MA19R07-E: Residential Lighting Turn-in/ Exchange Study

FINAL REPORT

September 23, 2019

SUBMITTED TO:
Massachusetts Electric Program Administrators and Energy Efficiency Advisory Council Consultants

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Executive Summary

The Massachusetts Program Administrators (PAs) are considering offering a Residential Lighting Turn-In/Exchange Program (the program), which would be designed to facilitate customer exchange of inefficient bulbs or fixtures for new light emitting diode (LEDs) bulbs. The program objective would be to accelerate adoption of LEDs by reducing the large stockpiles of stored inefficient bulbs or to encourage customers to change out inefficient bulbs before failure. The program design means that it should be considered an early replacement program.

Recent studies have found that while customers are inclined to replace inefficient bulbs with LEDs, most of those bulbs are still replaced upon failure rather than replaced early; additionally, incandescent bulbs made up the plurality (45%) of stored bulbs in Massachusetts homes in 2019 and some of these inefficient bulbs do get installed.[1] These findings are indicative of opportunities that may be addressed by a Turn-In program.

To support the development of this new program, the PAs and the Energy Efficiency Advisory Council consultants (EEAC consultants) requested that NMR Group, Inc. (NMR), facilitate a process to (1) come to a consensus agreement on considerations for impact factors related to the program including Net-to-Gross Ratios (NTGR), Delta Watt, Adjusted Measure Life (AML), Lifetime In-Service Rate (ISR), and Hours of Use (HOU), and (2) establish deemed savings values for the program.

Impact Factors

The final NTGR, Lifetime ISR, AML, Delta Watt, and HOU values adopted by the PAs and EEAC are included in Table 1. These estimates assume that the PAs' existing upstream program will end on or after December 31, 2021.

Table 1: Prospective Impact Factors by Program Year

Program Year	2019	2020	2021
Net-to-Gross Ratio[1] (NTGR)	62%	55%	46%
Delta Watt[2]	46.4	46.4	46.4
Adjusted Measure Life (AML)	3	2	2
Lifetime In-Service Rate (ISR)	91%	89%	88%
Hours-of-Use per Day[3] (HOU)	2.7	2.7	2.7

[1] Assumes upstream program continues through 2021
[2] Based on combined incandescent and halogen – excluding CFLs.
[3] Value may change due to results of a pending study.

[1] Section 6.1 of NMR's 2019 *RLPNC Study 18-10 2018-19 Residential Lighting Market Assessment Study* found that one-fifth (21%) of all replacements came from storage, with incandescent bulbs accounting for the plurality of the stored bulbs (45%).

SUMMARY OF RATIONALES

To support the PAs and EEAC consultants in defining prospective impact factors, NMR reviewed and analyzed existing data sources from previously completed evaluations of the upstream and direct install lighting programs. NMR developed draft impact factors and deemed savings values based on this review. These draft values were the focus of a memo (refer to Appendix A for the memo) and a consensus call led by NMR and attended by PAs and EEAC consultants. The group came to consensus about which values to select for inclusion in the program. Here, we provide a brief summary of rationale for each impact factor. Additional details and documentation of discussion are included in the body of the report.

- **NTGR Rationale Summary:** The group agreed that NTGR for the program was likely to fall somewhere between the upstream and direct install programs. There was also discussion on the decision-making involved in turning in working/workable bulbs as part of early replacement activities. The group discussed the NTGR found in the evaluation for the appliance recycling program. Then, the group agreed to take the average of the lower upstream lighting program NTGR values and higher direct install program NTGR values for each year (2019 through 2021). Refer to the
- NTGR section below for more details.
- **Delta Watt Rationale Summary:** Since the program is designed as an early replacement program, the group decided to use the existing condition wattage. In the absence of program data, the group agreed to leverage data regarding wattages and types of bulbs installed and stored in Massachusetts' homes from the most recent lighting on-site study (MA RLPNC 18-10). The group agreed to take the average of the incandescent and halogen Delta Watt estimates (regardless of shape) for both installed bulbs and bulbs in storage. Refer to the Delta Watts section below for more details.
- **AML Rationale Summary:** The group agreed to use the direct install program's AML values for each program year as it was lower than the upstream value and was a simpler, more straightforward approach. Refer to the **Error! Reference source not found.** section below for more details.
- **ISR Rationale Summary:** The group agreed to use the ISR extrapolation from the RLPNC 18-10 panel study based on the date bulbs are turned in with a sunset year of 2023. They agreed to this approach because the Turn-In program will operate more similarly to the upstream program than the direct install program given that customers will continue to install bulbs from storage after the first year. Refer to the ISR section below for more details.
- **HOU Rationale Summary:** The group agreed on 2.7 HOU, which is the current assumption for the direct install program. However, everyone agreed that this may change based on results of a HOU-specific study, which, as of July 2019, is still being planned. Refer to the Delta Watts section below for more details.

Section 1 Consensus Process

This project consisted of four main tasks: Task 1: Review Existing Data Sources and Develop Draft Impact Factors and Deemed Savings Values, Task 2: Update Deemed Savings Values, Task 3: Consensus Approach for Impact Factors and Deemed Savings Values, and Task 4: Reporting. Additionally, NMR presented the results of the first two tasks in a memo and a spreadsheet to the Program Administrators (PAs) and the Energy Efficiency Advisory Council consultants (EEAC). These results were also used as the basis for the consensus discussion that took place as part of Task 3 (refer to Appendix A for the memo and Appendix B for the spreadsheet).

For this study, we were interested in providing data to help inform the establishment of prospective impact factor values for LEDs that will be distributed as part of the program (Net-to-Gross Ratios [NTGRs], Delta Watts, Lifetime In-Service Rate [ISR], and Adjusted Measure Life [AML]). Given the consensus basis for the project, NMR sought to develop a method that allowed both the PAs and EEAC consultants to provide input into developing these estimates. To this end, NMR prepared a memo outlining the proposed impact factors and then held a call with the PAs and EEAC consultants to discuss the proposed values and build consensus around which values to use in the program. The group was able to come to consensus during this call. After the call, NMR revised the final impact factor values based on the feedback from the PAs and EEAC consultants. In the subsections below, we describe each impact factor and the consensus discussion that led to it being selected.

This study leveraged several prior studies conducted in Massachusetts by NMR, including the RLPNC 17-11 LED Net-to-Gross Consensus Panel Report,[2] the RLPNC 18-5 Home Energy Assessment LED Net-to-Gross Consensus,[3] the Delta Watt Update (MA19R02-E),[4] the RLPNC 18-10 2018-19 Residential Lighting Market Assessment Study,[5] the RLPNC 179: 2019—21 Planning Assumptions: Lighting Hours-of-Use and In-Service Rate,[6] and the Northeast Residential Lighting Hours-of-Use Study.[7]

[2] NMR. 2018. RLPNC 17-11 LED Net-to-Gross Consensus Panel Report. Submitted to the Massachusetts Program Administrators and Energy Efficiency Advisory Council Consultants. Web: http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_1711_LEDNTGConsensus_30JUNE2018_final.pdf

[3] NMR. 2018. RLPNC 18-5 Home Energy Assessment LED Net-to-Gross Consensus. Submitted to the Electric and Gas Program Administrators of Massachusetts. Web: http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_185_HEALEDNTG_REPORT_23July2018_Final.pdf

[4] NMR. 2019. Delta Watt Update (MA19R02-E). Submitted to the Massachusetts Electric Program Administrators and Energy Efficiency Advisory Council Consultants.

[5] NMR. 2019. RLPNC Study 18-10 2018-19 Residential Lighting Market Assessment Study. Submitted to the Electric and Gas Program Administrators of Massachusetts.

[6] NMR. 2018. RLPNC 179: 2019—21 Planning Assumptions: Lighting Hours-of-Use and In-Service Rate. Submitted to the Massachusetts Program Administrators and Energy Efficiency Advisory Council Consultants.

[7] NMR. 2014. Northeast Residential Lighting Hours-of-Use Study. Submitted to the Electric and Gas Program Administrators of Massachusetts. Web: http://ma-eeac.org/wordpress/wp-content/uploads/Northeast-Residential-Lighting-Hours-of-Use-Study-Final-Report1.pdf

Section 2 Impact Factor Discussion and Consensus Values

In this section, we document the discussion for each impact factor, the consensus values, and the rationale behind the agreed upon values.

2.1 NTGR

The group discussed whether, and how, to leverage the upstream and direct install NTGR values on the consensus call. The group also discussed whether the usage of bulbs from storage was a NTGR or an ISR issue. The discussion centered around the following points:

- Participating customers may value the LED more given the required effort of acquiring it, which could equate to higher levels of free-ridership. The customer will need to take the bulbs from their homes to the drop-off locations to receive the free LEDs and then install or store those LEDs.
- In-service rate may be low for the Turn-In customers (since they may be likely to place the program LED in storage), but the NTGR could be high since many people have incandescent or halogen bulbs in storage and are unlikely to simply throw them away without the program.
- If a customer sees marketing materials for, or hears about, the Turn-In program, the program is at the very least inducing early replacement, which is not necessarily free-ridership.
- The possibility of developing two separate NTGR values was discussed – one for bulbs that are working and taken out early (higher NTGR) and another for bulbs taken out of storage (lower NTGR).

2.1.1 Rationale

Prior to the consensus call, the PAs and EEAC consultants indicated that they believed that the NTGR value for the Turn-In program would likely be higher than the NTGR value for the upstream lighting program and more similar to the NTGR value of the direct install lighting program. During the consensus call, the group discussed this further. As the group discussed, while a Turn-In program may motivate customers to replace bulbs early, like through the direct install program, the customer's decision-making process in the Turn-In program will differ in some ways from the direct install program since the customer may have to put in a greater level of effort than a direct install customer would to receive the free LEDs. This level of effort on the customers' behalf may be indicative of a greater desire to procure LEDs, which, at least in some instances, may mean the customer values the LEDs more. The consensus group discussed whether, by design, a Turn-In program would to some degree be more attractive to customers inclined to replace bulbs with LEDs – creating a self-selection bias for customers with a higher level of free-ridership. If true, this could be indicative of a level of free-ridership amongst these customers that more closely

resembles the upstream lighting program than the direct install program. However, it is also possible that the program will simply induce early replacement behavior (which differs from free-ridership) in some customers who do not have the means or would not have thought to replace the bulbs early without the support and guidance of the program. The idea of developing two separate NTGR values was also discussed – with a lower value for bulbs that are removed from storage and a higher value for bulbs that are in use. For reference, the prospective NTGRs for the upstream program (RLPNC 17-11) are displayed in Table 8 (in Appendix A) and those for the direct install program (RLPNC 18-5) are displayed in Table 9. Note that the direct install NTGR values already account for naturally occurring market adoption (NOMAD) and overlap with the upstream program. See the RLPNC 18-5 NTG study for additional details.

As part of the conversation about the likely decision-making process, the NTGR derived in the evaluation of the appliance recycling program was discussed.[8] The consumer decision-making process for appliances may have some similarities with lighting. The research has shown that consumers will often keep working refrigerators or freezers even though they are used quite infrequently. The group theorized that consumers may demonstrate similar behaviors with lighting products and as such, findings related to appliance recycling effort may have some bearing on consumer decision making for a lighting Turn-In program. The RLPNC 18-1 evaluation report provided a NTGR for refrigerators of 44% and a NTGR for freezers of 56%. There are differences between the detailed NTGR parameters in this program compared to a lighting Turn-In program. The recycling NTGR values are not directly applicable to a lighting Turn-In program, but do provide some general context for NTGRs for a program with a similar purpose, though addressing a different market.

Ultimately, the group agreed to take the average of the lower upstream lighting program NTGR values (Table 8) and higher direct install program NTGR values (Table 9) for each year (2019 through 2021). This approach provides balance for the different customer decision-making processes that the Turn-In program will induce. Following the consensus call, NMR performed this analysis and provided the values shown in Table 2 to the PAs and EEACs. Note that to estimate NTGR for the Turn-In program; NMR averaged the Base NTGR values from the direct install program (which assumes a December 31, 2021, program end date) with the Standard bulb type NTGR values from the upstream lighting program.

Table 2: Consensus NTG Values

Program Year	2019	2020	2021
Base NTGR from Direct Install program	88%	80%	66%
Standard Bulb Type NTGR from Upstream Lighting program	35%	30%	25%
NTGR for Turn-in program (avg. of DI and Upstream programs)*	62%	55%	46%

*Assumes upstream lighting program continues through 2021.

[8] NMR. 2018. 18-1 Appliance Recycling Report. Submitted to the Electric and Gas Program Administrators of Massachusetts. Web: http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_181_ApplianceRecycleReport_26SEP2018_FINAL.pdf

2.2 DELTA WATTS

NMR, the PAs, and the EEAC consultants next discussed which Delta Watt values to assume for the Turn-In program. Table 3 shows the average wattage for A-line, reflector, specialty and all incandescent, halogen, incandescent and halogens combined, and CFL bulbs found in storage during the last round of on-site visits for the RLPNC 18-10 panel study. The table also shows the average Delta Watts assuming those same bulbs were replaced by equivalent LEDs. The Delta Watts shown in red are the difference between these two averages. It may be possible to update these Delta Watts with program tracking data when the Turn-In program begins to track the wattage of lamps collected as part of the program.

Table 3: Consensus Delta Watt Values

		Incan	Halogen	Incan+ Halo	CFL
Number of Installed and Stored Bulbs		***7,362***	***2061***	***9,423***	***6,211***
A-line (n=8,547)	*% of Stored Bulb Type*	*46%*	*30%*	*43%*	*76%*
	Wattage	64.3	50.2	61.9	15.9
	LED Eq	9.8	10.5	9.9	10.5
	Delta	***54.5***	***39.8***	***52***	***5.4***
Reflector (n=2,351)	*% of Stored Bulb Type*	*12%*	*41%*	*19%*	*12%*
	Wattage	72.4	58.6	65.4	15.5
	LED Eq	10.9	11.2	11	10.9
	Delta	***61.5***	***47.4***	***54.4***	***4.6***
Specialty (n=4,247)	*% of Stored Bulb Type*	*42%*	*29%*	*39%*	*12%*
	Wattage	34	82	41.3	13.8
	LED Eq	4.4	10.2	5.2	12.8
	Delta	***29.6***	***71.8***	***36.1***	***1***
All Bulbs (n=15,145)	Wattage	52.6	62.3	54.7	15.6
	LED Eq	7.6	10.7	8.3	10.8
	Delta	***44.9***	***51.6***	***46.4***	***4.8***

2.2.1 Rationale

In the absence of program data, the group agreed to leverage the lighting on-site data, which provides wattages and types of bulbs installed and stored in Massachusetts homes. Using that information, we theorize that any bulbs turned in through the program will represent the average of all remaining inefficient bulbs.

After some brief discussion, the group came to consensus around the idea of taking the average of the incandescent and halogen Delta Watt estimates for all bulb types for both installed bulbs and bulbs in storage (Table 4). The group agreed to use this deemed value for the time being and revisit it once bulbs begin to be collected through the Turn-In program. Following the consensus call, program staff confirmed that bulbs collected as part of the program will be tracked and indicated that CFLs would not be accepted. If any exceptions to CFL collection are made on a case-by-case basis, an alternative CFL to LED Delta Watt could be applied for those few lamps that are collected.

Table 4: Consensus Delta Watt Values

Program Year	2019	2020	2021
Delta Watt	46.4	46.4	46.4

*Based on combined incandescent and halogen – excluding CFLs.

2.3 Adjusted Measure Life

The upstream and direct install programs currently use separate calculations to develop Adjusted Measure Lives (AMLs)[9] for program-claimable savings (which are shorter than the actual physical lifetime of the bulbs). The upstream program calculates AML using the Delta Watts stream from the market adoption model, while the direct install program established an AML as part of the RLPNC 18-5 NTG study. NMR shared the various options that exist for establishing an AML for the Turn-In program with the PAs and EEAC prior to the consensus call:

- Adopting the AML used by the upstream lighting program
  - Six years for standard, as of 2018
  - Seven years for specialty, as of 2018
- Adopting the AML used by the direct install program
  - Three years for 2019
  - Two years for 2020 and 2021
- Establishing an AML based on a sunset year[10]

2.3.1 Rationale

During the consensus call, the group discussed which value to use for the Turn-In program's AML. They agreed to use the direct install program's AML values for each program year (Table 5) as it was lower than the upstream value and was a simpler, more straightforward approach. In addition, the group noted that this approach creates a balance by using a lower value for useful life and a higher Delta Watt value for the duration of the bulbs' remaining useful lives. Please note that values are rounded to the nearest whole number; this accounts for why the 2021 AML value does not appear to decrement from the 2020 value.

Table 5: Consensus Adjusted Measure Life

Program Year	2019	2020	2021
Adjusted Measure Life	3	2	2

[9] Adjusted Measure Life (AML) provides an estimate for the number of years for which a program can claim savings for a given lighting measure. The MA PAs have begun to use the term AML instead of the terms Effective or Estimated Useful Life (EUL) in the TRM which was prompted by the C&I duel baseline adoption. The MA PAs recommend using this new terminology for the Turn-In program as well. AML estimates are typically not as long as the actual physical (calculated) lifetime of the measure; the AML accounts for changes in the baseline due to EISA standards.

[10] A sunset year is defined as a point in time when the Massachusetts PAs will no longer take credit for installed bulbs. It also represents a point in time when consumers are unlikely to find non-LED bulbs available for purchase.

2.4 ISR

Prior to the call, NMR considered establishing a Turn-In specific ISR based on the percent of bulbs from storage being installed in sockets. However, upon reflection, that seemed to be an issue more closely related to NTGR than ISR. NMR then suggested that the Turn-In program rely on the ISR data and methods outlined for the upstream program as part of the 18-10 report. The rationale was that customers have been shown to install the vast majority of LEDs they obtain through the upstream program over time. We believe this will be the case with the Turn-In program as well. If customers turn in a bulb from storage, they will eventually use the LED to replace an installed bulb; if customers turn in a bulb that was already installed, then the LED will be likely to immediately replace an installed bulb. This is very similar to how the upstream program works from the customer's perspective.

2.4.1 Rationale

During the consensus call, the PAs and EEAC consultants agreed to use the ISR extrapolation from the RLPNC 18-10 panel study based on the date bulbs are turned in with a sunset year of 2023. The group agreed to this approach because the Turn-In program will operate more similarly to the upstream program than the direct install program given that customers will continue to install bulbs from storage after the first year.

We used the discounted future savings[11] method in order to determine Lifetime ISR by calculating the net present value based on the first-year ISR and the incremental ISR for each program year. This assumes a certain percentage of LEDs are installed in year 1, year 2, year 3, and so on until the sunset year. We then took the net present value of ISR (using a 2.54% discount rate)[12] to arrive at the lifetime ISR. With a sunset year of 2023, an LED provided through the program in 2019 would have five years to get installed (Table 6).

Table 6: Consensus Lifetime In-Service Rate

	Year of Participation		
Cumulative Installation (by year)	**2019**	**2020**	**2021**
2019	75%	N/A	N/A
2020	84%	75%	N/A
2021	88%	84%	75%
2022	90%	88%	84%
2023 (SUNSET YEAR)	92%	90%	88%
Recommended ISR (Lifetime Net Present Value)	**91%**	**89%**	**88%**

[11] The Massachusetts UPM suggests two methods to account for savings that occur after the year in which the program occurred. In the method used here, discount future savings, all the costs and benefits are claimed during the program year, but the savings (in terms of avoided costs, kilowatt-hours, or kilowatts) from the expected future installation of stored program bulbs are discounted back to the program year using a societal or utility discount rate. This method offers the simplicity of claiming all costs and benefits during the program year, and thus not having to track and claim future installations.

[12] The discount rate is set based on a twelve-month average of the historic yields from the ten-year United States Treasury note, using the previous year to determine the twelve-month average.

2.5 HOU

The group only briefly discussed HOU as HOU assumptions for all programs are planned to be evaluated as part of a separate study, which is still in the planning process (as of July 2019). As a placeholder, the group agreed on 2.7 HOU, which is the current assumption for the direct install program based on the average HOU for all lamps in a home (Table 7). However, we understand that this may change based on results of a pending study.

Table 7: Consensus Hours of Use Values

Program Year	2019	2020	2021
Hours-of-Use per Day[1] (HOU)	2.7	2.7	2.7

[1] Value may change due to results of a pending study.

Appendix A MA19R07-E: Residential Lighting Turn-in/ Exchange Study Memo

NMR provided the following memo to the PAs and the EEAC consultants on July 10, 2019. The memo was intended to inform the consensus discussion that occurred on July 11, 2019.

The overall goal of this memo is (1) to present data that may be helpful in establishing impact factors (NTGR, Delta Watt, HOU, and ISR) related to a potential new Lighting Turn-in/Exchange program and (2) to provide preliminary starting points for discussion of deemed savings values for the program.

Data presented in this memo come from previously completed evaluations of the upstream and direct install lighting programs.

A.1 NET-TO-GROSS RATIOS (NTGRS)

The PAs and EEAC consultants have stated that they believe NTG for the turn-in program will likely be higher than the NTG value of upstream lighting and may be more similar to the NTG value of the direct install lighting program.[13] For reference, the prospective NTGRs for the upstream program (*RLPNC 17-11*)[14] are displayed in Table 8 and those for the direct install program (*RLPNC 18-5)*[15] *are* displayed in Table 9.

The rationale for a higher NTG for the turn-in program is based on the assumption that customers will turn-in bulbs from storage or remove bulbs from service – essentially replacing these bulbs early. Evidence from Massachusetts' series of on-site lighting studies shows that customers are storing many inefficient lamps for future use. Even if inefficient bulbs cease to be available for purchase, some portion of bulbs in storage may eventually be installed—in fact, in 2018, 21% of all replacement bulbs came from storage. In addition, a turn-in program may motivate customers to replace bulbs early (like through the direct install program). For these reasons, NMR believes it is reasonable to expect the NTG for the turn-in program would be higher than the NTG for the upstream program.

However, on-site inventories of stored bulbs also reveal that not all stored bulbs end up installed. Monitoring bulbs found in storage over a four-year period, we found that after four years, about 19% of inefficient bulbs were installed. The remaining lamps were either being stored for future use or were disposed of (thrown away, recycled, or otherwise disposed of). In addition, it is possible that customers will turn in some lamps that are non-functioning and, while it would be

[13] RLPNC biweekly meeting February 7, 2019.
[14] NMR. 2018. RLPNC 17-11 LED Net-to-Gross Consensus Panel Report. Submitted to the Massachusetts Program Administrators and Energy Efficiency Advisory Council Consultants. Web: http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_1711_LEDNTGConsensus_30JUNE2018_final.pdf
[15] NMR. 2018. RLPNC 18-5 Home Energy Assessment LED Net-to-Gross Consensus. Submitted to the Electric and Gas Program Administrators of Massachusetts. Web: http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_185_HEALEDNTG_REPORT_23July2018_Final.pdf

feasible to implement program procedures to screen out failed bulbs (testing at turn-in), additional screening procedures would likely be overly burdensome for the program and participants.

So, while we believe NTG for the turn-in program should be higher than for the upstream program, we do not think it should be 100%. Instead, we suggest that the PAs and EEAC consultants consider the direct install prospective NTG as a guideline for maximum NTG for any turn-in program. This provides balance for the early replacement nature of the program, while recognizing the fact that some bulbs recycled through the program may not ultimately have been installed. Note that the direct-install NTG values already account for naturally occurring market adoption (NOMAD) and overlap with the upstream program. See the RLPNC 18-5 NTG study for additional details.

Table 8 RLPNC 17-11 – Recommended Prospective NTGRs — Upstream

Bulb Types	2019	2020	2021
Standard	35%	30%	25%
Reflector	45%	40%	35%
Specialty	45%	40%	35%

Table 9: RLPNC 18-5 – Prospective HEA LED NTGR and Effective Useful Lives — Direct Install

		Upstream Program Ends		
Program Year	Dec. 31, 2021 (Base)	Dec. 31, 2018	Dec. 31, 2019	Dec. 31, 2020
2019	88%	88%		
2020	80%	83%	82%	
2021	66%	74%	72%	69%

Table 10 shows an average usage rate of stored inefficient bulbs. These rates were calculated by tracking bulbs over time through the *RLPNC 18-10* panel study. We were able to follow a bulb from when it was first recorded as stored to find out if it had been installed, thrown away/recycled, given away, installed elsewhere, or was still in storage. We completed this process for bulbs first found in storage in 2015 as well as those first found in storage in the 2016, 2017, 2017-18, and 2018-19 studies. The table below shows an average of those install rates for incandescent bulbs and halogen bulbs as well as halogen and incandescent bulbs combined. We recommend that the group consider using the combined inefficient usage rates. While halogens have a higher first, second, and third year ISR, their fourth year ISR is similar to the incandescent fourth year ISR. In addition, because of averaging the usage rates from different samples (2015, 2016, 2017, and 2018) there is an odd decrease in usage rates for halogens in year four.

We provide this information as it may be helpful as input into discussions about NTG.

Table 10: Usage of Stored Inefficient Bulbs

Year	Incandescents	Halogen	Combined
1	6%	13%	7%
2	11%	19%	12%
3	15%	24%	16%
4	19%	21%	19%
*5 (estimated)**	*23%*	*n/a*	*22%*
*6 (estimated)**	*27%*	*n/a*	*25%*
*7 (estimated)**	*31%*	*n/a*	*28%*
*8 (estimated)**	*35%*	*n/a*	*31%*
*9 (estimated)**	*39%*	*n/a*	*34%*
*10 (estimated)**	*43%*	*n/a*	*37%*

*Estimated by using change in usage between third and fourth year.

Discussion Points:

- Similarity of turn-in program to upstream or direct install in terms of NTG
- Usage of bulbs from storage – NTG or ISR issue
- Other items brought up by consensus group

A.2 DELTA WATTS

Table 11 shows the average wattage for A-line, reflector, specialty and all incandescent, halogen, and CFL bulbs found in storage during the last round of on-site visits for the *RLPNC 18-10* panel study. The table also shows the average Delta Watts assuming those same stored bulbs were replaced by equivalent LEDs. The Delta Watts shown in red are the difference between these two averages. Note that we have included CFLs in the table in case the PAs ultimately choose to include CFLs as eligible bulbs as part of the turn-in program.

We recommend that the group consider using the Delta Watt average values associated with each bulb type and style as presented in Table 11 below. It may be possible to update these Delta Watts with program tracking data if the turn-in program tracks the wattage of lamps collected as part of the program. If not, the deemed values provided here should serve as a good proxy.

Table 11: Average Wattage of Stored Bulbs (RLPNC 18-5)

		Incandescent	Halogen	CFL
# of stored bulbs		***2,760***	***571***	***1,320***
A-line (n=2,200)	*% of Stored Bulb Type*	*40%*	*35%*	*29%*
	Wattage	67.3	50.6	15.7
	LED Eq	10.4	10.5	10.3
	Delta	***56.9***	***40.1***	***5.4***
Reflector (n=752)	*% of Stored Bulb Type*	*9%*	*42%*	*24%*
	Wattage	67.7	56.3	15.3
	LED Eq	10.7	10.7	10.7
	Delta	***57.0***	***45.6***	***4.6***
Specialty (n=1,699)	*% of Stored Bulb Type*	*51%*	*24%*	*8%*
	Wattage	30.5	94.4	13.5
	LED Eq	4.3	9.9	12.8
	Delta	***26.2***	***84.5***	***0.7***
All Bulbs (n=4,651)	Wattage	48.7	63.4	15.3
	LED Eq	7.3	10.4	10.7
	Delta	***41.4***	***53.0***	***4.6***

Discussion Points:

- Appropriateness of using stored bulb wattage for turn-in program Delta Watts
- Ability of program to track wattage of bulbs turned in
- Other points brought up by consensus group

A.3 Adjusted Measure Life

The upstream and direct install programs currently use separate estimates of adjusted measure life (AML). The upstream program based AML on the market adoption model, while the direct install program established an AML as part of the RLPNC 18-5 NTG study. Various options exist for establishing an AML for the turn-in program including:

- Adopting the AML used by the upstream program
  - 6 years for standard, as of 2018
  - 7 years for specialty, as of 2018
- Adopting the AML used by the direct install program
  - 3 years for 2019
  - 2 years for 2020 and 2021
- Establishing an AML based on a sunset year

If the consensus group agrees to establish a sunset year for ISR (discussed above), NMR thinks it would be simplest to use that sunset year to establish an AML. This would provide for a declining AML for each year of the turn-in program and provide internal consistency. For example, if the consensus group agrees to a sunset year of 2027, bulbs distributed as part of the turn-in program in 2019 would have an AML of nine years. Bulbs distributed as part of the turn-in program in 2020

would have an AML of eight years and bulbs distributed in 2021 would have an AML of seven years.

Discussion Points:

- General thoughts on AML for turn-in vs. upstream vs. direct install
- Appropriateness of using sunset year to establish AML
- Other points brought up by consensus group

A.4 In-Service Rate

Initially, NMR considered establishing a turn-in specific ISR based on the percent of bulbs from storage being installed in sockets. However, upon reflection, that seemed to be an issue more closely related to NTG than ISR – this is a point that the consensus group can discuss during our first meeting.

We suggest that the turn-in program rely on the ISR data and methods outlined for the upstream program as part of the *18-10* report. Our rationale is that customers have been shown to install the vast majority of LEDs they obtain through the upstream program over time. We believe this will be the case with the turn-in program as well. If customers turn-in a bulb from storage, they will eventually use the LED to replace an installed bulb; if customers turn in a bulb that was already installed, then the LED will immediately replace an installed bulb. This is very similar to how the upstream program works from the customer's perspective. The lifetime ISR values from the *RLPNC 18-10* report are included in Table 12. To establish an ISR for the turn-in program, the PAs and EEAC will need to agree on a sunset year; the sunset years established for the upstream program were 2022 for A-line and 2024 for Reflector and Specialty. Given that the turn-in program will address bulbs found in storage or currently installed, we believe that a later sunset year is appropriate for the turn-in program.

Table 12: LED In-Service Rate Extrapolation

Year	Incremental Install from Storage	Storage	ISR
1 – 2018	n/a	25%	75%
2 – 2019	34%	16%	84%
3 – 2020	27%	12%	88%
4 – 2021	17%	10%	90%
5 – 2022	17%	8%	92%
6 – 2023	17%	7%	93%
7 – 2024	17%	6%	94%
8 – 2025	17%	5%	95%
9 – 2026	17%	4%	96%
10 – 2027	17%	3%	97%

Discussion Points:

- Usage of bulbs from storage – NTG or ISR issue
- Appropriateness of using upstream ISR method
- Sunset year for turn-in program
- Other points brought up by consensus group

A.5 Hours of Use

HOU will be addressed as part of a different study.

Appendix B Impact Factors Spreadsheet

The spreadsheet imbedded below was provided to the PAs and EEAC council prior to the consensus call on July 11, 2019.

Impact Factors.xlsx