
New Jersey Recommended Net-to- Gross Ratios Overall Report

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SUBMITTED TO:

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NMR
Group, Inc.



Acronyms

Acronym	Definition
ACE	Atlantic City Electric
AFUE	Annual Fuel Utilization Efficiency
AML	Adjusted Measure Life
BCR	Benefit Cost Ratio
BPU	Board of Public Utilities
CEE	Consortium for Energy Efficiency
COP	Coefficient of Performance
CML	Coordinated Measure List
DSM	Demand-side Management
ECM	Electronically Commutated Motor
EER	Energy Efficiency Ratio
EV	Electric Vehicle
FR	Free Ridership
GSL	General Service Lamps
HRV	Heat Recovery Ventilation
HSPF	Heating Seasonal Performance Factor
HVAC	Heating, Ventilation, and Air Conditioning
HPwES	Home Performance with ENERGY STAR®
LED	Light Emitting Diode
MIW	Moderate Income Weatherization
NJCEP	New Jersey Clean Energy Program
NJNC	New Jersey Natural Gas
NJTRM	New Jersey Technical Reference Manual
NMR	NMR Group, Inc.
NPSO	Non-participant Spillover
NTG	Net-to-Gross
PSE&G	Public Service Electric and Gas
PTAC	Packed Terminal Air Conditioner
PTHP	Packed Terminal Heat Pump
PSD	Program Savings Document
PSO	Participant Spillover
PY	Program Year
QHEC	Quick Home Energy Check-up
RCT	Randomized Control Trial (Experimental) Design
SBDI	Small Business Direct Install
SEER	Seasonal Energy Efficiency Ratio
SO	Spillover
SWE	Statewide Evaluator
TRM	Technical Reference Manual
TSV	Thermostatic Shutoff Valve
UEF	Uniform Energy Factor
VFD	Variable Frequency Drive

Abstract

The New Jersey Board of Public Utilities (BPU), the Statewide Evaluator (SWE), and Rutgers University require critical program information as they plan programs and savings targets for the 2024 – 2026 triennium (Triennium 2). The SWE and Rutgers commissioned a study to craft recommended interim statewide net-to-gross (NTG) – inclusive of both free ridership and spillover – ratios to inform planning for Triennium 2 of the New Jersey Clean Energy Program (NJCEP) state-run and utility-based energy-efficiency programs. These values will also provide a starting point (and prioritization) for the annual NTG updates expected moving forward.

The study created residential and commercial measure inventories built from New Jersey’s Coordinated Measure List but also incorporating measures offered in the state-run programs and the delivery modes and target populations for the measures. Recommended NTG ratios were assigned to each measure in the inventory based on the results of an extensive literature review, accounting for state and federal energy-efficiency standards and national and New Jersey market trends. In total, the study assigned 394 residential and 282 commercial NTG ratios. These ratios varied from zero to one, with most residential NTG ratios falling between 0.60 and 0.79 and most commercial NTG ratios falling between 0.80 and 0.99, as shown in the tables below. The study also suggests a process for deciding when the assigned TRM value for a utility should reflect that utility’s researched NTG ratio for a measure or program.

Distribution of Residential NTG Ratios (n=394)

NTG Range	% Of Measures ^a	Typical Measure Groups in Range
1.00	8%	All non-lighting Comfort Partners measures; RCT behavioral programs
0.90 to 0.99	8%	Envelope insulation (moderate income); Multifamily building-wide HVAC; smart strips; thermostatic shut-off valve (TSV) showerheads
0.80 to 0.89	15%	Electric Vehicle (EV) chargers; envelope insulation; new construction; some HVAC (moderate income; cold climate heat pumps via hybrid incentive)
0.70 to 0.79	32%	Non-RCT behavior program; some HVAC (central AC; cold climate heat pumps w/o hybrid incentive; some non-cold climate; gas space and water heating equipment; various with hybrid incentive; smart thermostats); occupancy sensors; smart home
0.60 to 0.69	24%	Most direct install instant-saving measures (air-sealing, tune-ups, water conservation, etc.); some non-cold climate heat pumps; multifamily dryers
0.50 to 0.59	4%	Most appliances; appliance recycling
0.10 to 0.49	5%	Direct install lighting; some electronics; refrigerators
0.00	4%	Non-direct install GSLs; fixtures meant to replace GSLs

^a Percentage of measures to which study assigned NTG ratios, not percentage of achieved savings.

Distribution of Commercial NTG Ratios (n = 282)

NTG Range	% Of Measures ^a	Typical Measure Groups in Range
1.00	0%	NA
0.90 to 0.99	27%	Agriculture; unitary air conditioners; EV chargers; gas absorption chillers; power strips; refrigeration; retro-commissioning (gas); most small business direct install (SBDI)
0.80 to 0.89	33%	Custom natural gas (includes process); most gas HVAC; heat pumps; kitchen equipment
0.70 to 0.79	14%	Custom electric (includes process); electric chillers; electric retro-commissioning; SBDI non-GSL lighting and controls; motors; custom water heating; gas-fired direct hot water (storage & instant)
0.60 to 0.69	9%	Make-up air units; midstream HVAC measures; heat recovery; infrared heaters; exterior and high-low bay lighting; advanced and networked lighting controls; variable frequency drives (VFDs)
0.50 to 0.59	12%	Most appliances; most appliance recycling; custom, horticulture, and linear lighting,
0.10 to 0.49	3%	Dehumidifiers and refrigerators; dehumidifier recycling; office equipment
0.00	2%	GSL lighting

^a Percentage of measures to which study assigned NTG ratios, not percentage of achieved savings.

The study makes the following recommendations.

Recommendation 1: The NJCEP state- and utility-run programs should adopt the NTG ratios documented in accompanying spreadsheets and embedded in Appendix B.

Recommendation 2: The NJCEP state- and utility-run programs should prioritize primary future NTG research into the following:

- Given the many influences encouraging adoption of heat pumps, New Jersey should prioritize primary research to understand the net impact their programs have on the adoption of heat pump technology.
- New Jersey should conduct primary research into the NTG ratios for commercial lighting and lighting controls.
- New Jersey should prioritize research into the NTG ratios for the Moderate Income Weatherization (MIW) program.
- New Jersey should prioritize research into the NTG ratios for any multifamily-specific initiatives among the Existing Homes programs (HPwES, MIW, and QHEC).

The full list of recommended NTG ratios have been delivered as separate spreadsheets and will be incorporated into the New Jersey Technical Reference Manual.

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Executive Summary

The New Jersey Board of Public Utilities (BPU), the Statewide Evaluator (SWE), Rutgers University, and the New Jersey electric and natural gas utilities require critical program information as they plan programs and savings targets for the 2024 – 2026 triennium (Triennium 2). The SWE and Rutgers asked NMR Group, Inc. to craft recommended interim statewide net-to-gross (NTG) ratios to inform planning for Triennium 2 of the New Jersey Clean Energy Program (NJCEP) (state-run) and utility-based energy-efficiency programs. The recommended NTG ratios were assigned based on the results of an extensive review, accounting for state and federal energy-efficiency standards and national and New Jersey market trends. These NTG ratios are reported in accompanying spreadsheets and embedded in [Appendix B](#). They will be incorporated into the New Jersey Technical Reference Manual (NJTRM).

STUDY OBJECTIVES

The objectives of this study were as follows:

- Develop recommended statewide NTG ratios – inclusive of both free ridership (FR) and spillover (SO) – for the portfolio of New Jersey state- and utility-run programs. These values will inform planning for Triennium 2 and be incorporated into the NJTRM and provide a starting point (and prioritization) for the annual NTG updates expected moving forward.
- Compare recommended statewide values with existing and finalized utility-specific NTG ratio estimates.
- Advise the SWE on the situations in which utilities should claim their program-specific NTG ratios rather than default to the statewide values.

To achieve these objectives, the study considered the following information in assigning recommended values:

- Measures offered by NJCEP statewide and utility programs
- Program, measure, and market characteristics that influence net savings and NTG ratios
- NTG ratios adopted in TRMs¹ or savings guidance documents or reported in primary research for programs and measures in the Northeast and Mid-Atlantic states and Illinois
- Applicability of these other NTG ratios to the New Jersey context
- Degree to which utility-specific New Jersey NTG ratios meet criteria that justify claiming these specific values instead of the statewide value

¹ This includes similar savings guidance documents and publicly available benefit-cost ratio models.

OVERVIEW OF TASKS

The study relied on four tasks to achieve these objectives. The task titles serve as hyperlinks to the relevant sections in the report.



Task 1: Measure Inventory. This task involved creating a comprehensive list of all measures offered by the utilities and NJCEP Statewide programs. The inventory was built from the Coordinated Measure List (CML), then broke out measures by fuel type and delivery mode (e.g., online, direct install, midstream, etc.) and, where relevant, target population and program (e.g., Quick Home Energy Check-up (QHEC) and Home Performance with ENERGY STAR® (HPwES)).



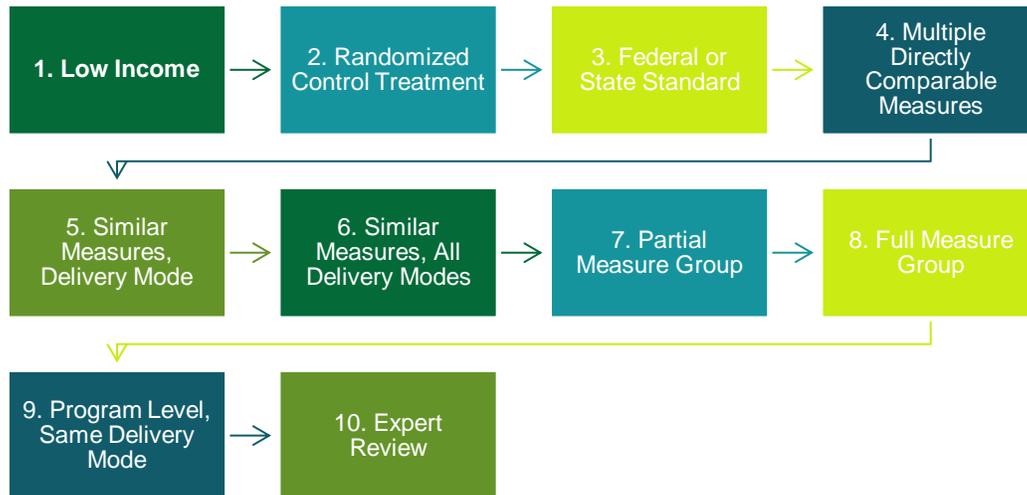
Tasks 2: Literature Review. For this task, the study located and recorded FR, SO, and NTG ratios reported in savings guidance documents and program evaluations in the Northeast, Mid-Atlantic, and Illinois. An examination of the NTG ratios identified factors associated with variation in the values and the relevance of the results to the New Jersey programs and markets. [Appendix C](#) presents the full list of sources from which NTG ratios were drawn.



Task 3: Recommend New Jersey Statewide NTG Ratios and Primary NTG Research Priorities. Using a hierarchical assignment ([Figure 1](#)), this task yielded recommended statewide NTG ratios. The hierarchical rules were based on program population (e.g., low-income customers), program design, federal and state energy-efficiency standards, the number and granularity of NTG ratios found in the literature for each measure, and market characteristics.

For each measure, the assignment started with the rule at the top of the hierarchy. If the measure was from a low-income program, it was assigned a NTG ratio = 1.0 unless it was lighting. If the measure was not in a low-income, the assignment proceeded to the next rule, whether the measure (or entire program) was subject to a randomized controlled trial (RCT) design, and so on. The task also yielded suggested prioritized programs and measures for future primary NTG research. The criteria for the future study prioritization included expected savings, rate of market commercialization, and the prevalence of relevant literature in other jurisdictions for informing New Jersey NTG ratios.

Figure 1: Assignment Hierarchy^a



^a See Section 2.3.2 and Section 2.3.3 for details.



Task 4: Advise SWE on Utility-Specific NTG Exceptions This task involved reviews of the program-wide and measure-specific NTG ratios that the utilities had submitted to the SWE as of February 14, 2023. Utility values were compared to the recommended statewide values for similar measures and programs. The task advised the SWE on the criteria for when the assigned TRM value for a utility should reflect that utility’s researched NTG ratio for a measure or program rather than the recommended statewide values.

KEY FINDINGS

Residential NTG ratios assigned ranged between zero and one (Table 1).²

General service lamps (GSLs) and related fixtures sold in retail stores or online received recommended NTG ratios of zero due to federal and state efficiency standards. Comfort Partners (the low-income program) and behavioral programs using an RCT design received NTG ratios of one. Over one-half of the NTG ratios fall between 0.60 and 0.79. This range includes most heating, ventilation, and air conditioning (HVAC) measures and direct install measures such as faucet aerators and low-flow showerheads.

² This report uses decimals to refer to all NTG ratios. They can be multiplied by 100% to change them into percentages. For example, 0.60 would become 60%.

Commercial NTG ratios assigned ranged between zero and 0.96. (Table 2).

As with residential, GSLs and related fixtures were assigned a NTG ratio of zero due to federal and state standards. Over one-half of the NTG ratios fall between 0.80 and 0.99. This range includes measures for agriculture, kitchen equipment, and most SDBI and natural gas HVAC, among others.

Table 1: Distribution of Residential NTG Ratios (n=394)

NTG Range	% Of Measures ^a	Typical Measure Groups in Range
1.00	8%	All non-lighting Comfort Partners measures; RCT behavioral programs
0.90 to 0.99	8%	Envelope insulation (moderate income); Multifamily building-wide HVAC; smart strips; thermostatic shut-off valve (TSV) showerheads
0.80 to 0.89	15%	Electric Vehicle (EV) chargers; envelope insulation; new construction; some HVAC (moderate income; cold climate heat pumps via hybrid incentive)
0.70 to 0.79	32%	Non-RCT behavior program; some HVAC (central AC; cold climate heat pumps w/o hybrid incentive; some non-cold climate; gas space and water heating equipment; various with hybrid incentive; smart thermostats); occupancy sensors; smart home
0.60 to 0.69	24%	Most direct install instant-saving measures (air-sealing, tune-ups, water conservation, etc.); some non-cold climate heat pumps; multifamily dryers
0.50 to 0.59	4%	Most appliances; appliance recycling
0.10 to 0.49	5%	Direct install lighting; some electronics; refrigerators
0.00	4%	Non-direct install GSLs; fixtures meant to replace GSLs

^a Percentage of measures to which study assigned NTG ratios, not percentage of achieved savings.

Table 2: Distribution of Commercial NTG Ratios (n = 282)

NTG Range	% Of Measures ^a	Typical Measure Groups in Range
1.00	0%	NA
0.90 to 0.99	27%	Agriculture; unitary air conditioners; EV chargers; gas absorption chillers; power strips; refrigeration; retro-commissioning (gas); most small business direct install (SBDI)
0.80 to 0.89	33%	Custom natural gas (includes process); most gas HVAC; heat pumps; kitchen equipment
0.70 to 0.79	14%	Custom electric (includes process); electric chillers; electric retro-commissioning; SBDI non-GSL lighting and controls; motors; custom water heating; gas-fired direct hot water (storage & instant)
0.60 to 0.69	9%	Make-up air units; midstream HVAC measures; heat recovery; infrared heaters; exterior and high-low bay lighting; advanced and networked lighting controls; variable frequency drives (VFDs)
0.50 to 0.59	12%	Most appliances; most appliance recycling; custom, horticulture, and linear lighting,
0.10 to 0.49	3%	Dehumidifiers and refrigerators; dehumidifier recycling; office equipment
0.00	2%	GSL lighting

^a Percentage of measures to which study assigned NTG ratios, not percentage of achieved savings.

RECOMMENDATIONS

The study makes the following recommendations.

Recommendation 1: The NJCEP state- and utility-run programs should adopt the NTG ratios documented in accompanying spreadsheets and embedded in Appendix B.

Recommendation 2: The NJCEP state- and utility-run programs should prioritize primary future NTG research into the following:

- New Jersey should prioritize primary research to understand the net impact their programs have on the adoption of heat pump technology, as there are many influences encouraging adoption of heat pumps that could influence NTG.
- New Jersey should conduct primary research into the NTG ratios for commercial lighting and lighting controls, given the uncertainty surrounding the current state of the New Jersey commercial lighting market and the savings associated with these measures.
- New Jersey should prioritize research into the NTG ratios for the Moderate Income Weatherization (MIW) program. Moderate income households have some, albeit limited, financial resources. However, the literature revealed little primary research on these programs, which tend to be recent additions to program portfolios nationwide. Therefore, studies are needed to establish actual program influence on the adoption of energy-efficient measures by this important customer group.

- New Jersey should prioritize research into the NTG ratios for any multifamily-specific initiatives among the Existing Homes programs (HPwES, MIW, and QHEC). Many TRMs – and in some cases, this study – default to assigning residential NTG ratios to in-unit measures and commercial NTG ratios to common area/building-wide measures. Yet, these assumptions may not accurately describe actual conditions for multifamily buildings. Therefore, studies are needed to establish actual program influence on the adoption of energy-efficient measures in both in-unit and common areas of multifamily buildings.

Section 1 Introduction

The New Jersey Clean Energy Program (NJCEP) and the state's electric and gas utilities offer dozens of programs designed to reduce energy consumption and utility bills for New Jersey residents and businesses. The NJCEP offers residential and commercial new construction and existing building programs to large energy users and state and local governments. The utility programs focus on existing buildings and energy-efficient products for residential (including moderate income), commercial, small business, and government customers. Both entities jointly manage or offer programs for low-income households.

The New Jersey Board of Public Utilities (BPU), the Statewide Evaluator (SWE), Rutgers University, and the New Jersey electric and natural gas utilities require critical program information as they plan the 2024 – 2026 triennium (Triennium 2). Specifically, the BPU ordered that program savings in the 2022 – 2024 triennium (Triennium 1) be based on net savings, but the BPU established a universal placeholder assumed net-to-gross (NTG) ratio of 1.0.³ With some exceptions, the timing of evaluation research on net savings in Triennium 1 did not result in empirical results for NTG ratios at a measure or program level to update Triennium 1 or to guide planning for Triennium 2. Therefore, there was a need for a global study aimed at deriving defensible statewide replacements for the placeholder NTG ratio of 1.0. These statewide values may be overridden in those relatively few cases in which program-specific NTG ratio values developed for Triennium 1 were available by February 14, 2023, and met criteria to exempt them from the statewide values.⁴

This study seeks to provide planning recommendations for NTG ratios reflecting the portion of reported or deemed savings attributed to program activity. The recommended values will also serve as a starting point for the annual NTG updates expected moving forward. NTG ratios encompass free-ridership (savings that would have been achieved in the absence of the program), participant spillover (additional, non-incented savings achieved by participants due to their program experiences), and non-participant spillover (savings achieved by non-participants but because of the program).⁵ Sometimes NTG ratios reflect the behavior of specific participants, while in other cases they reflect the lift that programs provide to sales of efficient products and services.

The SWE and Rutgers asked NMR Group, Inc. (NMR) to craft recommended statewide NTG ratios to inform planning for Triennium 2 of NJCEP (state-run) and utility-based energy-efficiency programs. These NTG ratios will be incorporated into the New Jersey Technical Reference Manual (NJTRM) either specifically or by reference. It is the expectation that these values will serve as starting point for NTG in the state and will be replaced over time with primary research conducted for New Jersey programs. The development of criteria for replacing the planning values goes beyond the scope of this study. However, this study does advise the SWE on whether NTG

³ This report uses decimals to refer to all NTG ratios. They can be multiplied by 100% to change them into percentages. For example, 0.60 would become 60%.

⁴ Although this precedes the final submission date necessary for inclusion in the Triennium 2 planning (March 6, 2023), the earlier date allowed time for the analysis summarized in this report.

⁵ An example of non-participant spillover is an HVAC contractor installing non-incented heat pump water heaters in the homes of customers who also do not receive program rebates.

ratios available as of February 14, 2023, should be used in place of the recommended values created for this study.

1.1 STUDY OBJECTIVES

The objectives of this study were as follows:

- Develop recommended statewide NTG ratios – inclusive of both free ridership (FR) and spillover (SO) – for the portfolio of New Jersey state- and utility-run programs. These values will inform planning for Triennium 2 and be incorporated into the NJTRM and provide a starting point (and prioritization) for the annual NTG updates expected moving forward.
- Compare recommended statewide values with existing and finalized utility-specific NTG ratio estimates.
- Advise the SWE on the situations in which utilities should claim their program-specific NTG ratios rather than default to the statewide values.

To achieve these objectives, the study considered the following information in assigning recommended values:

- Measures offered by NJCEP statewide and utility programs
- Program, measure, and market characteristics that influence net savings and NTG ratios
- NTG ratios adopted in TRMs⁶ or savings guidance documents reported in primary research for programs and measures in the Northeast and Mid-Atlantic states and Illinois
- Applicability of these other NTG ratios to the New Jersey context
- Degree to which utility-specific New Jersey NTG ratios meet criteria that justify claiming these specific values instead of the statewide value

1.2 ABOUT THIS REPORT

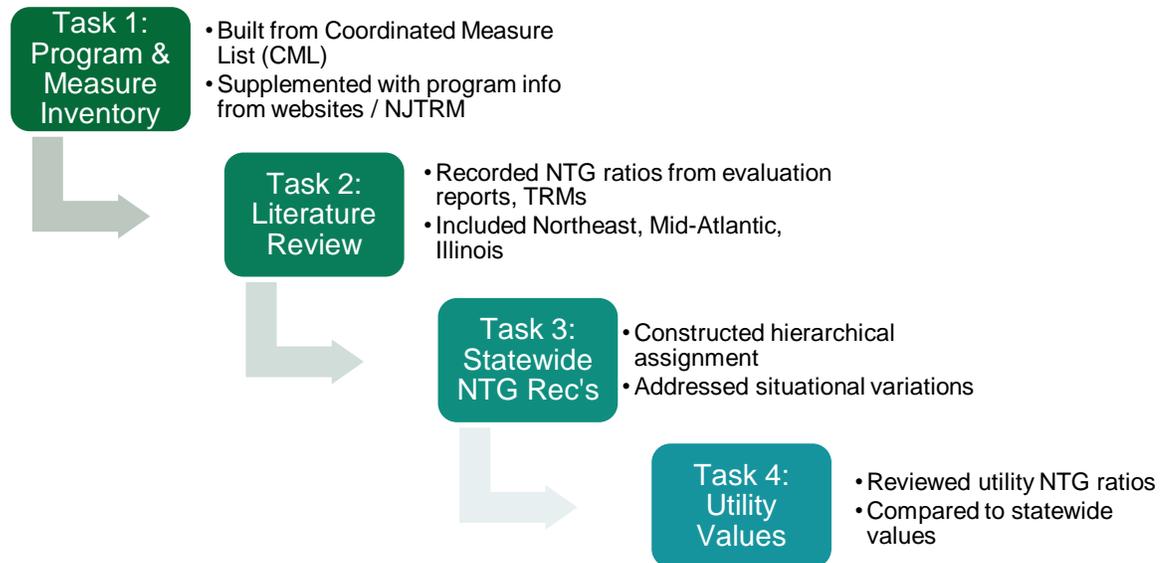
This report begins by [summarizing the study tasks](#). Next, it provides an overview of the [recommended statewide NTG ratios](#). The report advises the SWE on [utility-specific NTG ratios](#) and includes suggested priorities for future primary NTG research in New Jersey. The recommended NTG ratios have been provided as Excel spreadsheets that can be easily searched, sorted, and filtered.

⁶ This includes similar savings guidance documents and publicly available benefit-cost ratio models.

Section 2 Study Approach

This section summarizes the four tasks of the study approach (Figure 2), including the hierarchical assignment used to assign recommended NTG ratios. The hierarchical assignment, discussed in more detail in Section 2.3.2, incorporated program population (e.g., low-income customers), federal and state energy-efficiency standards, the number and relevance of NTG ratios found in the literature, and market characteristics.

Figure 2: Summary of Four Study Tasks



2.1 TASK 1: PROGRAM AND MEASURE INVENTORY

The first study task was to create a comprehensive inventory of all programs, measures, and the key factors that may influence NTG ratio assignments. The purpose of the inventory was to ensure the assignment of NTG ratios to all measures, accounting for factors such as delivery mode, fuel, and target population.

The measure inventory used the New Jersey Coordinated Measure List (CML) dated July 22, 2022, as a foundation.⁷ However, the CML does not include the state-run programs, and it only sometimes distinguishes by delivery mode, target population, and heating fuel.⁸ Reviews of the program descriptions and materials available on the NJCEP and utility websites provided the information needed to flesh out the full measure inventory. Table 3 lists the fields included in the inventory.⁹ The fields and their content differ slightly for residential and commercial programs.

⁷ Available at https://njcleanenergy.com/files/file/BPU/2022/10.14/NJ%20Coordinated%20Measures%20List%20-%20EMV%207_22_22.xlsx.

⁸ For example, the CML does not differentiate between clothes dryers in homes with electric versus natural gas water heating. Likewise, only some measures specifically note that they target the multifamily sector.

⁹ The draft inventory was circulated to the Working Group (WG) on January 3, 2023. A final version (forthcoming) incorporates feedback received on the draft and changes made to align with the final list of recommended NTG ratios.

The residential “measure group” is analogous to commercial “end use,” while commercial “measure group” provides breakouts of the end uses.

Table 3: Fields in Measure Inventory

Field	Residential	Commercial
Program Type	X	
Measure	X	X
Unique ID ^a	X	X
Program	X	
Measure Group	X	X
End Use		X
Fuel Type	X	X
Delivery Mode ^b	X	X

^a Based on utility assignment, with additions for measures specific to NJCEP programs and factors potentially related to NTG.

^b Such as online, midstream, direct install, etc.

Table 4 to Table 7 below compare the number of measures in the CML and the number in the measure inventory. The text above each table highlights some of the key drivers of differences between the number of measures in the CML and the inventory.

For the Efficient Products Program, the measure inventory accounts for delivery modes, fuel types, and different types of lighting products.

Table 4 summarizes the number of measures listed in the CML for the Efficient Products Program and the number listed in the measures inventory. The inventory accounts for delivery modes (i.e., upstream markdowns, online marketplaces, hybrid incentives shared by distributors, contractors, and/or customers, and downstream rebates), fuel types, and for different types of lighting products, which are only sometimes differentiated in the CML.

Table 4: Efficient Products – Number of Measures in CML vs. Measure Inventory

Measure Group	CML	Inventory	Reasons for Different Counts
Appliances	18	26	Delivery mode, fuel
Appliance Recycling	4	4	NA
Fans and Pumps	3	6	Delivery mode, fuel
Heating, ventilation, and air conditioning (HVAC) (includes thermostats)	37	105	Delivery mode, fuel
Lighting	6	13	Delivery mode, regulatory exemptions
Office / Plug Load	7	13	Delivery mode
Water Heating	8	17	Delivery mode, fuel
Other (Behavior, Contractor Incentive, Kits)	1	3	Program focus, kit contents
Total	84	187	

For Existing Homes, the measure inventory accounts for fuel type for a greater number of measures than the CML does.

Although the CML has specific electric and gas HVAC and water heating measures, the CML did not differentiate insulation or other measures by fuel type. Likewise, the CML did not fully account for the fuels that the thermostats could control. The measure inventory added entries for these situations for the Home Performance with ENERGY STAR® (HPwES), Moderate Income Weatherization (MIW), and Quick Home Energy Check-up (QHEC) (Table 5). The measure inventory also accounts for different types of behavior programs.

Table 5: Existing Homes – Number of Measures in CML vs. Measure Inventory

	General		HPwES		MIW		QHEC	
	CML	Inventory	CML	Inventory	CML	Inventory	CML	Inventory
Appliances	0	0	0	0	1	1	0	0
Fans and Pumps	0	0	3	3	3	3	0	0
HVAC (includes thermostats, water heater bundle)	0	0	31	38	31	38	5	6
Insulation and Envelope	3	6	7	14	7	14	0	0
Lighting	1	1	0	NA	2	2	2	2
Office / Plug Load	0	0	0	NA	1	1	1	1
Water Heating (minus gas heat bundle)	2	4	5	5	9	13	4	10
Other (Behavior, Contractor Incentive) ^a	1	6	1	0	0	0	0	0
Total	7	17	47	60	54	72	12	19

^a Difference due to fuel and to program focus; no NTG for contractor incentive

The CML covered only utility programs, but the measure inventory also encompasses NJCEP and jointly administered programs, namely the low-income focused Comfort Partners program and the Residential New Construction program.

Table 6 shows the number of entries in the measure inventory for the Comfort Partners (the low-income program) and Residential New Construction programs. These measures were identified through web and TRM searches. While the inventory lists Comfort Partners measures, most of these measures will receive a NTG ratio of 1.0 in keeping with industry standard practice. The inventory differentiates the Residential New Construction program by ENERGY STAR® homes, zero net-energy ready homes, the presence of renewable energy, and the number of units in the building.

Table 6: Comfort Partners and New Construction: Measure Inventory

	Comfort Partners	Residential New Construction
Appliances	1	0
HVAC (includes thermostats)	4	0
Insulation and Envelope	12	0
Lighting	4	0
Water Heating	9	0
Other (Behavior, Contractor Incentive, Kits)	2	0
Whole House	NA	7
Total	32	7

The number of measures in the CML and measure inventory are similar for the commercial sector.

Compared to residential, the commercial sector has fewer variations by delivery modes, and the CML had already accounted for fuel type for most measures. Therefore, the number of measures in the CML and measure inventory are more similar for commercial than for residential (Table 7). Inventory entries were added by delivery mode and fuel for some measures.

Table 7: Commercial Programs – Number of Measures in CML vs. Measure Inventory

End Use	CML	Inventory	Reasons for Different Counts
Agriculture	10	10	NA
Appliances	15	17	Delivery mode, fuel
Early Retirement / Appliance Recycling	4	4	NA
General	11	14	Delivery mode, fuel
HVAC	84	86	Delivery mode, fuel
Kitchen Equipment	38	40	Delivery mode, fuel
Lighting	37	44	Delivery mode, regulatory exemptions
Motors	7	7	NA
Office	5	5	NA
Plug Loads	8	8	NA
Refrigeration	20	20	NA
Variable Frequency Drives (VFDs) / Drives	3	3	NA
Water Heating	20	24	Delivery mode, fuel
Total	262	282	

2.2 TASK 2: LITERATURE REVIEW

The second task, a literature review, provided insights into the range of NTG ratios for similar programs and measures in other jurisdictions and the factors association with NTG variation. The literature search focused on studies published between 2019 to 2022 on websites of state regulatory bodies or utility program administrators, supplemented by the ESource Demand Side Management (DSM) Library.¹⁰ The literature search relied on the following terms paired with the names of specific measure groups, program types, and target populations.

- Net-to-gross and net savings
- Free-ridership and spillover
- Impact evaluation
- Savings verification
- Comprehensive evaluation
- Attribution

The review included locating and recording FR, SO, NTG ratios, and supporting information from TRMs, other energy-savings guidance documents, and evaluation reports from the states listed in Table 8.¹¹ As explained more below, the sources inconsistently measured or reported FR and SO.

Table 8: Type of Literature Review Source Material by State^a

State ¹	TRM or Similar	Evaluation Reports
Connecticut	x	x
Delaware		x
Illinois ^b		x
Maryland		x
Massachusetts	x	x
New Jersey		x
Pennsylvania		x
Washington DC	x	x

^a NMR did not review materials from New York State or Rhode Island. New York does not require reporting of net savings, so available reports may be biased. Rhode Island conducts very little primary NTG research, instead sourcing values from regional studies or neighboring states.

^b While not in the Northeast or Mid-Atlantic, Illinois engages in regular NTG research, the results of which inform NTG algorithms and values for states across the nation, including on the East Coast.

¹⁰ The DSM library serves as a repository of energy-efficiency program research across North America. The library will frequently contain studies that are difficult to find online or no longer available on regulatory or utility websites. ESource charges a fee to access the library.

¹¹ The study accessed TRMs from all states listed, but only those denoted in the table include NTG ratios.

Table 9 summarizes the approximate length of time the program administrator has consistently offered energy-efficiency programs, the state’s most recent score from the American Council for an Energy Efficient Economy(ACEEE),¹² and the number of sources used from each area. The literature review included programs of varying ages and perceived strength and aggressiveness according to ACEEE. The number of sources reflects the frequency of NTG research in the state, which is driven by evaluation budgets, program cycles, and regulatory requirements. Appendix C presents the bibliography of sources examined for this literature review.

Table 9: Portfolio Age, ACEEE Scores, and Number of Sources Reviewed

State	Approximate Portfolio Age	2022 ACEEE Score	# of Sources
Connecticut	20 years	9	4
Delaware	10 years	18	2
Illinois	10 years	16	42
Maryland	10 years	7	1
Massachusetts	20 years	2	11
New Jersey	5 years	14	1 ^{ab}
Pennsylvania	10 years	21	14
Washington DC	10 years	6	3

^a Apex Analytics and Demand Side Analytics. 2022. *New Jersey 2020 and 2021 Retail Lighting Sales Data Analysis*. Available at

<https://njcleanenergy.com/files/file/Library/FY23/NJ%20Residential%20Lighting%20Sales%20and%20NTG%20Analysis%2020220707.pdf>.

^b The treatment of New Jersey utility-specific studies completed for Triennium 1 are addressed in Section 2.4.

¹² Subramanian, S., W. Berg, E. Cooper, M. Waite, B. Jennings, A. Hoffmeister, and B. Fadie. 2022. *2022 State Energy Efficiency Scorecard*. Washington, DC: ACEEE. www.aceee.org/research-report/u2206.

NEW JERSEY RECOMMENDED NET-TO-GROSS RATIOS OVERALL REPORT

The full list of fields tracked are listed below. In total, the literature review identified 764 individual NTG ratios or their FR and SO components across the literature, 324 for residential, 90 for multifamily,¹³ and 350 for commercial.

- NMR ID (for easy reference)
- Month of Publication
- Year of Publication
- Year(s) of Research Focus
- State/Region of Focus
- Lead Contractor/Author
- Sponsoring Organization
- Document Type
- Title
- Sector
- Target Population
- Program Type
- Delivery Mode
- Measure
- End Use
- Primary/Secondary Research
- If Secondary or TRM: Original Source
- Study Method
- Sample Size
- Free Ridership (FR)
- Participant Spillover (PSO)
- Non-Participant Spillover (NPSO)
- Total Spillover (SO)
- NTG Ratio
- Error Bands/Confidence Intervals
- Drivers of NTG Findings
- Notes
- URL (if available)

Table 10 lists the number of individual NTG values that NMR extracted by state, sector, and document type.

Table 10: Number of NTG Ratios Extracted by State, Sector, and Document Type

State	Residential		Multifamily		Commercial		Total
	TRM	Report	TRM	Report	TRM	Report	
Connecticut	41	24	10	NA	32	6	113
Delaware	NA	4	NA	NA	NA	2	6
Illinois	NA	42	NA	10	NA	46	98
Maryland	NA	2	NA	NA	NA	3	5
Massachusetts	75	87	26	8	101	61	358
New Jersey	NA	NA	NA	NA	NA	2	2
Pennsylvania	NA	51	NA	1	NA	70	122
Washington DC	11	9	35	NA	3	2	60
Total	127	219	71	19	136	192	764

¹³ The multifamily counts include those classified in sources as “residential” or “C&I” but specifically called out that the value applied to multifamily. They do not include values in which a TRM said to apply single-family residential values to multifamily units or commercial values to multifamily common areas or equipment.

Free ridership, SO, and NTG ratios were analyzed to describe the distribution of values for individual measures, measure groups/end uses, delivery modes, and program types. This review also assessed the sensitivity of NTG values to such factors as whether the values were based on primary research, secondary research, or a group-decision making process;¹⁴ the study addressed FR and/or SO (see below); and the results were to be applied retrospectively or prospectively. This assessment informed the development of the NTG assignment hierarchy and the situational variations applied to those assignments.

One important observation from the literature assessment was the lack of systematic patterns in NTG ratios based on whether the original sources reported FR or SO. [Table 11](#) summarizes the percentage of NTG ratios from the literature that reported FR or SO. While the majority of NTG ratios reported FR, fewer than one-half reported SO. The inconsistent reporting of the two NTG components could reflect any of the following.

- Some NTG estimation methods (e.g., market-lift, some consensus processes) cannot isolate FR and SO even though those components are embedded in the estimate.
- Studies may have decided not to measure spillover, with the most common reasons for the exclusion being:
 - Not enough time had passed since participation for spillover to have occurred.
 - The measure (e.g., appliance recycling) or delivery mode was not conducive to spillover.
 - Insufficient budget was available to measure spillover.
- Some NTG ratios may have been based on both evaluated FR and SO, but the source (often TRMs) only reported the full NTG ratio.

Table 11: Percentage of NTG Ratios with Free Ridership and Spillover Broken Out^a

NTG Component	Residential	Multifamily	Commercial
Total # of NTG Ratios	324	90	350
% with FR	63%	84%	65%
% with Any SO ^b	40%	21%	33%

^a The percentages in the tables include deemed FR and SO (i.e., determined by a process other than primary research) and FR and/or SO measured at the program level but applied to individual measures within the program.

^b Any combination of PSO, NPSO, or total SO

Other overarching observations included the following:

- Common sources of variation for NTG ratios included study methodology (e.g., participant surveys, market actor interviews, Delphi or consensus processes) and whether the NTG ratios from the literature sources were retrospective (estimating the past) or prospective (predicting the future). Prospective predictions take program influence and changes, level of market commercialization, and federal and state codes and standards into account.

¹⁴ Common examples include Delphi and consensus-building processes and TRM advisory groups.

- The more sources that exist for a measure, the more varied the NTG ratios for that measure. This is to be expected, as usually a larger number of data points yields greater variation. Greater variation allowed for the setting of more granular recommended statewide NTG ratios, such as by delivery mode or heating fuel type.
- The broader the measure (or measure group or end-use), as listed in the NTG ratio source, the more the NTG ratios tended to vary. There are two main reasons for this. First, some sources listed NTG ratios for broad groups (e.g., commercial custom electric). The individual measures within these groups differ across jurisdictions, influencing the reported NTG ratios. Second, the literature contains more NTG ratios for broader measure groups or whole programs (e.g., commercial kitchen equipment or home energy assessments) than for more specific measures (e.g., commercial fryers or duct sealing).
- The jurisdictions included in this literature review use the terms *upstream* and *midstream* differently. For consistency, the study categorized NTG ratios according to the framework below (and when the source allowed us to make a judgement):

Upstream refers to measures incented through retail stores in agreements made with manufacturers, retailers, and buying groups (e.g., for independent stores). Upstream designs often target end-use customers in the residential, small business, and multifamily sectors and the contractors and property and building managers that serve these sectors.

Midstream refers to measures incented through distributors in agreements made with manufacturers, manufacturer representatives, and distributors. Midstream designs usually target contractors and builders across all sectors as well as larger multifamily and commercial building and property managers.

The literature review sometimes identified a small number of, or even no, NTG ratios for measures identified in the inventory. In these cases, the study included a search for supplemental information, including ENERGY STAR shipment data¹⁵ and market trend discussions in industry literature.

2.3 TASK 3: STATEWIDE NTG RECOMMENDATIONS

The main objective of this study is to assign recommended statewide NTG ratios to assist in planning for Triennium 2 and provide a starting point (and prioritization) for the annual updates expected moving forward. The measure inventory and literature review provided the groundwork for these assignments. However, the number and relevance of NTG ratios for specific measures by fuel, delivery mode, and target population varied. This required setting guiding principles to assign NTG ratios.

¹⁵ ENERGY STAR. *Unit Shipment Data Annual Summary Reports*. Available at https://www.energystar.gov/partner_resources/products_partner_resources/brand_owner_resources/unit_shipment_data/archives.

2.3.1 NTG Assignment Guiding Principles

NTG assignments were based on full NTG ratios; the study did not assign specific recommended statewide FR or SO values to measures.

As noted above, the literature assessment described above did not find systematic patterns in NTG ratios based on whether the original sources reported FR or SO, largely due to the inconsistent measurement and reporting of these two components (Table 11). There was insufficient information to assign FR and SO for New Jersey, so the assignments focused on NTG ratios only.

For measures that were not assigned a specific multifamily NTG ratio according to the assignment hierarchy (see below), the residential NTG ratios apply to in-unit multifamily measures, and commercial NTG ratios apply to common area and building-wide multifamily.

The literature review found very few NTG ratios for the multifamily sector. Most of these were deemed values listed in TRM-like documents and not based on primary research. The recommended NTG ratios include multifamily values assigned according to the hierarchical assignment and situational variations described in Section 2.3.2 and Section 2.3.3, respectively. For all measures in which the study did not assign a specific multifamily value, residential NTG ratios apply to in-unit measures, and commercial values apply to common area and building-wide measures.

A hierarchical assignment was constructed to assign NTG ratios for all measures in the inventory. The number and nature of NTG ratios in the literature varied by measure. To offer examples, the literature yielded no NTG ratios for electric vehicle (EV) chargers; NTG ratios for moderate-income measures came only from deemed values in TRM-like documents for Connecticut and Massachusetts; and the eight NTG ratios for smart thermostats were spread across multiple delivery modes and fuels. Given this variation, a series of hierarchical rules were developed based on the number and relevance of NTG ratios available and/or the characteristics of the measure, measure group, delivery mode, target population, and program. The next section (Section 2.3.2) describes the process in detail.

2.3.2 Hierarchical Assignment

The hierarchical NTG assignment balances standard industry practice, federal and state regulations,¹⁶ number, and variability of NTG ratios recorded for a given measure per delivery mode, and target population.

The following questions informed the assignment of NTG ratios:

¹⁶ Most notably New Jersey A5160 (and the DOE rulemakings on GSL efficiency standards. See *Establishes minimum energy and water efficiency standards for certain products sold, offered for sale, or leased in the State*. 2022. New Jersey Assembly 5160, 219th Legislature. Available at <https://legiscan.com/NJ/text/A5160/2020>, and Department of Energy, "Energy Conservation Standards for General Service Lamps." Federal Register Vol. 87, no. 89 (May 9, 2022): Page 27439, <https://www.govinfo.gov/content/pkg/FR-2022-05-09/pdf/2022-09477.pdf>.

- Is there a widely accepted industry practice for assigning a NTG ratio to this measure/program?
- Did the literature yield NTG ratios that exactly match the combination of measure, delivery mode, fuel type, and target population? If not, what is the next highest level of aggregation for which the literature yields at least two independent values?¹⁷
- Are some of the NTG ratios at this level of aggregation derived from primary research? If not, what is the next highest level of aggregation that includes values estimated from primary research?
- What adjustments should be made for situational factors not adequately captured in the NTG values found in the literature?

These questions led to the development of the hierarchical assignment rules in [Figure 3](#) and the situational variations in [Table 12](#). Measures were assigned a NTG ratio based on the first rule that applied to them. The bullets below explain each of the rules.

1. Low Income: Following industry standard practice, if the measure was offered through a low-income program (i.e., Comfort Partners), it was assigned a NTG = 1.0.¹⁸ Lighting served as the exception and was assigned based on either federal or state standards or using situational variation criteria.

2. Randomized Control Trial (RCT): Behavioral programs that rely on a randomized control trial (RCT) design do not offer measures. Instead, they suggest ways that households can reduce their energy use. Households in such programs are randomly assigned to a treatment group that receives these suggestions or a comparable control group that does not. Program savings reflect the difference in pre-post treatment energy use in the treatment and control groups. Randomization means that any FR is exhibited equally by the treatment and control groups and factored into the program savings estimate. For this reason, RCT behavioral programs were assigned a NTG = 1.0.¹⁹

3. Federal or State Regulations: Some measures in the inventory are subject to recently implemented federal or state energy-efficiency regulations. For light emitting diode (LED) bulbs and fixtures meant to replace general service lamps (GSLs), a NTG of zero was assigned to those offered upstream, online, or through commercial programs. For direct install lighting residential GSLs, the assignment relied on New Jersey market research. The assignment of NTG ratios to all non-lighting measures in the New Jersey A5160 defaulted to other rules in the hierarchy, as the impact of the legislation on programs is uncertain.

4. – 9. Assigned based on NTG ratios found in the literature review: The next six parts of the hierarchy draw values directly from the literature review. The underlying logic reflects that the literature provides comparable NTG ratios based on of varying levels of

¹⁷ That is, if a TRM adopted a value from an evaluation report, the assignment treated this as a single value.

¹⁸ Actual NTG ratios for low-income programs may not always be zero. Some low-income participants may still have adopted certain energy-efficient measures on their own without program support.

¹⁹ Home Energy and Business Energy Report programs, such as those implemented by Oracle. The decision tree leaves open the possibility that RCTs could have lighting measures, but this measure inventory does not include this combination.

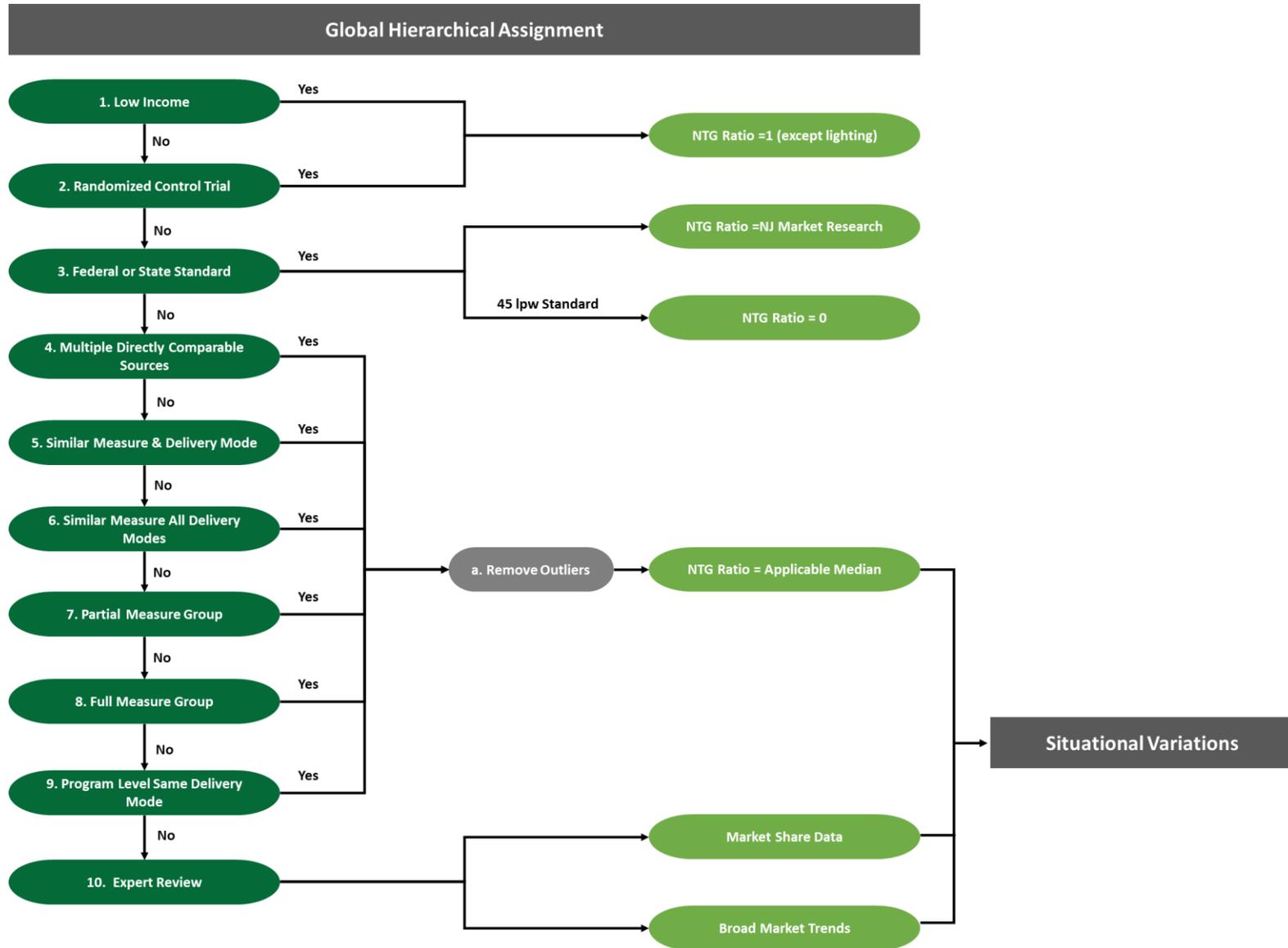
granularity. Some values from the literature were directly comparable to New Jersey measures at the level of the measure, target population, and delivery mode. Other literature values matched New Jersey's only at the program-level. The hierarchy assigned values at the most granular level reliably supported by the available literature review results.

More specifically, *4. Multiple, Directly Comparable Sources* served as the most granular and preferred assignment rule among this group. If too few directly comparable NTG values existed, the next rule was applied, *5. Similar Measures and Delivery Mode*. This rule grouped closely related measures within the same delivery mode. The assignment followed this same process until the literature had to be aggregated at the *9. Program Level, Same Delivery Mode*. This last rule was most commonly used to assign measures directly installed or distributed through the QHEC residential program and numerous commercial measure groups.

All assignments made from on literature applied the median (rather than the mean) due to the variation in methodologies and inconsistent treatment of FR and SO among NTG values found in the literature.

10. Expert Review: For measures for which the literature did not yield suitable NTG ratios, the assignments reflect the evaluators' interpretation of market information, such as ENERGY STAR shipment data or broad industry trends, based on their prior NTG experience. This approach was most common for emerging measures (e.g., EV chargers, advanced power strips, and thermostatic shutoff valve [TSV] showerheads) or ones infrequently supported by program administrators in other jurisdictions (e.g., home office equipment).

Figure 3: NTG Assignment Hierarchy



2.3.3 Situational Variations

Specific situations created the need to adjust some NTG ratios, presented in Table 12.

These adjustments differed slightly between the residential and commercial sectors. The bullets below explain the variations.

Removed Outliers. For both sectors, outliers from the applicable literature were removed from NTG ratios before assigning the NTG ratio median as the recommended values for New Jersey. These outliers tended to be individual retrospective NTG ratios with extremely high SO or FR rates that were out of step with other values. Most were also based on small sample sizes.²⁰

Boosted assigned NTG ratios. Sometimes the NTG ratios from the literature suggested that the NTG ratios were slightly higher for specific sub-groups of measures or target populations, but the number of NTG ratios found was too small on which to base assignments. In these cases, percentage boosts (5% or 10%) were applied over the most similar NTG ratio derived from the hierarchical assignment. The 10% boosts were assigned to measures installed in multifamily units or buildings (unless otherwise noted), low-income direct install lighting, moderate-income programs, cold climate heat pumps, and measures with a strong program impact (i.e., limited adoption outside of programs). The hybrid incentive delivery mode received a 5% boost, as studies usually, but not universally, find positive net-impacts when offering midstream incentives.

Decreased assigned NTG ratios. Downward adjustments were made to some NTG ratios. Most of these were modest annual step downs due to rates of commercialization while others were larger due to the additional influence of state or federal energy-efficiency standards.

Most of these were modest annual step downs of three or five percentage points based on the rate of commercialization (i.e., commercial success regardless of program support) and other factors driving their adoption. Rapid commercialization means that a rapidly increasing percentage of the population is adopting the measure without intervention. To avoid having a decreasing NTG ratio as a result, programs must find a way to prevent the increasingly numerous natural adopters from constituting an increasing portion of program participants. Because this is difficult to do, the study assumed that NTG ratios would decrease over time for these rapidly commercializing measures.

The two most critical sets of measures receiving annual steps downs are heat pumps across all sectors (step down of three percentage points) and commercial lighting (step down of five percentage points).

- Heat pumps received a step down because their numerous advantages have contributed to increasing popularity among consumers. Additionally, the federal

²⁰ These outlying NTG ratios may be accurate for the program and period in which they were collected, but they are a poor guide for prospective application.

Inflation Reduction Act (IRA) created tax credits and other incentives for households, property owners, and businesses to install heat pumps.²¹

- Commercial lighting received a step down due to rapid market commercialization for LED-based technology. A recently completed study points to an existing strong commercial LED market in New Jersey, and similar studies in other jurisdictions likewise point to a rapid commercializing market for LED-based commercial lighting. It is likely that the technology will continue its rapid advance towards being the preferred lighting option for most commercial applications.²²

Residential direct installations of GSL LEDs covered by state and federal regulations received an aggressive step down of 50%. Direct installations of these measures will yield early retirement savings, but the NTG ratio must also consider the four-year measure life, regulatory standards, and rapid commercialization of LEDs.

The final penalty was a single 10% reduction from an assigned program-level NTG ratio (Level #9 in the hierarchy) for measures within the group that are also widely adopted without program support.

Considered New Jersey, ENERGY STAR, and Other Market Trend Data. For cases in which the literature provided inadequate guidance on NTG, NTG ratios were assigned based on the best available market trend data. The recently completed *2020 and 2021 Retail Lighting Sales Data Analysis* served as the basis for direct install LED NTG ratios (and applied other boosts and penalties relative to the initial value).²³ ENERGY STAR shipment data²⁴ provided guidance for numerous residential and commercial products, with industry news articles on broad market trends being the final rule of the hierarchy.

²¹ Inflation Reduction Act of 2022. Public Law 117-169 – August 16, 2022. Available at <https://www.govinfo.gov/content/pkg/PLAW-117publ169/pdf/PLAW-117publ169.pdf>.

²² DNV. 2022. *New Jersey Non-Residential Lighting Market Characterization*. Available at: <https://njcleanenergy.com/files/file/Library/FY23/NJ%20Non-Res%20Lighting%20Market%20Characterization%20FINAL%20Report%2020220630.pdf>.

²³ Apex Analytics and Demand Side Analytics. 2022. *New Jersey 2020 and 2021 Retail Lighting Sales Data Analysis*. Available at <https://njcleanenergy.com/files/file/Library/FY23/NJ%20Residential%20Lighting%20Sales%20and%20NTG%20Analysis%2020220707.pdf>.

²⁴ ENERGY STAR. *Unit Shipment Data Annual Summary Reports*. Available at https://www.energystar.gov/partner_resources/products_partner_resources/brand_owner_resources/unit_shipment_data/archives

Table 12: Situational Variations

Residential	Commercial
a. Removed Outliers	a. Removed Outliers
b. 10% Multifamily Boost	b. 10% Strong Program Impacts Boost
c. 10% Moderate Income Boost	c. 5% Hybrid Rebate Boost ^a
d. 5% Hybrid Rebate Boost ^a	d. 10% Cold Climate Boost
e. 10% Cold Climate Boost	e. Annual Decrease (3 percentage points) Due to Moderate Commercialization
f. Annual Decrease (3 percentage points) Due to Moderate Commercialization	f. Annual Decrease (5 percentage points) Due to Rapid Commercialization
g. Annual Decrease (5 percentage points) Due to Rapid Commercialization	g. 10% Decrease Due to Common Nature of Measure
h. 10% Low-income Boost	h. National Shipment Data
i. 50% Annual Decrease Due to Adjusted Measure Life (AML) and Federal and State standards	i. Broad Market Trends
j. NJ Market Research ^b	
k. National Shipment Data ^c	
l. Broad Market Trends	

^a Hybrid rebate split between distributor, contractor, and/or customer.

^b Apex Analytics and Demand Side Analytics. 2022. *New Jersey 2020 and 2021 Retail Lighting Sales Data Analysis*. Available at <https://njcleanenergy.com/files/file/Library/FY23/NJ%20Residential%20Lighting%20Sales%20and%20NTG%20Analysis%2020220707.pdf>.

^c ENERGY STAR. *Unit Shipment Data Annual Summary Reports*. Available at https://www.energystar.gov/partner_resources/products_partner_resources/brand_owner_resources/unit_shipment_data/archives.

Table 13 and Table 14 summarize the percentage of NTG assignments made under each level of the hierarchy. The tables also present examples of typical measures, programs, and variations assigned under each rule. About one-half of residential NTG ratios was assigned the median using 6: *Similar Measures, All Delivery Modes*. This reflects the assignment of nearly all HVAC NTG ratios (including boilers and furnaces, central air conditioning, air-source and mini-split heat pumps, and smart thermostats) at this level. More than one-half of commercial NTG ratios was assigned based on 9: *Program Level, Same Delivery Mode*. This is due to the common industry practice of assigning a program-wide NTG ratio for commercial programs (including custom, prescriptive, small business).

Table 13: Percentage of Residential Assignments by Hierarchical Rule

Rule	Products	All Others	Typical Example	Common Variation
1. Low Income	0%	14%	Comfort Partners	GSLs
2. Randomized Control Treatment	0%	1%	Home Energy Reports	None
3. Federal or State Standard	5%	1%	Most Lighting	None
4. Multiple Directly Comparable Measures	11%	0%	Appliances	b. Multifamily
5. Similar Measures, Delivery Mode	5%	2%	Appliance Recycling	None
6. Similar Measures, All Delivery Modes	48%	33%	Most HVAC	c. Moderate Income
7. Partial Measure Group	2%	0%	Some Appliances	b. Multifamily
8. Full Measure Group	3%	10%	Envelope Insulation	c. Moderate Income
9. Program Level, Same Delivery Mode	13%	24%	Low-Flow Showerheads	c. Moderate Income
10. Expert Review	13%	15%	Home Office Equipment	f. Annual Decrease of 3 percentage points due to moderate commercialization

Table 14: Percentage of Commercial Assignments by Hierarchical Rule

Rule	%	Typical Example	Common Variation
1. Low Income	0%	NA	
2. Randomized Control Treatment	0%	NA	
3. Federal or State Standard	2%	GSLs	None
4. Multiple Directly Comparable Measures	12%	Custom Lighting	f. Annual Decrease of 5 percentage points due to rapid commercialization
5. Similar Measures, Delivery Mode	6%	Heat Pumps	e. Annual Decrease of 3 percentage points due to moderate commercialization
6. Similar Measures, All Delivery Modes	6%	Lighting Controls	e. Annual Decrease of 3 percentage points due to moderate commercialization
7. Partial Measure Group	6%	Linear LEDs	f. Annual Decrease of 5 percentage points due to rapid commercialization
8. Full Measure Group	<1%	Roadway Lighting	None
9. Program Level, Same Delivery Mode	56%	Small Business Direct Install (SBDI) ^a	g. 10% Decrease Due to Common Nature of Measure
10. Expert Review	11%	Exterior; Low & High Bay Lighting	NJ Market Adjustment

^a Majority of NTG values were assigned at the program level.

2.4 TASK 4: UTILITY-SPECIFIC EXCEPTIONS

As noted above, the BPU ordered that program savings in the 2022 – 2024 triennium (Triennium 1) be based on net savings, but the BPU established a universal placeholder assumed NTG ratio of 1.0.²⁵ With some exceptions, the timing of evaluation research on net savings in Triennium 1 did not result in empirical results for NTG ratios at a measure or program level to update Triennium 1 or to inform planning for Triennium 2. However, some evaluations were completed that yielded program-specific NTG ratio values for Triennium 1. One of the objectives of this study is to advise the SWE on the situations in which utilities may apply their program-specific NTG ratios rather than default to statewide values. This section describes the criteria considered in providing this advice.

Atlantic City Electric (ACE), New Jersey Natural Gas (NJNG), and Public Service Gas and Electric (PSE&G) had submitted evaluations by February 14, 2023, that included FR, PSO, and NTG ratios derived from primary research. Although this precedes the final submission date necessary for inclusion in the Triennium 2 planning (March 6, 2023), the earlier date allowed time for the analysis summarized in this report. [Table 15](#) lists the programs for which these utilities provided primary Triennium 1 NTG ratios.

²⁵ This report uses decimals to refer to all NTG ratios. They can be multiplied by 100% to change them into percentages. For example, 0.60 would become 60%.

Table 15: Programs with Primary Triennium 1 NTG Ratios, by Utility and Sector

Sector	Program Type	ACE	NJNG	PSE&G
Residential	Appliance / Downstream Rebates	X		X
Residential	Appliance Recycling	X		X
Residential	HPwES		X	X
Residential	Online Marketplace	X		X
Residential	QHEC			X
Residential	Residential HVAC	X		
Residential	Welcome Kits			X
Multifamily	Multifamily Sub-Program			X
Commercial	C&I Prescriptive and Custom	X		X
Commercial	SBDI			X

This study examined the types of information available from the utility reports and used these to craft a decision-making process to determine when utilities should default to statewide NTG ratios or use their own researched program-level or measure-level NTG ratios.

The decision-making process considers four elements: precision estimates, sample sizes, the treatment of LEDs (GSLs and fixtures meant to replace them), and the granularity of NTG ratios provided. These elements are important for the following reasons.

- **Precision** provides one way to assess how accurately the estimated NTG ratio captures the true NTG ratio.²⁶ Precision is a function of sample size and how narrow or widespread the data are. It is used to construct confidence intervals. All things being equal, smaller precision – and tighter confidence intervals – are better. The industry standard is to use 10% precision at the 90% confidence level. However, this is often difficult to achieve for low-incidence measures or when populations are small. Therefore, measure-level precision of 90/15 was considered acceptable in the decision-making process.
- **Sample Sizes** provide another statistic to assess the robustness of a NTG estimate. Small sample sizes are prone to the influence of outliers, even when drawn according to statistical random sampling. For this reason, the process considered a minimum sample size at 30.
- **Treatment of LEDs** is important because the federal and state lighting efficiency standards have outlawed the sale of these measures and drastically cut their NTG ratios (see [Section 2.3.2](#) above). Therefore, Triennium 1 NTG estimates for individual LEDs or at the program-level that incorporate LEDs are not appropriate guides to expected NTG ratios for Triennium 2.
- **Granularity of NTG ratios** refers to whether the study reported a NTG ratio at the measure-level, program-level, or somewhere in between. This study uses “measure-level” to mean individual measures (e.g., a clothes washer) or aggregations of some, but not all, measures in a program (e.g., air sealing and insulation vs. HVAC and water heating within a residential HVAC program). The process consider how precision, sample sizes, and the

²⁶ Precision is used to create a confidence interval and suggests that the true population estimate is contained within that interval, based on the stated confidence level.

treatment of LEDs may influence a NTG ratio first at the measure-level and then at the program-level.

Two overarching questions and a series of follow-up questions underly the decision-making process for advising the SWE on which NTG ratios to use. This process is described below and shown in [Figure 4](#).

1. Was a precision estimate directly related to the measure or program provided?

- a. If no, [apply the statewide recommended value](#).
- b. If yes, proceed to Question 2.

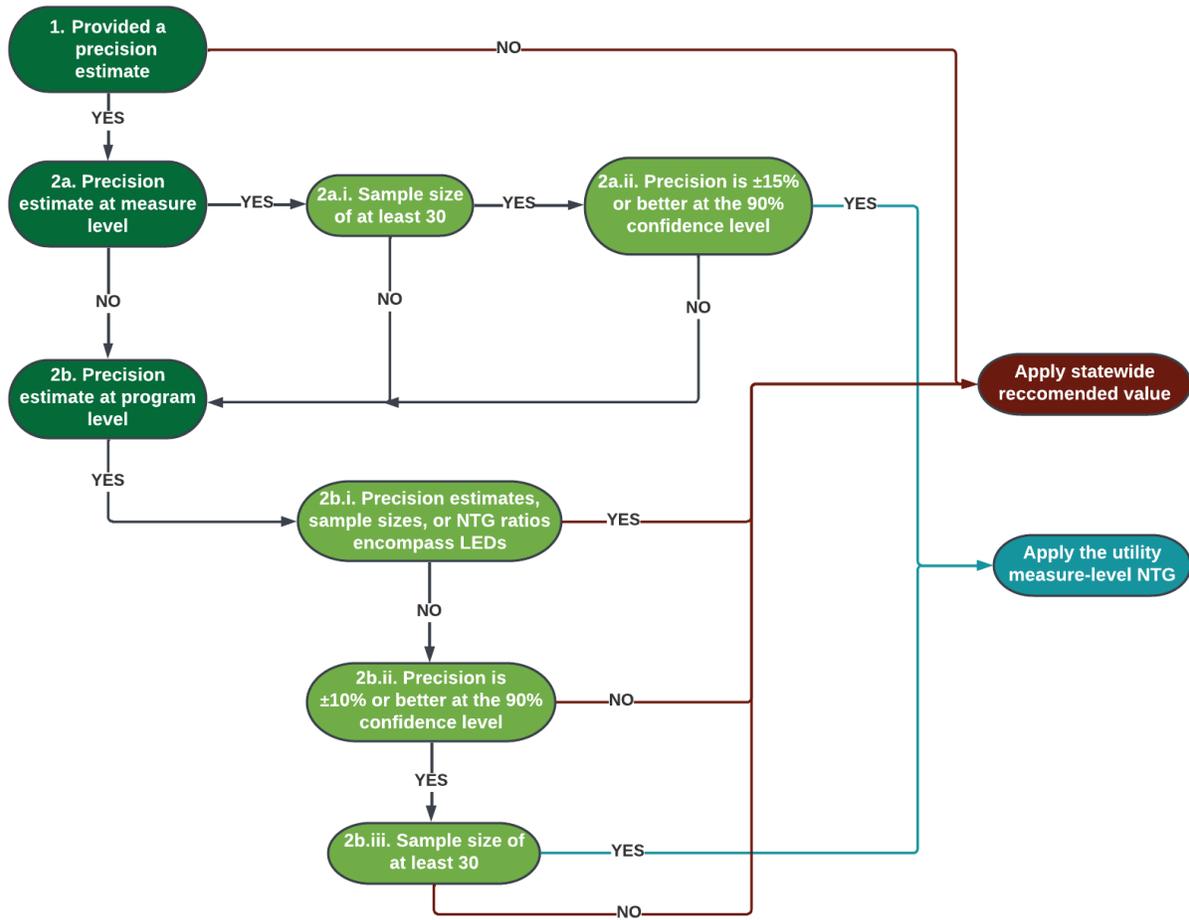
2. At what level – measure or program – was the precision provided?

- a. Measure-level criteria
 - i. Is the sample size at least 30, which provides a second statistic on which to assess the robustness of the NTG estimate? If no, proceed to Question 2b. If yes, proceed to 2.a.ii.
 - ii. Is precision $\pm 15\%$ or better at the 90% confidence level? If no, proceed to Question 2b. If yes, [apply the utility measure-level NTG](#).
- b. Program-level criteria
 - i. Do any program-level precision estimates, sample sizes, or NTG ratios encompass LEDs (GSL or fixtures meant to replace them)? If yes, [apply the statewide recommended value](#). If no, proceed to 2.b.ii.
 - ii. Is precision $\pm 10\%$ or better at the 90% confidence level? If no, [apply the statewide recommended value](#). If yes, proceed to 2.b.iii.
 - iii. Is the program-level sample size at least 30?
 1. If yes, [apply the utility program-level NTG for any measure in program not meeting criteria for 2.a.ii](#).
 2. If no, [apply the statewide recommended value](#).

Note that some measure- or program-level NTG ratios may be defaulted to the statewide NTG ratio by more than one criterion. For example, they could have a small sample size, precision levels wider than $\pm 10\%$, and include LEDs.

[Appendix A](#) summarizes the application of this process to the specific NTG ratios provided by utilities before February 14, 2023, and any clarifications supplied by March 6, 2023.

Figure 4: Utility-Specific NTG Decision Process



Section 3 Summary of Results and Recommendations

The study recommends NTG ratios for the 394 residential and 282 commercial entries listed in the measure inventories.

This section presents an overview of the distribution of assigned NTG ratios. The tables presented in this section are intended to communicate the results in a compact and easily assimilated manner. They are not intended to be the primary resource used in determining the specific values to apply when estimating program or measure savings. The full list of recommended NTG ratios presented in accompanying spreadsheets (one for residential programs and one for commercial programs) and embedded in [Appendix B](#) will serve as the primary NTG assignment resource. The Excel spreadsheets can be easily searched, sorted, and filtered.

Most NTG ratios were assigned to individual measures, but a few apply to programs (e.g., behavioral with an RCT design) or groups of measures (e.g., custom HVAC – gas). The tables below also match NTG ratios to the CML unique identification numbers (Unique ID) for some of the highest-savings measures and those most affected by external factors, such as state or federal regulations and commercialization.

Two key points should be kept in mind when reviewing these NTG ratios:

1. The tables in this section focus on program year (PY) 2024 NTG ratios. NTG ratios change over time for some measures (e.g., lighting, heat pumps, smart thermostats), depending on the rate of commercialization and other external factors (see [Section 2.3.3](#)). NTG ratios for later program years are documented in the spreadsheets.
2. Although the study assigned NTG ratios to nearly 700 measures, similar measures or measures aggregated into measure groups often received the same NTG ratio. This is especially true for commercial NTG ratios, as evaluations rarely differentiate measure-specific NTG ratios for commercial programs.

3.1 RECOMMENDED RESIDENTIAL NET-TO-GROSS RATIOS

Residential NTG ratios ranged between zero (for GSL lamps and related fixtures subject to state and federal regulations) to one (for most Comfort Partners measures and RCT) (Table 16).

Over one-half of the NTG ratios fall between 0.60 and 0.79. These two categories contain most HVAC measures (in the 0.70 to 0.79 range) and direct install measures such as faucet aerators and low-flow (not TSV) showerheads, which were assigned a program-wide NTG ratio (in the 0.60 to 0.69 range).

Table 16: Distribution of Residential NTG Ratios and Typical Measure Groups in the Range

(n = 394)

NTG Range	% Of Measures ^a	Typical Measure Groups in Range
1.00	8%	All non-lighting Comfort Partners measures; RCT behavioral programs
0.90 to 0.99	8%	Envelope insulation (moderate income); Multifamily building-wide HVAC; smart strips; thermostatic shut-off valve (TSV) showerheads
0.80 to 0.89	15%	Electric Vehicle (EV) chargers; envelope insulation; new construction; some HVAC (moderate income; cold climate heat pumps via hybrid incentive)
0.70 to 0.79	32%	Non-RCT behavior program; some HVAC (central AC; cold climate heat pumps w/o hybrid incentive; some non-cold climate; gas space and water heating equipment; various with hybrid incentive; smart thermostats); occupancy sensors; smart home
0.60 to 0.69	24%	Most direct install instant-saving measures (air-sealing, tune-ups, water conservation, etc.); some non-cold climate heat pumps; multifamily dryers
0.50 to 0.59	4%	Most appliances; appliance recycling
0.10 to 0.49	5%	Direct install lighting; some electronics; refrigerators
0.00	4%	Non-direct install GSLs; fixtures meant to replace GSLs

^a Percentage of measures to which study assigned NTG ratios, not percentage of achieved savings.

3.1.1 Residential Lighting

Except occupancy sensors (NTG = 0.75) and horticulture LEDs distributed through Comfort Partners (NTG = 1.00), NTG ratios for residential lighting fell below 0.50 (Table 17). Holiday lights and LED nightlights were assigned based on recent ENERGY STAR shipment data and stepped down by five percentage points each year. All GSLs and the fixtures meant to replace them received a zero NTG ratio. The hierarchical assignment assumed the current (2023) QHEC lighting NTG ratio matched the inefficient lighting market share in 2021 (30%).²⁷ The situational variations called for boosting this base NTG ratio by 10% for moderate income and another 10% for low-income direct install lighting. As discussed in Section 2.3.3, extremely rapid commercialization and state- and federal standards are forcing the residential lighting market to LEDs, so the direct install LED Lamp (GSL) NTG ratios were cut in half each year.

Table 17: Residential Lighting NTG Ratios for 2024

Measure	Unique ID	NTG Ratio
LED Lamps (GSLs)	RL1001	0.00
LED Fixtures to replace GSLs	RL1002	0.00
LED Table/Desk Lamps	RL1003	0.00
LED Holiday Lights	RL1004	0.45
Ceiling Fans	RL1005	0.00
Occupancy Sensors	RL1006	0.75
LED Nightlight	RL1008	0.45
LED Lamps (GSL Standard, MIW)	RM11041	0.17
LED Lamps (GSL Specialty, MIW)	RM11042	0.17
LED Lamps (GSL Standard, QHEC)	RQ10001	0.15
LED Lamps (GSL Specialty, QHEC)	RQ10002	0.15
LED Lamps (GSL Standard, Comfort Partners)	NA	0.18
LED Lamps (GSL Specialty, Comfort Partners)	NA	0.18
Horticultural LEDs (Comfort Partners)	NA	1.00

²⁷ Apex Analytics and Demand Side Analytics. 2022. *New Jersey 2020 and 2021 Retail Lighting Sales Data Analysis*. Available at <https://njcleanenergy.com/files/file/Library/FY23/NJ%20Residential%20Lighting%20Sales%20and%20NTG%20Analysis%2020220707.pdf>.

3.1.2 Residential Insulation / Envelope

Envelope insulation (i.e., attic, roof, ceiling, wall, floor, and attic floor) was assigned a NTG ratio of 0.87 for Home Performance with ENERGY STAR (HPwES) (Table 18). The other envelope measures (e.g., air and duct sealing, weatherstripping) are typically distributed through direct install programs. Rarely do programs isolate the NTG ratios for these measures, so they were assigned a NTG = 0.60, the median of all program-wide NTG ratios in the literature for programs directly installing similar measures. The assignment called for boosting Moderate Income Weatherization (MIW) NTG ratios by 10%, yielding a NTG = 0.96 for envelope insulation and 66% for the other measures.

Table 18: Residential Insulation and Envelope NTG Ratios for 2024

Measure	Unique ID	NTG Ratios Both Fuels
Attic/Roof/Ceiling Insulation	RH9002	0.87
Wall Insulation	RH9003	0.87
Floor Insulation	RH9004	0.87
Air Sealing	RH9005	0.60
Duct Sealing	RH9006	0.60
Ductwork / Duct Insulation	RH9007	0.60
Attic Floor Insulation	RH9009	0.87
Weatherstripping 17-Foot Roll Foam	RI12001	0.60
Gaskets	RI12002	0.60
Attic/Roof/Ceiling Insulation	RM11001	0.96
Wall Insulation	RM11002	0.96
Floor Insulation	RM11003	0.96
Air Sealing	RM11004	0.66
Duct Sealing	RM11005	0.66
Ductwork / Duct Insulation	RM11006	0.66
Attic Floor Insulation	RM11008	0.96
Furnace/Air Handler Filter Whistle	RS13002	0.60

3.1.3 Residential HVAC

Table 19 and Table 20 on the next few pages present the recommended NTG ratios for residential HVAC, separated by fuel and program. Some of the NTG ratios also apply to multifamily installations. The range from 0.60 for measures such as HVAC maintenance (both fuels) to 0.95 for non-heat pump, in-unit electric HVAC in multifamily buildings with moderate income residents.

Table 19: Residential Electric HVAC NTG Ratios by Program

Measure	Efficient Products			HPwWES		Moderate Income	
	Unique ID	NTG Downstm	NTG Hybrid	Unique ID	NTG	Unique ID \	NTG
Central Air Conditioning Tier 1 (SEER >=16, EER >=12.5)	RV7001	0.74	0.78	RH9012	0.74	RM11011	0.81
Central Air Conditioning Tier 2 (SEER >=18, EER >=13)	RV7002	0.74	0.78	RH9013	0.74	RM11012	0.81
Air Source Heat Pump - Cold Climate (SEER >=18, EER >=12, HSPF >=10, and COP >=1.75 at 5 def F)	RV7005	0.75	0.79	RH9016	0.75	RM11015	0.82
Air Source Heat Pump Tier 1 (SEER >=16, EER >= 12.5, HSPF >=9)	RV7003	0.68	0.72	RH9014	0.65	RM11013	0.72
Air Source Heat Pump Tier 2 (SEER >=18, EER >=13, HSPF >=10)	RV7004	0.68	0.72	RH9015	0.71	RM11014	0.78
Air to Water Heat Pump (COP >1.75 at full load capacity and 110 deg F water temp)	RV7006	0.78	0.82	RH9017	0.78	RM11016	0.86
All ducted and ductless air source heat pumps and heat pump water heater - multifamily	NA	0.93	NA	NA	0.93	NA	0.93
All non-heat pump HVAC/ water heating - multifamily	NA	0.86	NA	NA	0.86	NA	0.95

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Measure	Efficient Products			HPwWES		Moderate Income	
	Unique ID	NTG Downstm	NTG Hybrid	Unique ID	NTG	Unique ID \	NTG
Ductless Mini Split Air Conditioner (SEER >= 20, EER >=12.5)	RV7009	0.68	0.72	RH9020	0.65	RM11019	0.72
Ductless Mini-Split Heat Pump Multi ^b	RV7008	0.68	0.72	RH9019	0.71	RM11018	0.78
Furnace Fans (ECM motor install)	RV7010	0.63	0.66	NA	NA	NA	NA
Geothermal Heat Pump ENERGY STAR ^c	RV7007	0.67	0.72	RH9018	0.67	RM11017	0.77
HVAC Maintenance	RV7027	0.60	0.60	NA	NA	NA	NA
HVAC Quality Install	RV7028	0.60	0.60	RH9034	0.60	RM11033	0.66
Properly Maintained Furnace	RV7030	0.60	NA	RH9041	0.60	RM11039	0.66
PTAC - CEE Tier 2 - Multi Family	RV7011	0.93	NA	RH9022	0.93	RM11021	0.93
PTHP - CEE Tier 2- Multi Family	RV7012	NA	0.93	RH9023	0.93	RM11022	0.93

^a Please see [Acronyms](#) for the full list of acronyms used in this table.

^b (SEER >= 18, EER >=12.5 or HSPF >= 10); Single (SEER >= 20, EER >=12.5 or HSPF >= 10)

^c Closed Loop Wtr to Air EER >= 17.1; Closed Loop Wtr to Wtr EER >= 21.1; Open Loop Wtr to Air EER >= 16.1; Open Loop Wtr to Wtr EER >= 20.1

Table 20: Residential Natural Gas HVAC NTG Ratios by Program

Measure	Efficient Products			HPwWES		Moderate Income	
	Unique ID	NTG Downstm	NTG Hybrid	Unique ID	NTG	Unique ID \	NTG
Gas Boiler (>95% AFUE)5	RV7015	0.76	0.80	RH9027	0.76	RM11026	0.84
Gas Boiler (90-95% AFUE)5	RV7014	0.76	0.80	RH9026	0.76	RM11025	0.84
Gas Combi Heat Tier 1(AFUE >95%)	RV7018	0.76	0.80	RH9030	0.76	RM11029	0.84
Gas Combi Heat Tier 2(AFUE >97%)	RV7019	0.76	0.80	RH9031	0.76	RM11030	0.84
Gas Furnace - Tier 1 (>95%)5	RV7016	0.76	0.80	RH9028	0.76	RM11027	0.84
Gas Furnace - Tier 2 (>97%)5	RV7017	0.76	0.80	RH9029	0.76	RM11028	0.84
HVAC Maintenance	RV7027	0.60	0.60	NA	NA	NA	NA
HVAC Quality Install	RV7028	0.60	0.60	NA	NA	NA	NA
Properly Maintained Boiler	RV7029	0.60	NA	RH9039	0.60	RM11038	0.66
Properly Maintained Furnace	RV7030	0.60	NA	RH9040	0.60	RM11039	0.66
Qualifying Gas Heat with qualifying Gas Water Heat <55gallons,UEF>.64	RV7020	0.76	0.80	RH9032	0.76	RM11031	0.84
Qualifying Gas Heat with qualifying Gas Water Heat >55gallons,UEF>.64	RV7021	0.76	0.80	RH9033	0.76	RM11032	0.84
Quality Install	RV7031	0.60	0.60	RH9034	0.60	RM11033	0.66
Reset controls for boiler	RV7013	0.75	0.80	RH9025	0.75	RM11024	0.85

^a Please see [Acronyms](#) for the full list of acronyms used in this table.

3.2 RECOMMENDED COMMERCIAL NET-TO-GROSS RATIOS²⁸

Commercial NTG ratios ranged between zero (for GSL lamps and related fixtures subject to state and federal regulations) to 0.96 (for natural gas retro-commissioning) (Table 21).

Over one-half of the NTG ratios fall between 0.80 and 0.99. These two categories include measures for agriculture, kitchen equipment, and most SBDI and natural gas HVAC, among others. The structure of the commercial tables in the sections that follow differ from residential due to the greater reliance on measure group and program-wide NTG ratios. Except for SBDI (Table 25), the tables group NTG ratios first by measure category and then by measure. They then list all Unique IDs to which the NTG ratio in the final column should be applied. Lines separate the aggregated measures and measure groups for specific NTG ratios.

Table 21: Distribution of Commercial NTG Ratios and Typical Measure Groups in the Range

(n = 282)

NTG Range	% Of Measures ^a	Typical Measure Groups in Range
1.00	0%	NA
0.90 to 0.99	27%	Agriculture; unitary air conditioners; EV chargers; gas absorption chillers; power strips; refrigeration; retro-commissioning (gas); most small business direct install (SBDI)
0.80 to 0.89	33%	Custom natural gas (includes process); most gas HVAC; heat pumps; kitchen equipment
0.70 to 0.79	14%	Custom electric (includes process); electric chillers; electric retro-commissioning; SBDI non-GSL lighting and controls; motors; custom water heating; gas-fired direct hot water (storage & instant)
0.60 to 0.69	9%	Make-up air units; midstream HVAC measures; heat recovery; infrared heaters; exterior and high-low bay lighting; advanced and networked lighting controls; variable frequency drives (VFDs)
0.50 to 0.59	12%	Most appliances; most appliance recycling; custom, horticulture, and linear lighting,
0.10 to 0.49	3%	Dehumidifiers and refrigerators; dehumidifier recycling; office equipment
0.00	2%	GSL lighting

^a Percentage of measures to which study assigned NTG ratios, not percentage of achieved savings.

²⁸ The utilities questioned whether New Jersey’s prevailing wage requirement impacts NTG ratios in the state. This study did not explore how project costs influence NTG ratios and is unable to address this question. This issue highlights the importance of conducting New Jersey-specific NTG research.

3.2.1 Lighting

Commercial lighting NTG ratios ranged from zero (for GSLs and fixtures meant to replace them) to 0.75 for street lighting (Table 22). Custom lighting (NTG = 0.53) was based on 75 different commercial lighting NTG ratios found in the literature. The same NTG ratio was applied to unspecified ENERGY STAR fixtures, exit signs, horticulture lighting, and delamping. Linear fixtures (NTG = 0.58) reflected the median of 16 linear lamp and fixture values from the literature. The recently completed non-residential lighting report for New Jersey concluded that the program impact was greater for exterior and high/low bay lighting than linear lighting in the state.²⁹ Therefore, the study assigned these two lamp types 10% higher than linear. Advanced and networked controls values also reflect the median of NTG ratios found in the literature. All lighting and controls values (except street lighting) are stepped down by five percentage points each year due to rapid commercialization.

²⁹ DNV. 2022. *New Jersey Non-Residential Lighting Market Characterization*. Available at: <https://njcleanenergy.com/files/file/Library/FY23/NJ%20Non-Res%20Lighting%20Market%20Characterization%20FINAL%20Report%2020220630.pdf>.

Table 22: Commercial Lighting NTG Ratios by Measure Category

Measure Category ^a	Measure	Unique ID ^b	NTG	
Controls and Sensors	Advanced and Networked	CL1026	CL1031	0.69
		CL1027	CL1033.5	
		CL1028	CL1033.6	
		CL1029		
	Vacancy or Occupancy control (Switch/Wall/External Mount)	CL1030	0.62	
Custom Lighting		C20001.5	0.53	
Exterior Lamps, Fixtures, and Similar		CL1009	CL1021	0.64
		CL1014	CL1033.4	0.64
GSLs and Fixtures Meant to Replace GSLs (A-line, PAR, R, G, etc.)		CL1006	CL1019	0.00
		CL1015	CL1033.2	
		CL1016.1		
High and Low Bay Lamps, Fixtures, and Similar		CL1008	CL1018	0.64
		CL1013	CL1033.3	
Linear Lamps, Fixtures, and Similar (Interior)		CL1001	CL1011	0.58
		CL1002	CL1012	
		CL1003	CL1017	
		CL1004	CL1020	
		CL1005	CL1023	
		CL1007	CL1033.1	
		CL1010		
Miscellaneous	LED ENERGY STAR LED fixture not otherwise specified	CL1016.2	0.53	
	Exit Signs	CL1022	0.53	
	Street/Roadway and Area Lighting	CL1024	0.75	
	Horticultural Lighting (Controlled Environment Agriculture)	CL1025	0.53	
	Delamping	CL1032	0.53	

^a Similar measures, usually with same NTG ratio

^b Decimal places indicate Unique IDs split by the evaluators due to market conditions or regulatory standards

3.2.2 HVAC

With a few exceptions, commercial HVAC NTG ratios were 0.70 or higher (Table 23 and Table 24). The NTG ratios typically reflect the median of measure-group or program-wide values in the literature.

Table 23: Commercial Electric HVAC NTG Ratios by Measure Category

Measure Category ^a	Measure	Unique ID ^b		NTG
Chillers - w/ or w/o Variable Frequency Drives		CV7051	CV7054	0.77
		CV7052	CV7055	
		CV7053	CV7056	
Custom - Electric		C20001.3		0.77
Heat Pumps		CV7003	CV7010	0.83
		CV7004	CV7011	
		CV7006	CV7012	
		CV7008		
Midstream		CV7063		0.63
Unitary Air Conditioners (not Heat Pumps)		CV7001	CV7007	0.93
		CV7002	CV7009	
		CV7005		
Miscellaneous	Demand Control Ventilation	CV7039		0.86
	Dual Enthalpy Economizer Controls, all sizes	CV7036	CV7038	0.86
		CV7037		
	Thermostat - Smart	CV7035		0.82
	Water-cooled & Evaporative Cooling Air Conditioners, all Sizes	NA		0.93

^a Similar measures, usually with same NTG ratio

^b Decimal places indicate Unique IDs split by the evaluators due to market conditions or regulatory standards

Table 24: Commercial Natural Gas HVAC NTG Ratios by Measure Category

Measure Category ^a	Measure	Unique ID ^b		NTG
Chillers	Gas Absorption Chillers, all sizes	CV7057	CV7059	0.90
		CV7058		
	Gas Engine Driven Chillers	CV7060		0.90
	Gas Fired Low Intensity Infrared Heating, all sizes	CV7061	CV7062	0.64
Custom - Gas		C20001.3		0.82
HVAC Unless Specific Otherwise		CV7014	CV7029	0.84
		CV7015	CV7030	
		CV7016	CV7031	
		CV7017	CV7032	
		CV7018	CV7033	
		CV7019	CV7040	
		CV7020	CV7041	
		CV7021	CV7042	
		CV7022	CV7043	
		CV7023	CV7044	
		CV7024	CV7045	
		CV7025	CV7046	
		CV7026	CV7049	
		CV7027	CV7050	
	CV7028			
Miscellaneous	90% TE Make-up Air Unit	CV7013		0.64
	Thermostat - Smart	CV7035		0.80
	Ventilation with Heat Recovery Gas HRV	CV7047	CV7048	0.64
	Gas Cooling Application Regenerative Desiccant Unit GC7	NA		0.80

^a Similar measures, usually with same NTG ratio

^b Decimal places indicate Unique IDs split by the evaluators due to market conditions or regulatory standards

3.2.3 SBDI

Based on the literature, the study assigned a SBDI NTG ratio of 0.91 for most program measures. However, according to the hierarchy, GSLs and the fixtures meant to replace them received a NTG ratio of zero (Table 25). The hierarchy also dictated specific NTG ratios for SBDI prescriptive lighting and lighting controls (76%, stepped down by five percentage points each year) as well as heat pumps (88%, stepped down by three percentage points each year).

Table 25: Uniquely Assigned SBDI NTG Ratios by Measure Category^a

Measure	Unique ID ^b	NTG
Prescriptive GSLs, Fixtures Meant to Replace GSLs (A-line, PAR, R, G, etc.)	CSBDI1034.2	0.00
Prescriptive Lighting other than GSLs	CSBDI1034.1	0.76
Lighting Controls (Occupancy Sensors, Photocell with Dimmable Ballast)	CSBDI1035	0.76
Air-Air Cooled Heat Pump Systems, Split System and Single Package	CSBDI1002	0.88
Water Source Heat Pumps	CSBDI1003	0.88
Heat Pump Hot Water (HPHW)	CSBDI1006	0.88

^a That is, not assigned the program-wide SBDI NTG = 0.91.

^b Decimal places indicate Unique IDs split by the evaluators due to market conditions or regulatory standards

3.3 PRIORITY PRIMARY NTG RESEARCH AREAS

The study suggests that the NJCEP and utilities should prioritize the following area for primary research in Triennium 2. These priorities reflect a combination of the five factors below:

1. Larger anticipated energy and savings
2. Limited existing literature
3. Increasing rate of market commercialization
4. External forces impacting market adoption of the measure (e.g., heat pump tax credits from the federal IRA)
5. Underserved population (i.e., traditionally lower program participation rates)

The suggested studies listed below each reflect at least two of these five factors.

Table 26: Factors Guiding Future Study Priorities

Study	Heat Pump Tech	Commercial Lighting	MIW	Multifamily
Larger anticipated savings	X	X		
Limited existing literature			X	X
Increasing rate of market commercialization	X	X		
External forces	X			
Underserved population	X ^a		X	X

^a For units installed in low- and moderate-income and multifamily households

3.3.1 Heat Pump Technology for Space Conditioning and Water Heating

Numerous forces are driving the commercialization of heat pumps, and this likely affects the program influence on their adoption. Therefore, New Jersey should prioritize primary research to understand the net impact their programs have on the adoption of heat pump technology.

Heat pumps have numerous advantages. They can lower overall household energy use, reduce carbon footprints, and permit the conditioning of spaces not served by heating or cooling systems. Cold climate models have increased trade ally and end-user confidence in relying solely on heat pumps for the space heating and cooling loads. For these reasons, heat pumps have seen an increased rate of commercialization. This commercialization will likely continue as households, property owners, and businesses take advantage of the tax credits and other incentives for heat pumps available through the federal IRA. In short, NJCEP and utility program incentives are only one of the numerous market forces encouraging the adoption of heat pumps. This fact, coupled with the importance of this measure to the portfolio for securing clean energy savings, makes it a strong candidate for primary NTG research across all programs and sectors in which it is offered.

3.3.2 Commercial Lighting

New Jersey should conduct primary research into the NTG ratios for commercial lighting and lighting controls.

A recent market characterization study of the commercial lighting market in New Jersey suggested that the programs had little impact on linear lamps and a greater but unspecified impact on integrated luminaires, exterior lighting, and high- and low-bay lighting.³⁰ Yet, this study was based on a small number of distributors and did not explicitly measure NTG ratios. Commercial lighting retrofits have long served as the single biggest contributor to achieved energy-savings in program portfolios. While it would be difficult to deny the rapid movement of lighting towards LED technology, New Jersey should examine the market in more detail and determine current NTG ratios for different technologies across commercial programs and delivery modes.

3.3.3 Moderate Income Weatherization

New Jersey should prioritize research into the NTG ratios for the MIW program.

Energy-efficiency programs that target moderate income customers are relatively new throughout the nation. Therefore, the literature provided little guidance on NTG ratios for program and measures targeted at moderate-income customers, necessitating the use of a situational variation to assign NTG ratios for this important program. Little is known about the degree to which programs induce moderate-income households to adopt energy-efficiency measures without incentives. It is likely that the NTG falls below 1.0 for at least some program measures given that these households have some financial resources. Yet, given income limitations, it is also likely that at least some NTG ratios will be higher than for the same measures targeted at customers with incomes above the moderate-income threshold. The question remains: where does the true NTG ratio fall? If this study proceeds, the NJCEP and utility-programs could be among the first in the nation to conduct systematic NTG research into the important program serving a typically underserved customer group.

3.3.4 Multifamily Initiatives

New Jersey should prioritize research into the NTG ratios for multifamily initiatives.

The study yielded only 90 NTG ratios specified for multifamily buildings. Most of these values were deemed rather than based on primary research. Using the hierarchy, the study assigned multifamily-specific NTG ratios when supported by the literature and applied a 10% multifamily boost for such measures as appliances and in-unit HVAC. For all other measures, the study defaults to the industry standard practice of applying residential NTG ratios to in-unit measures and commercial NTG ratios to common-area measures. However, the actual multifamily NTG ratios may differ from the assumptions routinely made in the literature. Moreover, many multifamily households rent, limiting the measures they can adopt on their own without landlord permission. Condominium owners also must seek permission from associations to install certain measures in their homes. Landlords are often reluctant to perform upgrades due to split incentives

³⁰ DNV. 2022. *New Jersey Non-Residential Lighting Market Characterization*. Available at: <https://njcleanenergy.com/files/file/Library/FY23/NJ%20Non-Res%20Lighting%20Market%20Characterization%20FINAL%20Report%2020220630.pdf>.

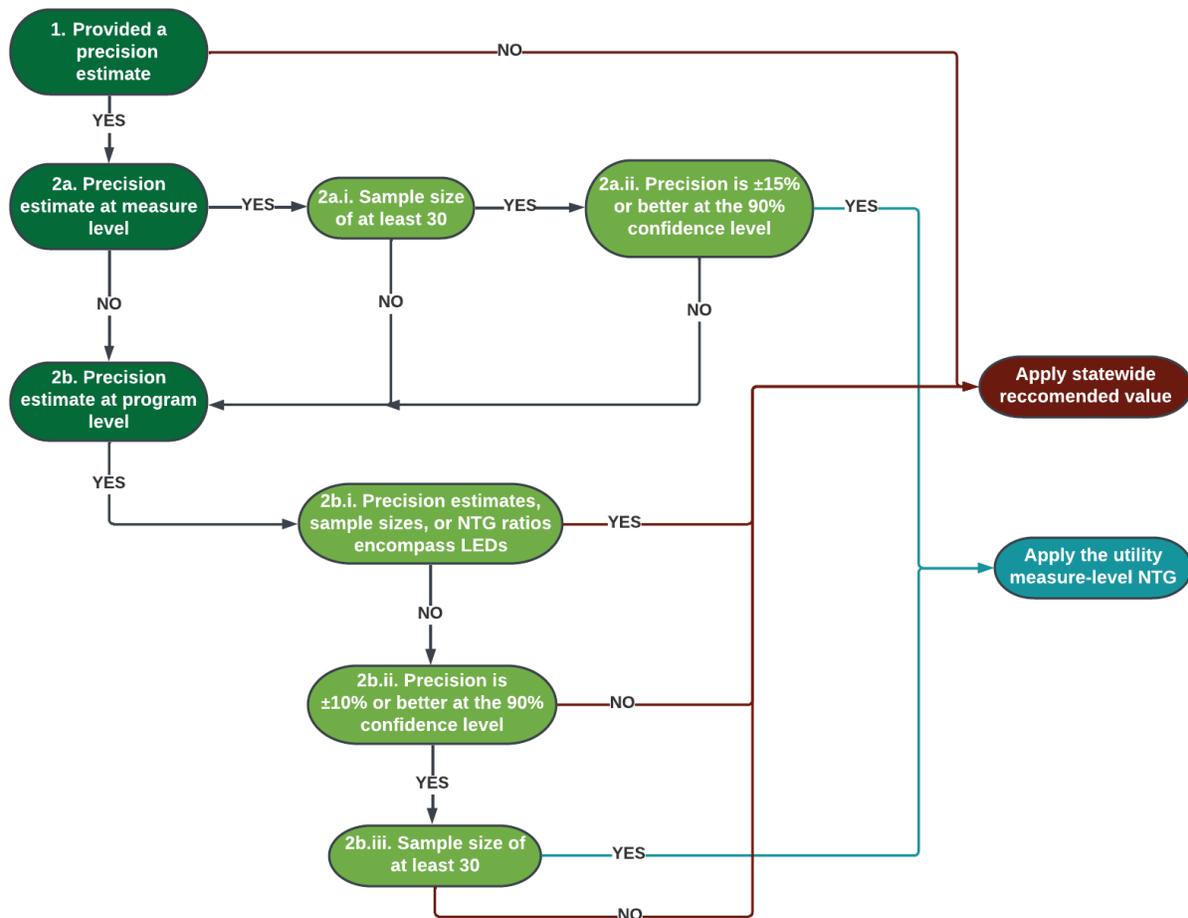
(i.e., they bear the cost of the installation, but their tenants reap the energy savings). For these reasons, multifamily tenants and buildings tend to be underserved by energy-efficiency programs. The NJCEP and utility-programs should consider establishing these multifamily values for their service territories, again showing leadership in research for an underserved customer group.

Appendix A Task 4: Assessment of Utility-Specific Net-to-Gross Ratios

Section 2.4 describes the decision-making process for advising the SWE on whether utilities should apply statewide NTG ratios or their own program- or measure-level NTG ratios estimated from primary research. This appendix applies the process specified in the earlier section to NTG ratios delivered in reports by February 14, 2023, and clarified by March 6, 2023.

The schematic of the process is copied from Section 2.4 below for ease of reference.

Figure 5: Utility-Specific NTG Decision Process



As noted earlier, by February 14, 2023, ACE, NJNG, and PSE&G had delivered studies with primary NTG values based on the statewide self-report method. Most of the confidence intervals were provided at the program level. Some of the program-level NTG ratios included LEDs. The utilities were asked to provide measure-level or program-level confidence intervals and recalculate NTG ratios without embedded lighting measures. ACE and NJNG were able to

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respond to these requests by March 6, 2023. PSE&G asked follow-up questions on March 9, 2023, but this date exceeded the deadline set for delivery of the NTG report.

The analysis below removes several programs on the advice of the utilities, all of which should default to the statewide recommended NTG ratios:

- ACE and PSE&G cautioned that their commercial NTG ratios should be treated as informational due to small sample sizes. ACE’s C&I Prescriptive and Custom NTG was based on five respondents. PSE&G’s C&I Prescriptive NTG ratio was also based on five respondents, and SBDI was based on four respondents.
- In comments delivered on March 9, PSE&G cautioned that their multifamily program had a low response rate and should be treated as informational.
- In follow-up materials, ACE removed lighting from the Online Marketplace resulting in a sample size of 11. The utility noted that the results should be treated as informational only due to small sample sizes.

The tables below summarize the decisions for each utility, program, and measure based on application of the process described above.

Table 27: Atlantic City Electric

Measure	Unique ID	n	NTG	Precision	Decision	Rule
Appliance Rebates						
Program Level	Multiple					
Clothes Washers	RA2001 and RA2002	128	50%	± 6%	Apply program-level NTG	2.b.iii
Clothes Dryers	RA2004 and RA2005					
Refrigerators	RA2006 and RA2007					
Air Purifiers	RA2012					
Room AC	RA2013					
Dehumidifiers	RA2014					
Heat Pump Water Heaters	RW3001					
Appliance Recycling						
Program Level	Multiple					
Refrigerators	RE6001	158	See statewide values	± 15%	Apply statewide NTG	2.b.ii
Freezers	RE6002					
Room AC	RE6003					
Dehumidifiers	RE6004					
Residential HVAC						
Program Level	Multiple					
CACs	RV7001 and RV7002	29	See statewide values	± 3%	Apply statewide NTG	2.b.iii.2
ASHPs	RV7003 to RV7004					
DMSHPs	RV7008 and RV7009					
Smart Thermostats	RV7022 to RV7026					

Table 28: New Jersey Natural Gas HPwES

Measure	Unique ID	n	NTG	Precision	Decision	Rule
Program Level	Multiple	89	87%	4%	Apply measure-level NTG	2a.ii
Air Sealing & Insulation	RH9002 to RH9005	89	89%	4%	Apply measure-level NTG	2a.ii
Duct Sealing	RH9006	8	77%	24%	Apply program-level NTG	2.b.iii
Cooling System	RH9012 to RH9013	21	81%	8%	Apply program-level NTG	2.b.iii.1
Heating System	RH9026 to RH9031	28	87%	6%	Apply program-level NTG	2.b.iii.1
Water Heating	RH9035 to RH9038	7	87%	14%	Apply program-level NTG	2.b.iii.1

Table 29: Public Service Electric and Gas

Measure	Unique ID	n	NTG	Precision	Decision	Rule
Appliance Rebates						
Program Level	Multiple					
Clothes Washers	RA2001 & RA2002					
Clothes Dryers	RA2004 & RA2005					
Refrigerators	RA2006 & RA2007	338	49%	± 9%	Apply program-level NTG	2.b.iii.1
Heat Pump Water Heaters	RW3001					
Smart Thermostat	RA2015 to RA2020 RV7022 to RV7026					
Appliance Recycling						
Program Level	Multiple					
Refrigerators	RE6001					
Freezers	RE6002	239	60%	±5%	Apply program-level NTG	2.b.iii.1
Room AC	RE6003					
Dehumidifiers	RE6004					
HPwES						
Program Level	Multiple					
Air Sealing & Insulation	RH9002 to RH9005	37	85%	±4%	Apply program-level NTG	2.b.iii.1
HVAC / Water Heating	Multiple					

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Measure	Unique ID	n	NTG	Precision	Decision	Rule
QHEC						
Program Level w/lighting						
Faucet Aerator	RQ10003 & RQ10005	NA	See statewide values	±4%	Apply statewide NTG	2.b.1
Low-Flow Showerhead	RQ10004					
Smart Power Strip	RQ10006					
Online Marketplace						
Program Level w/lighting						
Air Purifiers	RA2012					
Smart Thermostats	RA2015 to RA2020					
Showerhead	RA2025		See statewide values		Apply statewide NTG	
Aerator	RA2026	267	See statewide values	±12%	Apply statewide NTG	2.b.1
Power Strips	RP5001 & RP5002					
Kit (Energy Savings Kit and Water Conversation Kit)	RS13001					
Welcome Kits						
Program Level w/lighting						
LED Night Light	RL1008 (by itself; none as part of kit)					
Advanced Power Strip	RS13001 - Powerstrips	-	See statewide values		Apply statewide NTG	
Bathroom Aerator	RS13001 - Water Conservation	211	See statewide values	±12%	Apply statewide NTG	2.b.1
Kitchen Aerator	RS13001 - Water Conservation					
Low Flow Showerhead	RS13001 - Water Conservation					

B

Appendix B Recommended Statewide Net-to-Gross Ratios

The recommended NTG are embedded below.



Commercial_Recom
mendedNTGRatios_



Residential_Recom
mendedNTGRatios_

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The table below lists all the sources from which NMR extracted NTG ratios.

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