23	22	20	18	16
Specialty 2018	27	26	25	23	22	20	17
Specialty 2019	23	22	21	20	18	16	14

<sup>1</sup> Note: All values rounded to nearest watt. Values are not rounded in the attached MAM Excel files.

Table 9: MAM Direct Install Delta Watt Comparison 2017 – 2019

Bulb Type and MAM Year	Delta Watts						
	2019	2020	2021	2022	2023	2024	2025
GSL 2017	38	38	38	37	37	37	37
GSL 2018	41	41	41	41	40	40	40
GSL 2019	43	44	43	43	43	42	43
Reflector 2017	52	52	51	51	51	51	51
Reflector 2018	48	47	47	47	47	47	47
Reflector 2019	45	45	45	45	45	45	45
Specialty 2017	40	40	40	40	40	40	40
Specialty 2018	43	43	43	43	43	43	43
Specialty 2019	36	36	37	37	36	36	36

<sup>1</sup> Note: All values rounded to nearest watt. Values are not rounded in the attached MAM Excel files.

Table 10: Linear Fixture Weighted Average Delta Watts

Length	Output	Ballast	Planning Delta Watts	2019 Sales
24"	Standard	Bypass	7.4	13,385
36"	Standard	Bypass	13.6	19,828
48"	Standard	Bypass	19.7	529,839
96"	Standard	Bypass	26.4	34
Total Sales				563,086
<b>T8 Weighted Average Delta Watts</b>			<b>17.9</b>	<b>19.2</b>