RLPNC 18-5 Home Energy Assessment LED Net-to-Gross Consensus

FINAL

July 23, 2018

Preliminary Data for Consensus Discussions

SUBMITTED TO:
The Electric and Gas Program Administrators of Massachusetts

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Executive Summary

The Massachusetts Program Administrators (PAs) and the Energy Efficiency Advisory Council consultants (EEAC consultants) are currently creating the comprehensive three-year program portfolio plan for the 2019 through 2021 program period. Part of this process includes the setting of prospective net-to-gross ratios (NTGRs) for light emitting diode (LED) bulbs offered through various initiatives. This study was designed to provide a means through which the PAs and EEAC consultants could come to consensus on what prospective NTGR values should be used for LEDs installed as part of the Home Energy Services (HES) initiative. Prospective NTGR for LEDs distributed as part of the Retail Products initiative were set as part of the RLPNC 17-11 LED NTG Consensus study (presented separately).[1]

The HES initiative is the primary mechanism the Program Administrators (PAs) use to partner with non-low-income residential customers living in 1- to 4-unit (single family) to improve their homes' existing efficiency. The initiative's whole home energy assessment (HEA) includes the installation of a variety of instant savings measures including efficient lighting. This study focused exclusively on the efficient lighting component of the HEA.

Impact Factors

The final NTGR and Effective Useful Life (EUL) values adopted by the PAs and EEAC are included in Table 1. Since it is uncertain if the upstream LED program will exist for all years 2019 – 2021, the PAs and EEAC consultants agreed to varying NTGR values based on when the upstream program ends. For example, the base case is the upstream program ending on or after December 31, 2021. The other scenarios assume the upstream program ends at some point before or during the 2019 – 2021 program period—resulting in higher NTGR values for LEDs installed as part of HEA.

[1] http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_1711_LEDNTGConsensus_30JUNE2018_final.pdf

Table 1: Prospective HEA LED NTGR and Effective Useful Lives

Program Year	Effective Useful Life	Upstream Program Ends			
		Dec. 31, 2021 (Base)	Dec. 31, 2018	Dec. 31, 2019	Dec. 31, 2020
2019	3	88%	88%		
2020	2	80%	83%	82%	
2021	2	66%	74%	72%	69%

CONSENSUS PROCESS

To support the PAs and EEAC consultants in defining prospective NTGRs, NMR compiled data on the number of efficient lamps installed as part of HEA based on program records, as well as historical lighting market trends for single-family non-low-income households based on saturation data collected as part of nearly annual lighting on-site visits. Data from these various sources were combined into an Excel-based tool that was provided to the PAs and EEAC consultants to help arrive at consensus for three key inputs which drive prospective NTGR values. These three inputs were:

- **Market Movement.** Market movement is the average incremental number of efficient lamps installed per home per year (above what was previously installed), leading to a decrease of inefficient lamp saturation on a year-to-year basis. Market movement is a combination of naturally occurring market adoption (NOMAD) and upstream program influence.
- **Escalation** of Market Movement. The degree to which market movement is expected to change over time.
- **Market Movement Attributable to Upstream**. The amount of market movement attributable to the upstream program.[2]

The PAs and EEAC consultants entered estimates into the Excel Tool (embedded within this document) and arrived at consensus via email and phone conversations. While the PAs and EEAC consultants did not ultimately agree on the reasons and rationales behind the final values, they were able to agree on a set of values that enabled the calculation of the NTGRs and EULs presented above. Ultimately, the PAs and EEAC consultants agreed on the following values for the input variables:

[2] Note: market movement attributable to the upstream program should not be confused with HEA or Upstream program net-to-gross (NTG). NTG is the proportion of program units that could only occur due to a program (would not be done without a specific program). Market movement includes market movement due to a variety of factors including the upstream program.

Table 2: HEA LED NTGR Input Values

Input	2018	2019	2020	2021
Market Movement	3.0	3.5	4.0	4.6
Escalation	n/a	1.15	1.15	1.15
Market Movement Attributable to Upstream	n/a	31%	26%	21%

Section 1 Background & Historical Data

This report describes the process by which the Massachusetts Program Administrators (PAs), the Energy Efficiency Advisory Council consultants (EEAC consultants), and the residential retail lighting evaluation team, led by NMR Group, Inc., developed prospective net-to-gross ratios (NTGRs) for light emitting diode bulbs (LEDs). The PAs and EEAC consultants will use these prospective NTGRs to help plan the 2019 to 2021 Home Energy Assessment (HEA) portion of the Home Energy Services Initiative.

Forecasting NTGR is never easy; however, this study was able to leverage a rich set of longitudinal data provided by the extensive series of residential lighting saturation studies[3] conducted in Massachusetts and program tracking data from the HES initiative.[4] These two data sets allowed the PAs and EEAC consultants to explore market trends to help inform estimated future market changes in the absence of HEA. The underlying principle behind this effort was to estimate market movement expected during the 2019 – 2021 program period. Market movement was defined as the incremental number of efficient lamps installed per home per year (above what was previously installed), leading to a change in inefficient socket saturation on a year-to-year basis, this movement encapsulates both naturally occurring market adoption (NOMAD) and the effects of the LED portion of PAs' Retail Products Initiative (upstream). Market movement effects the calculation of NTGRs for HEA by changing both the numerator (number of claimed lamps) and the denominator (number of installed lamps).

1.1 Historical HEA Performance

According to data available via Mass Save, between 2013 and 2017, the PAs have averaged between 22 and 35 lighting measures per HEA; see Table 3 for a year-by-year breakdown. Historically, the HEA program included the installation of CFLs and LEDs, but beginning in 2017 the program began installing only LEDs; program staff anticipates that the program will support only LEDs during the 2019 through 2021 program period. Additionally, HEA only replaces inefficient lighting (incandescent and halogen lamps) and targets replacing 100% of inefficient lighting in participating homes. Prior to switching to LEDs, the PAs reported that HEA contractors had difficulty replacing 100% of inefficient lamps because participants did not want CFLs installed in some fixtures for which LEDs were unavailable at that time (specialty fixtures, dimmers, dining rooms, etc.). The PAs reported that the greater availability of LEDs to fill specialty sockets has increased the reach of the program within individual homes.

[3] http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_179_LtgMarketAssessment_28March2018_FINAL-1.pdf
[4] http://masssavedata.com/Public/HESActivity

Table 3: HEA Lighting Measure Activity[5]

Year	Assessments	Avg. Lighting Measures*
2013	83,218	22
2014	89,416	27
2015	100,539	35
2016	76,758	23
2017	83,873	25

* Historically, the HEA program included the installation of CFLs and LEDs, but beginning in 2017 the program began installing only LEDs; program staff anticipates that the program will support only LEDs during the 2019 through 2021 program period.

1.2 Longitudinal Socket Saturation Data

Table 4 provides an overview of saturation changes among non-low-income single-family (1- to 4- unit) homes between 2012 and 2017. The data presented in Table 4 exclude self-reported and confirmed HEA participants who are otherwise included in the broader sample of homes presented in the separate market assessment reports. In addition, these values exclude low-income households, which are eligible to participate in income-eligible programs. As the data show, the saturation of inefficient lighting has fallen from 61% to 43%. Note that the market experienced a period of stagnation between the 2013 and 2014 visits.[6] Changes in saturation tracked between 2012 and 2017 are the result of both naturally occurring market adoption (NOMAD) and the influence of the upstream lighting program.

Due to differences in sampled homes, the average number of sockets varies on an annual basis. To eliminate this element of variance in our calculations (see below) we used a uniform value of 60 sockets in all calculations – the average of sockets from the 2014-2017 studies; we chose to exclude the average sockets from 2012 and 2013 due to changes in on-site protocols and procedures that were introduced by NMR beginning with the 2014 visits (visit timing Jan-Feb 2015).

[5] Note: Due to reporting idiosyncrasies, some lighting measures that were installed during the 2016 calendar year, were reported as part of the 2015 HEA program year. This makes it appear as if the HEA program had a spike in the average number of lighting measures installed in 2015. In actuality, this is not the case but the data contained on MassSaveData.com has not been adjusted to correct for this.

[6] http://ma-eeac.org/wordpress/wp-content/uploads/Lighting-Market-Assessment-and-Saturation-Stagnation-Overall-Report.pdf

Table 4: Single Family Market Movement 2013 - 2017

Visit Year Ending	Visit Timing	Sample Size	Avg. Sockets*	Inefficient Saturation**
2012	Jan – Mar 2013	63	48***	61%
2013	May – Jun 2014	129	52***	55%
2014	Jan – Feb 2015	132	60	56%
2015	Dec 2015 – Mar 2016	163	61	52%
2016	Oct 2016 – Jan 2017	131	58	48%
2017	Oct – Dec 2017	75	62	43%

* Average sockets include all lamp types: LEDs, CFLs, Linear, Halogen, and Incandescent.

** Incandescent and halogen combined

*** Data collection protocols and procedures were updated beginning in 2015 when NMR took over on-site data collection responsibility. The updated protocols and procedures resulted in identifying additional sockets on average (i.e. identifying lamps that had previously been overlooked and empty sockets)

In addition to looking at overall trends, NMR examined the number of lamps replaced by panelists each year as part of the nearly annual lighting on-site visits.[7] We found that panelists replaced about 13-14% of their sockets on an annual basis. With a base of 60 sockets, we can reasonably assume that HEA-eligible households will replace an average of seven to eight lamps each year in the absence of the HEA program. We anticipate that the number of replaced lamps will decrease over time as LED saturation increases and customers need to replace fewer lamps due to failure (given longer lives of LEDs).

Finally, NMR examined the proportion of remaining inefficient lamps by shape. Focusing on just the sample of 2017 on-site visits completed with HEA-eligible households, 42% of remaining inefficient lamps are A-line, 24% are reflectors, and 34% are other specialty shapes.[8]

1.3 MARKET MOVEMENT

The residential lighting market in Massachusetts is subject to two main driving forces: NOMAD and program-induced adoption (either via the upstream program or lamps replaced as part of HEA). By reviewing changes in saturation over time, we developed an estimate of combined adoption. By limiting our sample to non-HEA participants, we eliminated HEA-induced adoption from our analysis.

By limiting our sample in this way, we are left with a combination of NOMAD and upstream program influence, which we term market movement (MM).

[7] Panel visits involve revisiting the same households on an annual basis and tracking difference in lighting saturation. These visits included marking lamps in homes to ensure lamps observed are the same or new. Additional details on panel visits can be found in the RLPNC 17-9 Study.

[8] For the entire sample of 2017 on-site visits, 50% of remaining inefficient lamps were A-line, 19% were reflector, and 31% were other specialty shapes.

These market movement values help to estimate the counterfactual or non-HEA program participant scenario. For example, between 2016 and 2017, the proportion of inefficient sockets decreased from 48% to 43%. Assuming an average of 60 sockets per home, that was a decrease of three inefficient lamps per home. Therefore, in the absence of the HEA program, the average household would have replaced three inefficient lamps with efficient lamps, as a result of both NOMAD and influence from the upstream program. Historical estimates of market movement are presented in Table 5.

Table 5: Market Movement

Visit Year Ending	Inefficient Sockets	Market Movement
2012	37	n/a
2013	33	4
2014	34	-1
2015	31	3
2016	29	2
2017	26	3

Section 2 Consensus Process

While historical data on market movement provides useful context, for this study we were interested in providing data to help inform the establishment of prospective NTGR estimates. This necessitated developing a method to estimate future market movement values. 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 an Excel-based tool that allowed the PAs and EEAC consultants to explore the impact of changing assumptions on market movement, remaining inefficient sockets, estimated useful life, and ultimately HEA NTGR. NMR revised the original tool based on feedback from the PAs and EEAC consultants, as well as based on the final consensus values.

2.1 Excel Tool

The Excel Tool provided an overview of data as well as sensitivity analyses for various inputs. NMR designed the tool to be as simple and easy to use as possible and provided instructions on its use in a Microsoft Word document and through a webinar.

The Excel Tool was organized to allow the group to make decisions in bite-sized chunks, with each decision building upon the last. The tool was meant to help facilitate conversation by providing updated NTGR and EUL estimates in real-time based on decisions made by the group. NMR asked the consensus group to develop input values for the five highlighted cells in the Excel Tool, but the tool could also be manipulated or updated manually as desired.

During the consensus process, NMR revised the original tool based on feedback from the PAs and EEAC consultants, as well as the final consensus values. The final iteration of the tool, containing final values, is provided in an spreadsheet attached to this document named RLPNC_185_ExcelTol_23July2018_Final.xlsx

The Excel Tool is divided onto three separate tabs within the Excel file: *NTG Calculations, Scenario Summary, and EUL Calculations*. Brief descriptions of each tab are included below:

NTG Calculations

The Excel Tool provided historical estimates of inefficient sockets and market movement. On the *NTG Calculations* tab, the PAs and EEAC consultants could manipulate estimated future values for market movement by entering values in two cells (highlighted in yellow). The first cell (G20) provided a means to adjust market movement in 2018 – this was called annual market movement and carried forward to each subsequent year. The second cell (G21) provided a means to either increase or decrease market movement by a multiplier.

The *NTG Calculations* tab also included an opportunity for the PAs and EEAC consultants to assign values for the portion of NOMAD attributable to the upstream program (cells H11:H13, highlighted in orange).

Based on market movement estimates and upstream attribution, the Excel Tool calculated estimated HEA first-year NTGR values (cells L11:L13).

Finally, the *NTG Calculations* tab provided calculations for three scenarios in which the upstream program was forecasted to end (Dec. 31, 2018, Dec. 31, 2019, Dec. 31, 2020). These formulas in these scenarios account for differences in installed HEA lamps and updated NTG values resulting from these calculations.

Scenario Summary

The *Scenario Summary* tab included a table summarizing the NTGR values from the *NTG Calculations* tab (Cells A1:E6) as well as notes and tables providing insight into why and how the various scenarios differ and why NTGR estimates vary as a result.

EUL Calculations

The *EUL Calculations* tab included data and formulas to calculate EULs for 2019, 2020, and 2021. Note: NMR initially experimented with including separate EUL calculations in various scenarios for if/when the upstream program ended but, due to rounding, found this did not have any impact on final EUL values. Therefore, to simplify the tool, the final iteration only included one set of EUL values for each program year.

EUL was calculated automatically based on values locked in on the *NTG Calculations* tab. The EUL formulas are included in cells E10:G11 and rounded to the nearest whole year. The formulas consider annual HEA savings for each year after participation (decrementing for market movement in each year) and calculate adjusted EUL based on these values. Market movement values are linked from the *NTG Calculations tab*.

2.2 Market Movement Estimates

The PAs and EEAC consultants each provided estimated market movement values as well as rationales via email. Both groups provided their estimates within the Excel Tool provided by NMR. Table 6 contains the estimates, rounded to the nearest tenth. The PAs assumed market movement would accelerate in the near-term, reaching 3.5 in 2018 and 3.8 in 2019 and 2020, before beginning to decrease in 2021. The EEAC consultants assumed market movement would hold steady in 2018 and then increase by 15% in each subsequent year.

The PAs' market movement estimates were higher than the EEAC estimates in 2018 and 2019 and lower than the EEAC estimates in 2020 and 2021. Through 2021, the PAs estimated total market movement of 17.5 versus 18.1 for the EEAC consultants—a close match over the combined program period. The two estimates diverged after 2021 as the PA estimates leveled off and the EEAC consultant estimates continued to escalate.

Using the market movement estimates provided, NMR calculated the remaining number of inefficient lamps for both the PA and EEAC scenarios. Figure 1 provides a summary of these values. The PA market movement estimates suggested that the residential lighting market will be fully transformed by the end of 2023, as no inefficient lamps remain in 2024. The EEAC consultant market movement estimates suggested that the market will be fully transformed one year earlier, by the end of 2022 (no inefficient lamps remain in 2023). Note: NMR adjusted the final years of

market movement estimates provided by the PAs and EEAC consultants to ensure that total market movement did not exceed the number of inefficient sockets in any given year.

Table 6: PA and EEAC Market Movement Estimates

Program Year	PA MM Estimate	EEAC MM Estimate	PA minus EEAC
2017 (Observed)	3.0	3.0	--
2018	3.5	3.0	0.5
2019	3.8	3.5	0.3
2020	3.8	4.0	(0.2)
2021	3.4	4.6	(1.2)
2022	3.9	5.2	(1.3)
2023	4.5	5.6*	(1.1)
2024	2.9*	n/a	2.9
Total through 2021	17.5	18.1	(0.6)
Total through 2024	*28.8*	*28.9*	*(0.1)*

*Market movement estimate reduced to equal the total number of remaining inefficient sockets.

Figure 1: Comparison of PA and EEAC Estimates of Inefficient Lamps

2.2.1 Rationales and Discussion

Here we have summarized the rationale provided by both the PAs and EEAC consultants.

PA Rationale:

In an email sent on June 14, 2018, the PAs provided estimates and their rationale. In short, the PAs believed that market movement is driven by lighting sales. While they have observed an increase in program sales in 2018, they did not believe that the increase would continue through the 2019 – 2021 program period or beyond. This aligned with preliminary program plans for the upstream program as well as interviews with suppliers conducted as part of the RLPNC 16-2 Supplier Interview Study.[9]

EEAC Rationale:

In an email sent on June 5, 2018, the EEAC consultants provided their estimates and rationale. In short, the EEAC consultants chose to use observed market movement from 2017 (last observed data) as the starting point for 2018. To inform their estimate of market movement for 2019 and beyond, the EEAC consultants examined the proportion of new lamps that were efficient vs. inefficient based on panelist behavior observed as part of the longitudinal lighting on-site panel visits.[10] The consultants found that inefficient share declined by roughly 5% each year between 2016 and 2018. The EEAC consultants then estimated remaining inefficient market share based on assuming a continued 5% decrement in inefficient market share through 2023, at which point inefficient share reached zero. Through trial and error, the EEAC consultants chose a market movement multiplier which allowed remaining inefficient sockets to reach zero in 2023. This value was 1.15.

2.2.2 Market Movement Consensus

NMR prepared a spreadsheet comparing the results from the EEAC and PA estimates and provided a summary of differences via email (email sent June 18, 2018). While the PAs did not necessarily agree with the rationale presented by the EEAC consultants, they agreed that the values generally arrived at a reasonable level of total market movement over the 2019 – 2021 program period. The PAs accepted the EEAC consultant market movement estimates (Table 7).

[9] http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC-16-2_MA2017SupplierInterviews_24FEB2017_Final-1.pdf

[10] Note: These figures are based on the full set of lighting panelists and are not limited to non-low-income single-family homes that have not participated in HEA.

Table 7: Final Market Movement Estimates

Program Year	MM Estimate
2017 (Observed)	3.0
2018	3.0
2019	3.5
2020	4.0
2021	4.6
2022	5.2
2023	5.6
2024	n/a*

*Based on preceding MM estimates, remaining inefficient sockets is zero after 2023, so additional MM is not possible.

2.3 Market Movement Attributable to the Upstream Program

As described earlier, both historical and estimated future market movement is a combination of NOMAD and upstream program support. It was important for the consensus group to establish the portion of market movement attributable to the upstream program for two reasons:

1. To allow for accurate calculation of NTGR of program-induced LEDs.
2. To provide a means of estimating market movement in the absence of the upstream program, allowing for calculation of prospective NTGR for possible future scenarios that do not include the upstream program.

In this section, we first discuss attribution consensus and then details about why attribution was necessary to calculate HEA NTGRs.

2.3.1 Market Movement Attribution Consensus

The consensus group quickly arrived at consensus for upstream attribution. NMR initially suggested basing attribution on data from the recently completed RLPNC 17-11 Upstream LED NTG Consensus study.[11] The results of that study were separated by bulb shape (A-line, reflector, and specialty). Since HEA replaces all shapes of inefficient lamps, NMR provided weighted average upstream NTG values based on the proportion of remaining inefficient lamps for each category.[12]

The EEAC consultants felt it important to estimate total LED sales rather than just upstream program sales. To estimate LED market size, the EEAC consultants used the regression and

[11] http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_1711_LEDNTGConsensus_30JUNE2018_final.pdf
[12] The current mix of remaining inefficient lamps (based on 2017 data) was: 42% A-line, 25% reflector, and 33% specialty.

fitted values included in the RLPNC 16-5 Sales Data Report.[13] The summary of the EEAC consultants' approach is provided, in their own words, below.

> *[It is important] to estimate total LED sales rather than just upstream program sales. This is the primary difference between attributions of the Upstream program to the Market (AUM) versus that program's NTG. Evaluation and research undertaken as part of evaluating the Upstream program included values that could be used to create this overall market-based estimate.*
>
> *The EEAC consultants examined the evaluation research conducted for lighting over the last two years for numerical estimates of LED market size. The EEAC consultants used the regression and fitted values included in the RLPNC 16-5 Sales Data Report to estimate LED sales outside of the upstream program. The overall market is then net program LEDs plus the counterfactual LEDs and this is the denominator for the AUM (while program NTG denominator is total program incented bulbs). This provided the starting point, historical, for the AUM as 45% to 31.8% depending upon the two scenarios associated with the regression modeling. Prospective AUM still needed to be estimated. There was no trend data available to derive the prospective values. The only prospective data available was that of the Upstream program NTG. Comparing that to the historical AUM provided the incremental difference that was then used to derive prospective AUM.*

The attribution values recommended by the EEAC consultants imply that the upstream program accounts for roughly 76% of all LED sales in Massachusetts. The PAs accepted the EEAC consultant recommended attribution values without comment. The final attribution numbers are provided in Table 8.

Table 8: Final Estimates of Market Movement Attributable to the Upstream Program

Program Year	Percent of MM Attributable to Upstream
2019	31%
2020	26%
2021	21%

2.3.2 Calculation of NTGR

The consensus group wrestled with this topic for quite some time. The consensus group exchanged numerous emails on the topic and held two ad hoc phone calls to discuss scenarios in depth. Here we have summarized the final rationale for how market movement attributable to the upstream program was treated for the purposes of calculating HEA NTGR.

All consensus group members quickly agreed that total market movement (NOMAD and upstream) should be used to reduce the number of inefficient lamps available to be installed by

[13] http://ma-eeac.org/wordpress/wp-content/uploads/RLPNC_165_1710_SalesDataReport_16NOV2017_FINAL.docx

HEA in any given year. For example, if we assume the total number of inefficient lamps per household was 22.8 in 2018 and market movement is estimated to be 3.5 LED bulbs per household in 2019, the total number of inefficient lamps available for HEA to replace in 2019 would be 19.3 (22.8 – 3.5). However, the group did not immediately agree on how to treat the portion of market movement attributable to the upstream program when calculating the HEA NTGR for a given year.

The original Excel Tool was setup to calculate NTG as (HEA Installed LEDs – Total MM) / HEA Installed LEDs. During review, the PAs suggested that this approach essentially made it impossible for the lamps attributed to upstream to be claimed by either the upstream program or HEA—since HEA participants have all remaining inefficient sockets replaced and will not purchase any lamps upstream after that. The PAs suggested calculating NTG as (HEA Installed LEDs – NOMAD) / HEA Installed LEDs.

The consensus group ultimately agreed that this adjustment was necessary. One EEAC consultant offered the following scenario to help think through the situation and arrive at this conclusion:

Assumptions

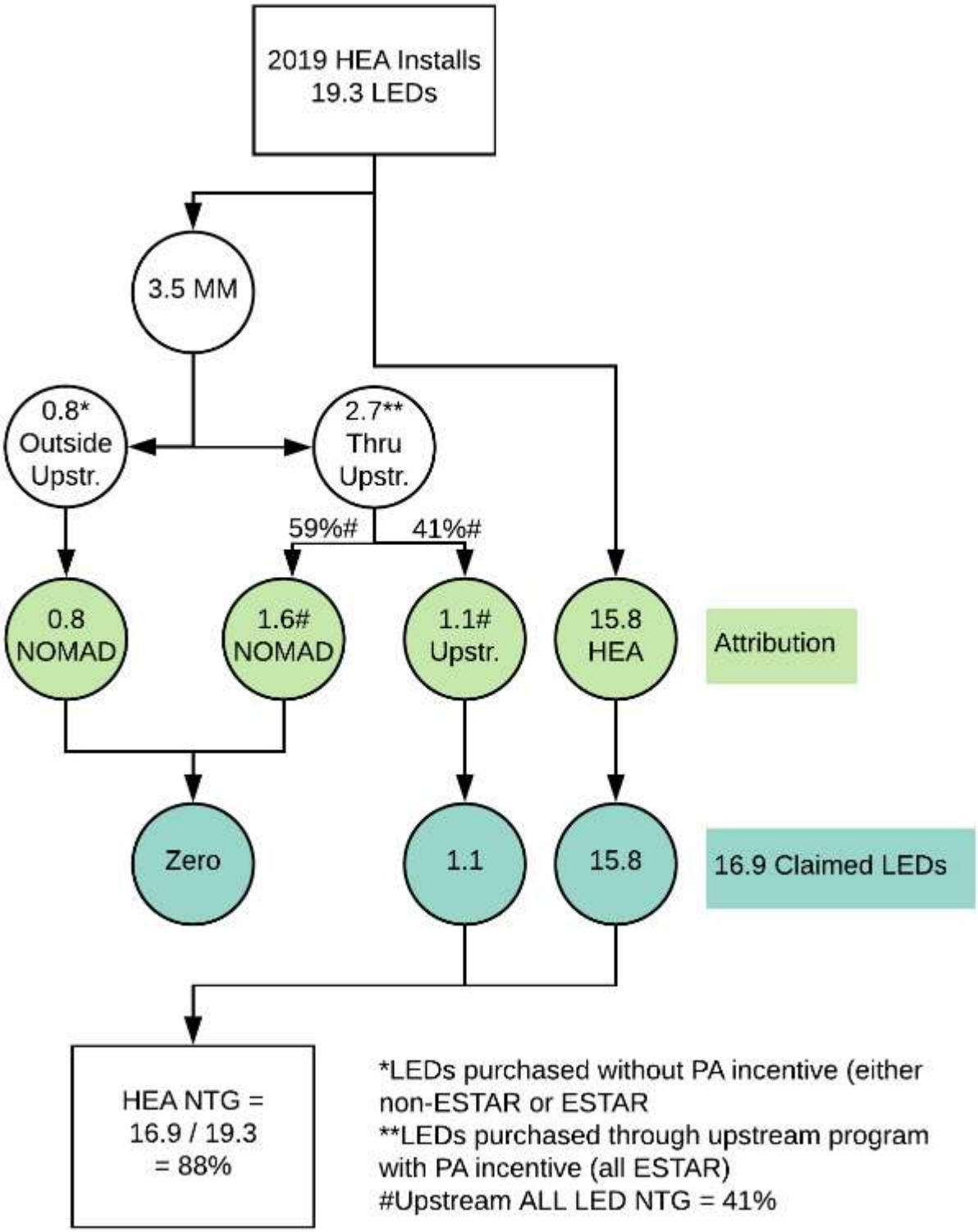
- NOMAD = 0; i.e. there is no naturally occurring adoption
- Upstream Adoption = 1; i.e. the upstream program is responsible for 1 LED per year in market movement
- Total Market Movement = 1
- HEA Installed LEDs = 20

Based on these assumptions, the NTGR for both upstream and HEA should be 100%, as there is no NOMAD. However, if we use the original NTG formula we are left at a total NTGR of 95%.

- Gross LEDs for HEA is 20,
- Gross LEDs for upstream is zero (as the LEDs were installed through HEA),
- Net LEDs for HEA are 19 (95% NTGR; [20 – 1] / 20).

The crux of the issue seems to have been not considering which program get credited gross savings for each program-induced LED. Changing the NTGR formula to (HEA Installed LEDs – NOMAD) / HEA Installed LEDs, solves this issue. To help illustrate this, NMR has prepared a simple flowchart showing attribution and allocation of LEDs (Figure 2). Readers may also review the formulas provided in the Excel Tool (embedded within this document) to see how the math works in each possible scenario.

Figure 2: Calculating 2019 HEA NTGR for Base Case (Upstream Continues)



2.3.3 Absence of Upstream

Early in the consensus process, the PAs and EEAC consultants agreed that the NTGR for HEA LEDs would be higher in the absence of the upstream program. The rationale being that if the upstream program were to end, market movement would decrease by the amount attributable to the upstream program. This would impact HEA by increasing the number of inefficient lamps available to be replaced as part of HEA, thus increasing both the numerator and denominator. The effect is cumulative and has a larger impact the earlier the upstream program ends. For any given year there is no impact if the upstream program ends after the HEA activity.

We have summarized the effect in the various scenarios on the second tab of the Excel Tool (embedded in Section 2.1). Here we provide 2020 as an example:

2020 Example. Based on the total market movement values from Table 7, if the upstream program ends after 2021, we expect the HEA program to install 15.3 LEDs during 2020. If the upstream program ends:

- Dec. 31, 2018, the HEA program will install 17.4 lamps in 2020. [2.1 additional lamps]
- Dec. 31, 2019, the HEA program will install 16.3 lamps in 2020. [1 additional lamp]
- Dec. 31, 2020, the HEA program will install 15.3 lamps in 2020 [no impact since it ends after the HEA activity in 2020]

In all cases, the math for which lamps are credited to the HEA program remains the same (HEA Installed – NOMAD). In the absence of the upstream program, the number of HEA LEDs installed increases and NOMAD stays the same.

Since it is unknown if the upstream program will continue through the 2019 – 2021 program period, the Stage 3 Workplan for this project specifically called for achieving consensus around nine separate NTGR estimates – three estimates assuming the upstream program continues through 2021 and six separate estimates differentiated by the year the program was assumed to end (2019, 2020, or 2021).

Appendix A Base Case Scenario Flowcharts

This appendix includes flowcharts describing how NTGR were calculated for each of the base case scenarios. The base case scenario is that the upstream program continues through 2021.

Figure 3: Calculating 2019 HEA NTGR for Base Case

(Upstream Continues)

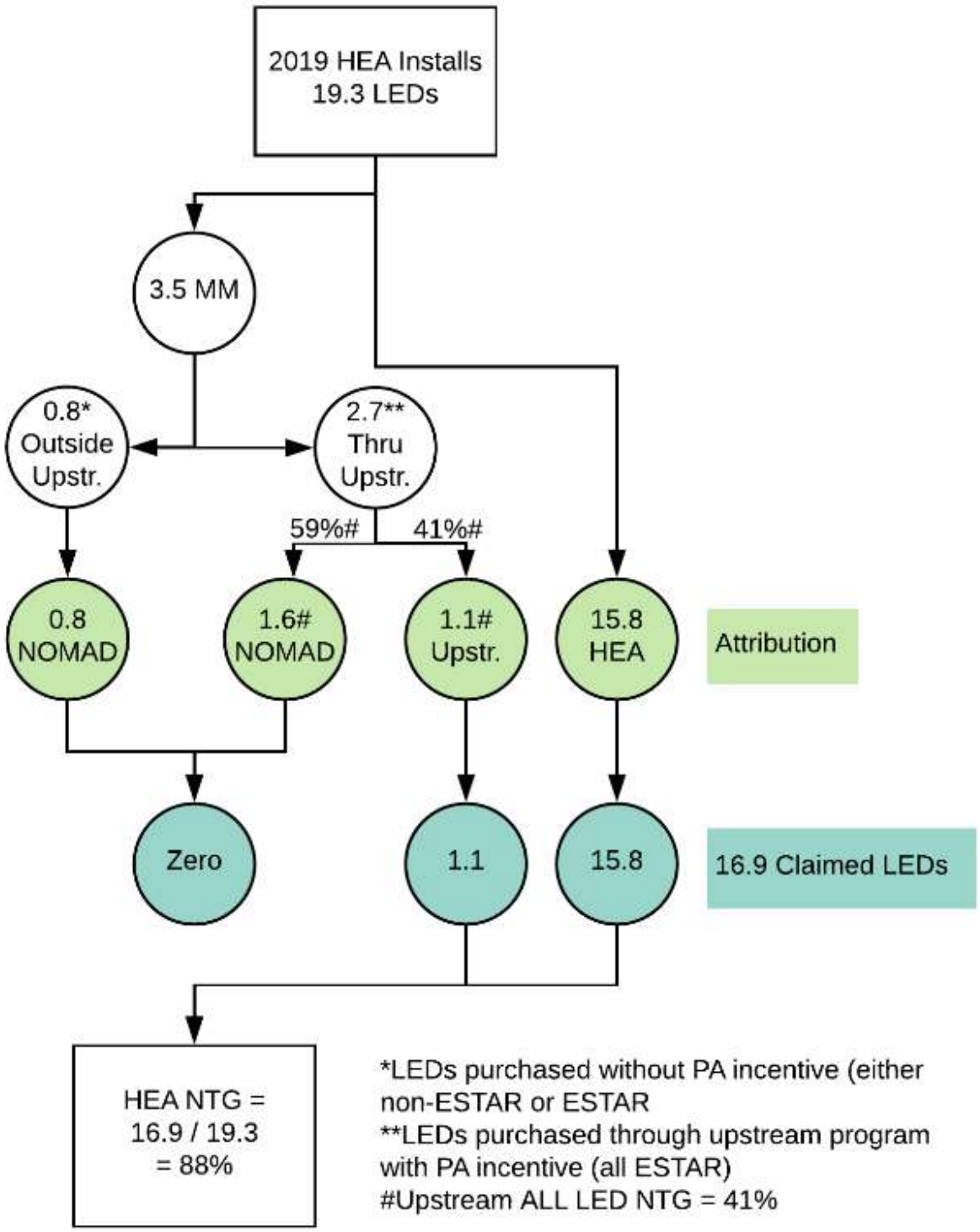


Figure 4: 2020 HEA NTGR for Base Case

(Upstream Continues)

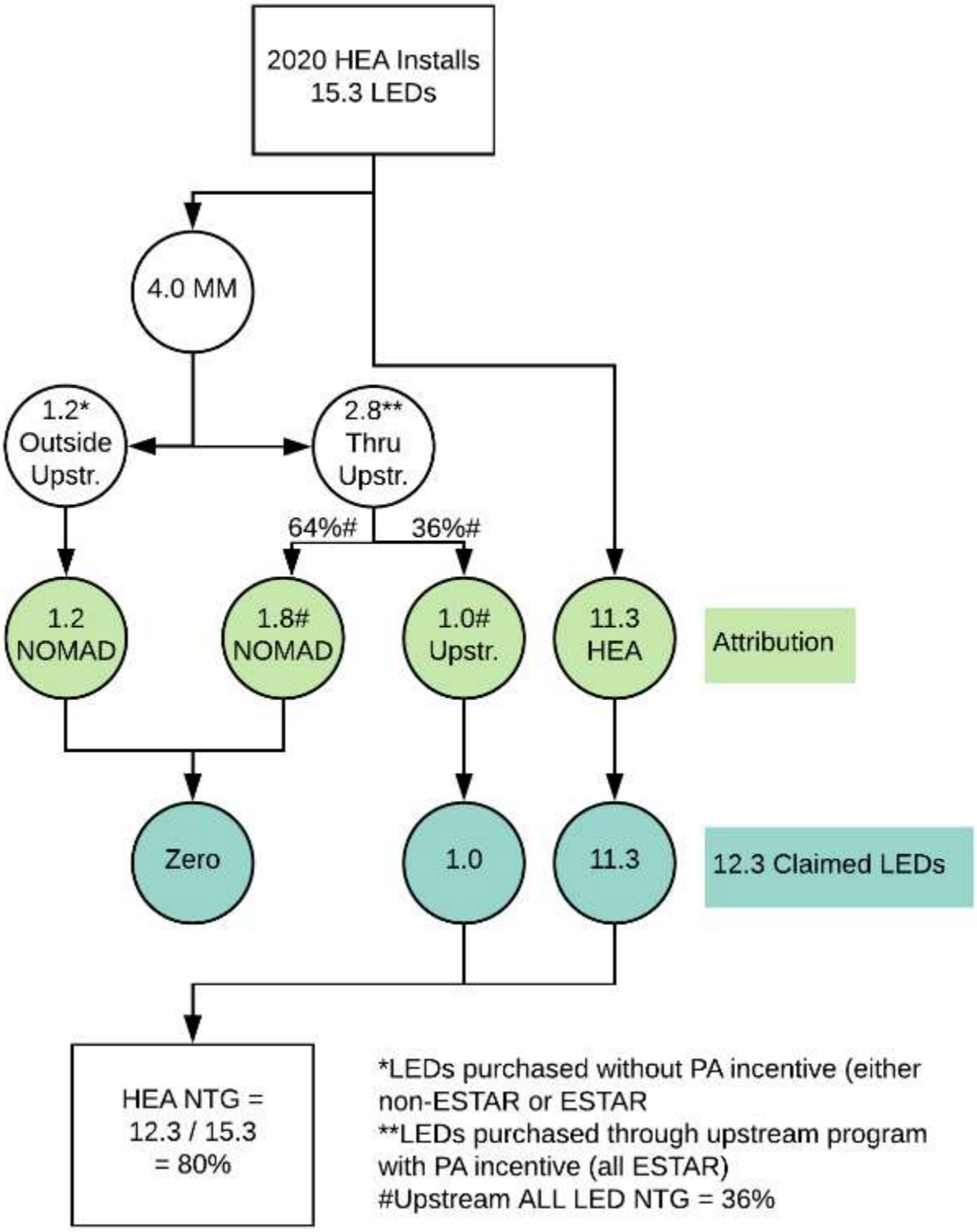
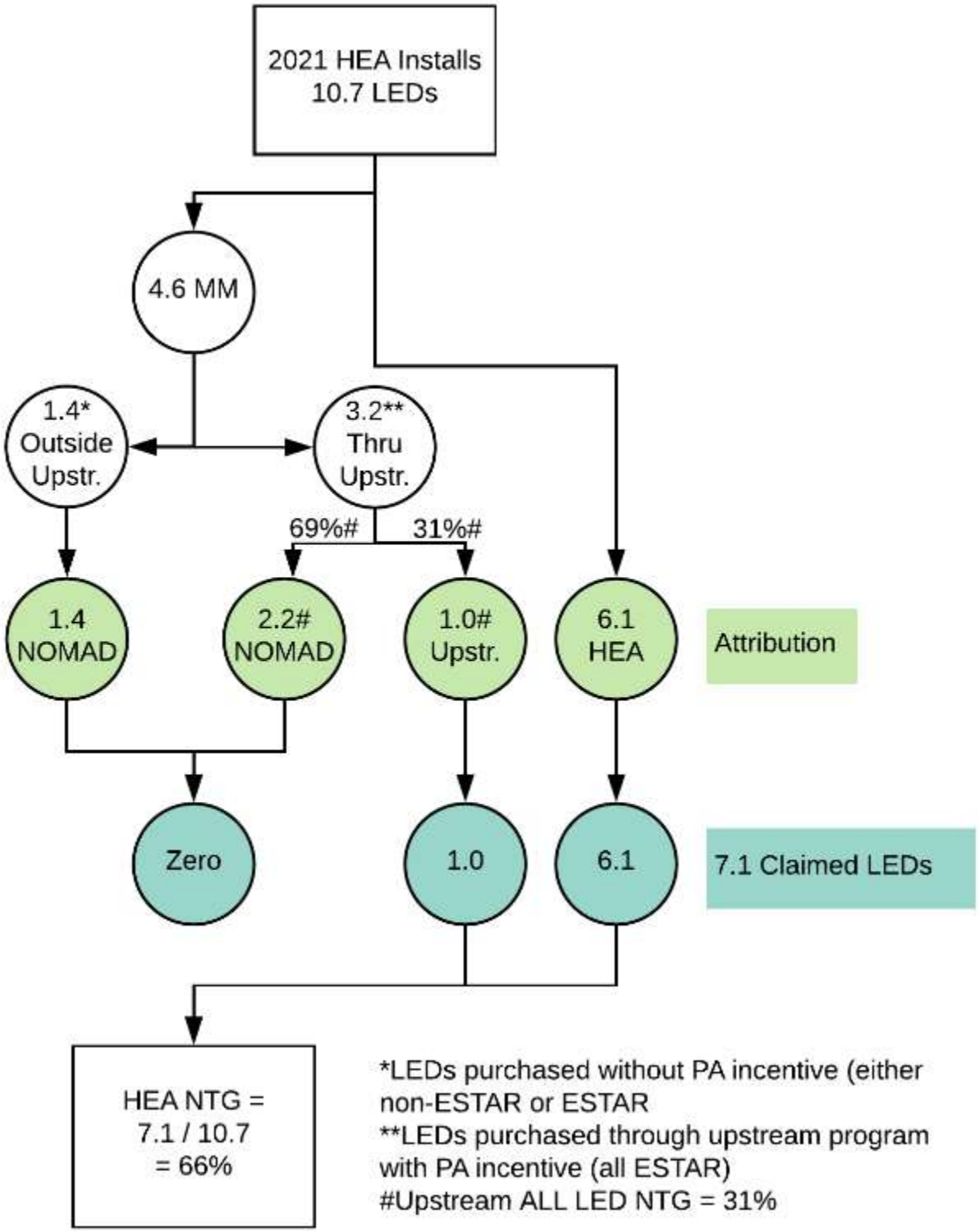


Figure 5: 2021 HEA NTGR for Base Case

(Upstream Continues)



Appendix B Upstream Ending Scenario Flowcharts

This appendix includes flowcharts describing how NTGR were calculated for each of the scenarios in which the upstream program ends. The three scenarios are based on which year the program ends.

B.1 Scenario 1: Program Ends December 31, 2018

In this scenario, the NTGR values for 2019, 2020, and 2021 each change:

- 2019 changes only slightly and rounds to the same value (88%).
- 2020 increases from 80% to 83%.
- 2021 increases from 66% to 74%.

Figure 6: Calculating 2019 HEA NTGR for Scenario 1

(Upstream Ends December 31, 2018)

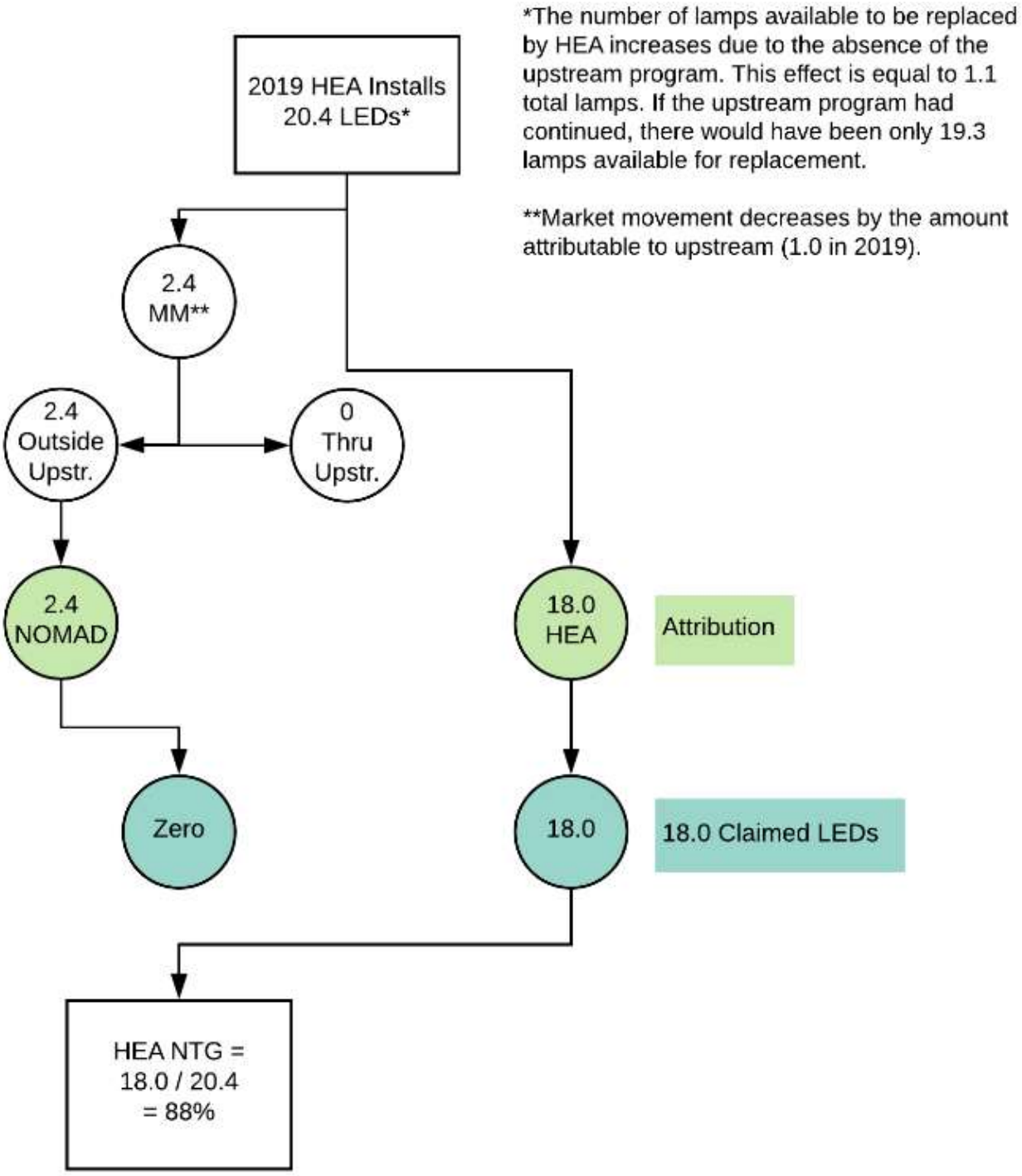


Figure 7: 2020 HEA NTGR for Scenario 1

(Upstream Ends December 31, 2018)

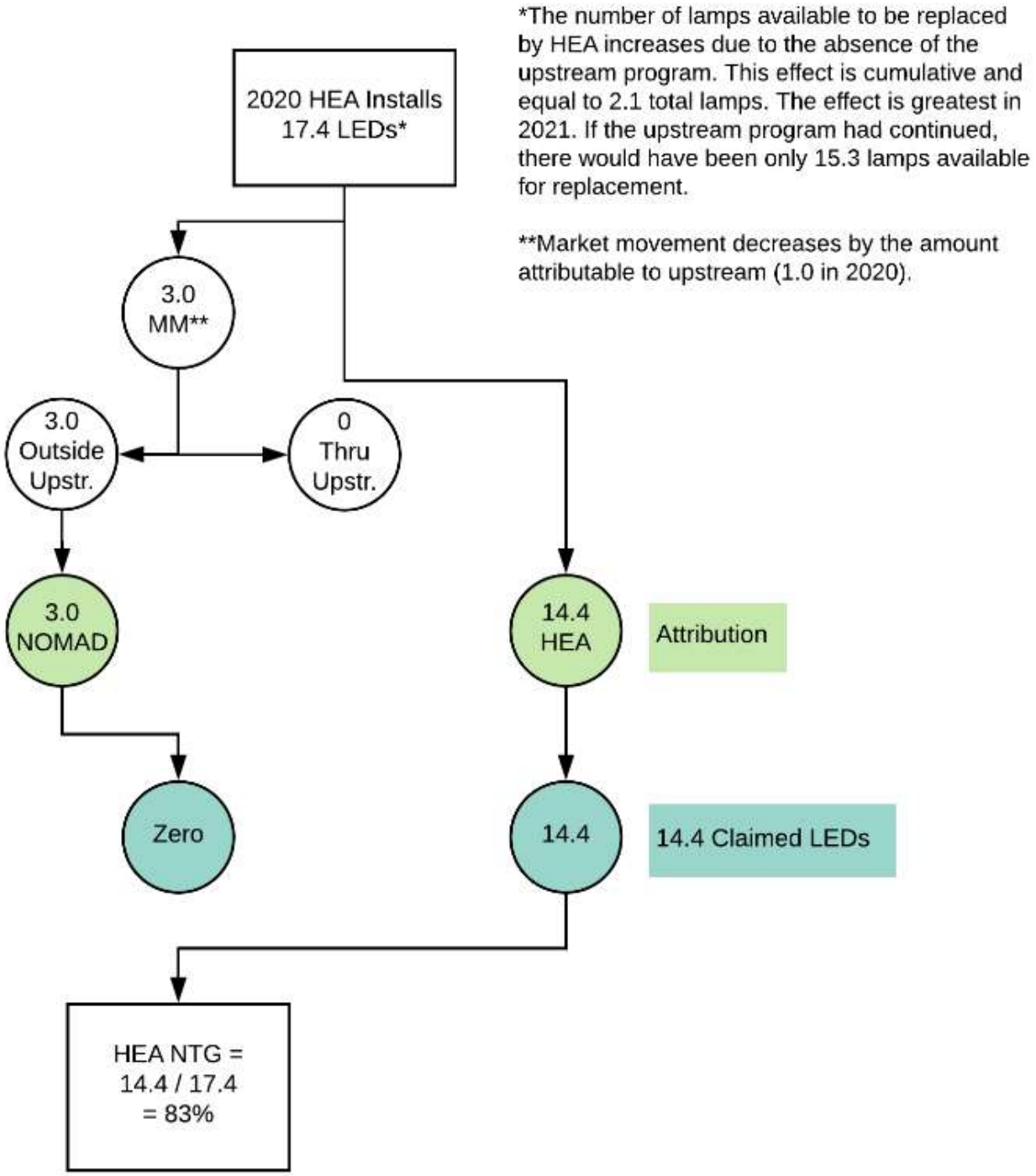
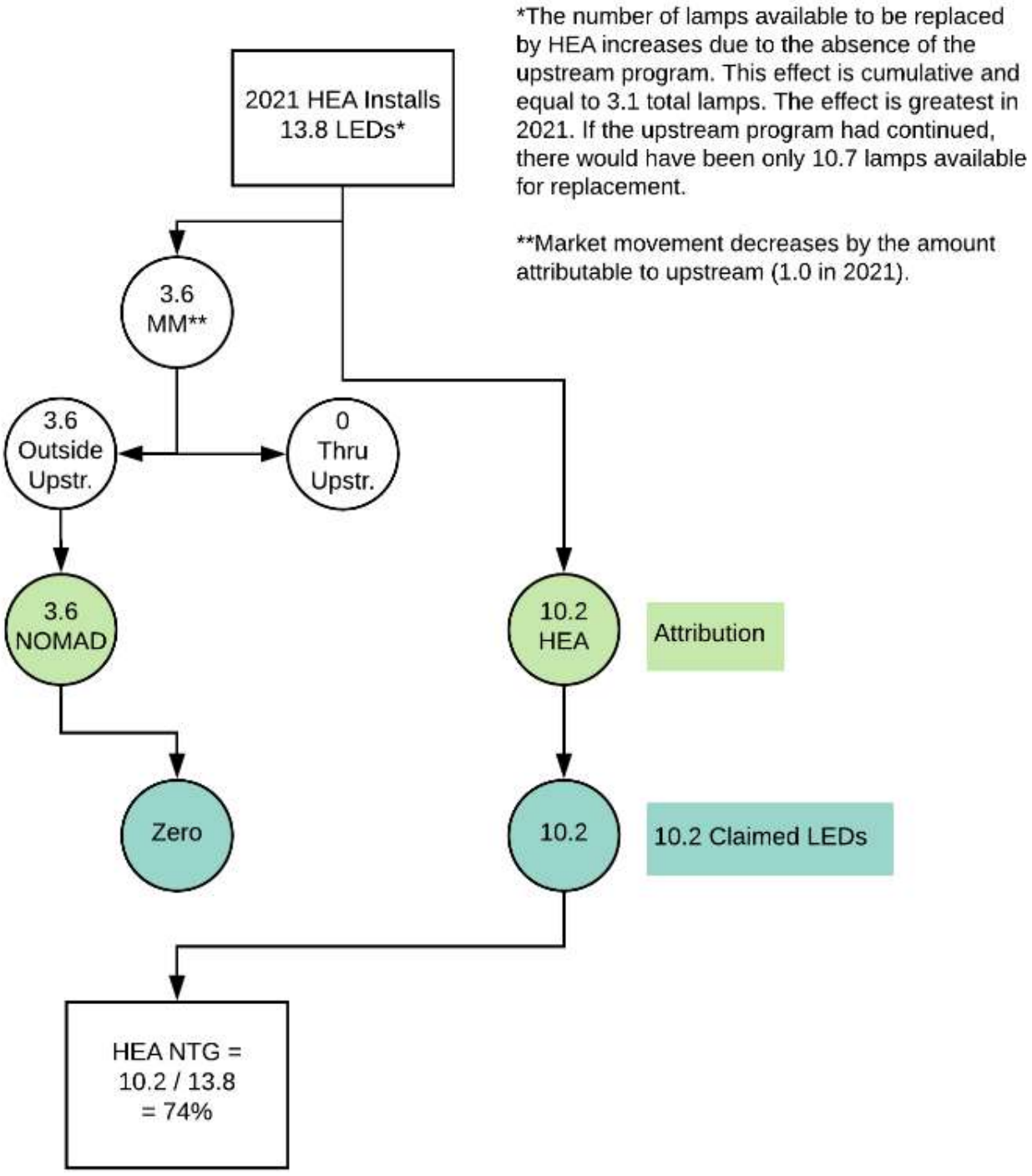


Figure 8: 2021 HEA NTGR for Scenario 1

(Upstream Ends December 31, 2018)



B.2 Scenario 2: Program Ends December 31, 2019

In this scenario, the NTGR values for 2020 and 2021 change:

- 2020 increases from 80% to 82%.

- 2021 increases from 66% to 72%.

Figure 9: Calculating 2020 HEA NTGR for Scenario 2

(Upstream Ends December 31, 2019)

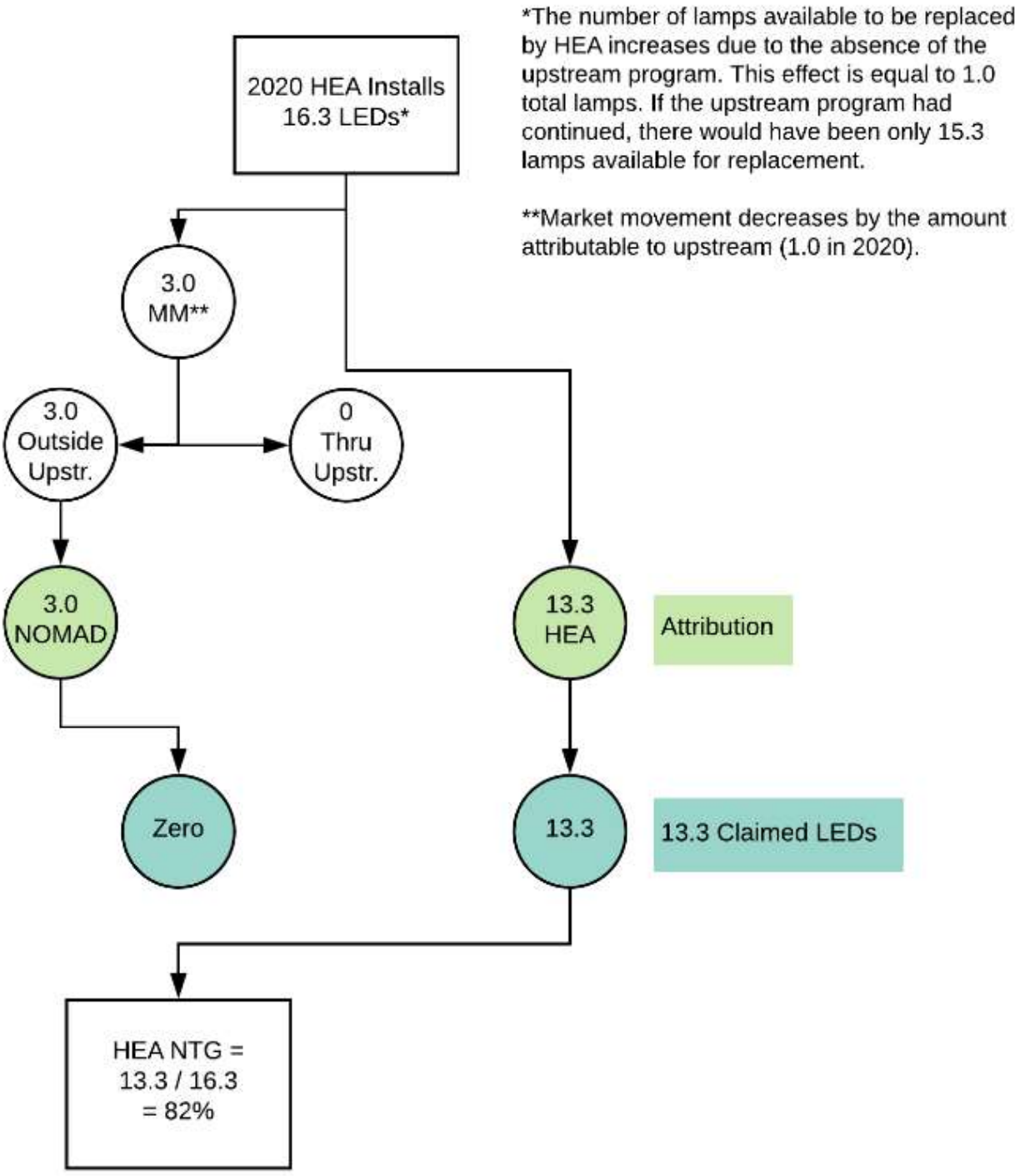
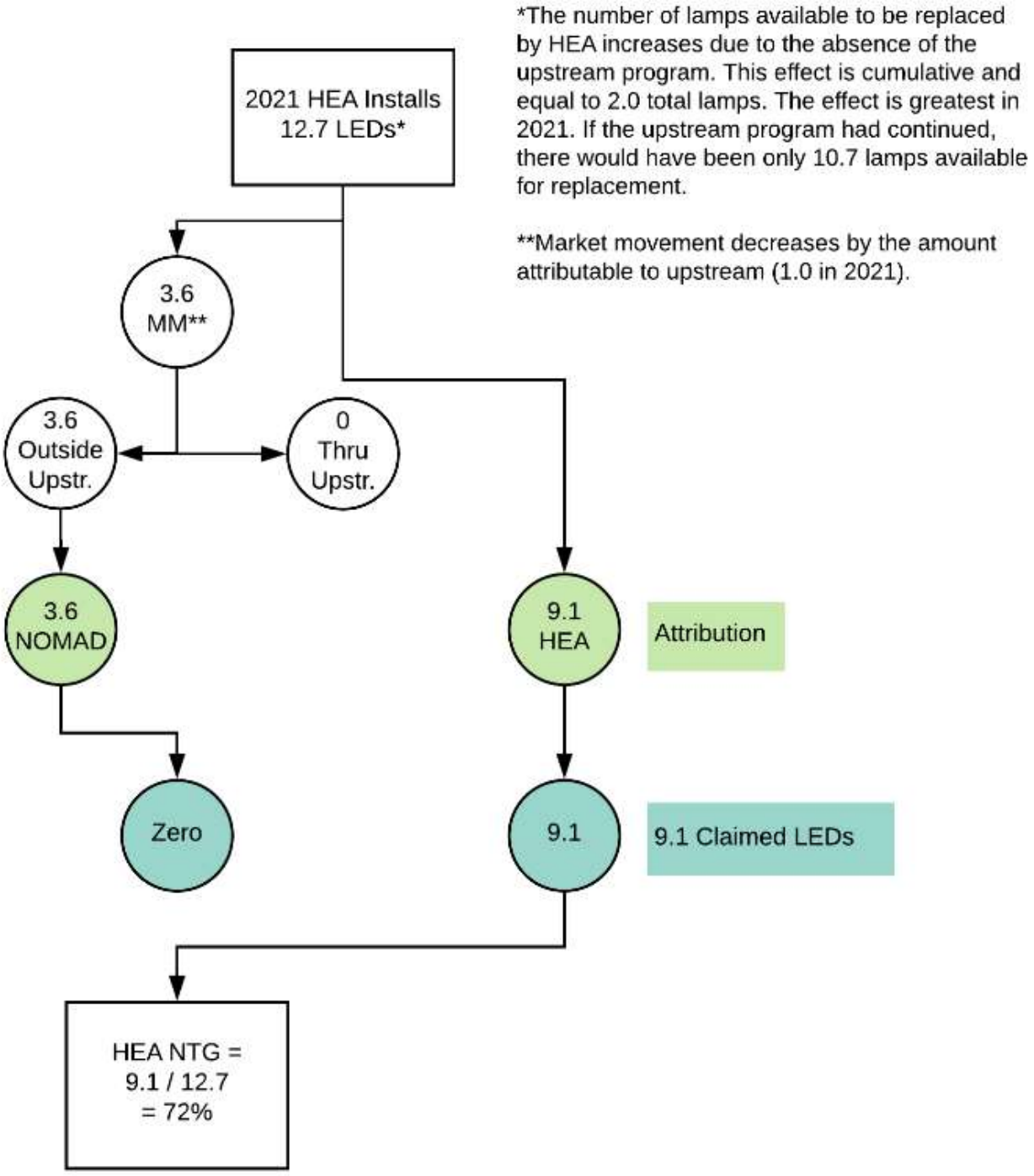


Figure 10: 2021 HEA NTGR for Scenario 2

(Upstream Ends December 31, 2019)



B.3 Scenario 3: Program Ends December 31, 2020

In this scenario, only the NTGR value for 2021 changes. It increases from 66% to 69%.

Figure 11: Calculating 2021 HEA NTGR for Scenario 3

(Upstream Ends December 31, 2020)