Lighting Impact Evaluation Study for the Electric Commercial & Industrial Program

Prepared for Niagara Mohawk Power Corporation d/b/a National Grid
By Ridgeline Energy Analytics, Inc. and
Demand Side Analytics
March 28, 2024
SEEP Activity: NG-1013

TABLE OF CONTENTS

Demand Side Analytics
DATA DRIVEN RESEARCH AND INSIGHTS

RIDGELINE energy analytics

Tables

Figures

1 EXECUTIVE SUMMARY

1.1 OVERVIEW OF THE EVALUATION APPROACH

This report describes an impact evaluation of the Electric Commercial and Industrial (C&I) program offered by Niagara Mohawk Power Corporation d/b/a National Grid ("National Grid" or "Company"). The Electric C&I Program provides technical services along with prescriptive, midstream and custom incentives to encourage the installation of a wide variety of energy-efficient electric measures.

The objective of this impact evaluation is to determine the Verified Gross Savings (VGS) totals for the period of investigation and VGS Realization Rates (VGS RR) for annual electricity savings) (measured in kWh) and electric demand savings (measured in kW) in accordance with The New York State Evaluation, Measurement & Verification Guidance (CE-05)[1] and Gross Savings Verification Guidance (CE-08).[2] The VGS RR is the ratio of verified gross savings to gross savings and indicates the realized savings of the program relative to the gross savings claimed by National Grid. The electric demand savings VGS RR was calculated based upon summer peak demand conditions, representing the demand savings that occurs during the peak demand period. The peak demand definition for New York is non-holiday weekdays, June through August, during the hour ending 5pm.

Table 1 lists the three components of the program along with the period of investigation for each component and the number of unique participants during the period of investigation. The prescriptive lighting component provides incentives and savings for lighting retrofits using predefined measure choices that define the lighting specifications and incentives for various measures. Customers and lighting installers can choose from a list of choices that are appropriate for their given lighting project. The custom lighting component offers a path for lighting projects that are not covered by the prescriptive lighting component choices or options. The midstream lighting component is offered in partnership with electrical supply houses and distributors to offer C&I customers incentives for efficient LED luminaires at the point of sale. The Prescriptive Lighting component population for this evaluation, shown in Table 1, is a subset of the projects completed from 2022-Q3 to 2023-Q2. Their inclusion in the evaluation was conditional on projects having a creation date after July 1, 2022, due to several key programmatic changes.

[1] New York State Department of Public Service Staff Guidance, CE-05: Evaluation, Measurement & Verification Guidance New York State (Issued November 1, 2016).

[2] New York State Department of Public Service Staff Guidance, CE-08: Gross Savings Verification Guidance (Issued August 23, 2019)

Table 1: LCI Program Component Evaluation Populations

Component	Period of Investigation	Unique Sites
Custom Lighting	2022 Q1 – 2022 Q4	112
Midstream Lighting	2022 Q1 – 2022 Q4	894
Prescriptive Lighting	2022 Q3 – 2023 Q2	322

1.2 SUMMARY OF RESULTS

The verified gross electricity and electric demand savings for the population of projects from the evaluation period are shown in Table 2 and Table 3, respectively.

Table 2 shows the reported gross MWh savings and verified gross MWh savings by program component for the population of projects from the evaluation period. Verified gross electricity savings were lower than gross electricity savings for the Custom Lighting component in part due to several indoor agricultural projects with low realization rates. The verified gross electricity savings for the Midstream and Prescriptive Program components were 106.3% and 101.1%, respectively. The VGS RR for electricity savings for all program components of the Electric Commercial and Industrial (C&I) program is 96.6% with a precision of ±4.7% at the 90% confidence level, achieving the study's overall precision target of ±10% at 90% confidence level.

Table 2: Evaluation Results – Population Electricity Savings

Component	Gross Savings MWh	VGS Realization Rate	Verified Gross Savings MWh	Relative Precision at 90% Confidence Level
Custom	32,193	0.869	27,968	4.5%
Midstream	21,863	1.063	23,247	13.4%
Prescriptive	21,950	1.011	22,192	3.8%
LCI Program	**76,006**	**0.966**	**73,407**	**4.7%**

Table 3 shows the gross and verified gross kW demand savings by program component for the population of projects from the evaluation period. Verified gross kW savings were lower than gross kW savings for each program component (VGS RR < 1.0). The VGS RR for all program components of the Electric Commercial and Industrial (C&I) program is 70.2% with a precision of ±8.0% at 90% confidence level. There was a high degree of variability in the verified gross kW savings values of the sampled prescriptive sites and a low VGS RR for this component. This was mainly caused by coincidence factors not being applied in gross kW savings calculations and by gross kW savings incorrectly translated to InDemand, National Grid's system of record for reporting to the New York Department of Public Service. These items are discussed in detail later in this report. While the study achieved its overall precision target of 10% at the 90% confidence level, the ±28.8% relative precision for the Prescriptive Component did not meet the component level precision target of 15% at 90% confidence level. The other components did meet their target relative precision values.

Table 3: Evaluation Results – Population Electric Demand Savings

Component	Gross kW	VGS Realization Rate	Verified Gross kW	Relative Precision at 90% Confidence Level
Custom	6,547	0.751	4,919	5.8%
Midstream	6,241	0.698	4,354	12.2%
Prescriptive	3,964	0.629	2,495	28.8%
LCI Program	**16,752**	**0.702**	**11,768**	**8.0%**

1.3 RECOMMENDATIONS

Based on the evaluation including desk reviews and site visits, the evaluation team has the following recommendations to help improve the VGS Realization Rates for the Electric C&I Program electricity and electric demand savings estimates for Custom, Prescriptive, and Midstream lighting projects. The following section is separated into recommendations that apply to all program components and those that are program component specific. More detail regarding these recommendations can be found in Section 5.

The term 'application workbook' refers to two Microsoft Excel-based spreadsheet tools that National Grid developed and uses to calculate savings for Custom and Prescriptive lighting projects. There are two application workbook versions that are used depending on the lighting project type and are titled the 'Commercial and Industrial Retrofit Program Lighting Systems & Controls Application' and the 'Illuminating Excellence C&I New Construction & Major Renovation Lighting Application.' National Grid does not use an application workbook to calculate savings for the Midstream component. Midstream component savings calculation methods are detailed in the report.

Cross-Component Recommendations

Finding 1: For the Custom and Prescriptive program components, there were many instances where a coincidence factor (CF) was not applied to total connected kW savings to calculate gross kW savings. This was mainly the result of an incorrect translation of gross kW savings values from project application workbooks to the InDemand tracking system.

Recommendation 1: National Grid staff should check the translation mechanism that copies application workbook data for Custom and Prescriptive lighting projects to the InDemand tracking system to ensure that gross kW savings are correctly saved.

Finding 2: The CFs that we observed in our metering data were generally lower than the CFs listed in the NYS TRM. This is one of the main causes that led verified gross kW savings to be lower than gross kW savings.

Recommendation 2: National Grid staff should review the coincidence factors (CF) estimated from meter data from this evaluation with the Technical Reference Management Committee[3] to determine if the CFs in the New York State Technical Reference Manual (NYS TRM) should be updated. This may include working with other utilities who recently completed lighting program evaluations and have meter-derived CF data.

Finding 3: The most common cause of incorrect HVAC savings estimates for Prescriptive and Custom component projects was the inadvertent omission of the site service zip code, which prevents the tool from correctly estimating HVAC savings when omitted.

Recommendation 3: National Grid staff should revise the Prescriptive and Custom program component application workbooks so that an error window (or similar flag) is shown if the service zip code is not entered. Alternatively, the application workbook could default to a Syracuse location assumption when the service zip code is missing.

Finding 4: The HVAC interactive effect multipliers in the NYS TRM recently changed with Version 11 (effective 2024). HVAC interactive effect multipliers are used in lighting savings calculations to account for the change in savings that result from LED lighting generating less heat than baseline lighting technologies.

Recommendation 4: National Grid staff should revise the HVAC interactive effect multipliers in the 'Illuminating Excellence C&I New Construction & Major Renovation Lighting Application' and the Midstream lighting deemed savings calculations to match those values in the NYS TRM Version 11.

Custom Program Recommendations

Finding 5: Two Custom lighting projects at indoor agricultural facilities were evaluated as part of this evaluation. Both lighting projects had low realization rates because of their slower than expected timelines to reach steady-state farming operations.

Recommendation 5: When supporting LED grow light projects at indoor agriculture facilities, National Grid contacts should speak with indoor agriculture sites about their start-up timelines and any related considerations, including any items likely to delay these start-up timelines (ex. licensure, product demand).

Finding 6: Two sampled indoor agricultural facilities used lighting baselines provided by engineering consultants. Now that a standard approach for estimating savings for these lighting projects is available, we recommend that standardized savings estimation approach be used.

---

[3] Case 15-01319, In the Matter of the New York State Technical Resource Manual, New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs- Version 11 (Issued October 6, 2023; effective Jan 1, 2024).

Recommendation 6: Electricity and demand savings for future lighting projects at indoor cannabis grow facilities should follow the savings methodology as established by the new Indoor Horticultural Lighting measure issued as a revision to the NYS TRM (issued 10/31/23). This methodology provides guidance for lighting at indoor cannabis grow facilities. We also recommend that National Grid work with the TRM Management Committee to establish baseline and operating lighting assumptions for non-cannabis grow facilities.

Midstream Program Recommendations

Finding 7: The Midstream program currently uses a measure code deemed savings, which is a bin approach, to estimate savings. The deemed wattage values varied greatly from actual wattages for some projects contributing to a large relative precision for the Midstream VGS RR electricity savings, larger than the other program components.

Recommendation 7: National Grid staff should revise the Midstream program savings estimation method to either 1) use the actual wattage of retrofit fixtures and derive a representative wattage for baseline fixtures by using a ratio of baseline-to-upgrade fixture wattages; or 2) modify the existing method so that fixture bins better match retrofits.

Finding 8: Currently, Midstream program savings calculations assume a CF of 1 in all interior lighting demand savings calculations, and this assumption is one of the factors causing the overestimation of demand savings by this program.

Recommendation 8: National Grid staff should revise the Midstream program demand savings estimation approach so that CFs for interior lighting projects are based on the NYS TRM.

Prescriptive Program Recommendations

There are no further recommendations for Prescriptive Lighting program component beyond those listed in the 'Cross-Component Recommendations' section above.

2 INTRODUCTION

Niagara Mohawk Power Corporation d/b/a National Grid retained Ridgeline Energy Analytics and its subcontractor, Demand Side Analytics (the evaluation team), to complete an impact evaluation study for the Electric Commercial and Industrial (C&I) program and the LED Street Lighting Program. The impact evaluation examined lighting offerings for program years (PYs) 2022 and 2023.

The objective of this impact evaluation is to determine the Verified Gross Savings (VGS) totals for the period of investigation and VGS Realization Rates (VGS RR) for electricity and electric demand savings in accordance with The New York State Evaluation, Measurement & Verification Guidance (CE-05)[4] and Gross Savings Verification Guidance (CE-08).[5] The VGS RR is the ratio of verified gross savings to gross savings and indicates the actual realized savings of the program relative to the gross savings claimed by National Grid. The VGS RR will be applied prospectively to gross savings from new program activity in National Grid's quarterly Clean Energy Dashboard submissions. The electric demand savings VGS RR is for summer peak demand, the demand savings that occurs during the peak demand period. The peak demand definition for New York is hot non-holiday weekdays, June through August, during the hour ending 5pm.

For evaluation purposes, we separated the lighting analysis into three distinct components:

1. Prescriptive Lighting offerings – The prescriptive lighting component provides incentives and savings for lighting retrofits using predefined measure choices that define the lighting specifications and incentives for various measures
2. Midstream Lighting offerings – The midstream lighting component is offered in partnership with electrical supply houses and distributors to offer C&I customers incentives for the most efficient LED luminaires at the point of sale.
3. Custom Lighting offerings – The Custom lighting component offers a path for lighting projects that are not covered by the prescriptive or midstream lighting component options.

This evaluation is a combination of automated desk reviews and on-site measurement and verification (M&V) visits across the census of 1,328 Prescriptive, Midstream, and Custom Lighting projects. The evaluation included detailed desk reviews of 125 sites, visits to 86 sites including those with only exterior fixtures, and light logger installation at 71 sites that had interior fixtures.

[4] New York State Department of Public Service Staff Guidance, CE-05: Evaluation, Measurement & Verification Guidance New York State (Issued November 1, 2016).

[5] New York State Department of Public Service Staff Guidance, CE-08: Gross Savings Verification Guidance (Issued August 23, 2019)

3 METHODS AND SAMPLING

3.1 SAMPLING

3.1.1 Sample Design

The following items needed to be defined upfront to design the sample:

- **Sampling unit**. The sampling unit, a “site,” is the unique combination of the business name and the physical location, based on the service address, where the project was installed. For example, if multiple projects were installed at the same site, the evaluation team grouped all applications within the period of investigation for sampling and analysis. If an organization completed projects at multiple locations across Niagara Mohawk service territory, each service location was treated as a distinct site eligible for selection in the evaluation sample.

- **Period of Investigation.** The impact evaluation targets the program periods which align with current and future program delivery models, since the VGS RR are applied prospectively. For Custom and Midstream Lighting, we sampled from projects completed between 2022-Q1 and 2022-Q4. The tracking methodology for the Prescriptive Lighting program underwent change in the first half of 2022, so the sample frame for this offering was projects with a creation date after July 1, 2022, and a rebate paid date on or before June 30, 2023.[6]

- **Precision targets**. Verified gross kWh and kW savings estimates are usually determined through the observation of key measure parameters, among a sample of program participants. A census evaluation would involve surveying, measuring, or otherwise evaluating the entirety of projects within a population. Although a census approach would eliminate sampling uncertainty, the reality is that M&V takes many resources, so sampling is necessary. When a representative sample of measures, projects, or participants is selected and analyzed, the sample statistics provide a reasonable estimate of the population parameters. There is an inherent risk associated with sampling because, even with the best sample design, the projects selected in the evaluation sample may not be representative of the program population. Sample sizes affect the uncertainty of the resulting estimates and the amount of variability between the gross and verified gross kWh and kW savings. Table 4 shows our error ratio assumptions by component. DPS Guidance suggests ±10% relative precision at the 90% confidence level at the program level. We targeted ±15% relative precision for each of the program components, reasoning that this would yield 10% or better relative precision at the program level.

---

[6] Prescriptive lighting projects have varying timelines from creation to completion. Some of the projects paid and reported from 2022-Q3 to 2023-Q2 have creation dates prior to 7/1/2022, so the sample frame from this component does not align directly with regulatory reporting.

Table 4: Error Ratio Assumption by Component

Component	Error Ratio Assumption	Rationale
Custom Lighting	0.6	Lack of TRM assumptions for specialty fixtures and network lighting controls. Changing state building code for new construction.
Midstream Lighting	0.7	Evaluation results in Maine and Pennsylvania
Prescriptive Lighting	0.5	Previous evaluation and program delivery changes to data collection and savings calculations

- **Size Stratification.** A given project's likelihood of selection was dictated by the size stratum. Table 5 shows the strata definitions based on a review of 2022 program tracking data. Most accounts in the "Large" strata were selected for evaluation, which means they have a case weight (N/n) of close to one in the stratified ratio estimation procedure used to compute VGS realization rates. On the other end of the spectrum, we sampled fewer sites from the "Small" strata, which means each sample point has a larger case weight.

Table 5: Proposed Size Stratification

Component	Size Stratum	Definition	Population Size
Custom Lighting	Large	> 1,000 MWh	6
	Medium	150 – 1,000 MWh	32
	Small	< 150 MWh	74
Midstream Lighting	Large	> 150 MWh	17
	Medium	50 – 150 MWh	100
	Small	< 50 MWh	777
Prescriptive Lighting	Large	> 300 MWh	18
	Medium	50 – 300 MWh	73
	Small	< 50 MWh	231

3.1.2 Summary of Sample

Table 6 lists the target sample sizes, by component, based on the considerations discussed above, that is, 90% confidence of 15% precision at the component level. The finite population correction factor is an adjustment that accounts for the decrease in uncertainty that results when the number of sampled projects is a large proportion of the smaller population.

Table 6: Evaluation Activities by Component

Component	Unique Sites	Error Ratio	Unadjusted Sample Size	Finite Population Correction Factor	Adjusted Sample Size
Custom Lighting	112	0.6	44	0.783	35
Midstream Lighting	894	0.7	59	0.967	58
Prescriptive Lighting	322	0.5	31	0.952	30
Total Electric C&I Lighting	**1,328**	**N/A**	**134**	**N/A**	**123**

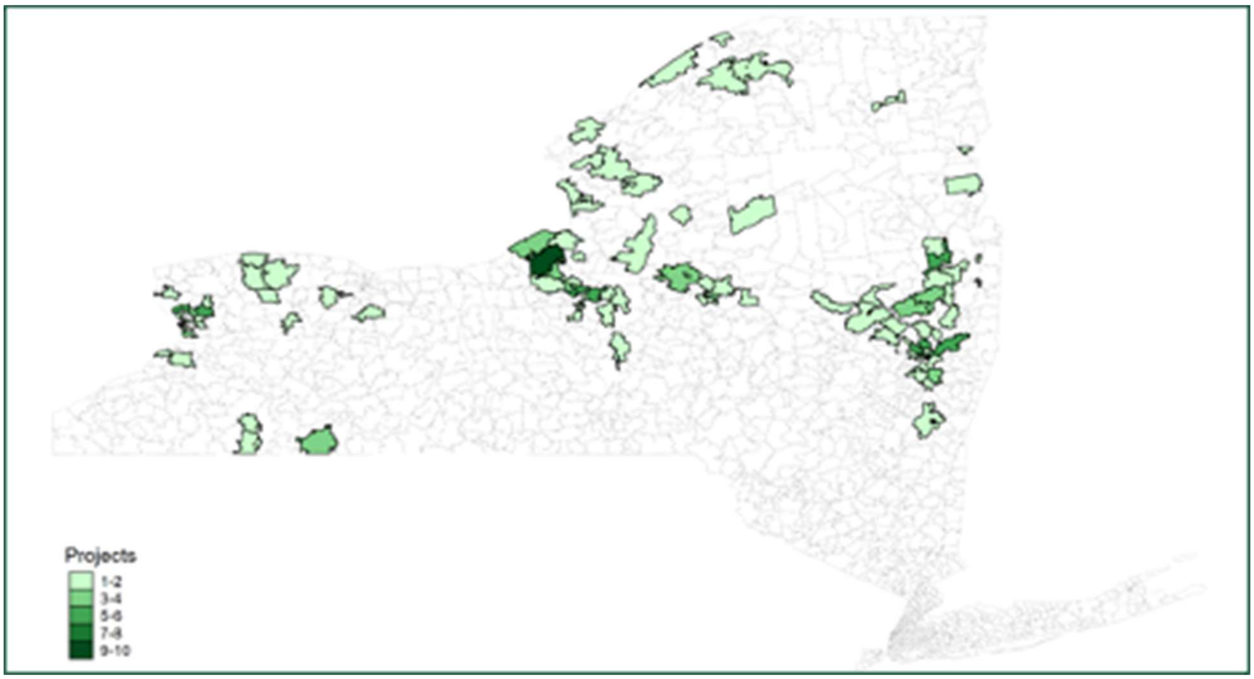
Table 7 lists proposed evaluation activities for the adjusted sample. At a minimum, all sampled sites received a desk review. After the initial desk review, a subset of sampled sites was selected for further review via a site visit. The conditions for selecting a site for site M&V depended on various factors like the site's energy savings contribution to the portfolio, high-impact measures involved, high-uncertainty savings estimations, and the feasibility to perform an accurate desk review.

Table 7: Evaluation Activities by Component

Component	Adjusted Sample Size	Desk Review	Site Visit	Logging / Metering
Custom Lighting	35	35	25	22
Midstream Lighting	58	58	36	28
Prescriptive Lighting	30	30	25	21
Total Electric C&I Lighting	**123**	**123**	**86**	**71**

The sampled sites were spread across the Albany, Buffalo, and Syracuse regions. Figure 1 looks at the distribution and concentration of our sampled sites.

Figure 1: Map of the Sampled Sites



3.1.3 Program-Level Results Aggregation

Once verified gross savings were calculated for each sampled project, the evaluation team calculated the VGS RRs using stratified ratio estimation. The case weights for each component and stratum are shown in Table 8. The case weights represent the number of sites in the population represented by each sample point and are used in the expansion of results from the sample to the program component.

Table 8: Case Weights by Component and Stratum

Size Stratum	Size Stratum	Definition	Population Size (N)	Sample Size (n)	Case Weight (N/n)
Custom Lighting	Large	> 1,000 MWh	6	6	1.00
	Medium	150 – 1,000 MWh	32	13	2.46
	Small	< 150 MWh	74	16	4.63
Midstream Lighting	Large	> 150 MWh	17	12	1.42
	Medium	50 – 150 MWh	100	21	4.76
	Small	< 50 MWh	777	25	31.08
Prescriptive Lighting	Large	> 300 MWh	18	5	3.60
	Medium	50 – 300 MWh	73	15	4.87
	Small	< 50 MWh	231	12	19.25

The stratified ratio estimation procedure also accounts for a finite population correction factor when the sample size is a material share of the population. Another factor that affects the precision of the VGS RRs is what share of the overall kWh and kW savings are evaluated. From a statistical standpoint, there is no sampling uncertainty from the evaluated projects. The uncertainty comes from the unevaluated projects which may have different relationships between verified and gross savings relative to what was observed in the sample. Table 9 shows the share of gross savings evaluated by component and for the program. Our sampling strategy which focused on large projects increases the share of the kWh and kW savings included in the sample and helps limit the statistical uncertainty of the results.

Table 9: Evaluated Gross MWh by Component

Component	Gross MWh - Population	Gross MWh - Sample	Share Evaluated
Custom Lighting	32,193	21,047	65.4%
Midstream Lighting	21,863	4,935	22.6%
Prescriptive Lighting	21,950	5,249	23.9%
Total	**76,006**	**31,231**	**41.1%**

3.2 FIELD DATA COLLECTION AND DESK REVIEW METHODS

3.2.1 Recruitment and Scheduling

Recruiters for the evaluation team began outreach to the contacts at the sampled projects in August of 2023. They used several methods to introduce the study and garner interest in participation:

- **Personalized Outreach.** There were several Custom Lighting accounts that were handled uniquely, due to their size, to streamline communications and maximize response rates. These accounts were assigned to a specific recruiter so that follow-ups and scheduling could be closely monitored and tailored to the customer's needs.

- **Outbound Emails.** The emails included a call to action in the subject line and a short description of the study purpose. For the Midstream program, the emails also listed the program-supported measures and distributor where the equipment was purchased to remind customers of their program participation and exhibit outreach authenticity.

- **Outbound Telephone Calls.** Following the initial email campaign, the recruitment team made outbound phone calls, using the telephone number on file with National Grid. Outbound recruiting was concentrated on matching the targeted number of site visits for each component across the three regions, as outlined in the Work Plan.

- **National Grid Account Manager and Technical Representative Coordination.** The recruitment team coordinated with the National Grid Technical Representatives, engineers who hold relationships with specific accounts, for contact refinement, specifically in cases where customer contact resources and research efforts were exhausted. The team also shared the site visit schedule with National Grid account managers, so they could attend site visits alongside the evaluation field engineers if they wished.

Although incentives were available for participation in this study, the recruitment team de-emphasized this and instead focused on how participating in the study was a unique opportunity to quantify energy savings and improve the territory's programs.

3.2.2 Desk Reviews

The evaluation team performed an engineering desk review of each sampled project using a standard procedure to compare savings calculations against the New York State Technical Resource Manual Version 9 (NYS TRM), effective January 2022 (unless another version is stated). The purpose of these desk reviews was to review available project information and assess savings calculations for completeness and accuracy. For those sites receiving a site visit, desk reviews were completed ahead of on-site activities so evaluation field engineers could familiarize themselves with projects and identify areas requiring additional focus while at site. While Custom and Prescriptive projects had a similar amount of project information available per project, far less information was available for Midstream projects. Given the difference in available project information, the desk review process for Custom and Prescriptive projects differed from Midstream projects. The desk review process for each of these program components is outlined below.

3.2.2.1 Custom and Prescriptive Desk Reviews

National Grid provided project files for all sampled Custom and Prescriptive projects. Generally, these files included the application workbook (and/or other supporting savings analysis files), upgraded light fixture cutsheets, project invoices, and pre- and post-inspection reports from National Grid. Occasionally, additional information was available such as project quotes, drawings, lighting schedules, incentive offer letters, and/or email communication between various project parties (ex. customer and vendor or customer and National Grid).

As noted above, the purpose of desk reviews was to review available project information to assess the accuracy of lighting project savings calculations. To do this, our evaluation engineers followed a prescribed path to review important project files with a focus on the main variables influencing the gross kWh and kW savings of a lighting project. The desk review process, including specific considerations when reviewing available information, is outlined further in the table below.

Table 10: Custom and Prescriptive Site Desk Review Considerations

Project File Type	Desk Review Considerations
Savings application workbook	• What type of lighting upgrade project is this? Custom or prescriptive? Major renovation or retrofit? • What version of the application workbook did National Grid, or its technical contractor use to estimate savings? • How do the estimated gross kWh and kW savings in the application workbook compared to National Grid tracked savings? Do we have the correct application workbook?
Light fixture cutsheets	• Do the supplied light fixture cutsheets match the upgrade fixture (or lamp) part numbers in the application workbook? • Using the correct cutsheet, note the upgrade fixture type, wattage, and control type.
Invoices and design drawings	• How do the listed fixture part numbers, quantities, and control types align with the application workbook?
Pre- and post-inspection forms	• What details, if any, are provided on baseline light fixtures in pre-inspection forms? The baseline fixture type, quantity, and control type are the important details. • How do the baseline and upgrade fixture quantities compare? • Does the post-inspection form highlight any disagreements between design documents, including the application workbook, and the project as completed?
Other desk review considerations	• What can we learn about the facility and/or space where the lighting upgrade project occurred? Of specific interest is the facility operating schedule, including hours or operation and seasonality, and HVAC system type so an assessment of baseline fixture hours and HVAC system type can be made, respectively. • Are the proposed baseline fixtures reasonable given our understanding of the facility type and/or space?

Information collected during the desk review process was compared to the inputs and assumptions in the application workbook and any inconsistencies were noted for further consideration. Additionally, any unknowns related to important variables were identified so that follow-up actions could be taken to collect missing information. If a site was to receive a site visit as part of evaluation activities, these inconsistencies and missing information were highlighted for further review during on-site activities.

3.2.2.2 Midstream Desk Reviews

Data for all sampled midstream projects was provided by National Grid in a combined table that organized project data by site IDs and a lighting upgrade application number. No project files were available for review for individual projects. The following information was reviewed as part of the desk review process for each sampled midstream project:

- Upgrade light fixture manufacturer and part number – A cutsheet for the upgrade light fixture was sourced and reviewed to determine the fixture type, wattage, and control mechanism.
- Upgrade fixture quantity
- Measure code – Each midstream application is labeled with a measure code that has a deemed kWh/yr/fixture and kW/fixture savings associated with it. The measure code is applied based on the light fixture type, wattage, and control type. Assumptions on fixture controls, HVAC system type serving the area with upgrade fixtures, and light fixture operating hours are embedded in these deemed savings values.
    - National Grid provided additional spreadsheets detailing their deemed savings estimates for each measure code. The review of these calculations is detailed in Section 4.5.

The information listed above was compiled and used to guide activities during midstream project site visits.

3.2.3 Field Data Collection

This section discusses field data collection activities completed during site visits. The primary goal of site visits was to verify key inputs and assumptions to lighting project savings calculations. Information and data were collected through a variety of methods including conversation with site contacts, site observations, and light logger deployment. Site visits were documented with both notes and photos. Light logger deployment and updates to lighting project savings calculations are discussed in Sections 3.2.4 and 4.5, respectively.

The evaluation field engineers conducting site visits aimed to follow a standard agenda to ensure all necessary data was collected during each visit. Typically, the first step for these engineers was to meet with the site contact to ask questions about the site and the lighting project. This portion of the site visit may have included a tour of the area where the lighting upgrade occurred as well as other relevant areas of the facility, such as the location of HVAC equipment. Following this time with the site contact, the evaluation field engineers would move to the second phase of the visit where they would observe and document upgrade and baseline lighting and relevant HVAC equipment in greater detail and deploy light loggers, if necessary. The main focuses for the site visit in terms of information and data collection are outlined below:

- The upgrade and baseline light fixture types, quantities, wattages, control types and quantities, and control setpoints

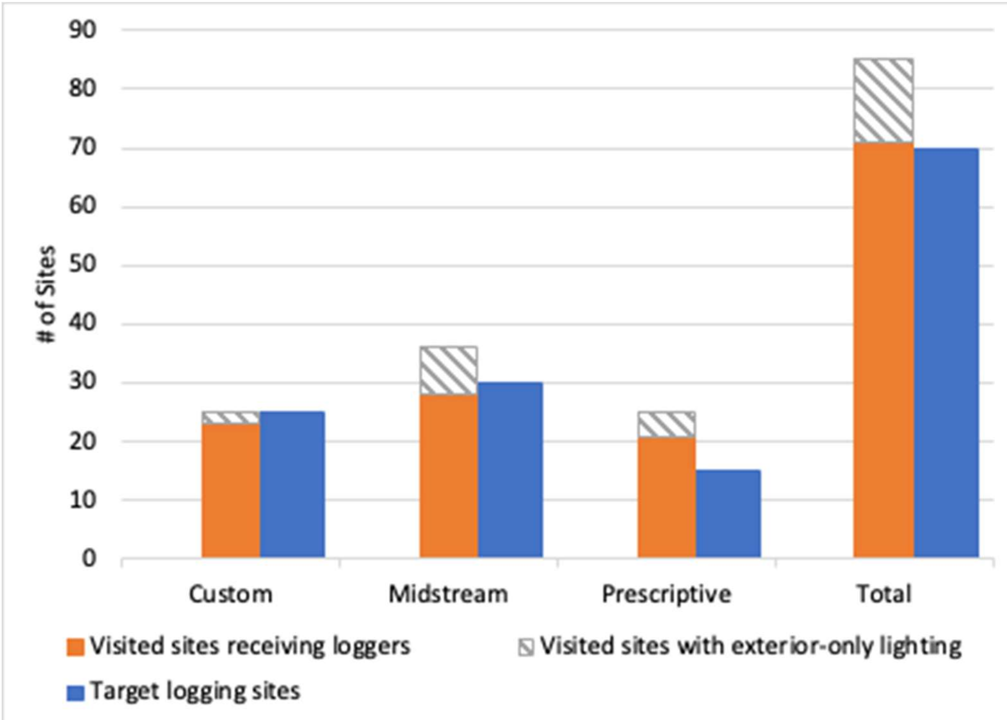
  - Learning more about baseline fixtures could be challenging because they are often removed and no longer on-site. Some strategies that were used to overcome this challenge are:
    - Interview various site contacts
    - Identify older technology lighting in adjacent and similar spaces across the facility. Light fixtures in bathrooms, mechanical rooms, or other less used spaces may be older technologies and can be indicative of baseline fixture technology.
    - Viewing any spare or uninstalled baseline fixtures still at the facility.
    - If none of the items listed above yielded information on baseline lighting, engineering judgement was used to assess the quality of the proposed baseline in savings calculations.
- General specifications for the HVAC system serving the area where the upgrade lighting project occurred.
  - Technicians examined HVAC systems at each site looking at the primary source of heating and cooling, the distribution system, nameplates, and service tags.
  - The most important details to gather regarding the HVAC system were the type of space conditioning in the area with upgrade lighting (both heating and cooling, only heating, or only cooling), the fuel type used for space conditioning (typically electricity or natural gas), and the type of HVAC system serving the area with upgrade lighting.
- The facility and upgrade lighting operating schedule, including weekly and seasonal schedules.
  - Collecting qualitative information about the facility and lighting operating schedules and comparing these with lighting operation observed in the field was helpful as a source of comparison for both the annual baseline lighting hours of use values in the application workbooks and annualized lighting hours of use from light logger data.
- Any priority items noted during desk reviews, such as inconsistencies in project information
  - Occasionally, priority items for further investigation would be identified during desk reviews ahead of site visits.

Information and data collected using the above methods was used to revise the inputs to lighting project savings calculations, as necessary, and this process is detailed in Section 4.5. Light logger deployment is detailed in the following section.

3.2.4 Logger Placment and Removal

Light loggers were installed to measure the hours of use of upgraded light fixtures. Overall, 845 light loggers were deployed at 71 sites from late August through late September 2023. These loggers were removed from mid-December 2023 through mid-January 2024. A summary of the number of sites in each program that received light loggers versus targets is shown in Figure 2. Loggers were not installed at most sites with exterior-only lighting upgrades because evaluation field engineers developed an accurate understanding of lighting hours of use via site observations and conversations with site contacts regarding exterior lighting controls (ex. timers or photocells).

Figure 2: Number of Sites Receiving Light Loggers by Program Component



Given the breadth of site types and upgrade lighting projects, the evaluation team developed guidance to ensure uniformity of approach by evaluation field engineers when installing light loggers. This guidance is outlined below starting with Table 11, which details the target number of loggers to be installed at each site based on lighting project savings. In general, lighting projects with higher kWh savings received more light loggers.

Table 11: Target Number of Lighting Logger for Site Visits

Lighting Program	Project Size	Lighting Project Savings	Target Loggers
Custom Lighting	Large	> 1,000 MWh/yr	30
	Medium	150 – 1,000 MWh/yr	22
	Small	< 150 MWh/yr	10
Midstream Lighting	Large	> 150 MWh/yr	16
	Medium	50 – 150 MWh/yr	10
	Small	< 50 MWh/yr	7
Prescriptive Lighting	Large	> 300 MWh/yr	18
	Medium	50 – 300 MWh/yr	14
	Small	< 50 MWh/yr	7

Aside from the target number of loggers per lighting project, the guidance below was also provided to evaluation field engineers on choosing which light fixtures to log, especially for the larger projects that installed upgrade lighting across a vast number of space types at a facility with varying hours of use (ex. large commercial space with offices, hallways, bathrooms, conference rooms, labs, a gym, and cafeteria). In general, our goal was to have each installed light logger represent as many fixtures as possible, whether fixtures were in the same space or the hours of use from a logger in one space could be used to accurately estimate fixture run-time in a similar space.

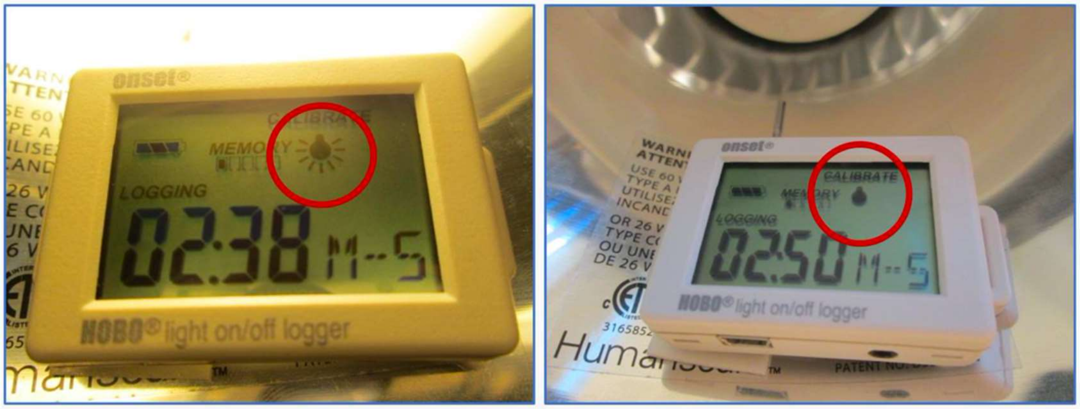
- Consider how a space with upgrade is used and how it is used relative to other spaces that received upgraded lighting. Install loggers in areas that will represent as many space types across the facility as possible (ex. a light logger in a low use space, such as a bathroom, might provide a representative run-time for lighting in other low use spaces).
    - Consider logging lighting in areas of unknown run-time
    - Place fewer loggers in known 24/7 spaces like hallways
- Consider how lighting is controlled in a space to determine the number of light loggers to install to ensure data is representative of lighting operation across the space (ex. lighting in a space on one circuit and controlled by a single switch or occupancy sensor versus lighting in a single space where each fixture has an integrated occupancy sensor)
- Ensure areas with high upgrade fixture counts receive a logger (i.e., areas generating significant project savings)
- If a facility contains duplicative, dominant space types like offices and classrooms, ensure a concentration of loggers are placed in these spaces to achieve a representative sample of these spaces

When installing loggers, evaluation field engineers performed a state test on each logger to confirm that the logger was correctly recording when the light was on and off and not affected by other light sources such as windows or nearby fixtures. Figure 3 shows the state indication on the display screen of logger. The state test involves turning the light on and off while looking at the screen, or covering and uncovering the sensor while the light is on.

Aside from performing a state test, evaluation field engineers also documented each light logger installation by noting the logger serial number, installation location details including space and light fixture type, and light logger start date and time. Evaluation field engineers also took several photos detailing the location of each logger and created a site layout sketch with logger locations to guide logger collection.

Lighting logger removals occurred from mid-December 2023 to mid-January 2024. At removal, the evaluation team inspected the loggers for damage. Evaluation field engineers performed a second state test on each logger at removal to ensure the logger was still functioning properly. If a logger did not seem to be operating properly, it and its data were flagged for further review.

Figure 3: Light Logger State Test



3.3 ANALYSIS METHODS

3.3.1 Logger Data Processing

Logger data was processed and aggregated in batches after the meters were collected from participating facilities. The data contained hourly logger data from August 2023 to January 2024 across 71 unique accounts, totaling 1.9 million hourly observations. Data was cleaned, adjusted for daylight savings, and any observations which occurred before the logger start date, or after the logger end date (pickup date) were removed. A “percent on” variable was generated, equaling the percent of each hour in the logging period that the light was on and was stored as an observation (i.e., 50% = 30 out of a possible 60 minutes).

Next, the data was annualized by training a regression model on the metered data and projecting logger patterns onto a hypothetical year. This step is important for accurately predicting annual usage when observed logger data does not cover a full year. The “percent on” variable is inherently bounded – a light cannot be on less than 0% of an hour and it cannot be on for more than 100% of an hour. Given the bounded nature of the data, the evaluation team opted for a fractional regression technique. Fractional regression is a model of the mean of the dependent variable y conditional on covariates x. Because y is in [0, 1], we must ensure that the conditional mean is also in [0, 1]. Essentially, we want a functional form that will not predict lighting operation less 0% or greater than 100% under any condition. We do this by using a maximum likelihood logit model for y. The fractional regression model specification used for each commercial lighting logger was:

$$\text{percentO}n_{l,d,h} = \beta_0 + \beta_1 DOW + \beta_2 HOUR + \beta_3 (DOW * HOUR)$$

Where:

- $percentOn_{l,d,h}$ = the “percent on” recorded by logger l on date d and hour h

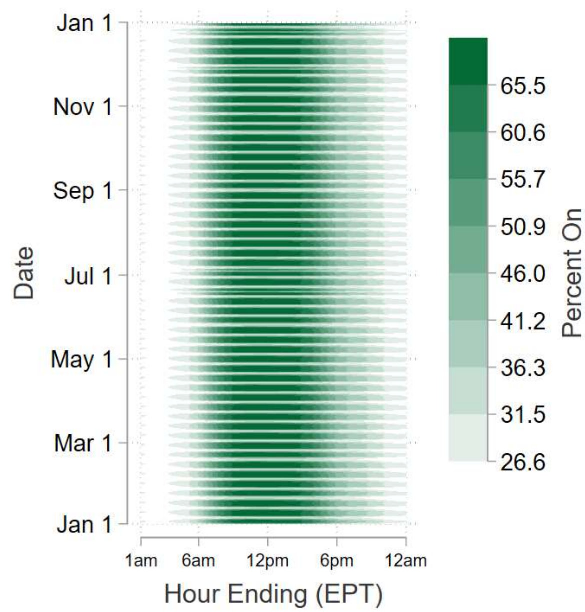
- DOW = a categorical variable equal to one on Sunday, two on Monday, three on Tuesday, and so on. Holidays are coded as eight, a separate category, regardless of which day of the week they fall on.
- $HOUR$ = a categorical variable for the hour of the day (1 to 24)
- ϵ = the error term

After estimating the regression for each logger, we use the coefficients to predict lighting usage across a generalized annual calendar. This is referred to as an 8,760-hour load shape because it contains predicted lighting usage for all 365*24 hours. We then estimate the summer CF for each logger as the average 'percent on' for hour ending 17:00 (4 pm to 5 pm) on non-holiday weekdays in June, July, and August.

3.3.2 Logger Data Analysis

Figure 4 shows a "heatmap" where high usage periods are colored darker than lighter usage periods. This example figure shows the average annualized profile of accounts in the dataset. During regular business hours, most interior lights are on. This percentage dwindles but does not drop to zero at night, as some lights always remain on or follow irregular schedules.

Figure 4: Example Heatmap of Percent On By Hour and Date



4 IMPACT EVALUATION ACTIVITIES AND FINDINGS

4.1 PROGRAM AND STUDY OVERVIEW

National Grid's Electric Commercial & Industrial Program includes multiple components which encourage customers to upgrade to high efficiency LED lighting and lighting controls. The three main components based on program delivery type model and gross savings approach are listed below. Table 12 lists several key impact evaluation questions that were developed at the outset of this evaluation for each component. Answers to these questions and other important study findings are detailed in Section 4.6.

- Prescriptive Lighting (Downstream)
- Custom Lighting
    - New Construction and Major Renovation (Illuminating Excellence)
    - Horticulture (cannabis and other indoor agriculture)
    - Classic Custom
- Midstream Lighting

Table 12: Electric Commercial & Industrial Program Key Impact Evaluation Study Questions

Component	Key Questions
Prescriptive Lighting	Is the application workbook used to organize projects, estimate gross savings, and populate the tracking system used correctly and free of issues? Do actual operating characteristics align with NYS TRM assumptions?
Custom Lighting	Are the gross savings calculation methods and "off-TRM assumptions" reasonable and consistent with industry standard practice? Are the wattage assumptions and controls factors for specialty lights and network lighting controls appropriate? Do the lighting power density (LPD) baselines for new construction projects align with the state building code?
Midstream Lighting	Was the program-supported LED lighting equipment installed? At the expected location? Do operating parameters match gross savings assumptions?

4.2 TRACKING DATA REVIEW

The evaluation team requested project files from National Grid for each sampled project and performed an engineering desk review to independently assess the project savings. The review evaluated the completeness and accuracy of the project documentation, as well as compared the applied assumptions against the NYS TRM. National Grid also has a tracking system, termed InDemand, that is used for reporting to New York State. In certain instances, the evaluation team also compared the savings from the project documentation to this reported savings file.

The three components had varying types of tracking data for the evaluation team to review. The Custom and Prescriptive components had Microsoft Excel-based application workbooks that detailed the assumptions and calculated the savings for the project. The Prescriptive workbooks underwent a systematic change in early to mid-2022, which affected the timeframe from which the sample was selected. Regardless of this change, the evaluation team performed the automated desk review, described below, for the sampled projects and the 2022 population.

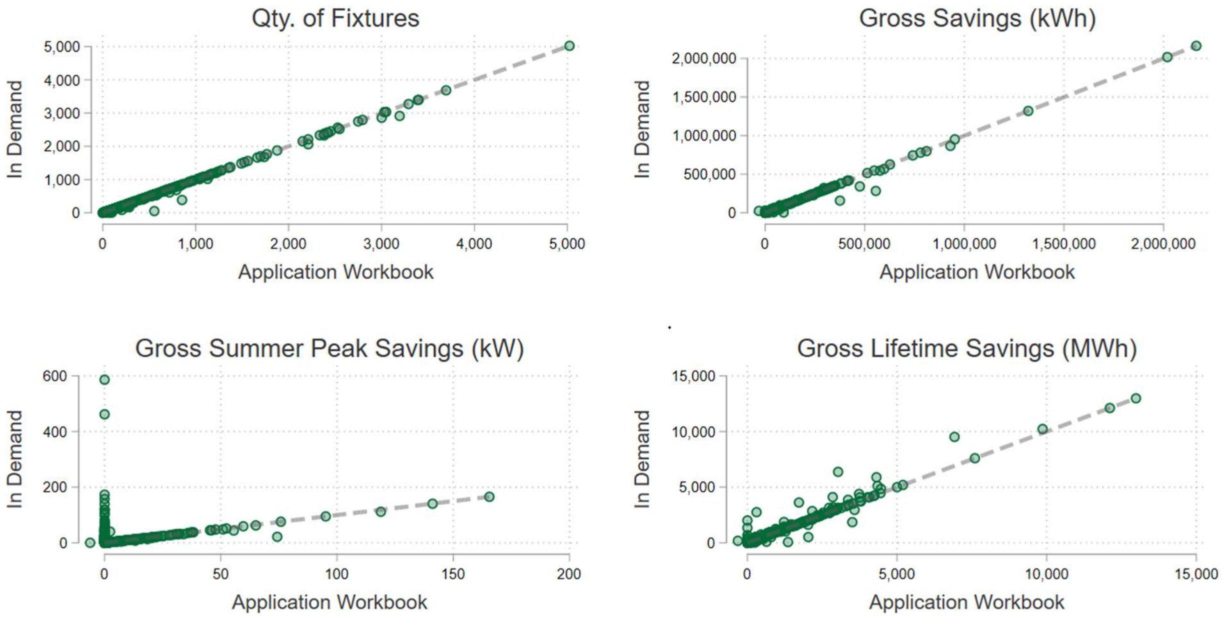
As introduced in Section 3.2.2.2, National Grid uses a deemed savings approach to estimate savings for Midstream projects. Excel-based spreadsheets detailing this deemed savings approach, including the development of savings estimates for each Midstream measure code and Midstream project savings tracking data, were reviewed in detail and our method and findings are outlined in Section 4.2.2.

4.2.1 Automated Desk Review – Prescriptive

To assess how savings values differed between the application workbooks and the gross savings stored in National Grid's tracking system of record (InDemand), we compared data from both sources. The workbooks contained gross kWh and kW savings estimates from lighting and controls, by measure. Workbook data is loaded into InDemand, so the savings estimates should match if the data was ingested properly.

Aggregating workbook data and InDemand data to the application number-level allowed us to directly compare gross kWh and kW savings estimates. Figure 5 shows how the two data sources compare, revealing that, for the most part, the two data sources match (the grey line shows where the two values are equal) for quantity of fixtures and gross kWh savings. Discrepancies happen occasionally due to incomplete imports or version control issues. Our team also noticed that certain application versions failed to apply TRM CF or HVAC interactive effect assumptions. Specifically, we found that newer application workbook versions included summer CF, while the earlier versions did not. Further, some application workbooks were missing key Excel sheets, or were missing key cell fields, or had been re-structured incorrectly (potentially by the user) which often caused calculation errors.

Figure 5: Comparison Between Application and Tracking Data



As mentioned above, HVAC interactive effect savings calculations were also reviewed as part of the automated desk review and the most commonly identified issue was the inadvertent omission of interactive effects for conditioned spaces. In the Prescriptive application workbook, service zip code is used to lookup factors for the nearest reference city. We found several instances where participants did not enter a service zip code in their application, causing the tool to apply no HVAC interactive effects even though a HVAC configuration was entered, and the program-supported fixtures were installed in conditioned spaces. In addition, related instances were identified where participants did not enter an HVAC system type in the Prescriptive application workbook, which also resulted in HVAC interactive effects not being calculated for program-supported fixtures installed in conditioned spaces. These same issues were found during the desk reviews of some sampled Prescriptive and Custom sites.

The evaluation team also received monthly billing data from National Grid for sites in the evaluation sample. Monthly bills were merged with weather data and split into pre-retrofit and post-retrofit periods using the installation date from InDemand. A regression analysis of each site was performed prior to the site visits to assess the gross savings a share of overall facility consumption and flag sites where gross savings exceeded baseline consumption. Gross savings more than annual consumption typically indicates that the program-supported fixtures were installed across multiple meters or on a different meter than the one listed in InDemand.

4.2.2 Midstream Deemed Savings

To scale their Midstream program, National Grid structured the Midstream program gross kWh and kW savings calculations using a streamlined deemed savings approach. In this approach, the various light fixtures forming an upgrade project are separated into distinct applications based on fixture type and wattage. A measure code that has deemed kWh/yr/fixture and kW/fixture savings values associated with it is applied to each application and gross savings at the application level are calculated by multiplying application fixture quantity by these deemed savings values. These application-level savings are summed to calculate gross kWh and kW savings at the project level. For the sake of clarity, an example of this calculation process is shown in Table 13. Additionally, Table 14 lists the various measure codes used to estimate savings for sampled Midstream projects, including descriptions of the measure code upgrade and baseline lighting. Note that the Midstream program includes additional measure code options beyond those listed below to categorize other upgrade lighting fixtures; however, the measure codes listed here are the only ones that were applied to sampled midstream projects.

Table 13: Example National Grid kW and kWh Savings Calculation for the Midstream Program

Site ID	App #	Site Name	Measure Code	Upgrade Qty	Upgrade Fixture Model Number	Deemed Peak kW Savings (kW/fixture)	kW Savings (kW) [A]	Deemed kWh Savings (kWh/yr/ fixture)	kWh Savings (kWh/yr)[B]
1	2345	Local Hospital	88UBP	20	LED Interior 2′×2′ Luminaire, 26 W	0.04	0.8	131	1,048
1	5678	Local Hospital	88UCP	100	LED Interior 2′×2′ Luminaire, 34 W	0.07	7.0	228	34,200
						Total Project Savings	**7.8**		**35,248**

[A] *Gross kW Savings = Upgrade Qty ´ Deemed Peak kW Savings/Fixture for Measure Code 88UBP or 88UCP*
[B] *Gross kWh Savings = Upgrade Qty ´ Deemed Peak kWh Savings/Fixture for Measure Code 88UBP or 88UCP*

Table 14: Midstream Baseline and Upgrade Measure Code Descriptions and Wattages

Measure Code	Representative Baseline Description	Baseline Wattage (W/fixture)	Representative Upgrade Description	Upgrade Wattage (W/fixture)
88UBP	2L T8 & 2L U-T8 -59W or 3L 2'T8 -47W	59	LED Interior 1×4 & 2×2 Luminaires or Integrated Retrofit Kits	25
88UCP	3L T8 -89W or 4L T8 -112W	92	LED Interior 2×4 Luminaires or Integrated Retrofit Kits	33
89UAP	2L T8 -59W or 2L 2'T8 -33W	50	DLC Premium LED Direct Linear Ambient Luminaires, ≤ 4 ft sections	26
89UBP	2L T8 -59W, 4L T8 -112W, or 2L T5 -63W	109	DLC Premium LED Direct Linear Ambient Luminaires, > 4 ft sections	61
86UAP	250W HID -270W	270	LED Interior High & Low Bay Luminaires or Retrofit Kits (>1,000 lm)	88
86UBP	6L T8 -224W, 4L T5 -234W or 400W HID -430W	345	LED Interior High Bay Luminaires or Retrofit Kits (>12,000 lm)	117
86UCP	575W HID -640W or 8L T5 -468W	545	LED Interior High Bay Luminaires (> 20,000 lm)	207
87UAP	70W MH -95W, 100W MH -128W, 175 MH -215W or 200W MH -232W	133	LED Exterior Wall/Pole/Arm Mounted Area & Flood Luminaires and Bollards LOW OUTPUT (250-5,000 lm)	30
87UBP	250W MH -295W (or Pulse Start - 270W) or 150W MH -190W (or Pulse Start -160W)	236	LED Exterior Wall/Pole/Arm Mounted Area & Flood Luminaires MID OUTPUT (5,000-10,000 lm)	59
87UCP	250W MH Pulse Start -270W, 350W MH Pulse Start -375W, or 400W MH Pulse Start -430W	382	LED Exterior Wall/Pole/Arm Mntd Area & Flood Luminaires HIGH OR VERY HIGH OUTPUT (>10,000 lm)	151
89UAPC	2L T8 -59W, 4L T8 -112W, or 2L T5 - 63W	53	LED Direct Linear Ambient Premium Luminaires w/ Integrated Control - ≤ 4 ft. sections	31
86UAPC	250W HID -270W	270	LED Interior High & Low Bay Premium Luminaires or Retro Kits (>1,000 lm) w/ Integrated Occupancy Sensor	40
86UBPC	4L T5 -234W, 400W HID -430W, or 350W MH -400W	352	LED Interior High Bay Premium Luminaires or Retro Kits (>12,000 lm) w/ Integrated Occupancy Sensor	124
86UCPC	575W HID -640W or 8L T5 -468W	522	LED Interior High Bay Prem Luminaires (> 20,000 lm) w/ Integrated Occ Sensor	164
87UCPC	250W MH -295W (or Pulse Start - 270W), 150W MH -190W (or Pulse Start -160W)	248	LED Exterior Wall/Pole/Arm Mounted Area & Flood Luminaires HIGH-VERY HIGH OUTput w/ Dim Control (>10,000 lm)	70

Given the fundamental nature of these measure codes in estimating savings for Midstream program lighting projects, the method that the program used to estimate gross kWh and kW savings for each measure code was reviewed. In general, it was found that the program follows the NYS TRM when calculating these savings values for each measure code, using assumptions for light fixture hour of use, HVAC interactive effect multipliers, and energy savings factors for fixtures with control savings. It was concluded that this method is generally acceptable in its ability to accurately estimate savings given the program goals of scaling and affording a more streamlined approach over the Custom and Prescriptive programs. That said, two structural deficiencies were identified in these calculations through this review process. First, for measure codes of fixtures assumed to be commonly installed in areas with mechanical cooling, gross kWh savings for these measure codes were overestimated due to the inclusion of both the electricity ($HVAC_c$) and electrical demand ($HVAC_d$) interactive effect multipliers in deemed electrical energy savings values (kWh/yr/fixture). Secondly, a CF of 1 was assumed for all interior fixtures, which overestimated electrical demand savings for many program applications given that many facilities participating in this program are closed or at low occupancy levels during the late afternoons or early evenings in June through August when the summer peak demand period typically occurs. Through the evaluation of the Midstream program, deemed savings calculations were revised to correct for these deficiencies by removing $HVAC_d$ multipliers from measure code gross kWh savings values and adjusting kW savings calculations so that a CF other than 1 could be entered.

Beyond the adjustments made to measure code deemed savings values outlined above, Midstream calculations were re-built to add flexibility so that adjustments could be made on an application level depending on information gathered during Midstream project desk reviews and site visits. Example adjustments include changing an application measure code or fixture quantity. These adjustments and the results of site-level review on the Midstream program are discussed in Section 4.5.

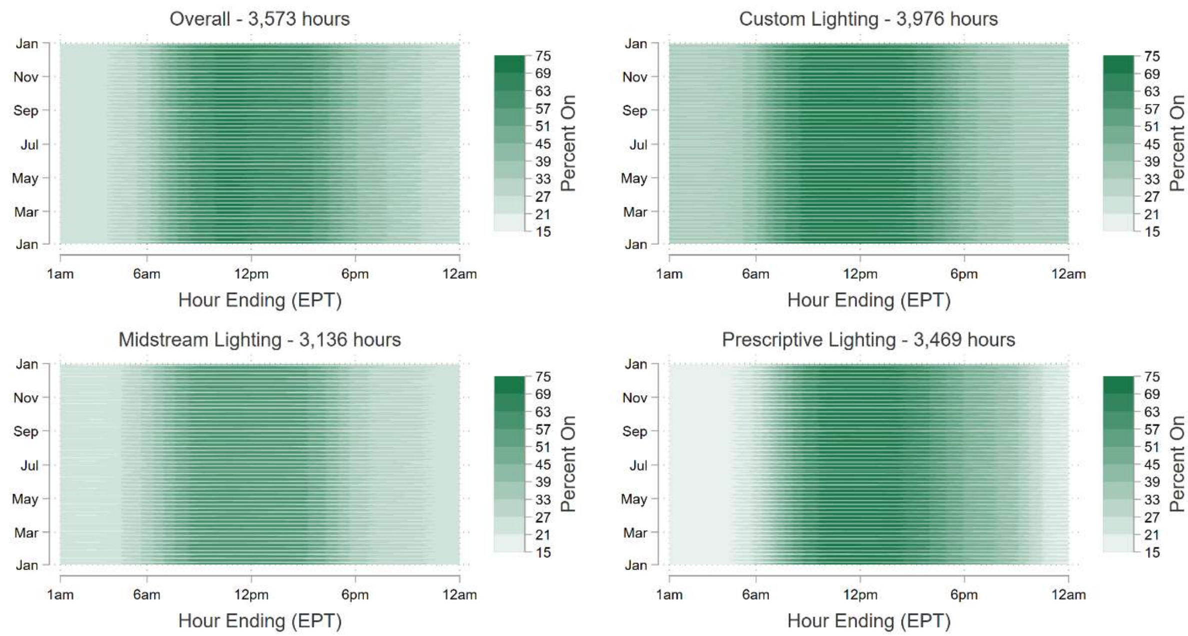
Finally, it is recommended that the Midstream program change its method for estimating savings to improve the accuracy of project-level savings estimates, which would address the high level of scatter observed in the Midstream program realization rate results, as illustrated in Figure 14. Instead of using a measure code deemed savings, or binned approach, it is recommended that savings calculations be revised to use the actual wattage of upgrade fixtures and derive a representative wattage for a baseline fixture by using ratios of representative baseline-to-upgrade fixture wattages (baseline fixture wattage/upgrade fixture wattages). This approach would be more accurate than the existing approach because savings calculations would be specific to each Midstream project in a way that the deemed savings approach cannot achieve since it uses discrete deemed values, which were found to differ to a great extent from actual and baseline fixture wattages for several sampled projects. A related example that details the challenge of using a deemed savings approach to estimate savings for the Midstream program is provided by site NG-M-047 in Table 22.

Ideally, the recommendation above is applied to improve the method used by the Midstream program to calculate savings estimates. However, an alternative approach to improve the accuracy of Midstream program savings calculations would be to refine its bin structure for upgrade LED fixtures. For example, an additional bin could be created to estimate savings for the upgrade high wattage high bay fixtures installed by site NG-M-047 that did not fit the Midstream program's existing bin structure well. The challenge of estimating savings for site NG-M-047 using the existing Midstream program bin structure is further detailed in Table 22.

4.3 LOGGER DATA ANALYSIS

Figure 6 is a heatmap showing the average annualized profile of accounts in the dataset for all program components and each individual program component. During regular business hours, most interior lights are on. This percentage dwindles but does not drop to zero at night, as some lights always remain on or follow irregular schedules.

Figure 6: Program and Program Component Heatmap of Percent On By Hour and Date



Next, Figure 7 shows the average percent on by hour for weekdays and weekends (including holidays). As expected, lights are on more hours during weekdays when businesses are more likely to be open. Like the heatmap above, this graph shows that lights are more likely to be on during the day, but some lights remain on into the night.

Figure 7: Load Shape by Hour of Day

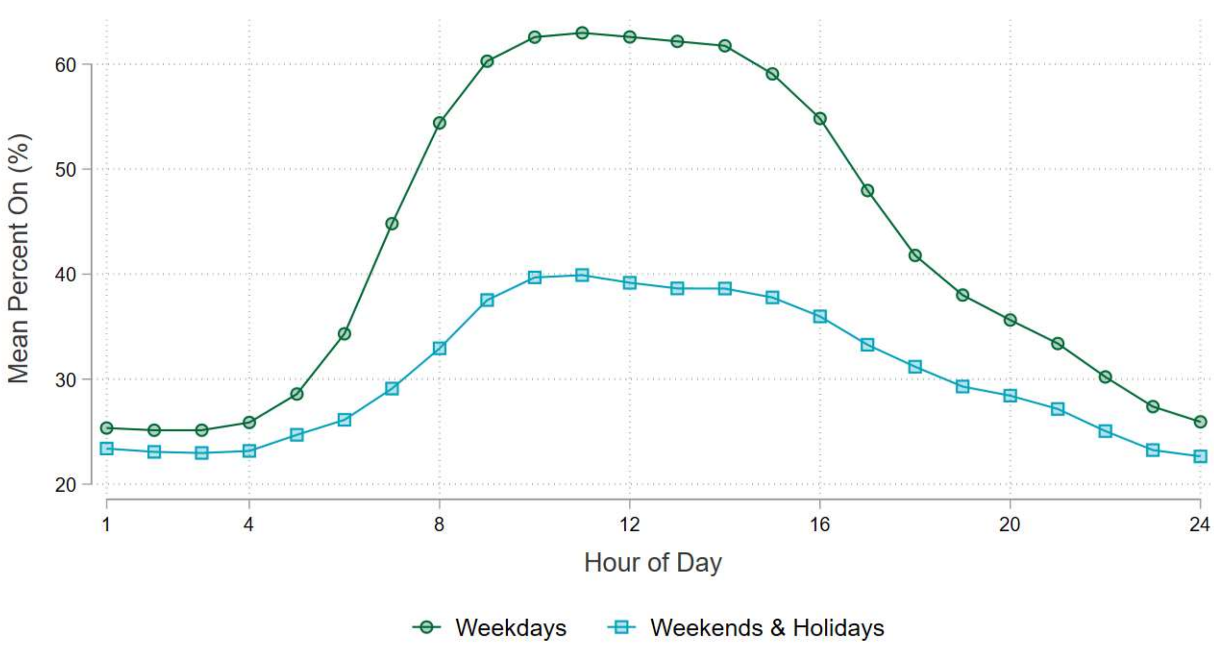


Table 15 below shows average predicted interior annual hours of use by program, out of a maximum of 8,760 hours per year. Loggers deployed at Custom program sites were on roughly 11 hours per day on average, or (3,975 / 8,760) * 24 hours. Using the same calculation, Midstream and Prescriptive Lighting program loggers were on only 8.6 and 9.2 hours per day, respectively.

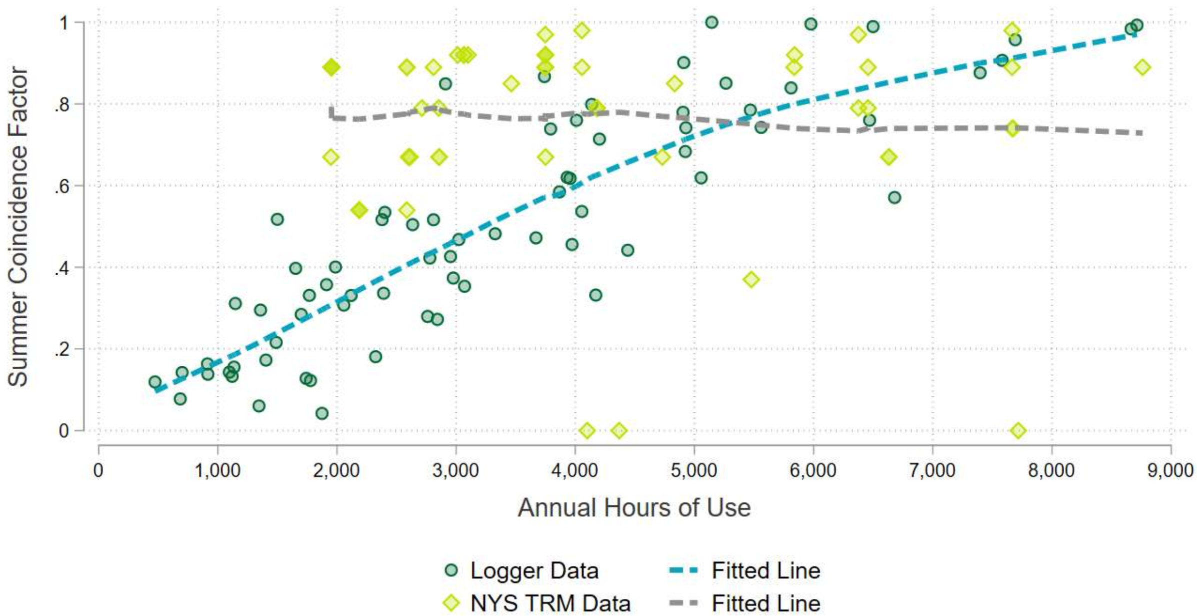
Table 15: Hours of Use and Summer CF by Program

Program	Interior Annual Hours of Use (hr/yr)	Summer Coincidence Factor
Custom Lighting	3,976	0.54
Midstream Lighting	3,136	0.44
Prescriptive Lighting	3,357	0.54

Figure 8 compares summer CF against annual hours of use for NYS TRM[7] default facility types and the site-level average logger data from this evaluation. Specifically, we include a scatter plot by site and a fitted moving average line to help visualize the relationship. The logger data from the evaluated sites show positive correlation between annual hours of use and summer CF (dashed blue line has a positive slope), which is to be expected. A site with 2,000 hours per year would be likely to have a portion of its lights turned out for peak periods, specifically from 4 to 5 pm on a non-holiday weekday in June, July, or August. This finding contrasts with the NYS TRM assumptions which shows no relationship between the two variables (dashed gray line is roughly flat). For example, the NYS TRM assumes annual hours of use of 1,955 hr/yr and 0.89 summer CF for the "Church" facility type. Based on the patterns observed across the over 800 light loggers deployed for this evaluation, a CF of 0.89 with fewer than 2,000 annual hours of operation is unlikely. Most sites with operating hours between 1,500 and 2,500 hours per year show an average summer CF between 0.3 and 0.5.

[7] New York State Department of Public Service Technical Resource Manual V. 10, pages 862-863 (Effective January 1, 2023).

Figure 8: Compare Relationship Between Summer CF and Interior Lighting HOU



4.4 HVAC INTERACTIVE EFFECTS

In addition to requiring less electrical input, LED lighting emits less waste heat as a byproduct than legacy inefficient lighting technologies. This reduction in waste heat has interactive effects with the building's HVAC system when the program-supported lights are installed in conditioned spaces. Specifically:

- The air conditioning system does not have to work as hard during the cooling season to reject waste heat from the lighting system. This creates additional energy savings during summer months and increases the peak demand savings from efficient lighting projects.
- The heating system must work harder during the heating season to make up for the waste heat no longer injected into the space by inefficient lighting equipment. If the space heating equipment is electric, this offsets the interactive energy savings from the summer months. If the space heating system is powered by fossil-fuel, there are no heating interactive effects on the kWh savings. Rather, the heating "penalty" is realized in the form of negative fuel savings.

National Grid incorporates assumptions from Appendix D of the applicable version of NYS TRM into its gross savings calculations for each of the three program components in this evaluation. The HVAC interactive effect multipliers in Appendix D were stable across Version 9 (effective 2022) and Version 10 (effective 2023) of the NYS TRM but changed significantly in Version 11 (effective 2024). The new HVAC interactive effect assumptions in V11 of the NYS TRM are generally lower than prior versions. This means, all else equal, an LED lighting upgrade in a conditioned space will receive slightly less of a kWh and kW savings increase from cooling interactive effects. The fossil fuel heating penalty will also be smaller. HVAC interactive effects were a minor factor in the overall VGS realization rates so the TRM change does not create issues with applying the VGS realization rates prospectively.

Field staff collected basic HVAC information for each facility and lighting space during the initial site visit. If the HVAC configuration assumed in the gross savings calculations matched the site visit findings, we made no change to the HVAC interactive effect assumptions. If the HVAC interactive effects were omitted from the calculations for a conditioned space, we applied the correct set of multipliers from Appendix D of the TRM for the closest reference city. If interactive effects were applied to an unconditioned space, we removed them. If the heating fuel found on-site differed from the gross savings assumptions, we applied the multipliers for the as-found configuration.

4.5 SITE-LEVEL SAVINGS ANALYSIS

The gross kWh and kW savings of sampled sites from the Custom, Prescriptive, and Midstream program components were evaluated based on information and data collected during desk reviews and site visits. The method used for these site-level analyses is outlined below.

Before diving into the general approach used to evaluate site-level savings calculations, it should be noted that National Grid calculates savings for Custom and Prescriptive Lighting projects similarly with a collection of application workbook tools that are described below.

Table 16: Descriptions of Application Workbooks Used to Estimate Lighting Project Savings

Savings Application Workbook Tool Type	Description
National Grid 'Commercial and Industrial Retrofit Program Lighting Systems & Controls Application'	This is a custom Microsoft Excel tool developed by National Grid to calculate savings for retrofit lighting and control upgrade projects completed within its Commercial and Industrial Retrofit Program. The lighting savings calculations in this tool follow the NYS TRM. This tool is revised on a periodic basis by National Grid and several revisions of this tool were encountered when reviewing sampled projects. The various revisions of this tool function like one another and no significant variation with respect to savings calculation methods was identified between tools.
National Grid 'Illuminating Excellence C&I New Construction & Major Renovation Lighting Application'	This custom Excel tool was developed by National Grid to calculate savings for new construction or major renovation lighting and control projects where a typical retrofit baseline is not available. Unlike the tool above, which relies on a baseline set by existing light fixtures, this tool uses lighting power density values from either the 'Building Area Method' or 'Space-By-Space Method' of the

	2020 Energy Conservation Construction Code of NYS (ECCCNYS) to estimate a baseline lighting power. The wattage of the upgrade lighting project is compared to this baseline to estimate project savings.
Custom lighting savings workbooks from contracted technical review firms, such as L+S Energy Services and ERS	Several sampled lighting upgrade projects had savings estimates provided in custom lighting savings workbooks developed by technical review firms L+S Energy Services and ERS. While these savings workbooks differed from the National Grid retrofit and new construction savings workbooks described above, they functioned similarly and followed the NYS TRM and 2020 ECCCNYS according to project being a retrofit or new construction type project.

For each sampled Custom and Prescriptive project, the accuracy of savings calculations in the application workbook were reviewed during the site-level analysis phase both at the time of the desk review and following site visits. While changes were made to the application workbook inputs based on collected data and information, no fundamental errors were detected in how these tools functioned from an Excel standpoint or the mathematics used in savings calculations. Further discussion on the process for making changes to tool inputs to generate verified savings results is provided below.

All sampled Custom, Prescriptive, and Midstream lighting projects were evaluated using a structured process that separated savings calculation updates into five revision categories, which are listed below in Table 17. This process was developed and followed so that program-level results could be summarized in a way that would clearly identify and communicate the main drivers affecting verified gross kWh and kW savings and program realization rates. To follow this process, evaluation engineers compared project data and information collected during the desk review and site visit phases against the inputs in National Grid savings calculations. Revisions to these inputs occurred in a stepwise approach following the order of the revision categories listed below when disagreement between these inputs and information collected via project documentation, on-site observations, and/or measured light logger data required. Refer to the rightmost column for examples of the type of disagreements that might necessitate a change in an existing savings calculation input.

Table 17: Revision Categories for Changes to National Grid Upgrade Lightings Calculation Inputs

Order of Revision	Savings Workbook Revision Category	Example Considerations for Making Revisions to National Grid Savings Calculation Inputs
1	Correct Fixture Count	• How does the fixture count in National Grid savings calculations compare to the fixture quantities listed in the project invoices and/or counted during the site visit? • How does the baseline fixture quantity compare to the upgrade fixture quantity? If there is a change in quantity between baseline and upgrade fixture quantities, is the change in lighting power density reasonable?
2	Correct Wattage	• Does the upgrade fixture part number in the application workbook match the part number observed during the site visit and/or in project documentation (ex. invoices)? How does the upgrade fixture wattage in the savings calculator compare with the data in the fixture cutsheet and in DLC documentation? • How does the proposed baseline fixture and its controls align with information gathered in the field?
3	Correct Upgrade Lighting Controls	• How do the upgrade lighting controls observed in the field and/or listed in project documentation compared to the controls detailed in the application workbook? Are the control type, quantities, and the important setpoints documented correctly?
4	Correct HVAC System Type	• Is the space where the upgrade lighting project occurred heated and/or cooled? If so, how does the observed HVAC system type compare to the entered HVAC system type? • Are HVAC savings computed and added properly to the lighting and control upgrade savings? For example, HVAC savings will not be computed properly if the site zip code is not entered.
5	Correct Baseline Operating Hours	• How do the baseline annual operating hours compare with the annual operating hours of the facility based on its weekly and seasonal schedule? Adjustments to baseline annual operating hours based on this consideration were only made if a large error in the National Grid value was noted when compared to site provided (or observed) operational schedules. • For projects where light loggers were deployed, savings calculation inputs were updated with annualized hours of use data from deployed loggers including annual baseline operating hours, CFs, and energy savings factors for projects including controls upgrades.

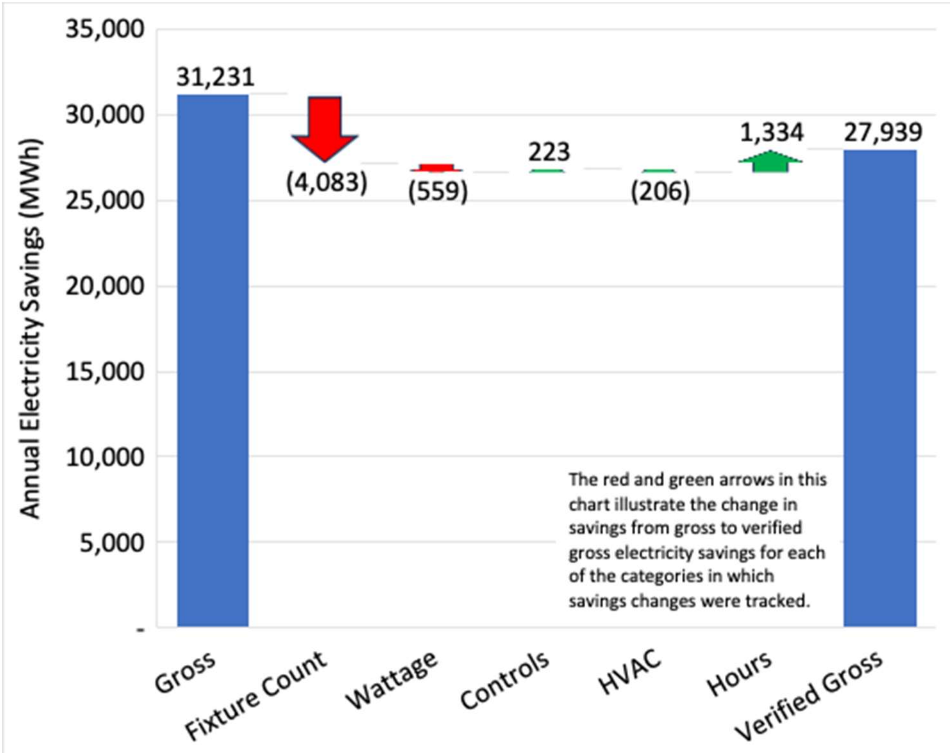
As detailed in Section 4.2.2, the Midstream program does not use the same application workbooks that the Custom and Prescriptive program use to calculate savings. Despite this, the Midstream program savings calculations were adapted to follow the savings calculation input revision structure outlined in Table 17 so that results from the Midstream program could be compared to and compiled with the results from the Custom and Prescriptive programs. The considerations listed in the rightmost column of Table 17 also apply to the Midstream saving calculation revision process, though a couple exceptions are worth noting. Since the Midstream program relies on measure codes with deemed kWh/yr/fixture and kW/fixture savings values calculated from representative upgrade and baseline light fixtures, adjusting the application measure code was one of the main methods to make corrections to incorrect fixture types or wattages. In many cases where an adjustment was required, the application measure code could be changed to another standard Midstream measure code. However, in certain cases, switching to another standard measure code would not accurately estimate savings for a required change. In such cases, a new measure code was created and used to estimate application savings. Some examples of when this occurred are detailed below:

- Measure codes 89UAP and 89UBP calculate savings for the installation of certain types of LED strip fixtures. See Table 14 for more information on these measure codes. Deemed savings estimates for these measure codes assume upgrade fixtures are installed in areas with mechanical cooling. However, these fixtures were occasionally observed to be installed in areas without mechanical cooling. To accurately calculate savings for these applications, new '89UAP (no AC)' and '89UBP (no AC)' measure codes were developed and applied in such situations.
- Measure codes 87UAP, 87UBP, and 87UCP calculate savings for increasing wattages of LED wall, pole, and arm mounted exterior area and flood fixtures. Measure code 87UCP calculates savings for the highest wattage fixtures and bases deemed savings on baseline and upgrade fixture wattages of 382 W and 151 W, respectively. While these wattages were representative of most higher output exterior fixtures, they fell short for several applications that installed 300 W exterior LED fixtures, the highest-powered exterior fixtures encountered during the Midstream evaluation and would have underestimated savings for this application. In this case, a new '87UCP - Very High' measure code was created with deemed savings calculated based a 1,080 W metal halide exterior baseline fixture (1,000 W MH with CWA ballast) and the upgrade 300 W LED exterior fixture.

The results of the site-level evaluation process detailed above are listed for each sampled site in Table 24 in the appendix. This table shows how savings for each sampled site changes with the revision categories detailed above in Table 17 and lists the final unweighted verified gross kWh and kW savings per site. Sampled sites accounted for about 40% of total program savings.

Figure 9 is a waterfall chart that shows the change in electricity savings from gross to verified gross savings for sampled lighting projects as a result of changes in the five revision categories. These five categories are the main categories that led to differences in gross and verified gross electricity savings estimates at the project level and are detailed further in Table 17. The unweighted realization rate for all site level analyses across the Custom, Prescriptive, and Midstream programs is approximately 89%. Evaluated fixture counts and wattages slightly reduce the savings, while changes in the evaluated controls and HVAC categories increase the savings. Evaluation results at the program component level are discussed in the following section.

Figure 9: Gross and Verified Gross Electricity Savings for All Sampled Sites



4.6 EXTRAPOLATED PROGRAM COMPONENT SAVINGS

Table 18 shows the verified and gross electricity savings by program component for the population of projects from the evaluation period. Verified gross MWh savings were lower than gross MWh savings for the Custom Lighting component in part due to several indoor agricultural projects with low realization rates. The electricity and electric demand VGS RR for the Midstream program component were 106.3% and 69.8%, respectively. One midstream project had an electricity VGS RR of 650% (site NG-M-047, detailed in Table 22) because the measure code for upgrade fixtures used in gross kWh savings estimates underreported the delta watts and the actual hours of use for light fixtures were nearly 3 times the estimated value. The unweighted realization rate for kWh savings when this site is not included is 93%. For Prescriptive projects, the VGS RR is about 1. The overall VGS RR for kWh savings for all lighting projects of the Electric Commercial and Industrial (C&I) program is 96.6% with a precision of ±4.7% at the 90% confidence level, achieving its overall precision target of 10% at 90% confidence level.

Table 18: Evaluation Results – Population Electricity Savings

Component	Gross MWh	VGS Realization Rate	Verified Gross MWh	Relative Precision at 90% Confidence Level
Custom	32,193	0.869	27,968	4.5%
Midstream	21,863	1.063	23,247	13.4%
Prescriptive	21,950	1.011	22,192	3.8%
LCI Program	**76,006**	**0.966**	**73,407**	**4.7%**

Table 19 shows the gross kW savings and verified gross kW savings by program component for the population of projects from the evaluation period. Verified gross kW savings were lower than gross kW savings for each program component (VGS RR < 1.0). The VGS RR for kW savings from lighting projects of the Electric Commercial and Industrial (C&I) program is 70.2% with a precision of ±8.0% at 90% confidence level, achieving its overall precision target of 10% at 90% confidence level. It should be noted that the 28.8% precision at 90% confidence for the electric demand VGS RR for the Prescriptive program did not meet the program level precision target of 15% at 90% confidence level. This is a result of the high degree of variability in the verified gross kW savings values of the sampled Prescriptive sites as well as the low VGS RR for this component. These items were mainly caused by CFs not being applied in gross kW savings calculations or gross kW savings being incorrectly translated to InDemand, National Grid's system of record that is used for reporting to New York Department of Public Service. These items are discussed in more detail below. Despite not achieving precision targets for the Prescriptive program, they were achieved for the Custom and Midstream program components.

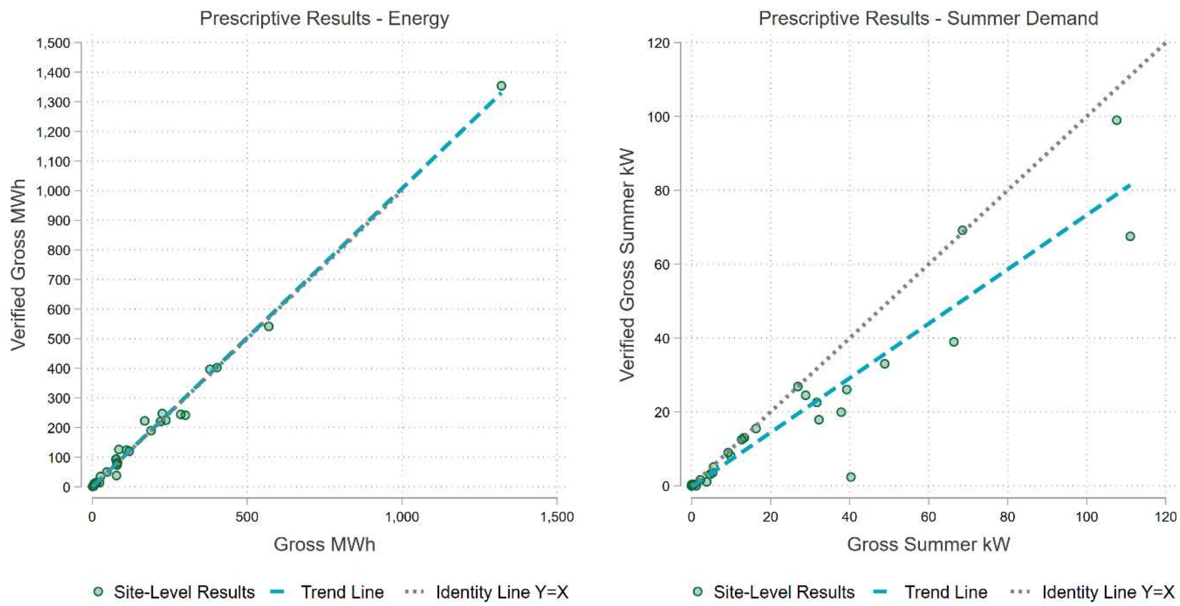
Table 19: Evaluation Results – Population Electric Demand

Component	Gross kW	VGS Realization Rate	Verified Gross kW	Relative Precision at 90% Confidence Level
Custom	6,547	0.751	4,919	5.8%
Midstream	6,241	0.698	4,354	12.2%
Prescriptive	3,964	0.629	2,495	28.8%
LCI Program	**16,752**	**0.702**	**11,768**	**8.0%**

4.6.1 Prescriptive Savings

The electricity VGS RR for the Prescriptive component was 101.1%, which means in aggregate the verified gross kWh savings estimated by the evaluation team were approximately 1% higher than the gross kWh values calculated by National Grid, stored in its InDemand tracking system and reported to NY DPS in its quarterly Clean Energy Dashboard submissions. The electric demand VGS RR was lower at 62.9%. Figure 10 provides a visual illustration of the realization rate at the site-level. Each green circle is the evaluated result from a site in the evaluation sample. The blue trend line approximates the realization rate (y = VGS RR * x). The grey trend line is presented for reference to illustrate what a 100% realization rate would look like overlaid on the data. We refer to the blue line as an approximation because the actual procedure weights each point differently based on the stratum case weight and evaluated savings.

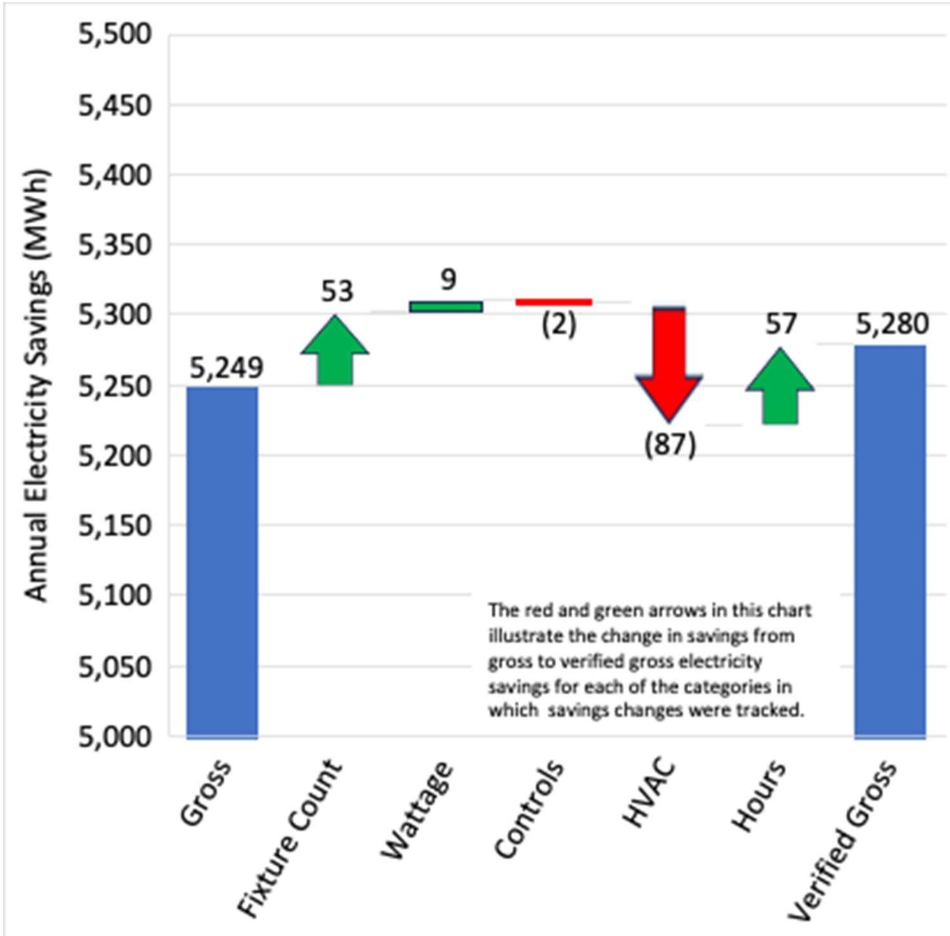
Figure 10: Ratio Estimation Example – Prescriptive Component



The component realization rates represent the average ratio of verified gross savings to gross savings. As shown in Figure 10, these ratios varied across projects. Because the impact evaluation relied on a sample of projects rather than a census, there is uncertainty (or a margin of error) around the estimated realization rates. The amount of uncertainty is a function of the sample size and the amount of variance observed between individual project results and the average ratio in the sample. The Prescriptive component's margin of error for energy at the 90% confidence level is ± 3.86% so the confidence interval of the realization rate is (97.2%, 105.0%). The relative precision is equal to the margin of error divided by the realization rate, or ± 3.81% at the 90% confidence interval. Once the realization rates were calculated, they are applied to all program activity for the period of investigation to estimate the verified gross savings for the LCI program.

Aside from several smaller lighting upgrade projects with annual electrical energy savings of less than 40 MWh/yr, the electricity VGS RR for Prescriptive projects are greater than 80%. This result is apparent in Figure 10, which shows that the VGS RR for gross kWh savings for sampled Prescriptive sites were all relatively close to the identity line. Figure 11 is a waterfall chart that shows the contribution of kWh savings adjustments that result for each savings revision category across all Prescriptive sites. Figure 11 shows that there are not any general issues that resulted in widespread reductions to gross kWh savings for Prescriptive Lighting projects.

Figure 11: Gross and Verified Gross Electricity Savings for Sampled Prescriptive Sites



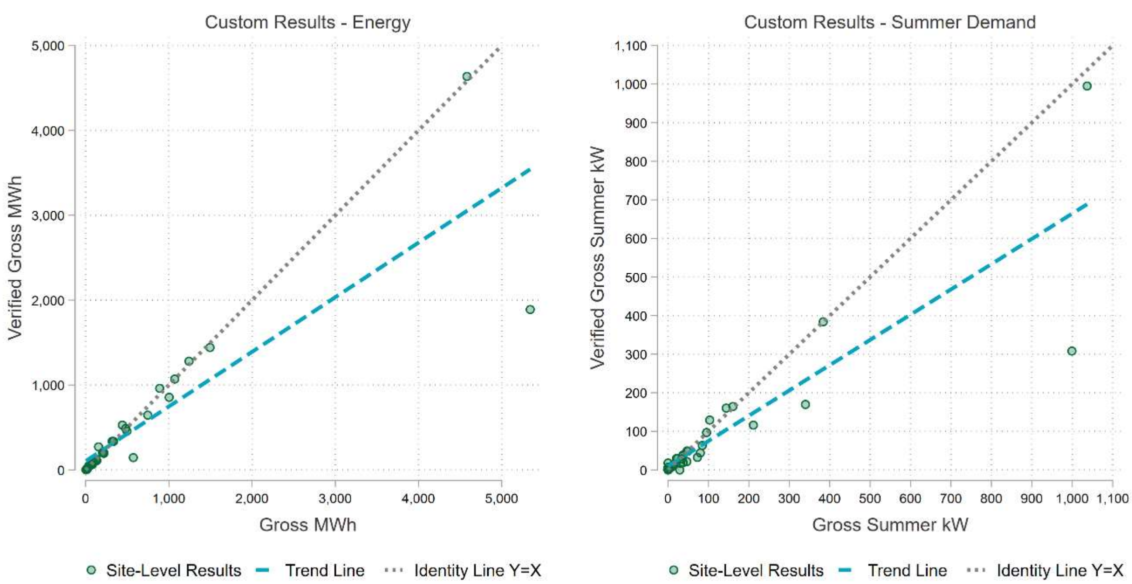
As noted above, the VGS RR for gross kW savings for Prescriptive sites was 62.9% meaning the verified gross kW savings estimated by the evaluation team were approximately 37% lower than the gross kW values calculated by National Grid. This result can mainly be attributed to an issue with the translation of gross kW savings results from Prescriptive application workbooks, the 'Commercial and Industrial Retrofit Program Lighting Systems & Controls Application' tool, to National Grid's InDemand tracking system. Of the 32 prescriptive projects that were evaluated, the gross kW savings value in InDemand was greater than the gross kW savings value in the workbook for 25 projects. In 16 of these instances, total connected demand savings were claimed in InDemand instead of gross kW savings (i.e. no CF was applied in InDemand). A specific reason for the mismatch in gross kW savings between the application workbook and InDemand could not be identified for the remaining 9 projects. The issue with the translation of gross kW savings to InDemand was highlighted to National Grid contacts during this evaluation and it is understood from this conversation that corrective action will be taken so that the newest revision of the 'Commercial and Industrial Retrofit Program Lighting Systems & Controls Application' tool will properly translate gross kW savings to InDemand.

Overall, it can be concluded through the evaluation of the Prescriptive program that the National Grid 'Commercial and Industrial Retrofit Program Lighting Systems & Controls Application' tool, the application workbook used for Prescriptive and Custom projects that are not new construction, correctly follows the NYS TRM calculation methodology and assumptions and that the NYS TRM assumptions approximate the operating characteristics of the evaluated lighting reasonably well. Lastly, aside from gross kW savings, the other important results from application workbooks translate well to National Grid's InDemand tracking system.

4.6.2 Custom Lighting

The Custom Lighting component had the largest gross savings of the three components with over 32,000 MWh of gross savings in 2022. Figure 12 shows the electricity and electric demand VGS RR for each site in addition to a fitted trend line, which approximates the VGS RR for the Custom Lighting program. The electricity and electric demand VGS RR were 86.9% and 75.1%, respectively, for the Custom Lighting program.

Figure 12: Custom Lighting Component Site-Level Results



From Figure 12, it can be seen that a few notable projects fall below the identity line to a greater extent than the other sampled sites, meaning their gross kWh and kW VGS RRs fall well below 100% and negatively impact the program-level realization rate results of the Custom Program to a greater extent than other sites. These sites are detailed in the tables below.

Table 20: Custom Projects that Negatively Affect the Program-Level the Electricity VGS RR

Site ID	Gross MWh Savings (MWh/yr)	Verified Gross MWh Savings (MWh/yr)	Electricity Savings Realization Rate (%)	Main Cause(s) Driving Change in Savings
NG-C-033	572.8	145.4	25%	This is major renovation lighting upgrade project at an indoor agriculture facility. Field evaluation engineers visited the site in mid-September and again in mid-December 2023 and at both visits it was found that over half of the (667) upgrade LED grow light fixtures were not in use (either not installed or not plugged in). Site contacts were unsure when the remaining fixtures would be used. Aside from a reduced fixture count, gross kWh savings estimates were reduced on account of light fixture hours of use decreasing from 8,760 hrs/yr to 6,026 hrs/yr based on measure light logger data. This reduction aligns with discussions with farmers regarding farming operations.
NG-C-015	5,342.1	1,889.8	35%	This is also a major renovation lighting upgrade project at an indoor agriculture facility. Like the above project, this site was only operating approximately 40% of its upgrade LED grow lights at the time of the site visit in mid-December 2023 and at a follow-up call in early March 2023 and could not provide a concrete timeline for when the remaining lights would be used in typical operations. Electricity and electric demand savings were further decreased due to upgrade and baseline grow light dimming practices that were not captured in National Grid savings calculations.
NG-C-024	746.5	645.4	86%	This is a warehouse where the wattage for (459) upgrade LED high bay fixtures was increased from 125 to 156 W based on information in the fixture cutsheets and Design Lights Consortium data. Additionally, gross kWh savings were further reduced as the warehouse was noted as being mechanically cooled in National Grid calculations, however, this is incorrect as the warehouse is only heated using natural gas fired equipment.
NG-C-014	1,003.5	855.3	85%	This is a manufacturer that installed upgrade LED high bay fixtures that are manually controlled. Gross kWh savings at this manufacturer decreased because the baseline annual hours of use decreased from an average of 6,534 to 5,561 hr/yr based on measured light logger hours of use data, which aligns well with the site operating schedule and lighting hours of use reported by the site (site runs 5 days/week, 4 am to midnight = 5,200 hrs/yr, though a fraction of lights run 24/7 for emergency and security purposes).

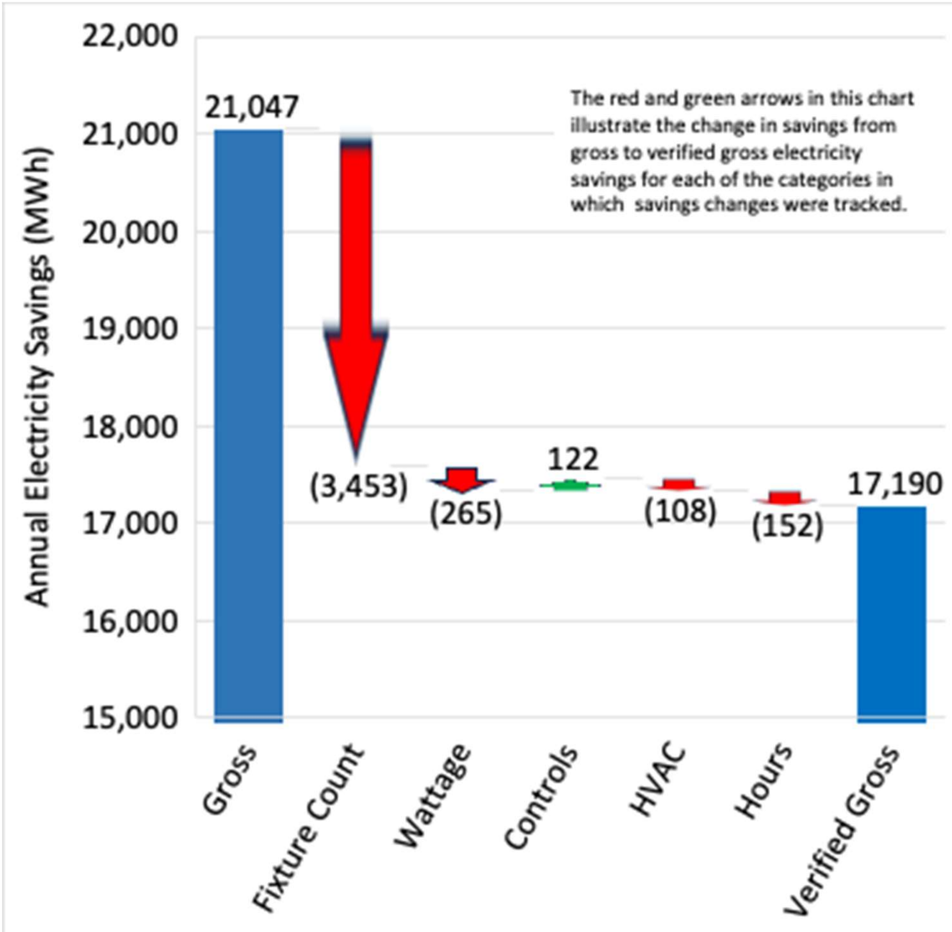
Table 21: Custom Projects that Negatively Affect the Program-Level the Electric Demand VGS RR

Site ID	Gross MW Savings (MW)	Verified Gross MW Savings (MW)	Demand Savings Realization Rate (%)	Main Cause(s) Driving Change in Savings
NG-C-017	211.1	116.1	55%	This is a high school that completed a facility-wide LED upgrade. The main cause for the reduction in gross kW savings was that National Grid's estimate did not include a CF. The measured CF from light logger data was 0.55.
NG-C-051	340.0	169.7	50%	The reduction in gross kW savings for this large manufacturing site is primarily due to the same issue outlined above in Section 4.6.1 regarding an incorrect translation of gross kW savings in the application workbook to InDemand. The gross kW savings value in the original National Grid application workbook was 159.2 kW, however, the peak demand savings in InDemand was 340.0 kW. The reason for the difference between the application workbook and InDemand peak demand values is unknown. Gross kW savings in the application workbook was increased to 169.7 kW because of increases to lighting control energy savings factors, re-estimated based on measured light logger data.

Beyond the two sites noted in Table 21, there are eight other sites whose electric demand VGS RR fall between 0 to 75%. In these cases, the site-level verified gross kW savings were less than claimed by National Grid due to either one of the two reasons listed in the table above: (1) no CF was applied to the total connected demand savings or (2) the gross kW savings estimated in the application workbook was incorrectly to InDemand.

Figure 13 is a waterfall chart that shows the contribution of savings adjustments for verified and gross electricity savings that result for each savings revision category across all Custom sites. The differences from one savings category to the next are primarily driven by the same type of adjustments that were detailed as examples in Table 20. Note that the major reduction in electricity savings in the 'Fixture Count' revision category can be primarily attributed to site NG-C-015, detailed in Table 20.

Figure 13: Gross and Verified Gross Electricity Savings for Sampled Custom Sites



In general, like the Prescriptive program, it can be concluded that the Custom program savings calculation methodology and corresponding assumptions follow the NYS TRM well for retrofit projects and ECCCNYS 2020 for new construction and major renovation projects. Aside from the new construction lighting upgrade projects at indoor agriculture sites NG-C-033 and NG-C-015, detailed above in Table 20, the realization rates for new construction and retrofit projects are similar, indicating that there are not any major deficiencies in National Grid's approach to estimating savings for new construction projects where challenges can be faced as a result of changes that may occur during the design and construction phases of new construction projects. Finally, like the Prescriptive program, it is worth re-emphasizing that the Custom program gross kW savings realization rates are heavily impacted by the lack of application of CFs either in the application workbooks or in the translation of gross kW savings to InDemand.

4.6.3 Midstream Lighting

The midstream component had the largest sample size of the three components with 58 sites. Figure 14 shows the electricity and electric demand VGS RR for each Midstream site individually in addition to a fitted trend line, which approximates the VGS RR for the Midstream Program. The electricity and electric demand VGS RR for the Midstream program was 106.3% and 69.8%, respectively. The scatter around the y = x line is relatively large. This is typical of midstream programs where the application of the equipment is often not well known. Another reason for the scatter away from y = x is the deemed savings approach used by National Grid to estimate Midstream project savings whereby actual fixture wattage was not used and instead fixtures were grouped into measure codes and an average deemed wattage savings was used to estimate gross kWh and kW savings.

Figure 14: Midstream Lighting Component Site-Level Results

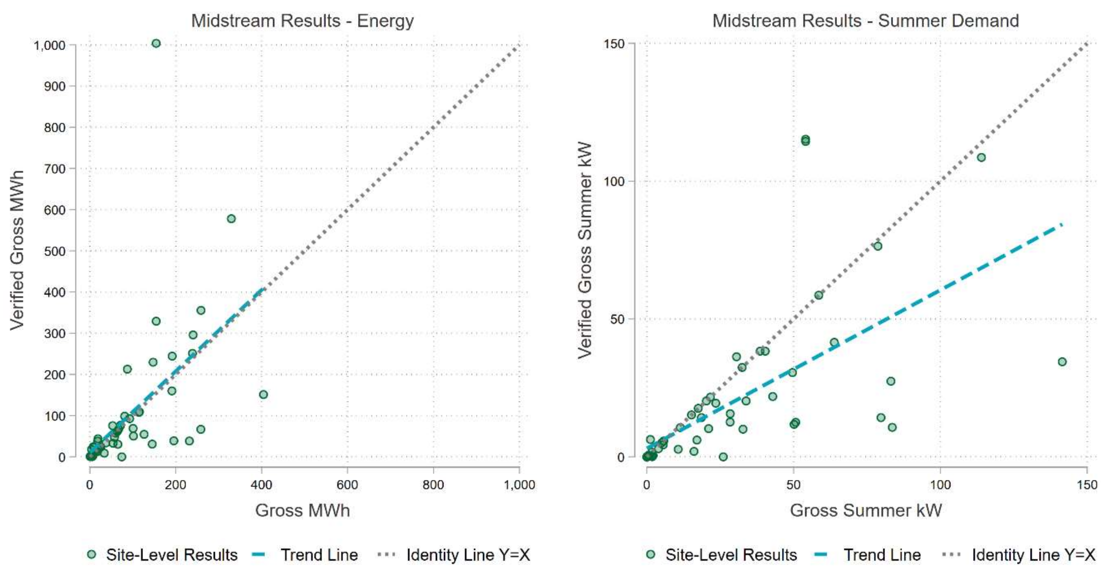


Figure 15 is a waterfall chart that shows the contribution of savings adjustments for gross electricity savings that result for each savings revision category across all Midstream sites. The most significant changes in gross electricity savings occur in the 'Fixture Count', 'Wattage', and 'Baseline Hours' revision categories. Characteristic site-level examples of the primary factors driving the changes in gross kWh and kW savings in each of these categories are discussed in the tables below.

The In-service rate (ISR) for light fixtures supported by the Midstream program is 91% for sampled Midstream sites. In other words, the percentage of program-supported fixtures that were not installed at sampled sites is 9%. The Midstream program electricity VGS RR of 106% reflects this ISR of 91%.

Figure 15: Gross and Verified Gross Electricity Savings for Sampled Midstream Sites

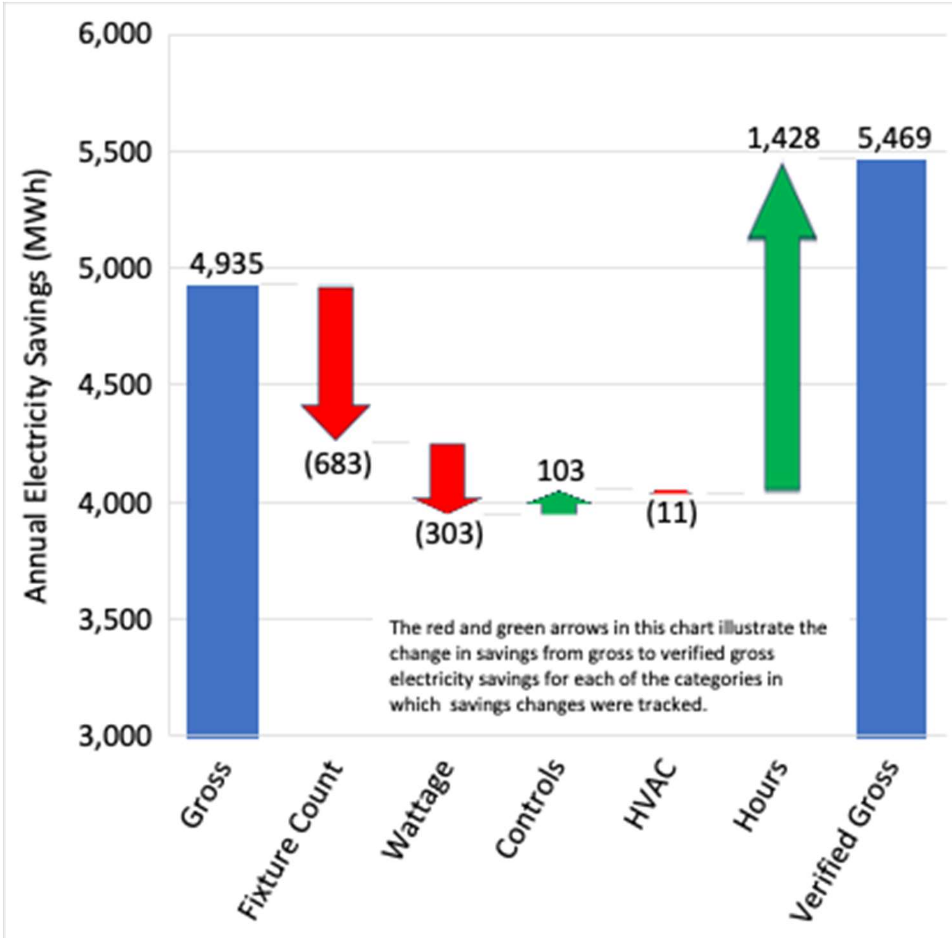


Table 22: Example Midstream Projects that Affected the Program-Level Realization Rates

Site ID	Gross MWh Savings (MWh/yr)	Verified Gross MWh Savings (MWh/yr)	VGS RR for Gross MWh Savings (%)	Gross kW Savings (kW)	Verified Gross kW Savings (kW)	kW Savings Realization Rate (%)	Main Cause(s) Driving Change in Savings
NG-M-037	404.3	151.0	37%	141.5	34.5	24%	This is a large dairy farm that purchased (250) mid-output LED high bay fixtures (86UBP) and (250) high output LED high bay fixtures (86UCP). When an evaluation field engineer visited the site in early September 2023, the site had only installed a total of (9) fixtures (86UBP). The evaluation field engineer spoke with the site again in late January 2024 to receive an update on installed fixture quantities and learned that an additional (96) 86UCP fixtures had been installed bringing the total number of installed fixtures to (9) 86UBP and (96) 86UCP fixtures. When asked about the planned installation timeline for the remaining fixtures, the farm owner could not provide a definitive timeline, though he was expecting the remaining fixtures to be installed sometime within the next two years. In this instance and other similar ones where site contacts could not provide a concrete timeline for fixture installation, evaluators took a conservative approach in calculating verified gross project savings using the number of currently installed fixtures.
NG-M-022	74.3	0.0	0%	26.0	0	0%	This is a car dealership that purchased (77) high output LED high bay fixtures (86UCP). The dealership had not installed any of the fixtures when an evaluation field engineer spoke with the site in mid-September and again in mid-December 2023. The dealership did not have a planned timeline to complete their lighting project.
NG-M-044	71.3	76.6	108%	21.0	10.2	49%	This is an industrial laundromat facility located in Glens Falls, NY. Despite the project's favorable electricity VGS RR, it is being noted here because approximately one third of the fixtures tracked in National Grid documentation were not found at this site. When the site contact was asked about this, they noted that the remaining fixtures were installed at other industrial and commercial laundromat facilities they owned that in Warrensburg, NY, and showed the evaluation field engineer some pictures of these fixtures at these facilities. Given that Warrensburg, NY is within National Grid territory, the realization rates for this project were not penalized for lower fixture counts. This logic was applied to other midstream sites who had installed a portion of purchased fixtures at addresses other than the address listed in National Grid documentation and it could be confirmed that these other facilities were National Grid electricity customers (situation applied to 2.4% of all sampled midstream fixtures). The main reason the electric demand VGS RR is equal to 49% is that the CF as calculated from light logger data was found to be approximately 0.5 and National Grid assumed a CF of 1 for all interior midstream upgrade fixtures. As would be expected, there are many instances of calculated CF being less than 1. Therefore, CF adjustment is one of the primary reasons that the Midstream program electric demand VGS RR is less than 1.0.

Site ID	Gross MWh Savings (MWh/yr)	Verified Gross MWh Savings (MWh/yr)	Annual MWh Savings Realization Rate (%)	Gross kW Savings (kW)	Verified Gross kW Savings (kW)	kW Savings Realization Rate (%)	Main Cause(s) Driving Change in Savings
NG-M-045	126.4	54.5	43%	42.9	21.9	51%	This site is a self-storage building and the main reason its gross kWh and kW savings were reduced is due to an inaccurate measure code being applied to most of its fixtures. The original measure code used for this upgrade lighting project was 86UAP, which is characterized as a 'LED Interior High & Low Bay Luminaire or Retrofit Kits (>1,000 lm)' and has a baseline and upgrade wattage of 270 W and 88 W, respectively. The installed fixtures have a wattage of 32 W, brightness of 5,000 lm, and were installed at approximately 10 ft ceiling height. In all, it was determined that measure code 86UAP was not an accurate characterization of this upgrade as this measure code is meant for higher wattage upgrade fixtures installed in low bay applications. The measure code for these fixtures was changed to 89UAP, which is characterized as a 'DLC Premium LED Direct Linear Ambient Luminaires, ≤ 4 ft sections' and has a baseline and upgrade wattage of 50 W and 26 W, respectively. This occurrence as described above was not an isolated one as measure code 86UAP was commonly misapplied to lower wattage strip fixtures that were not being used in low bay applications. This measure code change was applied to 11 other sites and is one of the major contributors to the change in the 'Wattage' revision category for the Midstream program.

NG-M-047	154.4	1,003.7	650%	54.1	114.1	212%	This site is a large warehouse with 60 ft tall ceilings where (160) 360 W LED high bay fixtures were installed. The significant increase in verified savings for this site is caused by two changes that were made during its evaluation:
							• The measure code for these fixtures was changed for 86UCP to a newly created, custom measure code named '86UCP – Very High'. While both these measures are both meant for high bay interior LED fixtures, the wattage savings between the representative baseline and upgrade fixtures for '86UCP – Very High' is more accurate for this application given the high wattage of these upgrade fixtures. The representative baseline and upgrade wattages for these measure codes is listed below.
							  ○ 86UCP: baseline – 545 W, upgrade – 207 W
							  ○ 86UCP – Very High: baseline – 1,080 W, upgrade – 360 W
							• National Grid's gross kWh savings estimate for this upgrade lighting project used an annual hours of use value of 2,857 hr/yr. The actual annual hours of use of the upgrade lighting were found to be 8,713 hr/yr, as measured by light loggers. The increase in lighting hours of use resulted in an increase in verified gross kWh savings.
							  ○ This example is representative of most of the Midstream sites that have electricity VGS RRs greater than 1. In other words, many of these sites with higher realization rates had fixtures with measured annual hours of use greater than the value assumed by National Grid in their savings estimates.

The examples listed in the table above are representative of the other sampled Midstream sites in that many of them had VGS RRs for gross kWh and kW savings affected in similar ways. Table 23 summarizes the main drivers for change within these various revision categories, most of which overlap with the reasons provided in the examples in the table above. The total change within these revision categories for sampled Midstream projects is illustrated in the Midstream waterfall chart in Figure 15 above. Recommendations for improvement to the Midstream program, mainly its method for estimating gross kWh and kW savings, are provided in the following section.

Table 23: Summary of Items Impacting Gross kWh and kW Savings for Midstream Projects

Fixture Count	Wattage	Controls	HVAC	Baseline Operating Hours
The primary reason for fixture count reductions was fixtures not being installed at the time of the site visit or a follow-up phone call and the site not having a concrete timeline for fixture installation.	The most influential fixture wattage reductions occurred with fixtures with measure code 86UAP that were reassigned to the 89UAP measure code. In these cases, the 89UAP measure code is a more representative code given the fixture upgrade wattage, application, and installation location.	Changes related to fixture controls were not as influential as the fixture count, wattage, and baseline operating hours categories. That said, there are several midstream projects whose upgrade fixture controls savings were not included in National Grid savings estimates. The measure codes for these sites were revised to include control savings.	This was the least influential of the five revision categories on savings. Measure codes for fixtures typically installed in areas with mechanical cooling, such as offices and other commercial settings, include HVAC savings. These assumptions were accurate in most cases; however, a few projects installed these fixtures in areas without mechanical cooling and needed their measure codes revised to not include HVAC savings.	This revision category was the most impactful in its effect on both gross kWh and kW savings. Overall, average hours of use measured by light loggers was greater than assumed hours of use in National Grid's estimated savings leading to an overall increase in gross kWh savings. National Grid assumed a coincidence factor of 1 for all gross kW savings calculations for interior fixtures. The average coincidence factor estimated from light logger data is approximately 0.75, making this a significant contributing factor to the program-level VGS RR for gross kW savings of 69.8%.

5 RECOMMENDATIONS

Based on the results from desk reviews and site visits, the evaluation team has the following recommendations to help improve the accuracy of the Electric C&I Program electricity and electric demand savings estimates for Custom, Prescriptive, and Midstream lighting projects. The following section is separated into recommendations that apply to all program components and those that are program component specific. To the extent that these changes address factors that affect program realization rates, a future impact evaluation study may be needed to update the VGS RRs in this report.

5.1 CROSS-COMPONENT FINDINGS AND RECOMMENDATIONS

Application of Coincidence Factors to Improve Peak Demand Savings Estimates

Finding 1: As discussed in the various program component results sections, Sections 4.6.1 through 4.6.3, there were many instances where, incorrectly, a CF was not applied to total connected kW savings to calculate gross kW savings. For the Custom and Prescriptive components, this was mainly due to an incorrect translation of gross kW savings values from project application workbooks to the InDemand tracking system.

Recommendation 1: National Grid staff should check and validate the translation mechanism that copies application workbook data for Custom and Prescriptive lighting projects to InDemand to ensure gross kW savings are being correctly saved to this tracking system.

TRM CF Values

Finding 2: CFs derived from our metering data were lower than TRM CFs. Figure 8 compares the logged site-level CFs to the default values in the TRM. Our metering results were generally well-aligned with the TRM hours of use but lower than the TRM CFs. This is consistent with a trend observed in another commercial lighting program impact evaluation for another New York electric utility.[8]

Recommendation 2: We suggest that National Grid work with the TRM Management Committee[9] to explore an update to the CF assumptions in the TRM.

HVAC Interactive Effect Multipliers

Finding 3: Several instances of incorrect HVAC savings estimates were identified for evaluated lighting projects. The most common cause of incorrect HVAC savings estimates for Prescriptive and Custom component projects was the inadvertent omission of HVAC interactive effect multipliers for conditioned interior spaces. As described in Section 4.4, HVAC interactive effect multipliers are values from the NYS TRM that are used in lighting savings calculations to account

---

[8] Case 15-01319, Central Hudson Commercial Prescriptive 2021-2022 Impact Evaluation. (Filed December 30, 2022).

[9] The TRM Management Committee includes representation from each of New York's major electric and gas utilities, LIPA, and NYSERDA

for the change in savings that result from LED lighting generating less heat than baseline lighting technologies. In the 'Commercial and Industrial Retrofit Program Lighting Systems & Controls Application' workbook, service zip code is used to look up factors for the nearest reference city. We found several instances where participants did not enter a service zip code in their application, causing the tool to apply no HVAC interactive effects even though an HVAC configuration was entered, and the program-supported fixtures were installed in conditioned spaces.

Recommendation 3: To eliminate this issue, it is recommended that application workbooks be modified so that an error window (or similar flag) be shown if the service zip code is not entered. Alternatively, the tool could default to Syracuse assumptions when the service zip code is missing.

Finding 4: As noted in Section 4.4, the HVAC interactive effect multipliers in the NYS TRM recently changed with Version 11 (effective 2024). While it is understood that National Grid has made changes to its 'Commercial and Industrial Retrofit Program Lighting Systems & Controls Application' workbook to accommodate these HVAC interactive effect multiplier changes, it is understood that this same update has not been extended to the 'Illuminating Excellence C&I New Construction & Major Renovation Lighting Application' and the Midstream lighting savings estimation tools.

Recommendation 4: We recommend that the HVAC interactive effect multipliers in these tools be updated as well.

5.2 CUSTOM PROGRAM RECOMMENDATIONS

Specific Considerations for Indoor Agriculture Lighting Upgrade Projects

Finding 5: Two Custom lighting projects at indoor agricultural facilities were sampled and evaluated as part of this evaluation. While these indoor facilities differed from each other in various ways, including the crops they grow, the lighting projects at these facilities had low realization rates for similar reasons, mainly the slower than expected timeline to reach steady-state farming operations. Based on this experience, it was concluded that the start-up timelines for indoor agricultural facilities are longer than typical program participants, meaning their upgrade lighting is slow to reach operations as detailed in National Grid gross savings estimates for these projects. Given this, it is

Recommendation 5: We recommend that additional time be added to National Grid processes when working with indoor agriculture sites to ensure savings are claimed at a pace that matches the typical start-up schedule of these facilities (i.e. savings are not claimed before the lighting project is fully commissioned and operating at steady-state operation). This includes National Grid contacts speak with these sites directly about their start-up timelines and any related considerations, including any items likely to delay their start-up timelines (ex. licensure, product demand). This will ensure that National Grid staff have a clear understanding of the lighting project timelines and can follow up at various project stage gates.

Finding 6: Both the sampled Custom lighting projects at indoor agricultural facilities noted in Finding 5 used lighting baselines that were provided by engineering consultants. A new Indoor Horticultural Lighting measure was issued as a revision to the NYS TRM 10/31/23 to guide savings calculations for LED grow lighting in indoor cannabis grow facilities. The new TRM measure characterization uses an industry standard methodology to estimate savings for horticulture lighting based on the difference in photosynthetic photon efficacy (PPE) between the program-supported LED lighting equipment and a stipulated PPE baseline.

Recommendation 6: Electricity and demand savings for future lighting projects at indoor cannabis grow facilities should follow the savings methodology as established by the new Indoor Horticultural Lighting measure issued as a revision to the NYS TRM 10/31/23. We recommend that National Grid work with the TRM Management Committee to establish PPE baseline and operating assumptions for non-cannabis grow facilities.

5.3 MIDSTREAM PROGRAM RECOMMENDATIONS

Modifying Midstream Fixture Bin Method

Finding 7: As discussed in 4.2.2, the Midstream program currently uses a measure code deemed savings, or binned approach, to estimate savings. The deemed wattage values varied greatly from actual wattages for some projects contributing to a large relative precision for the Midstream VGS RR electricity savings, larger than the other program components.

Recommendation 7: We recommend that National Grid staff revise the Midstream program savings estimation method to either 1) use the actual wattage of retrofit fixtures and derive a representative wattage for baseline fixtures by using a representative ratio of baseline-to-upgrade fixture wattages; or 2) modify the existing method so that fixture bins better match retrofits.

Consistent use of the CF Value in Calculating Demand Savings

Finding 8: As discussed in Section 4.6.3, the Midstream program savings calculations assume a CF of 1 in all interior lighting gross kW savings calculations. This assumption is one of the leading factors causing the overestimation of demand savings by this program.

Recommendation 8: We recommended that the NYS TRM CFs be used for estimating demand savings.

5.4 PRESCRIPTIVE PROGRAM RECOMMENDATIONS

There are no further recommendations for Prescriptive Lighting program component outside of those listed in Section 5.1 above.

6 APPENDICES

Table 24 details site-level results for all sampled sites. All sampled sites received a desk review. The ‘Site Visit?’ and ‘Metered?’ columns note the sites that received a visit and had their upgraded lighting metered.

Table 24: Lighting Impact Evaluation Study Site-Level Results

					Gross Savings		Verified Savings										Realization Rate	
					Electricity Savings	Peak Demand Savings	Correct Fixture Count		Correct Wattage		Correct Upgrade Controls		Correct HVAC System Type		Correct Baseline Hours		Electricity Savings	Peak Demand Savings
#	Site ID	Component	Site Visit?	Metered?	kWh/yr	kW	kWh/yr	kW	kWh/yr	kW	kWh/yr	kW	kWh/yr	kW	kWh/yr	kW	%	%
1	NG-C-003	Custom	No	No	204,452	49.4	204,452	48.7	204,452	48.7	204,452	48.7	204,452	48.7	204,452	48.7	100%	99%
2	NG-C-031	Custom	Yes	Yes	155,017	-	177,320	-	204,835	-	275,152	-	275,152	-	272,105	-	176%	-
3	NG-C-048	Custom	Yes	Yes	441,450	36.8	431,721	36.0	431,973	36.0	431,973	36.0	431,973	36.0	527,836	38.4	120%	104%
4	NG-C-001	Custom	Yes	Yes	3,914	1.2	4,696	1.4	4,470	1.4	4,470	1.4	4,470	1.4	2,439	0.7	62%	58%
5	NG-C-015	Custom	Yes	No	5,342,091	999.1	2,126,570	355.4	1,889,826	308.0	1,889,826	308.0	1,889,826	308.0	1,889,826	308.0	35%	31%
6	NG-C-034	Custom	Yes	Yes	38,982	9.5	38,609	9.5	38,919	9.8	47,082	12.5	46,730	12.4	49,408	8.0	127%	84%
7	NG-C-028	Custom	No	No	13,903	2.0	13,903	2.0	13,903	2.0	13,903	2.0	13,903	2.0	13,903	2.0	100%	100%
8	NG-C-029	Custom	No	No	204,132	35.9	204,132	35.9	204,132	35.9	204,118	35.9	204,118	35.9	204,118	35.9	100%	100%
9	NG-C-040	Custom	No	No	336,432	46.9	336,432	49.1	336,432	49.1	336,432	49.1	336,432	49.1	336,432	49.1	100%	105%
10	NG-C-051	Custom	Yes	Yes	1,494,403	340.0	1,497,788	159.2	1,497,297	159.0	1,497,297	159.0	1,497,297	159.0	1,441,914	169.7	96%	50%
11	NG-C-021	Custom	No	No	1,241,839	160.4	1,241,839	159.2	1,280,446	164.3	1,280,446	164.3	1,280,446	164.3	1,280,446	164.3	103%	102%
12	NG-C-026	Custom	Yes	Yes	890,265	144.0	950,303	166.4	949,313	166.2	974,838	166.3	974,838	166.3	961,191	160.2	108%	111%
13	NG-C-036	Custom	No	No	64,488	7.8	64,488	7.8	64,488	7.8	64,488	7.8	64,488	7.8	64,488	7.8	100%	100%
14	NG-C-014	Custom	Yes	Yes	1,003,507	103.0	1,003,507	103.0	1,003,507	103.0	1,003,507	103.0	1,003,507	103.0	855,254	129.2	85%	125%
15	NG-C-013	Custom	No	No	38,071	-	38,071	7.0	38,071	7.0	38,071	7.0	38,071	7.0	38,071	7.0	100%	-
16	NG-C-047	Custom	Yes	Yes	4,581,110	1,036.9	4,581,110	1,036.9	4,581,110	1,036.9	4,581,110	1,036.9	4,581,110	1,036.9	4,635,471	995.0	101%	96%
17	NG-C-025	Custom	No	No	38,021	8.3	41,058	8.2	40,891	8.2	40,891	8.2	40,891	8.2	40,891	8.2	108%	99%
18	NG-C-027	Custom	No	No	55,498	9.5	55,498	9.5	55,498	9.5	55,498	9.5	55,498	9.5	55,498	9.5	100%	100%
19	NG-C-032	Custom	No	No	18,168	-	17,932	3.1	7,166	1.2	7,166	1.2	7,321	1.2	7,321	1.2	40%	-
20	NG-C-012	Custom	Yes	Yes	96,869	30.8	96,869	30.8	96,869	30.8	96,869	30.8	96,869	30.8	96,869	16.6	100%	54%
21	NG-C-024	Custom	Yes	Yes	746,496	84.7	746,496	84.7	653,747	72.8	653,747	72.8	620,267	60.7	645,357	63.5	86%	75%
22	NG-C-033	Custom	Yes	Yes	572,766	72.6	256,312	32.5	256,312	32.5	256,312	32.5	193,895	32.5	145,421	32.5	25%	45%
23	NG-C-009	Custom	Yes	Yes	81,838	15.1	81,197	14.7	81,197	14.7	81,197	14.7	81,197	14.7	64,507	14.7	79%	97%
24	NG-C-016	Custom	Yes	Yes	25,198	2.7	27,060	2.7	27,060	2.7	27,060	2.7	27,060	2.7	25,076	2.8	100%	104%
25	NG-C-008	Custom	Yes	Yes	133,735	46.4	133,735	46.4	135,117	47.1	135,117	47.1	129,040	39.3	109,996	21.6	82%	47%
26	NG-C-017	Custom	Yes	Yes	496,529	211.1	496,529	211.1	496,529	211.1	496,529	211.1	496,529	211.1	456,699	116.1	92%	55%
27	NG-C-019	Custom	Yes	Yes	218,122	80.0	218,122	80.0	218,122	80.0	218,122	80.0	218,122	80.0	204,309	44.0	94%	55%
28	NG-C-035	Custom	Yes	Yes	125,012	37.4	125,012	37.4	133,710	41.8	133,710	41.8	127,905	34.8	107,389	19.1	86%	51%
29	NG-C-041	Custom	Yes	Yes	79,308	-	79,527	19.0	79,527	19.0	79,527	19.0	79,527	19.0	114,756	17.9	145%	-
30	NG-C-045	Custom	Yes	Yes	319,152	20.8	319,152	20.8	319,152	20.8	336,711	22.6	336,711	22.6	336,711	29.7	106%	143%
31	NG-C-038	Custom	Yes	Yes	481,121	95.4	481,121	95.4	481,121	95.4	481,121	95.4	481,121	95.4	487,648	97.0	101%	102%
32	NG-C-043	Custom	Yes	No	127,007	29.0	127,007	-	127,007	-	127,007	-	127,007	-	127,007	-	100%	0%
33	NG-C-005	Custom	Yes	Yes	89,450	34.2	89,450	34.2	89,450	34.2	89,450	34.2	89,450	34.2	122,891	28.8	137%	84%
34	NG-C-010	Custom	Yes	No	1,069,683	384.0	1,069,683	384.0	1,069,683	384.0	1,069,683	384.0	1,069,683	384.0	1,069,683	384.0	100%	100%
35	NG-C-022	Custom	Yes	Yes	218,612	23.0	217,149	31.2	217,149	31.2	217,149	31.2	217,149	31.2	194,707	29.1	89%	127%

					Gross Savings		Verified Savings										Realization Rate	
					Electricity Savings	Peak Demand Savings	Correct Fixture Count		Correct Wattage		Correct Upgrade Controls		Correct HVAC System Type		Correct Baseline Hours		Electricity Savings	Peak Demand Savings
#	Site ID	Component	Site Visit?	Metered?	kWh/yr	kW	kWh/yr	kW	kWh/yr	kW	kWh/yr	kW	kWh/yr	kW	kWh/yr	kW	%	%
36	NG-M-045	Midstream	Yes	Yes	126,357	42.9	135,764	47.9	35,786	13.3	59,077	21.9	59,077	21.9	54,594	21.9	43%	51%
37	NG-M-002	Midstream	Yes	Yes	2,964	0.9	2,468	0.9	2,468	0.9	2,468	0.9	2,468	0.9	1,628	0.4	55%	40%
38	NG-M-037	Midstream	Yes	No	404,250	141.5	98,509	34.5	98,509	34.5	98,509	34.5	98,509	34.5	151,022	34.5	37%	24%
39	NG-M-021	Midstream	No	No	63,725	15.2	63,718	15.2	61,566	15.2	61,566	15.2	61,566	15.2	61,566	15.2	97%	100%
40	NG-M-027	Midstream	No	No	115,478	40.3	115,079	40.3	109,286	38.3	109,286	38.3	109,286	38.3	109,286	38.3	95%	95%
41	NG-M-035	Midstream	No	No	18,868	-	14,499	-	43,916	-	43,916	-	43,916	-	43,916	-	233%	-
42	NG-M-089	Midstream	Yes	Yes	5,200	1.8	5,200	1.8	764	0.3	998	0.4	928	0.3	431	0.1	8%	3%
43	NG-M-009	Midstream	Yes	Yes	238,841	78.7	239,544	78.2	230,738	75.9	231,346	76.1	232,208	76.4	251,135	76.4	105%	97%
44	NG-M-059	Midstream	No	No	92,640	32.4	92,642	32.4	92,642	32.4	92,642	32.4	92,642	32.4	92,642	32.4	100%	100%
45	NG-M-015	Midstream	Yes	Yes	18,840	1.6	17,081	1.9	21,393	1.9	21,393	1.9	21,393	1.9	19,171	0.4	102%	26%
46	NG-M-066	Midstream	No	No	3,948	1.2	3,243	1.2	17,958	6.3	17,958	6.3	17,958	6.3	17,958	6.3	455%	516%
47	NG-M-075	Midstream	Yes	Yes	564	0.2	458	0.2	458	0.2	458	0.2	426	0.1	715	0.1	127%	50%
48	NG-M-074	Midstream	No	No	154,400	54.1	154,404	54.0	329,126	115.2	329,126	115.2	329,126	115.2	329,126	115.2	213%	213%
49	NG-M-081	Midstream	No	No	145,224	50.2	142,686	50.2	31,791	11.8	31,791	11.8	31,791	11.8	30,802	11.8	21%	23%
50	NG-M-064	Midstream	Yes	Yes	17,582	4.0	16,698	4.4	8,657	1.7	12,437	3.0	12,437	3.0	12,700	3.0	72%	75%
51	NG-M-008	Midstream	Yes	Yes	258,311	83.6	268,501	88.6	68,893	19.8	68,893	19.8	68,893	19.8	66,711	10.7	26%	13%
52	NG-M-007	Midstream	Yes	No	1,015	-	1,015	-	775	-	775	-	775	-	775	-	76%	-
53	NG-M-060	Midstream	Yes	Yes	191,695	63.8	189,626	63.9	189,626	63.9	219,576	74.4	244,395	83.1	244,395	41.5	127%	65%
54	NG-M-004	Midstream	No	No	57,000	17.5	47,460	17.6	47,460	17.6	47,460	17.6	47,460	17.6	47,460	17.6	83%	100%
55	NG-M-111	Midstream	Yes	No	8,120	-	8,117	-	24,528	-	24,528	-	24,528	-	24,528	-	302%	-
56	NG-M-071	Midstream	Yes	No	7,455	-	7,457	-	8,653	-	8,653	-	8,653	-	8,653	-	116%	-
57	NG-M-019	Midstream	No	No	1,031	0.3	852	0.3	852	0.3	852	0.3	852	0.3	852	0.3	83%	100%
58	NG-M-018	Midstream	Yes	Yes	329,404	114.0	329,402	113.2	327,967	113.2	327,967	113.2	314,941	108.6	577,933	108.6	175%	95%
59	NG-M-080	Midstream	Yes	Yes	101,512	32.8	86,810	28.0	88,689	28.7	104,131	34.1	67,021	21.0	50,305	10.0	50%	31%
60	NG-M-112	Midstream	Yes	Yes	33,559	10.7	14,704	4.8	14,704	4.8	14,704	4.8	14,704	4.8	8,883	2.7	26%	26%
61	NG-M-082	Midstream	No	No	231,686	79.8	259,501	90.8	38,426	14.2	38,426	14.2	38,426	14.2	38,426	14.2	17%	18%
62	NG-M-086	Midstream	No	No	60,357	5.1	57,527	5.1	57,527	5.1	57,527	5.1	57,527	5.1	57,527	5.1	95%	100%
63	NG-M-093	Midstream	No	No	1,816	-	1,816	-	1,816	-	1,816	-	1,816	-	1,816	-	100%	-
64	NG-M-101	Midstream	No	No	9,532	1.7	8,615	1.7	8,615	1.7	8,615	1.7	8,615	1.7	8,615	1.7	90%	100%
65	NG-M-102	Midstream	No	No	6,090	-	6,088	-	6,088	-	6,088	-	6,088	-	6,088	-	100%	-
66	NG-M-105	Midstream	No	No	57,900	20.3	57,901	20.3	57,901	20.3	57,901	20.3	57,901	20.3	57,901	20.3	100%	100%
67	NG-M-032	Midstream	Yes	Yes	53,075	18.6	53,076	18.6	53,076	18.6	53,076	18.6	53,076	18.6	75,662	14.2	143%	77%
68	NG-M-114	Midstream	Yes	Yes	81,060	28.4	81,062	28.4	81,062	28.4	81,062	28.4	81,062	28.4	98,608	15.6	122%	55%
69	NG-M-047	Midstream	Yes	Yes	154,400	54.1	154,404	54.0	329,126	115.2	329,126	115.2	329,126	115.2	1,003,729	114.4	650%	212%
70	NG-M-057	Midstream	Yes	Yes	240,274	49.6	204,843	49.8	151,613	31.3	151,613	31.3	151,613	31.3	295,937	30.6	123%	62%
71	NG-M-069	Midstream	Yes	No	114,415	38.6	108,739	38.6	107,852	38.3	107,852	38.3	107,852	38.3	107,852	38.3	94%	99%
72	NG-M-005	Midstream	Yes	No	1,015	-	1,015	-	1,015	-	1,015	-	1,015	-	1,015	-	100%	-
73	NG-M-012	Midstream	Yes	Yes	147,250	33.8	124,071	25.7	124,071	25.7	124,071	25.7	124,071	25.7	229,669	20.3	156%	60%
74	NG-M-116	Midstream	Yes	Yes	87,368	30.6	87,351	30.6	87,351	30.6	87,351	30.6	93,946	36.7	212,746	36.3	244%	119%
75	NG-M-014	Midstream	No	No	2,030	-	2,029	-	2,029	-	2,029	-	2,029	-	2,029	-	100%	-
76	NG-M-001	Midstream	Yes	Yes	54,079	17.1	46,768	17.1	37,897	14.0	37,897	14.0	35,236	11.7	32,862	6.1	61%	36%
77	NG-M-022	Midstream	No	No	74,305	26.0	-	-	-	-	-	-	-	-	-	-	0%	0%
78	NG-M-030	Midstream	Yes	Yes	100,647	28.4	93,739	26.7	89,882	25.7	89,882	25.7	89,850	25.7	69,007	12.6	69%	44%
79	NG-M-041	Midstream	Yes	Yes	6,934	2.1	5,772	2.1	5,772	2.1	5,772	2.1	5,772	2.1	1,799	0.5	26%	22%

					Gross Savings		Verified Savings										Realization Rate	
					Electricity Savings	Peak Demand Savings	Correct Fixture Count		Correct Wattage		Correct Upgrade Controls		Correct HVAC System Type		Correct Baseline Hours		Electricity Savings	Peak Demand Savings
#	Site ID	Component	Site Visit?	Metered?	kWh/yr	kW	kWh/yr	kW	kWh/yr	kW	kWh/yr	kW	kWh/yr	kW	kWh/yr	kW	%	%
80	NG-M-034	Midstream	No	No	190,970	58.6	159,104	58.6	159,104	58.6	159,104	58.6	159,104	58.6	159,973	58.6	84%	100%
81	NG-M-036	Midstream	No	No	37,522	11.4	36,653	11.4	33,957	10.6	33,957	10.6	33,957	10.6	33,957	10.6	90%	93%
82	NG-M-039	Midstream	No	No	22,124	0.6	21,810	0.6	21,810	0.6	21,810	0.6	21,810	0.6	21,810	0.6	99%	100%
83	NG-M-067	Midstream	Yes	Yes	65,333	16.1	61,372	15.7	53,831	13.1	53,831	13.1	53,578	12.8	30,412	2.0	47%	12%
84	NG-M-065	Midstream	No	No	25,540	5.7	25,537	5.7	23,863	5.7	23,863	5.7	23,863	5.7	23,863	5.7	93%	100%
85	NG-M-104	Midstream	No	No	66,887	21.6	66,886	21.6	66,407	21.6	66,407	21.6	66,407	21.6	66,621	21.6	100%	100%
86	NG-M-050	Midstream	Yes	Yes	71,612	23.5	63,787	21.0	73,394	21.0	73,394	21.0	73,394	21.0	76,198	19.5	106%	83%
87	NG-M-106	Midstream	Yes	Yes	15,971	-	13,244	-	12,048	-	12,048	-	12,048	-	12,213	-	76%	-
88	NG-M-046	Midstream	Yes	Yes	2,608	0.9	2,607	0.9	3,860	1.4	3,860	1.4	3,860	1.4	3,141	0.2	120%	27%
89	NG-M-051	Midstream	Yes	No	10,150	-	10,146	-	23,053	-	23,053	-	23,053	-	23,053	-	227%	-
90	NG-M-058	Midstream	Yes	Yes	18,255	5.6	14,147	5.2	14,147	5.2	14,147	5.2	13,154	4.4	38,138	4.4	209%	78%
91	NG-M-079	Midstream	Yes	Yes	258,777	83.2	255,708	82.7	254,513	82.7	262,767	85.7	273,244	89.4	355,533	27.4	137%	33%
92	NG-M-044	Midstream	Yes	Yes	71,255	21.0	71,259	21.5	71,259	21.5	93,123	29.0	93,123	29.0	76,637	10.2	108%	49%
93	NG-M-016	Midstream	Yes	No	195,500	50.7	38,750	12.5	38,750	12.5	38,750	12.5	38,750	12.5	38,750	12.5	20%	25%
94	NG-P-010	Prescriptive	Yes	Yes	285,557	37.9	285,557	21.6	286,704	21.6	286,704	21.6	286,704	21.6	244,691	19.9	86%	53%
95	NG-P-033	Prescriptive	Yes	Yes	237,652	28.8	235,563	23.1	235,546	23.1	235,375	23.1	223,317	20.1	224,865	24.5	95%	85%
96	NG-P-013	Prescriptive	Yes	Yes	77,958	9.9	105,993	12.0	105,993	12.0	108,620	12.3	105,075	10.8	38,145	8.1	49%	82%
97	NG-P-018	Prescriptive	Yes	Yes	569,677	68.6	596,644	53.6	596,644	53.6	596,644	53.6	596,644	53.6	541,331	69.2	95%	101%
98	NG-P-024	Prescriptive	No	No	14,923	5.5	14,923	5.1	14,923	5.1	14,923	5.1	14,923	5.1	14,923	5.1	100%	93%
99	NG-P-026	Prescriptive	No	No	402,162	5.3	402,163	3.5	402,361	3.5	402,361	3.5	402,361	3.5	402,361	3.5	100%	66%
100	NG-P-044	Prescriptive	No	No	5,152	0.7	5,152	0.6	3,091	0.4	3,091	0.4	3,091	0.4	3,091	0.4	60%	57%
101	NG-P-066	Prescriptive	No	No	47,173	4.7	50,107	3.1	49,896	3.1	49,896	3.1	49,896	3.1	49,896	3.1	106%	66%
102	NG-P-005	Prescriptive	Yes	Yes	1,320,728	107.6	1,320,728	90.0	1,320,728	90.0	1,320,728	90.0	1,240,150	76.0	1,354,157	99.0	103%	92%
103	NG-P-016	Prescriptive	Yes	Yes	220,350	32.2	220,350	17.9	220,350	17.9	220,350	17.9	220,350	17.9	220,350	17.9	100%	56%
104	NG-P-023	Prescriptive	Yes	Yes	77,470	16.3	75,136	13.2	73,725	13.2	74,317	13.3	74,317	13.3	93,550	15.5	121%	95%
105	NG-P-058	Prescriptive	Yes	Yes	300,349	39.3	300,050	29.0	300,050	29.0	300,050	29.0	300,050	29.0	241,802	26.1	81%	66%
106	NG-P-039	Prescriptive	Yes	No	119,530	1.1	120,163	-	120,163	-	120,163	-	120,163	-	120,163	-	101%	0%
107	NG-P-015	Prescriptive	Yes	Yes	13,078	3.8	13,078	2.5	13,078	2.5	13,078	2.5	13,078	2.5	13,883	1.1	106%	28%
108	NG-P-077	Prescriptive	Yes	Yes	23,261	-	23,030	-	23,030	-	23,030	-	24,498	8.0	14,104	0.3	61%	-
109	NG-P-073	Prescriptive	Yes	Yes	85,763	26.9	86,554	23.1	86,554	23.1	86,554	23.1	86,554	23.1	125,906	26.9	147%	100%
110	NG-P-061	Prescriptive	Yes	Yes	80,008	13.3	80,008	13.3	80,008	13.3	80,008	13.3	80,008	13.3	73,283	13.0	92%	98%
111	NG-P-021	Prescriptive	Yes	Yes	78,897	13.2	78,897	11.3	78,897	13.2	78,897	13.2	78,897	13.2	79,747	13.0	101%	98%
112	NG-P-064	Prescriptive	Yes	Yes	75,973	12.7	75,973	10.9	75,973	10.9	75,973	10.9	75,973	10.9	92,954	12.5	122%	98%
113	NG-P-040	Prescriptive	Yes	No	81,416	-	81,416	-	81,416	-	81,416	-	81,416	-	81,416	-	100%	-
114	NG-P-029	Prescriptive	Yes	No	1,051	-	1,051	-	1,051	-	1,051	-	1,051	-	1,051	-	100%	-

					Gross Savings		Verified Savings										Realization Rate	
					Electricity Savings	Peak Demand Savings	Correct Fixture Count		Correct Wattage		Correct Upgrade Controls		Correct HVAC System Type		Correct Baseline Hours		Electricity Savings	Peak Demand Savings
#	Site ID	Component	Site Visit?	Metered?	kWh/yr	kW	kWh/yr	kW	kWh/yr	kW	kWh/yr	kW	kWh/yr	kW	kWh/yr	kW	%	%
115	NG-P-019	Prescriptive	No	No	3,462	40.3	3,462	2.4	3,462	2.4	3,462	2.4	3,462	2.4	3,462	2.4	100%	6%
116	NG-P-078	Prescriptive	Yes	Yes	189,785	-	189,785	-	189,785	-	189,785	-	189,785	-	189,785	-	100%	-
117	NG-P-025	Prescriptive	Yes	No	4,625	-	4,625	-	2,698	-	2,698	-	2,698	-	2,698	-	58%	-
118	NG-P-036	Prescriptive	Yes	Yes	26,582	9.2	26,582	7.3	26,582	7.3	26,582	7.3	26,582	7.3	34,867	9.0	131%	98%
119	NG-P-027	Prescriptive	Yes	No	4,625	-	4,415	-	2,575	-	2,575	-	2,575	-	2,575	-	56%	-
120	NG-P-007	Prescriptive	Yes	Yes	379,731	111.0	379,960	69.1	389,683	69.9	389,683	69.9	389,683	69.9	396,772	67.5	104%	61%
121	NG-P-035	Prescriptive	Yes	Yes	169,283	48.9	169,283	32.6	173,551	33.1	173,551	33.1	173,551	33.1	222,519	33.0	131%	68%
122	NG-P-063	Prescriptive	Yes	Yes	226,087	66.4	222,590	35.7	222,590	35.7	217,678	33.4	225,733	40.1	247,497	39.0	109%	59%
123	NG-P-060	Prescriptive	Yes	Yes	110,692	31.7	110,692	23.7	112,124	23.7	112,124	23.7	112,124	23.7	124,178	22.6	112%	71%
124	NG-P-046	Prescriptive	Yes	Yes	9,693	2.2	7,203	1.4	7,203	1.4	7,203	1.4	7,203	1.4	13,313	1.6	137%	74%
125	NG-P-034	Prescriptive	No	No	6,430	-	10,950	-	10,950	-	10,950	-	10,950	-	10,950	-	170%	-
				Total	**31,230,484**	**6,416**	**27,147,196**	**5,176**	**26,588,187**	**5,003**	**26,811,295**	**5,042**	**26,605,238**	**5,009**	**27,939,152**	**4,645**		