

MEMORANDUM

To: Massachusetts Energy Efficiency Program Administrators

From: NMR Group, Inc.

Date: March 30, 2018

Re: MA RLPNC 16-6: Web Scraping Results June 2016 – November 2017

This memo is the final update to MA RLPNC 16-6: Lighting Shelf Stocking report. The purpose of this memo is to provide updated information on web scraping results for average bulb pricing, pricing trends over time, product turnover, and ENERGY STAR® product availability. This memo utilizes data collected from June 2016 to November 2017. It is important to remember when looking at web scraping pricing data that we are observing pricing for products *available* for sale – it does not reflect which products customers actual purchase. In addition, we know from past studies that there are differences in pricing and availability of products online compared to in-store.¹

For this study, NMR collected location-specific data from the websites of two major home improvement retailers in Massachusetts and Upstate New York. We present the data from each retailer separately throughout the memo. Based on conversations with each of the retailers regarding their online data, we believe the data from Retailer 1 is more indicative of changes in market prices due to two key reasons:

- **Inclusion of program incentives.** Based on the web scraping data, as well as conversations with representatives from Retailer 1, we believe online prices for Retailer 1 more accurately reflected incentives in Massachusetts. This was due to a decision by the retailer to ensure that online prices match in-store prices (including any energy efficiency program incentives). The web scraping data as well as conversations with representatives from Retailer 2 confirmed that online prices were less reflective of program incentives and in-store prices.
- **Stability of category offerings.** Based on conversations with representatives from Retailer 2, we know that during the period studied, Retailer 2 instituted a complete reorganization of their lighting products and implemented a number of changes in the lighting products offered both online and in-stores. Changes included dramatically reducing the number of products offered, reducing the number of manufacturers represented in their store, and changing their primary lighting supplier. These changes have led to more dramatic changes in the prices observed through web

¹ As part of the [RLPNC 16-6 Shelf Stocking Study](#), we compared physical in-store shelf-stocking visits and web scraping at a subset of the stores visited. We found strong correspondence between online and in-store offerings at Retailer 1 and greater variation in online and in-store product ranges for Retailer 2. In addition, we noted that rebates were not consistently incorporated into online pricing.

scraping and may not reflect broader changes in the overall marketplace. Retailer 1 did not go through the same changes during this period and the data revealed less dramatic changes.

Key Findings:

- **LED prices were approaching halogen prices for A-line and reflector/flood bulb types, but remained the more expensive option by high margins in the candle and globe categories.** In November 2017, the average LED A-line was \$2-\$4 more expensive than an incandescent or halogen A-line. LED reflectors were observed to be \$4-\$6 more expensive than incandescent reflectors and \$1-\$5 more expensive than the average halogen reflector (Table 5 and Table 6). It should be noted that these findings reflect pricing and availability at two retailers in one channel (home improvement) and are not sales-weighted.
- **The average cost of standard A-line and reflector/flood LEDs offered for sale at two major home improvement retailers fell between June 2016 and 2017.** The average price of standard A-line decreased 25% over a sixteen-month period and the average price of a reflector LED decreased 16-18%, with trends and prices varying by retailer (Table 5 and Table 6).² While the cost of LED specialty lamps (including candle/flame) was still higher than less-efficient equivalent bulb types, the differences in cost were more moderate than previously observed. Preliminary findings from RLPNC 17-12 Lighting Decision Making study show the average price of an LED decreasing nearly 25% from 2016 to 2017, while other bulb types (CFL, incandescent, and halogen) did not see a significant change in price. Findings from RLPNC 17-12 are weighted according to channel and sales data.
- **Among globe and candelabra categories, CFL options appear to be on the decline, and we observed only a small number of halogen products.** While CFL and halogen alternatives do exist for globe and candelabra bulbs, it appears that at least these two retailers are stocking fewer of these products, meaning the baseline for globe and candelabra bulbs is increasingly an incandescent bulb.
- **Program rebates were reflected in the price differences between product categories in Massachusetts and New York, especially when bulbs were split out by ENERGY STAR status.** Using ENERGY STAR status as a proxy for incandescent bulbs, it appeared that store location-specific rebate information was more consistently available online for both retailers,³ an improvement in data accuracy since the RLPNC 16-6 Shelf Stocking Study⁴ was published in 2017.

² Prices listed are from the New York store location, where bulbs are not eligible for rebates.

³ When we initially conducted this analysis in 2017 for the RLPNC 16-6 Shelf-Stocking study, the online price did not consistently reflect a sale or rebate; a consumer might see a different price online for the same product than in her local store, even if her browser was set to “shop” at the retailer’s local store location. Because we only collected pricing data as reflected online, price differences in earlier iterations of this study may not have reflected meaningful differences between Massachusetts and New York.

⁴ <http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC-16-6-%E2%80%93Lighting-Shelf-Stocking-Report.pdf>

Memo Organization:

This memo is organized into two sections:

1. **Overall Pricing and Market Trends.** In this section, we take a broad look at the overall market without attempting to adjust for program incentives.
2. **Pricing by ENERGY STAR Status.** In this section, we explore differences in bulb prices based on ENERGY STAR status.

Section 1 Overall Pricing and Market Trends

1.1 DATA COLLECTION

NMR collected location-specific data from the websites of two major home improvement retailers in Massachusetts and Upstate New York. We collected data from four store locations for each retailer in each state. After comparing weekly product data from each store, we determined availability and pricing was very similar across retail locations in the same state, and any differences were assumed to be random. As such, we ultimately restricted the analysis to one store location in each state in order to maximize clarity and comparability.⁵ This is the same strategy as adopted in the MA RLPNC 16-6: Shelf Stocking report.⁶

Data collection occurred continuously throughout the period and included the number of products available, package price, number in package, bulb type, bulb shape, lumens, and wattage. Average and median prices presented throughout the report were calculated using the unit price of each bulb to most accurately reflect the choices available to consumers. Where indicated, some figures and tables show data for “in-stock” bulbs – bulbs that were indicated to be in-stock at the store location at the time of scraping. In theory, product links for each bulb were available for viewing online, regardless of which store location your browser was set to view; the in-stock flag should provide a better indication of which bulbs may have been “on the shelf” for a consumer shopping in store.

1.2 PRICE TRENDS

1.2.1 Organization of Data

When we examined the data from the two areas, we found that prices of CFL, halogen, and incandescent bulbs were substantially similar in both areas (see [Table 3](#)). Given this, in the following figures, we present the price values from the New York comparison area for all bulb types and overlay the LED prices from Massachusetts. This provides a quick snapshot of the price of bulbs in a non-program area as well as the effect of program incentives on LED prices in Massachusetts. Bulbs have been divided into wattage equivalence bins: 25-watt, 40-watt,

⁵ We chose the closest store location of both Retailers 1 and 2 to Boston, Massachusetts and Syracuse, New York.

⁶ NMR Group, Inc. “MA RLPNC 16-6: Lighting Shelf Stocking.” March 31, 2017. <http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC-16-6—Lighting-Shelf-Stocking-Report.pdf>.

60-watt, 75-watt, and 100-watt bins for A-line, candle, and globe bulbs, and 45-watt, 65-watt, and 75-watt bins for reflectors.⁷ In each figure, as well as in [Table 1](#), bulb categories by wattage equivalence bins are organized according to the most commonly stocked products in each category, from most to least products. [Table 1](#) shows the number of products that were available in each category at the end of the data collection period, for reference.

As discussed previously, we believe the data from Retailer 1 is more indicative of changes in market prices of the period observed due to two key reasons:

- **Greater inclusion of program incentives in online prices.** Based on discussions with Retailer 1, we know that they have made great effort to ensure that online prices align with in-store prices when store location is selected. Retailer 2 does not as clearly differentiate between program-supported LEDs and in-store sales (see [Figure 9](#)), which may affect how LED prices are recorded in the dataset.
- **Greater stability of category offerings.** Based on conversation with Retailer 2, we know that their lighting category went through a transition during the period of study. Not only did they transition primary lighting suppliers, but they also went through a concerted effort to reduce the number of lighting products offered both online and in-stores. For this reason, trend lines in [Figure 1](#) through [Figure 6](#) have been smoothed to increase readability and greater stability of category offerings. It is important the reader keep this in mind when reviewing the detailed results that follow.

1.2.2 Results

Across all bulb shapes, the average cost of a non-program LED has decreased over the past 18 months. This trend is illustrated graphically in the figures below as well as in [Table 5](#) and [Table 6](#), which show the average price of bulbs at the beginning and end of the data collection period. With some exceptions, **non-program LEDs were still the most expensive bulb type when compared to similar products, despite the considerable downward trend of the cost of LEDs.**

As seen in [Table 3](#), due to program incentives for ENERGY STAR LEDs, the average cost of all LEDs was consistently lower in Massachusetts than in New York across all bulb shapes. We observed the same pattern in [Figure 1](#) through [Figure 6](#), with the dashed line representing LED prices in Massachusetts generally trending below the solid line representing LED prices in New York. For a comparison of LED prices based on ENERGY STAR status, please see [Section 2](#).

A-line

[Figure 1](#) shows the pricing trends of standard, non-specialty A-line bulbs in the most popular categories: 40-watt, 60-watt, 75-watt, and 100-watt equivalent bulbs. [Figure 1](#) excludes vintage or Edison-style decorative bulbs because they were generally more expensive than similar standard bulbs, as shown in [Table 9](#) in [Appendix A](#).

⁷ Wattage equivalence bin calculations and additional explanation available in Appendix B in RLPNC 16-6: Lighting Shelf Stocking.

While the average cost of non-program A-line LED bulbs has fallen over time, it was still the most expensive bulb option. While it appears the price of non-program LEDs has fallen below the price of equivalent incandescent bulbs in 100-watt equivalent categories, it is important to note that there were only two incandescent products in stock at Retailer 2, likely due to EISA standards.. An average standard A-line LED bulb was more expensive than an average standard A-line incandescent bulb in both Massachusetts ([Table 5](#)) and New York ([Table 6](#)).

Reflector

We observed similar trends for reflector/flood bulbs in [Figure 3](#) and [Figure 4](#). **The average unit price of reflector/flood LED bulbs has decreased over the past year, but non-program LEDs were consistently the most expensive bulb option.** In New York, LED reflectors were \$1-\$5 more expensive than halogens and \$4-\$6 more expensive than incandescent products ([Table 6](#)). However, there were far more LED products on the shelf in each reflector bin than CFL, incandescent, or halogen bulbs ([Table 1](#)).

Globe and Candelabra

LEDs were more expensive than similar inefficient globe ([Figure 5](#)) and candelabra bulbs ([Figure 6](#)). **Among globe and candelabra categories, CFL options are no longer observed to be available at these two retailers and there were only a small number of halogen products ([Table 1](#)), leaving incandescent bulbs as the primary alternative to specialty LEDs.** In RLPNC 17-9, we observed that rooms with the highest saturation of specialty sockets had the lowest saturation of efficient bulbs.

Figure 1: Average Price of Standard A-line Bulbs
(Excluding “smart” bulbs, dimmable CFLs, and Edison-style decorative bulbs)

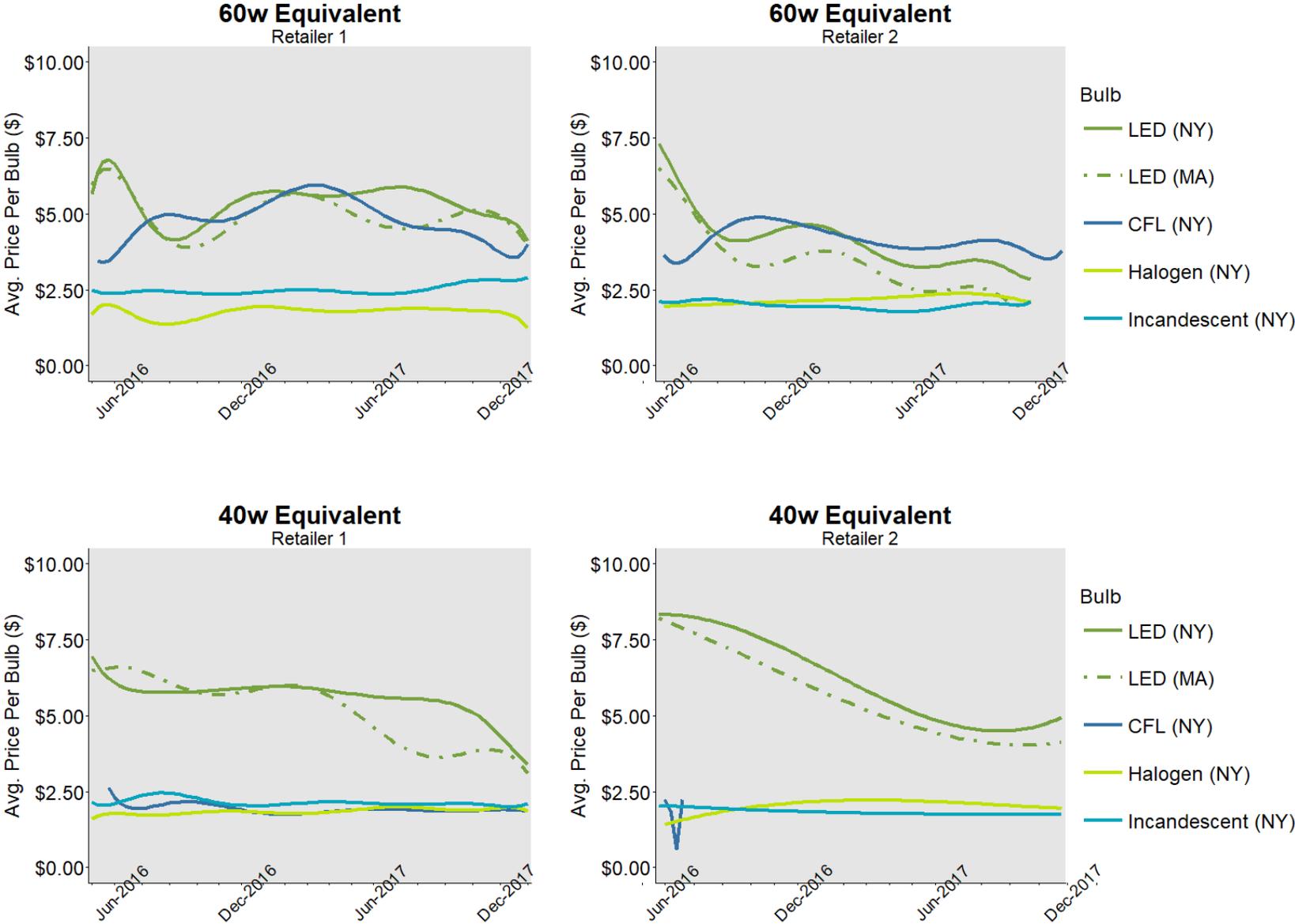


Figure 2: Average Price of In-Stock Standard A-line Bulbs, Cont'd

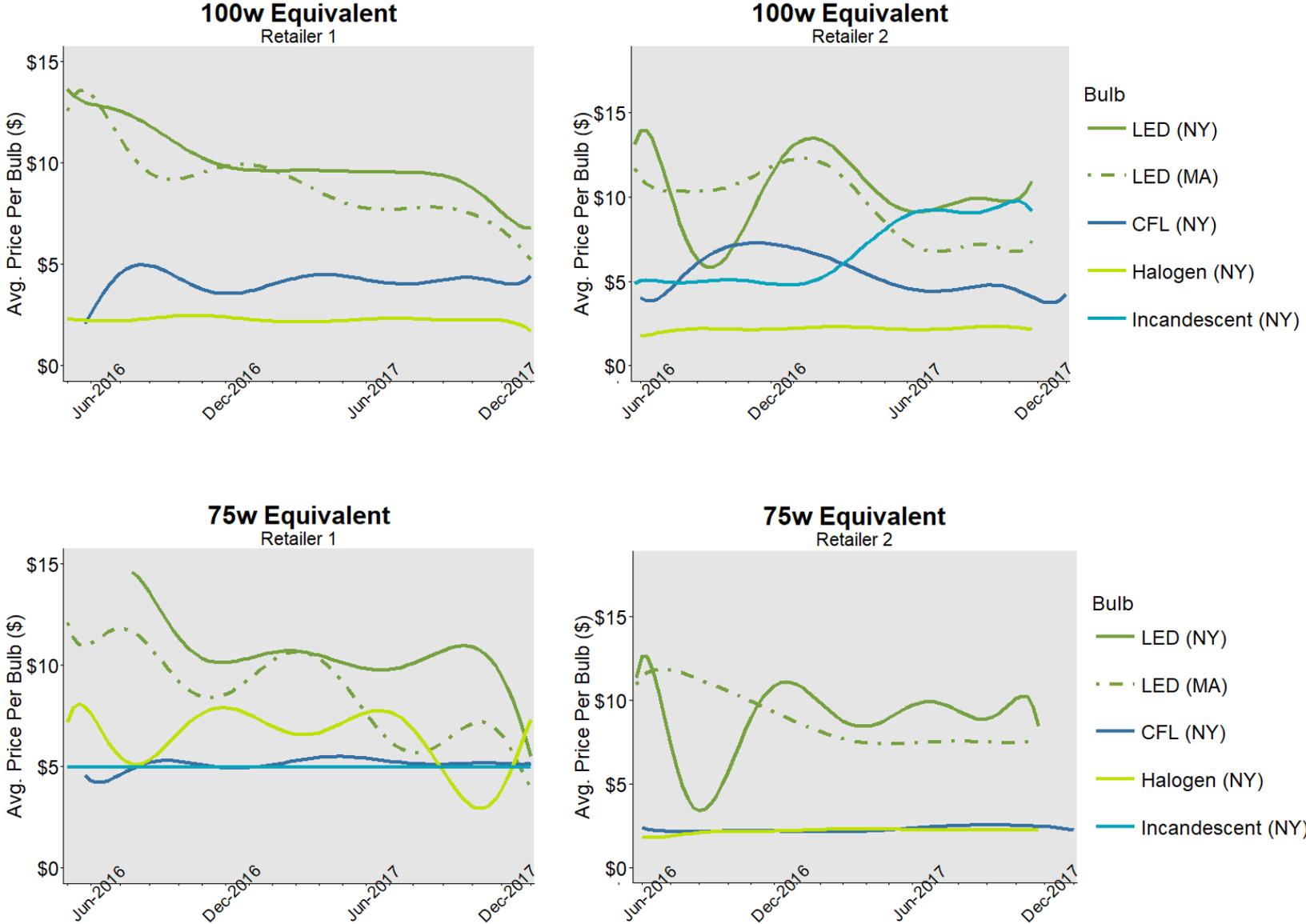


Figure 3: Average Price of In-Stock Reflector/Flood Bulbs

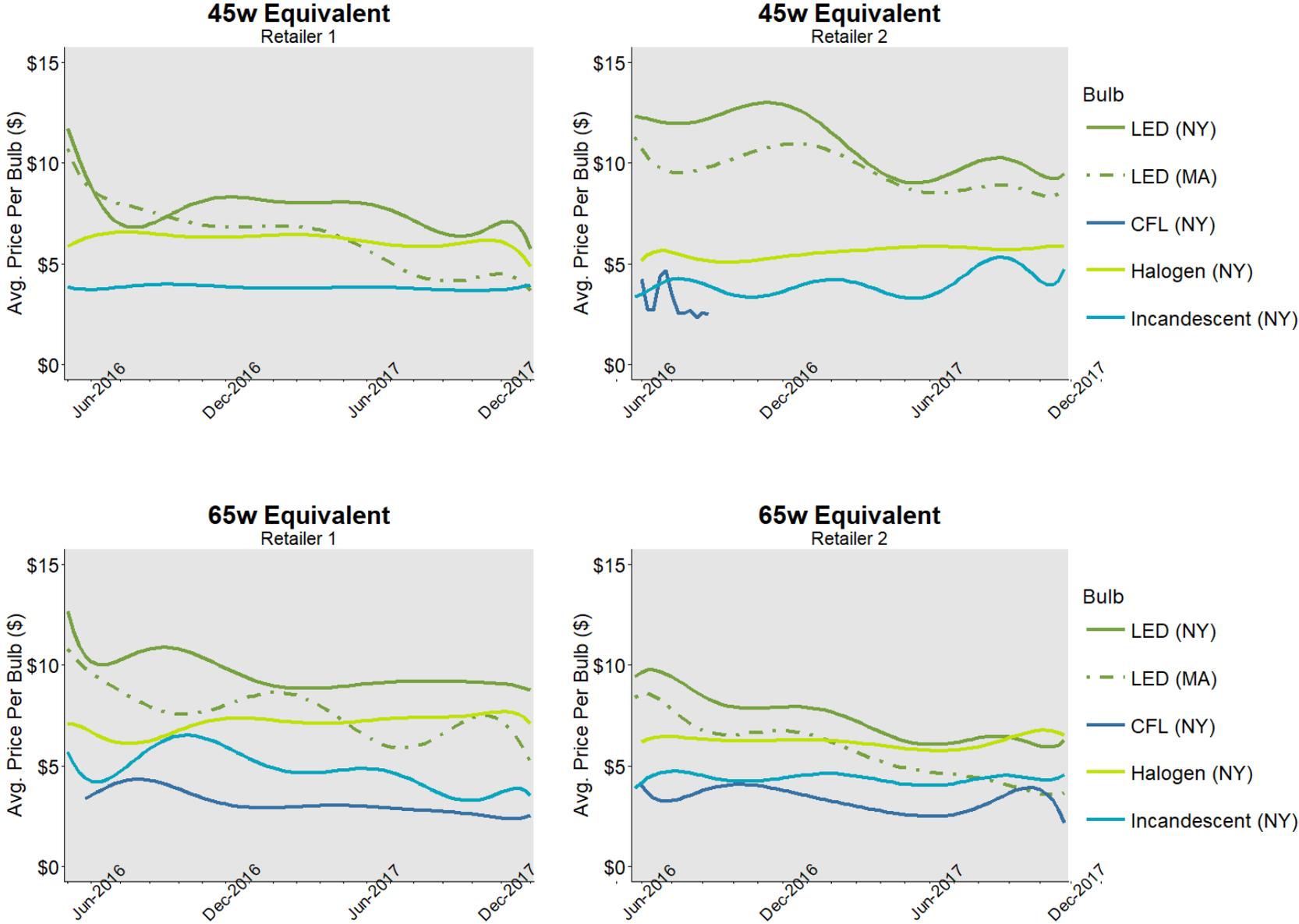


Figure 4: Average Price of In-Stock Reflector/Flood Bulbs, Cont'd

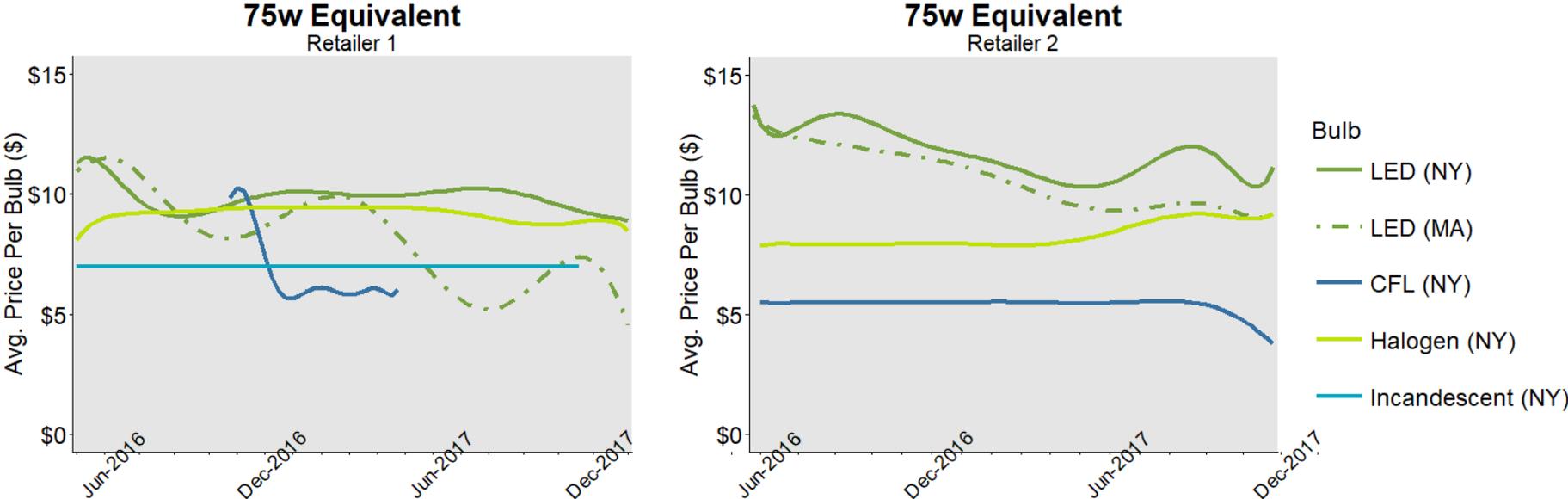


Figure 5: Average Price of In-Stock Globe Bulbs

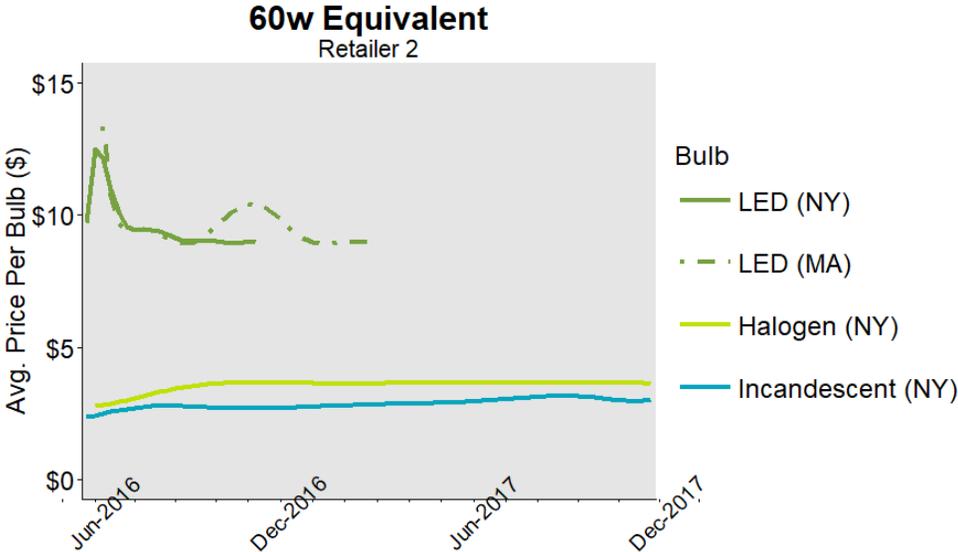
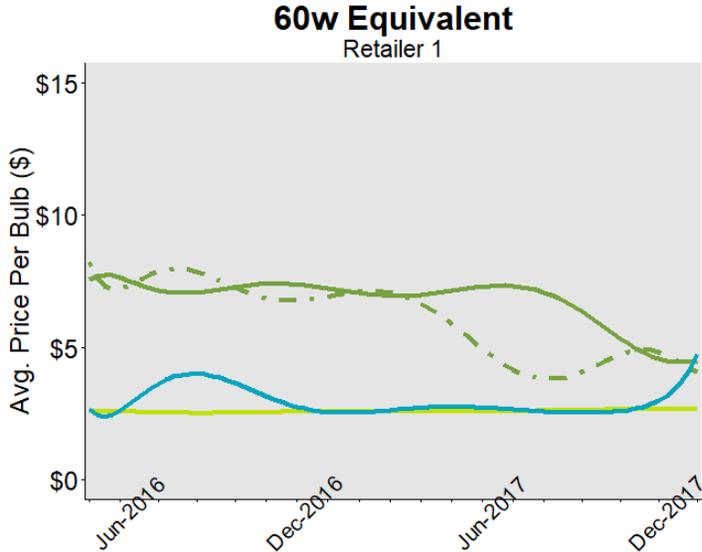
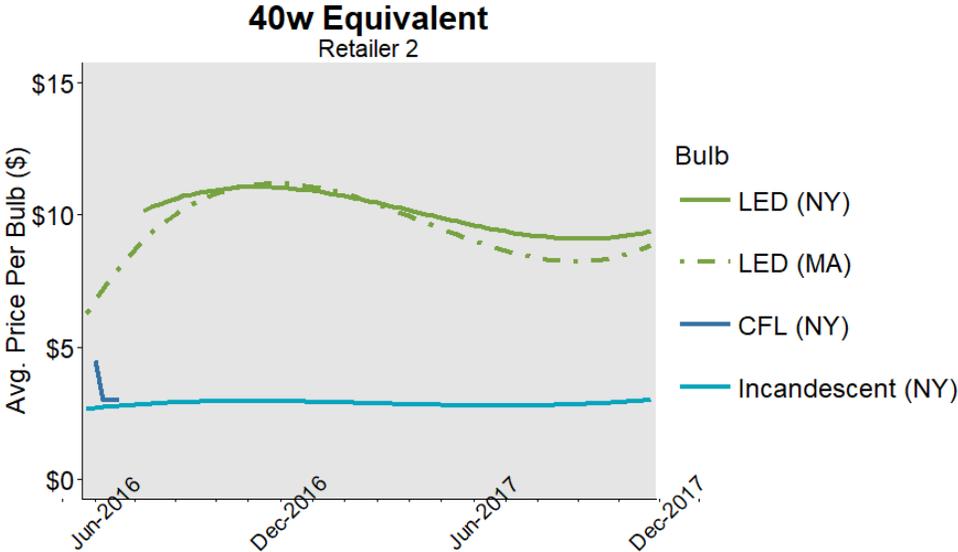
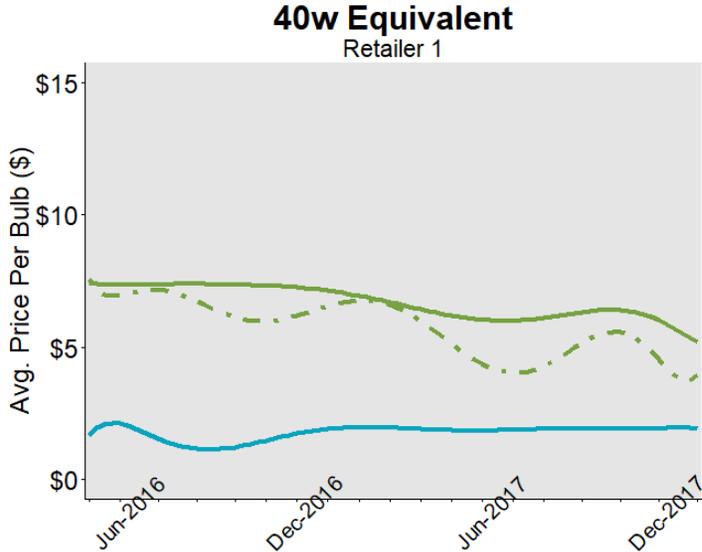


Figure 6: Average Price of In-Stock Candle Bulbs

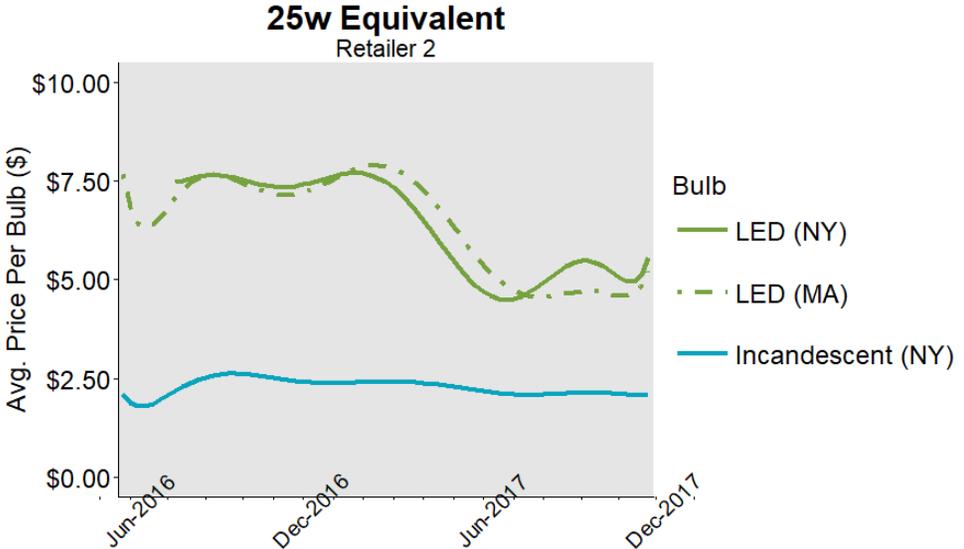
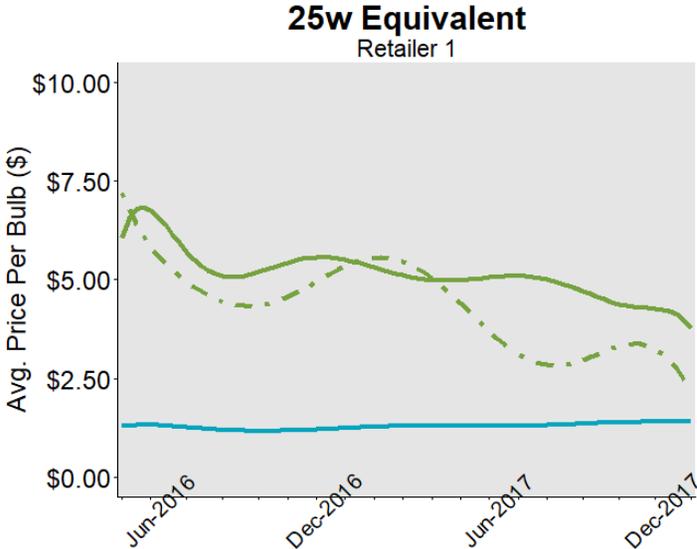
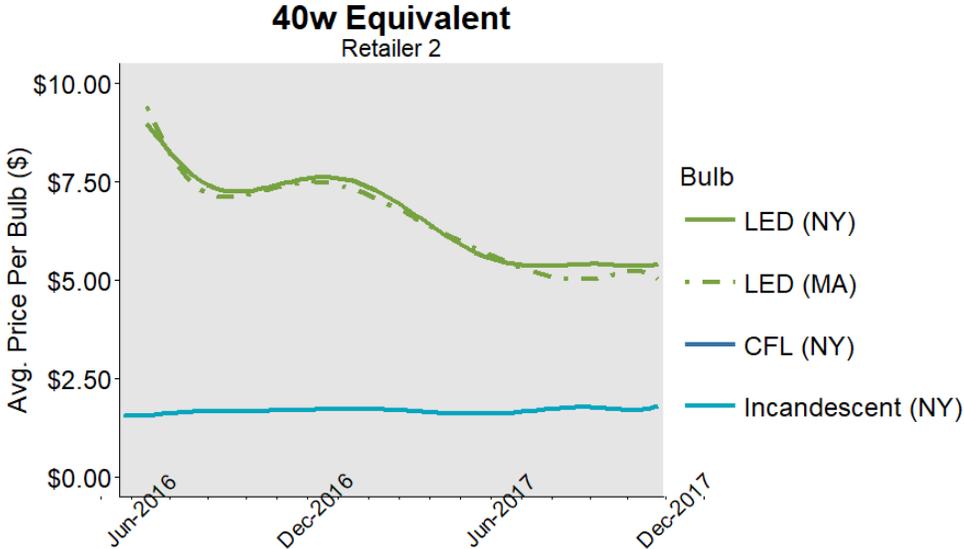
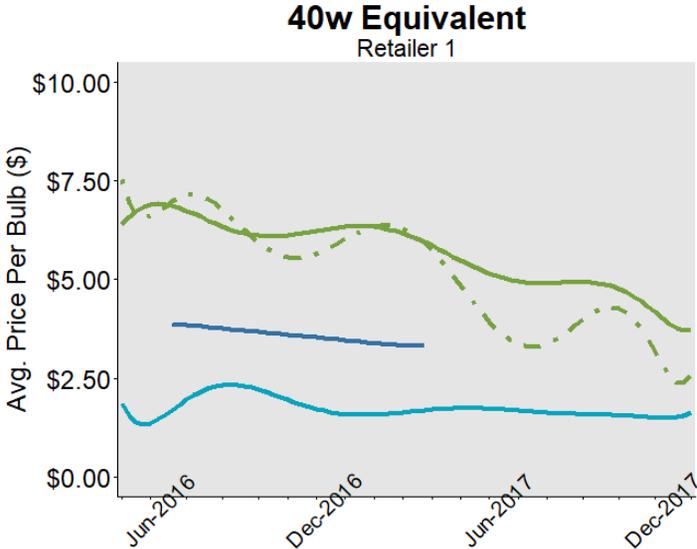


Table 1: Number of In-Stock Products by Wattage Equivalency Bin

(From last week of data collection – November 2017 – at New York store locations; excludes “smart” and Edison-style bulbs)

Wattage Equivalence	Retailer 1				Retailer 2			
	LED	CFL	Incandescent	Halogen	LED	CFL	Incandescent	Halogen
A-Line								
60w	38	9	5	7	13	5	10	6
40w	22	2	4	4	13	--	5	3
100w	15	3	0	6	3	4	2	5
75w	1	3	1	3	2	1	--	4
Reflector/Flood								
45w	19	--	4	7	27	--	3	11
65w	23	1	4	14	10	1	7	9
75w	11	0	1	6	11	1	--	5
Globe								
40w	15	--	6	--	16	0	11	--
60w	11	--	1	2	0	--	7	3
Candle/Flame								
40w	20	0	6	--	10	--	10	--
25w	6	--	3	--	4	--	3	--

Table 2: Number of In-Stock Products by Bulb Shape

(From last week of data collection – November 2017 – at New York store locations)

Bulb Shape	Retailer 1				Retailer 2			
	LED	CFL	Incandescent	Halogen	LED	CFL	Incandescent	Halogen
A-Line	100	18	22	23	53	14	48	19
Reflector/Flood	60	1	10	34	55	3	10	29
Globe	30	0	14	2	23	0	23	3
Candle/Flame	41	0	9	3	16	0	19	2

While it may seem concerning that LEDs appeared to have crossed the threshold of average prices for similar inefficient bulbs in a few of the figures above, it is important to note that, while wattage equivalence bins are a useful tool for comparing like products, it is an imperfect measure.⁸ Twenty-five percent of bulbs in Retailer 1 and 27% of bulbs at Retailer 2 were not classified into one of the wattage equivalence bins used in Figure 1 through Figure 6.⁹ Looking at the average unit price of all bulbs in these categories, LEDs were more expensive than other bulbs of a similar shape in both New York and Massachusetts, where rebates helped close the gap. While the price of LEDs has fallen and increasingly more LED products were stocked in major retail locations, they are still more expensive than similar halogen and incandescent bulbs, on average.

Table 3: Price Comparisons Overall – In Stock

(One week of product data in November 2017, excluding “smart” and Edison-style bulbs; number of products in parentheses.)

	Retailer 1		Retailer 2	
	Massachusetts	New York	Massachusetts	New York
Standard A-line (Excluding Specialty Bulbs)				
LED	\$5.95 (54)	\$6.55 (53)	\$4.64 (49)	\$5.53 (44)
CFL	\$3.56 (13)	\$3.79 (13)	\$4.40 (12)	\$4.69 (12)
Halogen	\$1.78 (19)	\$1.94 (18)	\$2.11 (18)	\$2.08 (19)
Incandescent	\$3.29 (20)	\$2.98 (20)	\$3.42 (43)	\$3.39 (45)
Reflector/Flood Bulbs				
LED	\$7.25 (68)	\$9.13 (68)	\$9.82 (82)	\$11.04 (79)
CFL	\$2.77 (3)*	2.77 (3)*	3.84 (1)	3.20 (2)
Halogen	\$7.90 (27)	\$7.63 (27)	\$6.50 (39)	\$6.51 (38)
Incandescent	\$3.82 (11)	\$4.28 (11)	\$4.94 (16)	\$4.82 (17)
Globe				
LED	\$4.48 (12)	\$5.56 (12)	\$8.15 (23)	\$8.76 (19)
CFL	--	--	--	--
Halogen	\$2.66 (2)	\$2.66 (2)	\$3.65 (3)	\$3.65 (3)
Incandescent	\$1.96 (11)	\$2.02 (11)	\$2.78 (25)	\$2.96 (27)
Candle/Flame				
LED	\$4.60 (21)	\$5.07 (21)	\$5.11 (14)	\$5.33 (14)
CFL	--	--	--	--
Halogen	\$1.99 (2)	\$1.99 (2)	\$1.89 (2)	\$1.89 (2)
Incandescent	\$1.75 (18)	\$1.73 (18)	\$1.83 (23)	\$1.80 (27)

Bold and colored text indicates cost in November 2017 is at least 10% different in NY compared to MA for both mean and median price differences. Median price shown in Appendix B.

*In-stock marker was invalid for this week of data; price shown reflects all bulbs available.

⁸ Some price differences between Retailer 1 and Retailer 2 are driven by discount brand bulb offerings. Differences in price by brand are not outlined in this memo in order to maintain retailer anonymity. Furthermore, this analysis does not take into account shopping behavior and shows only products available; for a discussion of the impact of brand offerings on sales, see RLPNC 17-12 Lighting Decision Making.

⁹ These percentages are of the subset of bulbs in the dataset that were A-line, spiral, reflector/flood, globe, or candle/flame.

1.3 DETAILED BULB PRICING

There were fewer bulbs per package, on average, in bulbs available in-store than all products, which included online-only offerings (Table 4). For example, there was a 120-pack of incandescent A-line bulbs available to order online at Retailer 2, but the largest size pack of incandescent A-line bulbs available in store contained 16 bulbs. For specialty bulb shapes (reflector/flood, globe, and candle/flame bulbs), incandescent bulbs were sold in larger multi-packs, on average, than LED bulbs. For A-line bulbs sold in-store, packs of halogens contained an average of two additional bulbs per package than LEDs.

Table 4: Average Number of Bulbs per Package

	Retailer 1		Retailer 2	
	In Stock	All Products	In Stock	All Products
Standard A-line (Excluding Specialty Bulbs)				
<i>LED</i>	2.5	2.8	1.9	4.3
<i>CFL</i>	2.5	2.5	2.5	3.2
<i>Halogen</i>	4.3	4.4	3.8	3.9
<i>Incandescent</i>	1.5	2.2	2.1	7.9
Reflector/Flood				
<i>LED</i>	2.5	2.7	1.7	2.0
<i>CFL</i>	2.5	2.7	2.5	2.2
<i>Halogen</i>	1.8	1.8	1.7	4.4
<i>Incandescent</i>	4.5	4.6	4.2	4.4
Globe				
<i>LED</i>	2.5	2.7	1.0	2.1
<i>CFL</i>	--	--	--	1.8
<i>Halogen</i>	2.5	2.5	1.6	5.6
<i>Incandescent</i>	3.2	3.2	1.8	4.3
Candle/Flame				
<i>LED</i>	2.2	2.3	1.3	3.7
<i>CFL</i>	3.0	3.0	2.0	4.4
<i>Halogen</i>	2.0	2.0	2.0	16
<i>Incandescent</i>	3.0	2.9	4.0	7.8

The following tables provide a high-level snapshot of average bulb prices by type and technology at the beginning of the data collection period (August 2016) compared to the most recent data available (November 2017).¹⁰ The number of available products is noted in parentheses.¹¹ The following tables show changes in average price over time in both states.

¹⁰ We have data through December 2017 included in this memo, as seen in Figures 1-3, but the most recent and consistent period of data collection in this quarter fell within the month of November 2017.

¹¹ Data collection began in July 2016, but the most complete period of data points from both retailers is available beginning August 2016.

Note that the values in these tables may differ slightly from Table 3 because the following tables contain a subset of the data. By only averaging the price of bulbs scraped from the store location in each state, we can be sure that price differences are driven by rebates or sales rather than missing bulbs.¹² Overall, **the cost of an average LED bulb has decreased across all bulb categories** since we began data collection in July 2016. **The number of A-line and reflector/flood LED products available has increased, while CFL offerings continued to decline.** These findings are consistent with trends noted in the MA RLPNC 16-6: Lighting Shelf Stocking report.

Table 5: Average Price of “In Stock” Bulbs – Massachusetts

(Excludes “smart” and Edison-style bulbs; number of products parentheses)

	Retailer 1		Retailer 2	
	August 2016	November 2017	August 2016	November 2017
Standard A-line (Excluding Specialty Bulbs)				
LED	\$7.41 (76)	\$5.75 (68)	\$7.13 (29)	\$4.64 (49)
CFL	\$4.49 (9)	\$3.56 (13)	\$3.76 (31)	\$4.33 (13)
Halogen	\$2.08 (23)	\$1.78 (21)	\$1.62 (32)	\$2.11 (18)
Incandescent	\$3.74 (32)	\$3.37 (22)	\$3.12 (40)	\$3.50 (44)
Reflector/Flood				
LED	\$11.01 (52)	\$7.19 (76)	\$12.57 (53)	\$9.73 (83)
CFL	\$3.48 (1)	\$2.77 (3)	\$4.82 (15)	\$3.54 (2)
Halogen	\$7.56 (52)	\$7.61 (36)	\$6.55 (59)	\$6.41 (40)
Incandescent	\$5.66 (22)	\$3.73 (12)	\$4.31 (19)	\$4.94 (16)
Globe				
LED	\$7.36 (27)	\$4.56 (16)	\$13.62 (3)	\$8.15 (23)
CFL	--	--	\$3.46 (2)	--
Halogen	\$2.55 (3)	\$2.66 (2)	\$2.15 (3)	\$3.65 (3)
Incandescent	\$2.16 (20)	\$1.86 (13)	\$2.78 (26)	\$2.78 (25)
Candle/Flame				
LED	\$6.68 (37)	\$4.66 (25)	\$8.14 (5)	\$4.85 (15)
CFL	--	--	\$1.86 (1)	--
Halogen	\$3.32 (3)	\$3.32 (3)	\$2.31 (3)	\$1.89 (2)
Incandescent	\$1.77 (25)	\$1.75 (18)	\$2.08 (28)	\$1.83 (23)

Bold and colored text indicates cost in November 2017 has undergone a 10% change since August 2016 for both mean and median price differences. Median prices shown in Appendix B.

¹² Due to some aberrations in the function of the web-scraping code, some product links may not be recorded in a given week, which is why comparing price trends over time provides a more complete picture than a week-to-week snapshot. To remove noise from the state-to-state price comparison, average prices in Table 2 are calculated only from products that were scraped from both Massachusetts and New York store locations. However, all “in-stock” products scraped from that store location on a given week are shown in the average prices in Table 4 and Table 5

NMR collected data from store locations in Massachusetts and New York. Pricing trends observed in Massachusetts, including the decrease in cost of an average LED bulb, were also reflected in the New York data (Table 6). We include New York stores as a comparison group because New York essentially ended all upstream incentives in 2014. Massachusetts program administrators continued to incent ENERGY STAR LEDs, although support for CFLs ended as of January 1, 2017. When looking at all LEDs and not controlling for ENERGY STAR status, we observed that LEDs were less expensive in Massachusetts than in New York across all bulb categories, and particularly at Retailer 1 (Table 6).¹³

Table 6: Average Price of “In Stock” Bulbs – New York

(Excludes “smart” and Edison-style bulbs; number of products in parentheses)

	Retailer 1		Retailer 2	
	August 2016	November 2017	August 2016	November 2017
Standard A-line (Excluding Specialty Bulbs)				
LED	\$7.72 (73)	\$5.83 (84)	\$7.37 (26)	\$5.53 (44)
CFL	\$4.46 (9)	\$4.47 (18)	\$4.41 (23)	\$4.69 (12)
Halogen	\$3.19 (23)	\$2.08 (20)	\$1.85 (30)	\$2.08 (19)
Incandescent	\$3.51 (37)	\$2.98 (20)	\$2.98 (35)	\$3.39 (45)
Reflector/Flood				
LED	\$10.57 (53)	\$8.86 (80)	\$13.45 (46)	\$11.04 (79)
CFL	\$3.48 (1)	\$2.69 (4)	\$4.50 (10)	\$3.20 (2)
Halogen	\$7.19 (52)	\$7.64 (32)	\$6.61 (52)	\$6.51 (38)
Incandescent	\$5.33 (22)	\$4.30 (12)	\$4.23 (18)	\$4.82 (17)
Globe				
LED	\$7.55 (25)	\$5.69 (26)	\$9.87 (1)	\$8.76 (19)
CFL	--	--	\$3.46 (2)	--
Halogen	\$2.58 (4)	\$2.66 (2)	\$2.48 (2)	\$3.65 (3)
Incandescent	\$2.02 (20)	\$1.93 (12)	\$2.68 (25)	\$2.96 (27)
Candle/Flame				
LED	\$7.23 (29)	\$5.17 (35)	\$1.99 (1)	\$5.33 (14)
CFL	--	--	--	--
Halogen	\$3.98 (2)	\$1.99 (2)	\$2.31 (3)	\$1.89 (2)
Incandescent	\$1.71 (25)	\$1.73 (18)	\$2.08 (28)	\$1.80 (27)

Bold and colored text indicates cost in November 2017 has undergone a 10% change since August 2016 for both mean and median price differences. Median prices shown in [Appendix B](#).

¹³ Defined as a 10% difference in both the mean and median prices. Differences between the two states based on ENERGY STAR status are discussed in [Section 2](#).

Section 2 ENERGY STAR LEDs

Due to program incentives, LEDs are less expensive overall in Massachusetts than in New York (Figure 7). However, since the Massachusetts program only supports ENERGY STAR certified LEDs, when we look at prices overall, we are diluting the effect of incentives as any non-program LEDs in the Massachusetts data may artificially increase costs. To help understand the full effect of program incentives, we compared the unit price of the same LED products in Massachusetts and New York (Table 7). While not every ENERGY STAR product offered included an incentive, it is a proxy for products included in the program. We compared the products during the same one-week period of data collection in November 2017 to ensure maximum reliability and limit noise caused by sale or close-out pricing deductions.

Out of 328 LEDs at Retailer 1 that were ENERGY STAR certified at some point during the data collection period, 244 products (78%) were less expensive in Massachusetts than in New York.¹⁴ At Retailer 2, out of 138 ENERGY STAR certified LEDs in the database, 87 products (63%) were less expensive. These products reflected the rebates offered by Massachusetts PAs, but there were most likely additional incentivized products available at Massachusetts locations not reflected in the pricing data online.¹⁵

Furthermore, available rebates were more clearly marked on the web-pages of ENERGY STAR bulbs at Retailer 1 than at Retailer 2, as shown in Figure 8 and Figure 9. At Retailer 1, the customer could see the original price (\$20.97), the “sale” price (\$10.97), the amount of the rebate (\$10.00), and the program sponsor (“Eversource”). On the left side of Figure 8, the New York store location had the full price (\$20.97) for this particular product, a 4-pack of ENERGY STAR A-line bulbs. At Retailer 2, the product appeared on sale in both states, but it appeared the “sale” price at the Massachusetts location (\$7.69) included a rebate, although that was not clearly specified.

Figure 7 compares the average price of all ENERGY STAR bulbs to all non-ENERGY STAR-certified bulbs, excluding smart LEDs. Over the course of the data collection period, the average price difference between ENERGY STAR- and non-ENERGY STAR-certified LEDs was \$1.50 at Retailer 1 and \$2.20 at Retailer 2. On some weeks, the difference was as high as \$3.70 (Retailer 1) and \$5.30 (Retailer 2).

¹⁴ The price comparison was only made for weeks in which the product was labeled ENERGY STAR certified.

¹⁵ This was found to be the case when web-scraping data and shelf-stocking observations were compared to a list of incentivized products sold at Massachusetts retailers in 2016.

Figure 7: Average Cost of LEDs by ENERGY STAR Status
(Base: Excludes “smart” bulbs)

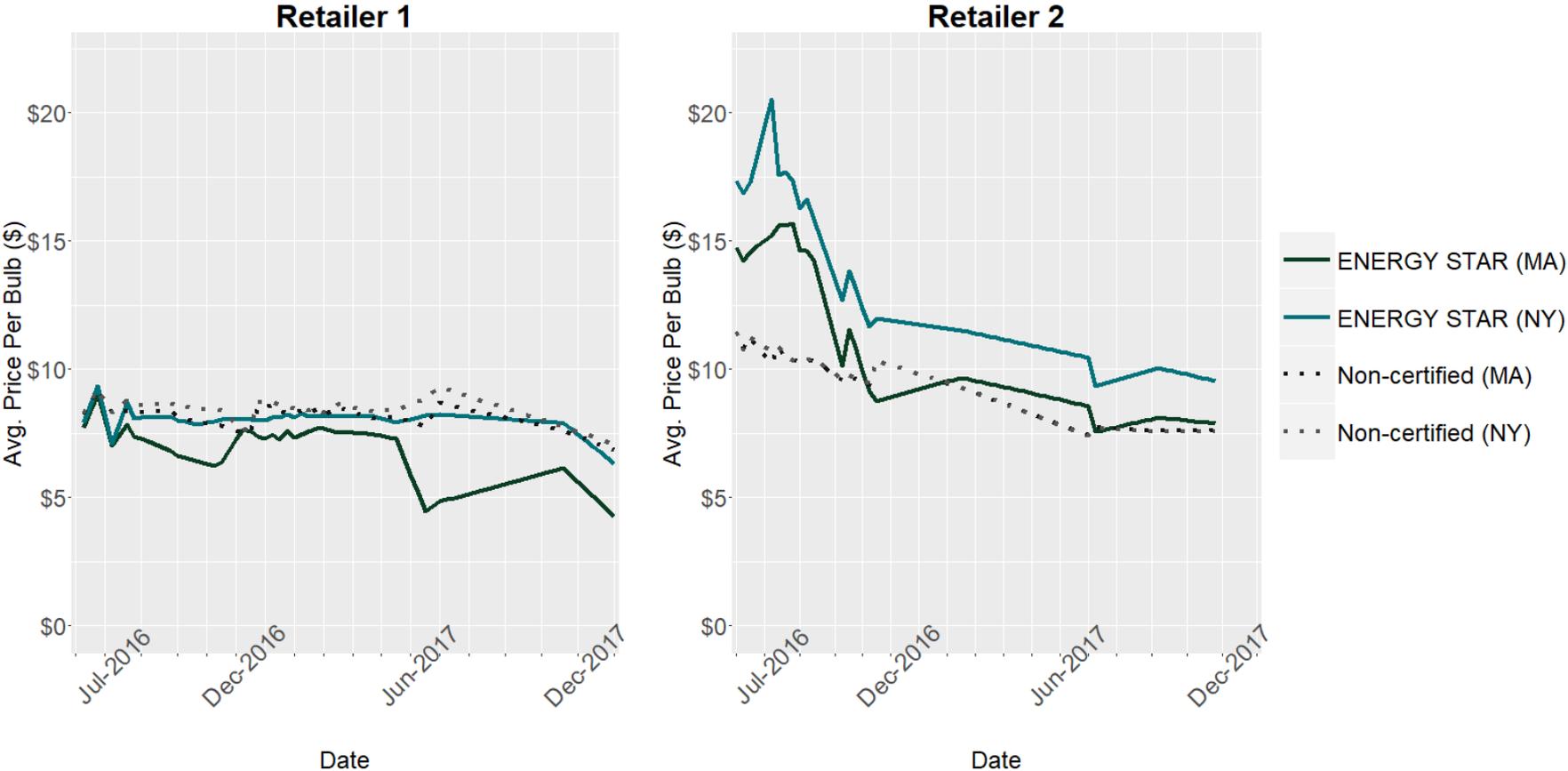


Figure 8: Rebate Information at Retailer 1

Massachusetts Store Location	New York Store Location
Was \$20.97	
\$10⁹⁷ /each (limit 4 per order)	\$20⁹⁷ /each (limit 4 per order)
After \$10.00 Instant Rebate Details	
No mail-in necessary. Store rebate provided by Eversource	

Figure 9: Rebate Information at Retailer 2

Massachusetts Store Location	New York Store Location
\$7.69 Was \$13.98	\$12.58 Was \$13.98
SAVE 45% thru 05/18/2018	SAVE 10% thru 05/18/2018

When ENERGY STAR bulbs were examined separately,¹⁶ price differences between Massachusetts and New York were observable for ENERGY STAR bulbs, and largely disappeared among the non-ENERGY STAR bulb categories. ENERGY STAR reflector/flood bulbs at both retailers in Massachusetts were more than ten percent less expensive (taking both mean and median prices into account). ENERGY STAR bulbs in Massachusetts were observed to be \$1-\$2 less expensive, on average, than bulbs in New York, in line with actual rebate amounts. As of the summer of 2017, the average rebate for a standard A-line was \$3.11, and \$3.50 for all bulbs (including specialty).¹⁷

Table 7: Average Price Comparison by ENERGY STAR Status

(One week of product data in November 2017, excluding “smart” or Edison-style bulbs; number of products in parentheses.)

	Retailer 1		Retailer 2	
	Massachusetts	New York	Massachusetts	New York
ENERGY STAR LEDs				
A-line	\$5.46 (16)	\$6.50 (16)	\$3.47 (21)	\$5.18 (21)
Reflector/Flood	\$7.06 (54)	\$9.43 (54)	\$9.67 (40)	\$11.94 (40)
Globe	\$3.56 (9)	\$4.56 (9)	\$8.31 (5)	\$10.51 (5)
Candle/Flame	\$3.57 (13)	\$4.23 (13)	\$5.15 (4)	\$5.65 (4)
Non-ENERGY STAR LEDs				
A-line	\$6.03 (60)	\$6.18 (60)	\$4.48 (32)	\$4.64 (32)
Reflector/Flood	\$7.34 (27)	\$7.66 (27)	\$9.48 (53)	\$9.58 (53)
Globe	\$4.85 (13)	\$5.16 (13)	\$8.18 (14)	\$8.18 (14)
Candle/Flame	\$5.17 (13)	\$5.28 (13)	\$4.35 (15)	\$4.35 (15)

Bold and colored text indicates cost in November 2017 is at least 10% different between the two states for both mean and median price differences. Median prices shown in [Appendix B](#).

2.1 LED PRODUCT RATINGS

Besides bulb price and features, NMR also collected data on ratings and reviews. The results of this analysis were presented as part of the 2017 International Energy Program Evaluation Conference (IEPEC) proceedings.¹⁸ Using the data collected via web scraping, we conducted a regression analysis of bulb features and determined that brand, color temperature, price, efficiency,¹⁹ and warranty length were the top predictors of LED bulb rating. Customers also rated larger packs of bulbs higher than smaller packages.

¹⁶ Only LEDs were examined; the data point is one week in November 2017, when CFLs were no longer eligible for ENERGY STAR certification.

¹⁷ The average rebate amount was calculated from the upstream lighting dataset provided by EFI.

¹⁸ IEPEC 2017 Proceedings. “Five Stars – Would Totally Buy Again!!! A Novel Method and Data Source to Study Consumer Lighting Decision-Making.” https://www.iepec.org/wp-content/uploads/2017/08/Pierce_IEPEC2017_Poster.pdf.

¹⁹ Efficiency was calculated as the ratio of lumens to wattage.

While we explored ENERGY STAR status, we did not find a consistent relationship between reviewer satisfaction and ENERGY STAR status. Specifically, we analyzed two datasets: one of individual customer reviews with separate quality, value, and overall ratings; and another with the average ratings of bulbs as presented in the product details.²⁰ According to overall website-reported averages, non-ENERGY STAR bulbs had slightly higher average rating (4.37 out of 5) than ENERGY STAR bulbs (4.21). However, looking at individual reviews, there was a significant difference in quality rating for ENERGY STAR bulbs (4.45 out of 5) compared to non-ENERGY STAR LEDs (4.28), but this difference was not reflected in the bulb value rating or overall score. Within our sample of reviews, the overall rating of ENERGY STAR bulbs may have been impacted by customer dissatisfaction over the shatter-resistant coating of a particular brand. These findings reflect LED satisfaction in the MA RLPNC 17-9 2017-18 Residential Lighting Market Assessment Study,²¹ in which LED satisfaction was high overall (over 90% of householders were somewhat or very satisfied with their LEDs), and there was no difference between satisfaction of LED bulbs by ENERGY STAR status.

Table 8: Product Ratings by ENERGY STAR Status

	ENERGY STAR	Non-ENERGY STAR
Product Rating (Overall)	4.21	4.37
<i>Individual Customer Reviews</i>		
General Rating	4.28	4.28
Value Rating	4.28	4.26
Quality Rating	4.45*	4.28

*Significantly different from Non-ENERGY STAR bulbs at the 90% confidence level.

²⁰ Many models of bulbs were present in both data sets, but the products covered by each were not identical.

²¹ Link when published

Appendix A Standard vs. Edison-Style Bulbs

Across most bulb types and shapes, Edison-style bulbs were more expensive than standard light bulbs and were particularly prevalent in the A-line category. As such, they were excluded from the average price analysis in [Figure 1](#) and average and median price analyses in tables throughout this memo.

Table 9: Average Price of Bulbs – Standard v. Edison

(Massachusetts retailers; one week of product data in November; number of products in parentheses)

	Retailer 1		Retailer 2	
	Standard	Edison	Standard	Edison
LED				
<i>A-line</i>	\$5.77 (93)	\$9.25 (6)	\$4.19 (55)	\$8.73 (6)
<i>Globe</i>	\$4.39 (29)	\$11.67 (1)	\$8.45 (19)	\$10.78 (6)
<i>Candle/Flame</i>	\$4.39 (32)	--	\$4.36 (20)	\$4.84 (6)
<i>Reflector/Flood</i>	\$6.99 (96)	--	\$9.68 (92)	--
<i>Tube</i>	\$14.24 (18)	--	\$9.64 (13)	\$8.98 (4)
Incandescent				
<i>A-line</i>	\$3.08 (15)	\$3.97 (4)	\$2.74 (36)	\$6.49 (34)
<i>Globe</i>	\$1.86 (13)	--	\$2.67 (27)	\$6.48 (6)
<i>Candle/Flame</i>	\$1.75 (18)	--	\$1.30 (43)	\$2.99 (2)
<i>Reflector/Flood</i>	\$3.73 (12)	--	\$5.21 (20)	--
<i>Tube</i>	\$2.94 (10)	--	\$2.65 (32)	\$7.92 (9)

Appendix B Median Prices

Tables in the body of the memo featuring average price of bulbs are recreated below to reflect median prices. The number of products in each category is expressed in parentheses.

Table 10: Median Price of In-Stock Bulbs (Massachusetts)

(Excludes “smart” and Edison-style bulbs; number of products in parentheses)

	Retailer 1		Retailer 2	
	August 2016	November 2017	August 2016	November 2017
Standard A-line (Excluding Specialty Bulbs)				
LED	\$6.24 (76)	\$5.97 (68)	\$5.98 (29)	\$4.98 (49)
CFL	\$2.74 (9)	\$2.48 (13)	\$2.81 (31)	\$3.49 (13)
Halogen	\$1.87 (23)	\$1.54 (21)	\$1.75 (32)	\$2.00 (18)
Incandescent	\$3.23 (32)	\$3.23 (22)	\$2.47 (40)	\$3.00 (44)
Reflector/Flood				
LED	\$9.98 (52)	\$6.58 (76)	\$11.23 (53)	\$8.98 (83)
CFL	\$3.48 (1)	\$2.44 (3)*	\$4.86 (15)	\$3.54 (2)
Halogen	\$7.80 (52)	\$8.73 (36)	\$6.78 (59)	\$6.98 (40)
Incandescent	\$4.97 (22)	\$2.58 (12)	\$4.48 (19)	\$4.48 (16)
Globe				
LED	\$6.99 (27)	\$3.96 (16)	\$12.73 (3)	\$7.98 (23)
CFL	--	--	\$3.46 (2)	--
Halogen	\$2.50 (3)	\$2.66 (2)	\$1.48 (3)	\$3.98 (3)
Incandescent	\$2.23 (20)	\$1.82 (13)	\$1.99 (26)	\$2.24 (26)
Candle/Flame				
LED	\$6.97 (37)	\$4.32 (25)	\$8.08 (5)	\$4.98 (15)
CFL	--	--	\$1.86 (1)	--
Halogen	\$1.99 (3)	1.99 (3)	\$1.89 (3)	\$1.89 (2)
Incandescent	\$1.37 (25)	\$1.12 (18)	\$1.34 (28)	\$1.16 (23)

Bold and colored text indicates cost in November 2017 has undergone a 10% change since August 2016 for both mean and median price differences.

*In-stock marker was invalid for this week of data; price shown reflects all bulbs available.

Table 11: Median Price of In-Stock Bulbs (New York)

(Excludes “smart” and Edison-style bulbs; number of products in parentheses)

	Retailer 1		Retailer 2	
	August 2016	November 2017	August 2016	November 2017
Standard A-line (Excluding Specialty Bulbs)				
<i>LED</i>	\$6.49 (73)	\$5.49 (84)	\$6.38 (26)	\$5.48 (44)
<i>CFL</i>	\$2.74 (9)	\$2.62 (18)	\$3.14 (23)	\$3.50 (12)
<i>Halogen</i>	\$1.87 (23)	\$1.81 (20)	\$1.88 (30)	\$1.99 (19)
<i>Incandescent</i>	\$2.73 (37)	\$2.85 (22)	\$2.52 (35)	\$2.98 (45)
Reflector/Flood				
<i>LED</i>	\$9.97 (53)	\$8.16 (80)	\$12.98 (46)	\$9.98 (79)
<i>CFL</i>	\$3.48 (1)	\$2.44 (4)	\$4.67 (10)	\$3.20 (2)
<i>Halogen</i>	\$7.23 (52)	\$7.97 (32)	\$6.74 (52)	\$6.73 (38)
<i>Incandescent</i>	\$4.47 (22)	\$3.83 (12)	\$4.16 (18)	\$4.48 (17)
Globe				
<i>LED</i>	\$6.99 (25)	\$5.47 (26)	\$9.87 (1)	\$7.98 (19)
<i>CFL</i>	--	--	\$3.46 (2)	--
<i>Halogen</i>	\$2.58 (4)	\$2.66 (2)	\$2.48 (2)	\$3.98 (3)
<i>Incandescent</i>	\$1.99 (20)	\$2.15 (12)	\$1.99 (25)	\$2.33 (27)
Candle/Flame				
<i>LED</i>	\$7.49 (29)	\$4.66 (35)	\$1.99 (1)	\$4.99 (14)
<i>CFL</i>	--	--	--	--
<i>Halogen</i>	\$3.98 (2)	\$1.99 (2)	\$1.89 (3)	\$1.89 (2)
<i>Incandescent</i>	\$1.49 (25)	\$1.24 (18)	\$1.25 (28)	\$1.16 (27)

Bold and colored text indicates cost in November 2017 has undergone a 10% change since August 2016 for both mean and median price differences.

Table 12: Median Price Comparisons Overall

(One week of product data in November 2017, excluding “smart” and Edison-style bulbs; number of products in parentheses.)

	Retailer 1		Retailer 2	
	Massachusetts	New York	Massachusetts	New York
Standard A-line (Excluding Specialty Bulbs)				
<i>LED</i>	\$5.97 (54)	\$5.97 (53)	\$4.98 (49)	\$5.48 (44)
<i>CFL</i>	\$2.48 (13)	\$2.48 (13)	\$3.50 (12)	\$3.50 (12)
<i>Halogen</i>	\$1.54 (19)	\$1.74 (18)	\$2.00 (18)	\$1.99 (19)
<i>Incandescent</i>	\$3.23 (20)	\$2.85 (20)	\$2.99 (43)	\$2.98 (45)
Reflector/Flood Bulbs				
<i>LED</i>	\$6.58 (68)	\$8.16 (68)	\$8.98 (82)	\$9.98 (79)
<i>CFL</i>	\$2.44 (3)	\$2.44 (3)	\$3.84 (1)	\$3.20 (2)
<i>Halogen</i>	\$8.97 (27)	\$7.97 (27)	\$6.98 (39)	\$6.73 (38)
<i>Incandescent</i>	\$2.49 (11)	\$3.66 (11)	\$4.48 (16)	\$4.48 (17)
Globe				
<i>LED</i>	\$3.61 (12)	\$4.98 (12)	\$7.98 (23)	\$7.98 (19)
<i>CFL</i>	--	--	--	--
<i>Halogen</i>	\$2.66 (2)	\$2.66 (2)	\$3.98 (3)	\$3.98 (3)
<i>Incandescent</i>	\$1.99 (11)	\$2.23 (11)	\$2.24 (25)	\$2.33 (27)
Candle/Flame				
<i>LED</i>	\$4.32 (21)	\$4.32 (21)	\$4.98 (14)	\$4.99 (14)
<i>CFL</i>	--	--	--	--
<i>Halogen</i>	\$1.99 (2)	\$1.99 (2)	\$1.89 (2)	\$1.89 (2)
<i>Incandescent</i>	\$1.12 (18)	\$1.24 (18)	\$1.16 (23)	\$1.16 (27)

Bold and colored text indicates cost in November 2017 is at least 10% different in NY compared to MA for both mean and median price differences.

Table 13: Median Price Comparison by ENERGY STAR Status

(One week of product data in November 2017, excluding “smart” and Edison-style specialty bulbs; number of products in parentheses)

	Retailer 1		Retailer 2	
	Massachusetts	New York	Massachusetts	New York
ENERGY STAR LEDs				
A-line	\$4.74 (16)	\$5.19 (16)	\$2.49 (21)	\$3.99 (21)
Reflector/Flood	\$6.24 (54)	\$8.66 (54)	\$8.49 (40)	\$10.48 (40)
Globe	\$3.31 (9)	\$3.61 (9)	\$3.98 (5)	\$6.49 (5)
Candle/Flame	\$2.98 (13)	\$3.24 (13)	\$3.89 (4)	\$4.89 (4)
Non-ENERGY STAR LEDs				
A-line	\$5.97 (60)	\$5.97 (60)	\$4.98 (32)	\$4.98 (32)
Reflector/Flood	\$6.99 (27)	\$7.49 (27)	\$8.49 (53)	\$8.49 (53)
Globe	\$3.79 (13)	\$3.79 (13)	\$7.98 (14)	\$7.98 (14)
Candle/Flame	\$5.17 (13)	\$5.57 (13)	\$4.98 (15)	\$4.98 (15)

Bold and colored text indicates cost in July 2017 is at least 10% different between the two states for both mean and median price differences.