2017 Distributed Energy Resources (DER) Potential Study

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EXECUTIVE SUMMARY

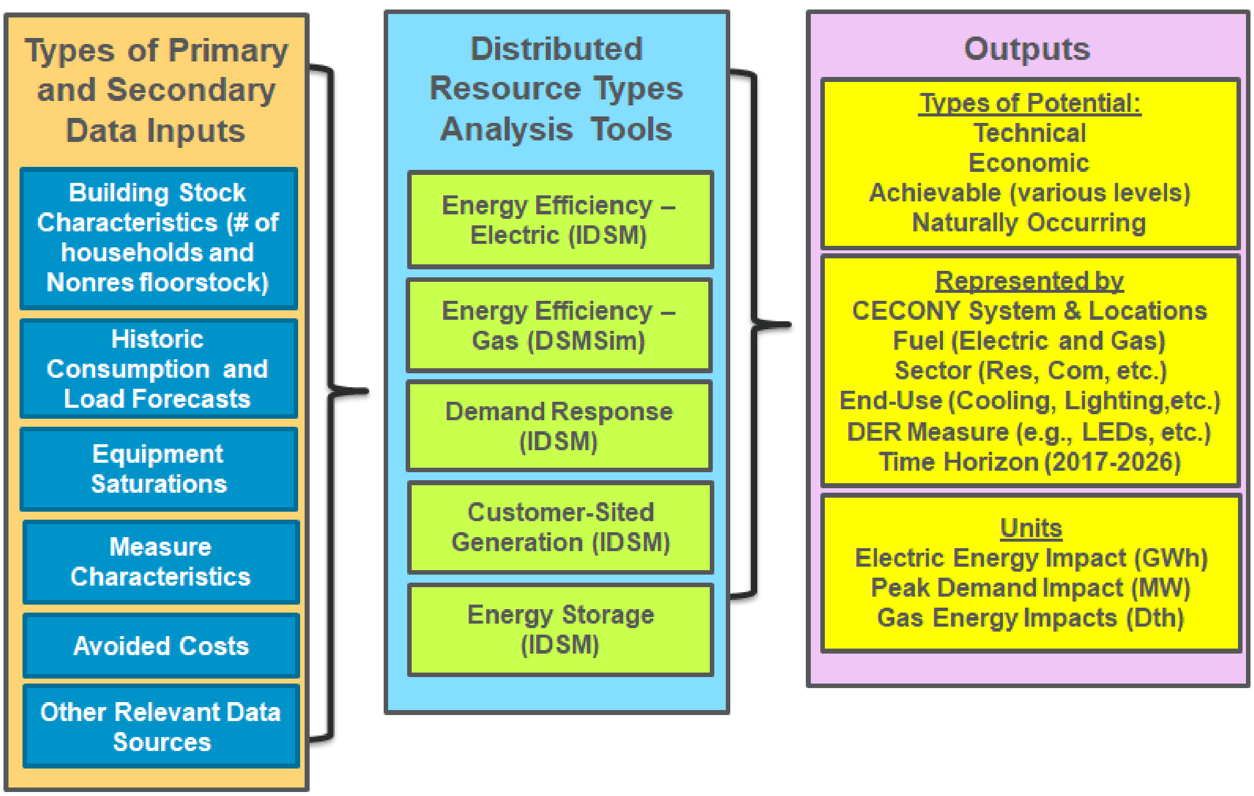
Introduction

Consolidated Edison of New York (CECONY) engaged Navigant Consulting, Inc. (Navigant) to prepare a distributed energy resource (DER) potential assessment for electricity and natural gas demand-side resources across its territory over a 10-year planning horizon, from 2017 to 2026. This assessment was commissioned by CECONY as part of its continued efforts to identify and understand market potential for DERs for current and future planning. The objective of the assessment is to inform the market potential from all DERs including energy efficiency, demand response (DR), customer-sited generation (CSG) and energy storage for the residential, commercial, and industrial sectors. A major feature of the study was to collect primary data about CECONY customer energy use characteristics to inform the assessment. The results of this potential study are being used to inform CECONY's strategic planning and program design efforts.

Approach

This section provides a high-level summary of the approach detailed in Section 2 of this report. Figure 1 summarizes the overall approach. The figure illustrates the flow of the study beginning with the types of data (primary and secondary), the tools that were used for each of the DER resource types, and the representative outputs. Each part of the study is described in greater detail in the sections that follow.

Figure 1. DER Potential Study Flow



Source: Navigant

Data Inputs

A key objective of this study was to enhance existing data available from CECONY with primary market research and secondary data. Navigant collected a significant amount of existing data from CECONY at the onset of the project, including information about current building stocks. For the residential sector, the building stock metric was number of households and for commercial it was floor area (i.e., square footage). CECONY provided its most current energy and demand forecasts as well as avoided energy and capacity costs.

Navigant then supplemented these data sources with primary data collected directly from CECONY's customers through online surveys with residential customers and phone surveys with commercial customers across representative segments. The surveys were aimed at capturing information about CECONY's customer base, including end-use and equipment densities, efficiency levels, and demographics. To ensure that the survey results were sufficiently rigorous, onsite visits were conducted for sub-samples of the completed surveys for the residential and commercial customers.

Finally, Navigant used secondary data sources to supplement and validate the various primary data sources, such as to supplement the commercial survey data, given lower-than-expected response rates.

The DER potential study examines the savings potential for a total of 155 DER measures, including 72 electric energy efficiency measures, 24 gas energy efficiency measures, 27 DR measures, 14 CSG measures, and 18 storage measures. For each measure, Navigant developed estimated savings, costs, lifetime, and other parameters. All measures were considered for the technical potential analysis. The measures were then subjected to an economic screen using measure-level costs and CECONY's avoided costs. Measures passing the screen were then carried forward to subsequent levels of DER potential (i.e., economic, achievable, etc.).

Analysis Tools

The estimates of DER potential were carried out using two models. For the electric DER potential analysis covering energy efficiency, DR, CSG and storage, Navigant utilized the Integrated Demand Side Management (IDSM) model, which was developed for CECONY in a prior project by Energy and Environmental Economics, Inc. (E3). IDSM provides estimates of DER potentials for the CECONY electric system as a whole, and for specific geographic locations in the CECONY service territory. For the natural gas energy efficiency potential analysis, Navigant utilized its own DSMSim model. DSMSim provides estimates of gas energy efficiency potential for the CECONY natural gas system as a whole. Estimates of potential were than further broken down by borough and gate station.

Outputs

The outputs for this study included eight types of DER potential for electric:

- ***Technical potential:*** Instantaneous deployment of all DER measures regardless of cost or customer preferences
- ***Economic potential:*** Instantaneous deployment of all cost-effective DER measures, regardless of customer preferences
- ***Theoretical achievable:*** Phased-in deployment of all cost-effective DER measures based on increased program budgets and higher market adoption

- ***Programmatic achievable:*** Phased-in deployment of all cost-effective DER measures based on current program budgets and market adoption
- ***Alternative program achievable:*** Same as programmatic achievable with the addition of behavioral and operational efficiency measures
- ***Reduced programmatic achievable:*** Phased-in deployment of all cost-effective DER measures based on reduced program budgets and market adoption
- ***Naturally occurring potential (Scenario 1):*** Customers adopt DER measures as if – theoretically – no energy efficiency programs existed in the market
- ***Naturally occurring potential (Scenario 2):*** Customers adopt DER measures where energy efficiency programs exist but the customer did not utilize the program or were not aware of the program

For the gas energy efficiency analysis, the following eight potential types were created:

- ***Technical potential:*** Instantaneous deployment of all gas energy efficiency measures regardless of cost or customer preferences
- ***Economic potential:*** Instantaneous deployment of all cost-effective gas energy efficiency measures, regardless of customer preferences
- ***Theoretical high achievable:*** Phased-in deployment of all cost-effective gas energy efficiency measures based on high program budgets and incentives greater than 100% of incremental cost which lead to high market adoption
- ***Theoretical achievable:*** Phased-in deployment of all cost-effective gas energy efficiency measures based on high program budgets and incentives at 100% of incremental cost which lead to high market adoption
- ***Programmatic achievable:*** Phased-in deployment of all cost-effective gas energy efficiency measures based on current program budgets and market adoption
- ***Alternative program achievable:*** Same as programmatic achievable with the addition of behavioral and operational efficiency measures
- ***Naturally occurring potential (Scenario 1):*** Customers adopt gas energy efficiency measures as if –theoretically – no energy efficiency programs existed in the market
- ***Naturally occurring potential (Scenario 2):*** Customers adopt gas energy efficiency measures where energy efficiency programs exist but the customer did not utilize the program or were not aware of the program

The results are represented at the CECONY system level and for specific geographic locations within the CECONY service territory. Results are further disaggregated for each of the fuel types served by CECONY (electricity and natural gas), each sector (residential, commercial, industrial), each customer segment (large office, hospital, retail, etc.), each end-use (cooling, lighting, whole-building, etc.), and each specific DER measure.

Findings

Reference Energy Use

As noted earlier, Navigant used primary data as a foundation for this study. Reference energy usage was developed from the primary data and ultimately served as a "baseline" against which various DER measures' technical, economic, and achievable potentials could be established. A reference forecast was developed and served as a starting point for developing population totals that would enable the development of various levels of DER potential. CECONY's load forecasts were used as control totals and cross-checks as various DER potentials were developed.

CECONY provides electricity to almost three million residential customers. The residential segments range from single family dwellings in suburban and outer borough communities to large multi-family housing complexes in dense urban areas, creating a vast diversity in residence type and energy consumption across the residential sector. In multi-family buildings, the individual dwelling units are considered residential, while the common areas are considered within the commercial sector under multi-family common area due to the types and usage of equipment. CECONY provides electricity to almost half a million commercial customers covering nearly three billion square feet of floor space across a variety of building types including offices, retail, restaurants, grocery stores, schools, colleges, hospitals, nursing homes, hotels and motels, entertainment, warehouses, industrial facilities, and multi-family common areas.

In addition, CECONY provides gas service to nearly a million customers in Manhattan, the Bronx, parts of Queens and Westchester County. The residential segments served by CECONY are represented by single family and small multi-family dwellings in suburban communities to the more dense urban communities. CECONY provides gas to nearly one billion square feet of floor space to a variety of commercial building types that encompass offices, retail, restaurants, grocery stores, schools, colleges, hospitals, nursing homes, hotels and motels, entertainment, warehouses, industrial facilities, and common areas of large multi-family buildings.

Overall DER Potential

Table 1 provides a summary of cumulative programmatic achievable potential for each of the five DER resource types for each year during the forecast time horizon. This table summarizes both annual energy and peak demand savings estimates for electric energy efficiency measures, and then provides annual energy for natural gas energy efficiency measures, and peak demand impacts for DR, CSG and storage measures. Consistent across all resource types is that over the 10-year timeframe, impacts grow significantly. By 2026, the 3,517 GWh of energy efficiency savings represent 5.6% of CECONY's forecasted sales. For gas, the 4,102 thousand dth represents 2.3% of CECONY's forecasted sales. For DR, the programmatic achievable potential is forecast to grow from about 250 MW in 2017 to almost 900 MW in 2026. In 2026, this represents about 6.4% of CECONY's system peak load. For CSG, the over 200 MW of programmatic achievable potential represents approximately 1.5% of CECONY's system peak load. For storage, the 545 MW of programmatic achievable potential represents approximately 3.7% of CECONY's system peak load.

Table 1. Summary of DER Programmatic Achievable Potential by Resource Type

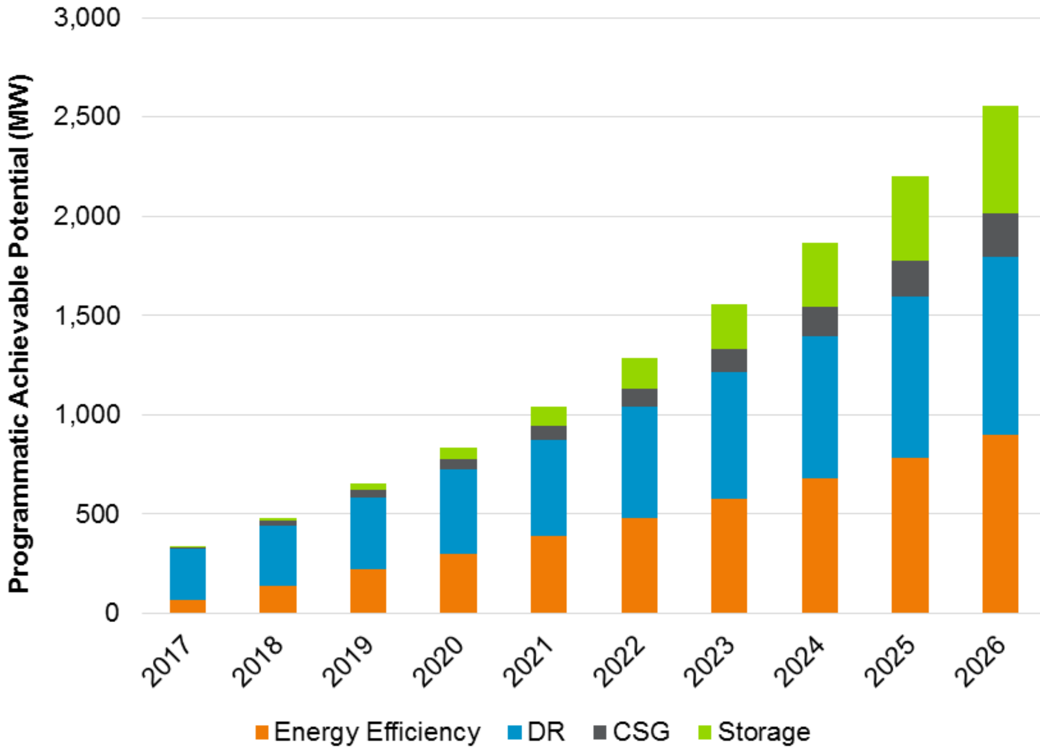
DER Resource Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Energy Efficiency-Electric Annual Energy (GWh)	289	618	1,019	1,323	1,641	1,971	2,331	2,708	3,104	3,517
Energy Efficiency-Electric Peak Demand (MW)	66	138	224	302	387	480	575	677	785	899
Energy Efficiency-Gas Annual Energy (thousand dth)	352	718	1,095	1,486	1,898	2,323	2,759	3,204	3,650	4,102
Demand Response Peak Demand(MW)	256	306	361	423	489	562	639	721	808	898
Customer-Sited Generation Peak Demand (MW)	9	21	34	49	67	88	114	144	181	216
Energy Storage Peak Demand (MW)	6	14	33	61	100	155	229	324	427	545

Source: Navigant

Figure 2 summarizes the cumulative capacity savings potential for all DERs, excluding gas energy efficiency.[1] When all the DER electric resources are combined, we project just over 2,500 MW of peak demand programmatic achievable potential in 2026. The two big resources that contribute to this potential are demand response and energy efficiency at just over one-third of the total impact for each. Energy storage contributes another fifth of the total impact and customer-sited generation at just under 10%.

[1] Gas EE was not included in this chart due to differences in units.

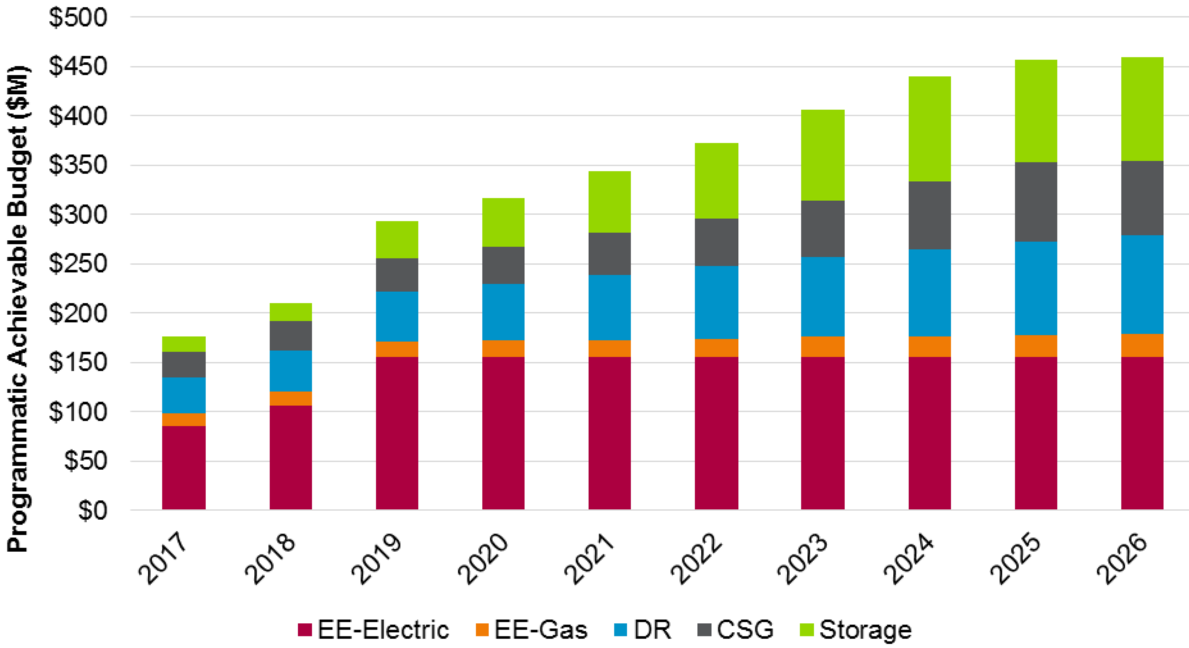
Figure 2. Programmatic Achievable Potential – DER Cumulative Demand Reduction (MW)



Source: Navigant

Figure 3 summarizes the estimated annual budgets needed to reach the projected levels of programmatic achievable DER potential. Budgets include the incentives that would need to be paid to CECONY's customers to encourage them to adopt the various DER measures, as well as the administrative costs for energy efficiency and DR. The budget associated with the programmatic achievable potential is estimated at $177 million in 2017 and increases to more than $450 million by 2026. For DERs where CECONY programs exist, current program budgets were used for programmatic achievable. For DERs where CECONY programs do not exist, theoretical program budgets were developed based on the projected market potentials.

Figure 3. Programmatic Achievable Potential – DER Annual Budget ($M)

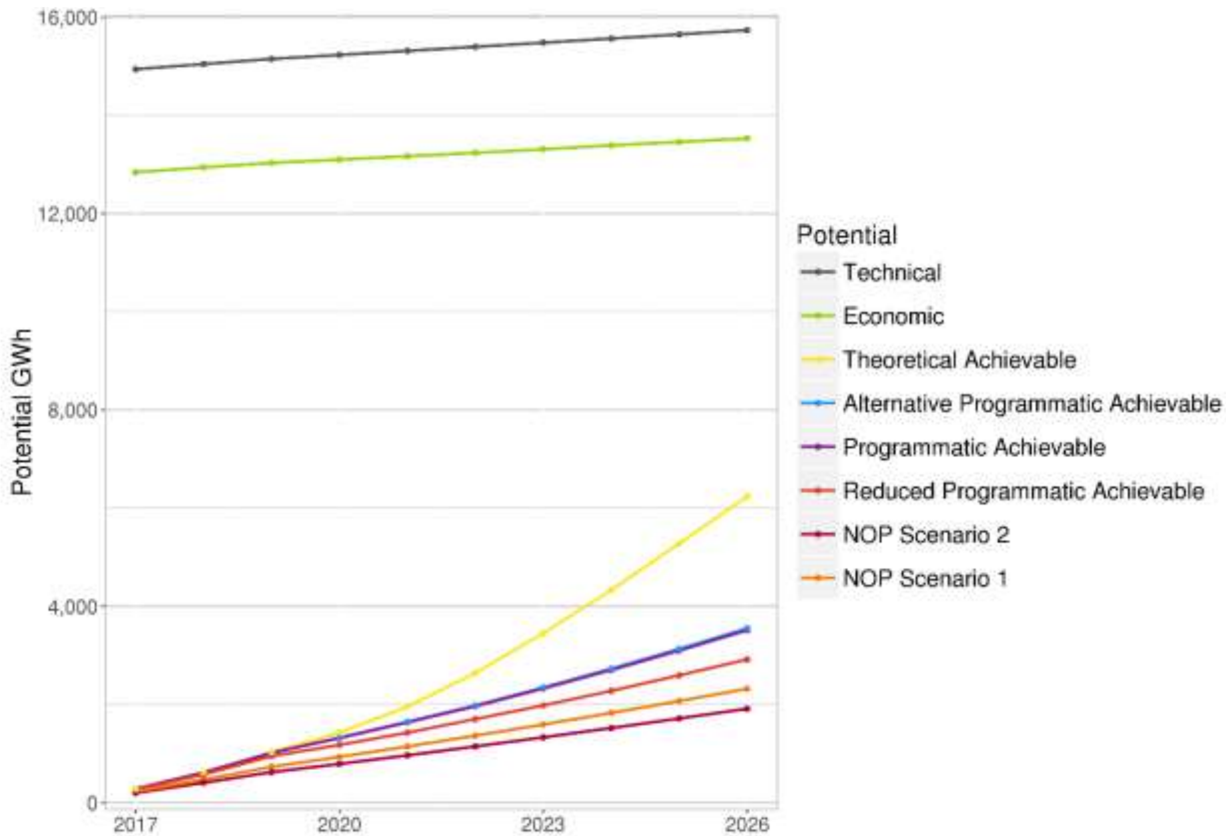


** Energy efficiency and DR budgets consider both administrative and incentive costs. CSG and storage budgets only consider incentive costs, due to CECONY's limited experience with these program types to inform administrative cost estimates.*
Source: Navigant

Energy Efficiency Potential – Electric

The energy efficiency potential analysis was carried out separately for electric and gas. The electric energy efficiency potential results are summarized in Figure 4. The values associated with this chart are included in Table 2. The figure highlights the various levels of electric energy efficiency potential for the entire 10-year time horizon of this study. Technical potential is 14,940 GWh in 2017, growing to 15,734 GWh by 2026, which represents 24.8% of the reference forecast. Economic potential is 13,529 GWh or 21.4% of the reference forecast in 2026. Programmatic achievable potential grows from 289 GWh and 0.5% of the reference forecast in 2017 to 3,517 GWh cumulatively and 5.6% of the reference forecast in 2026. In 2026, programmatic achievable potential is roughly 25% of the economic potential.

Figure 4. Electric Energy Efficiency Cumulative Potential Results Summary (GWh)



Source: Navigant

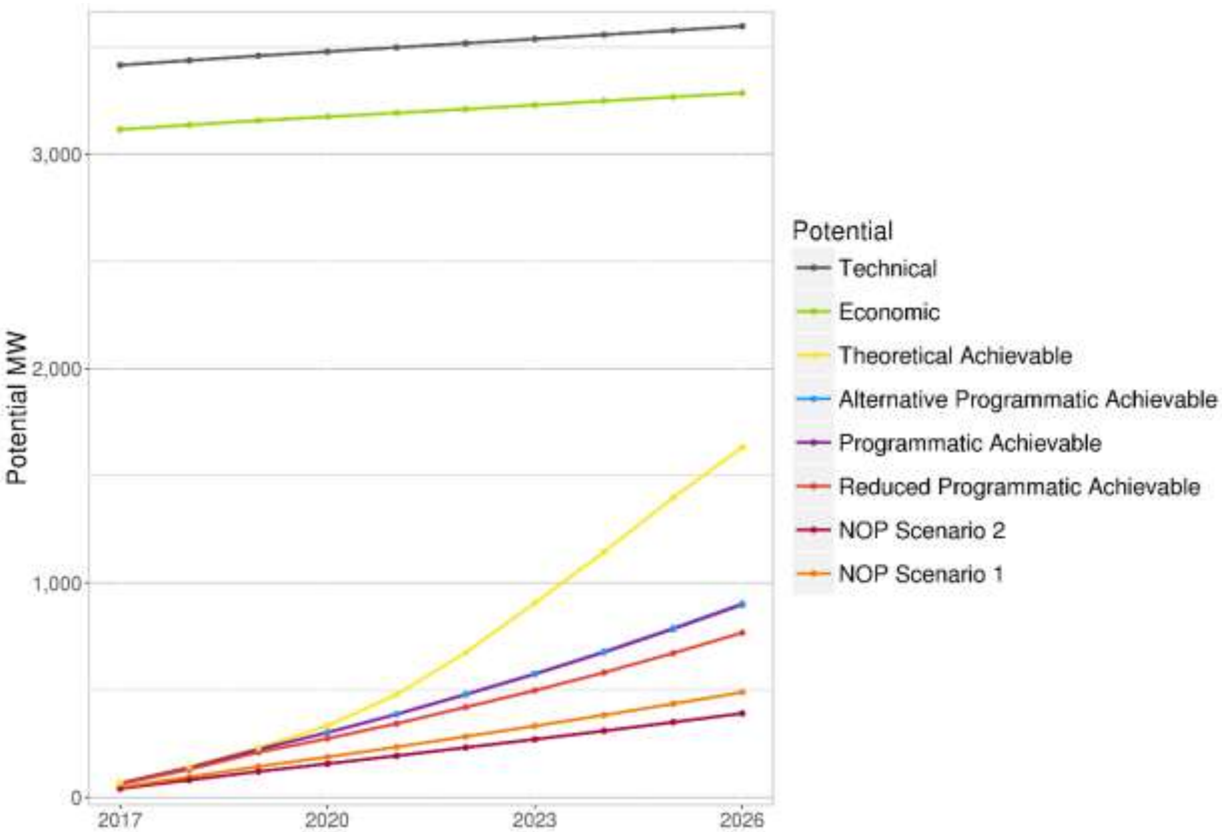
Table 2. Electric Energy Efficiency Cumulative Potential Forecast by Scenario (GWh)

Potential Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Technical	14,940	15,044	15,148	15,230	15,312	15,395	15,479	15,563	15,648	15,734
Economic	12,840	12,940	13,032	13,099	13,168	13,236	13,309	13,388	13,458	13,529
Theoretical Achievable	286	630	1,031	1,433	1,963	2,646	3,457	4,335	5,284	6,240
Alternative Programmatic Achievable	289	618	1,022	1,329	1,651	1,985	2,350	2,733	3,136	3,556
Programmatic Achievable	289	618	1,019	1,323	1,641	1,971	2,331	2,708	3,104	3,517
Reduced Programmatic Achievable	272	579	954	1,181	1,431	1,708	1,986	2,283	2,598	2,922
NOP Scenario 1	234	476	735	938	1,150	1,370	1,598	1,833	2,076	2,325
NOP Scenario 2	204	412	627	795	970	1,151	1,336	1,526	1,720	1,919

Source: Navigant

Figure 5 and Table 49 provide the corresponding peak demand savings for electric energy efficiency. The demand results are consistent with energy in terms of percentages relative to forecasts. This suggests that for the mix of measures assessed in this study, they tend to contribute to peak load reductions in the same proportion as the corresponding energy reductions over the course of each year.

Figure 5. Electric Energy Efficiency Cumulative Potential Forecast by Scenario (MW)



Source: Navigant

Table 3. Electric Energy Efficiency Cumulative Potential Forecast by Scenario (MW)

Potential Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Technical	3,415	3,437	3,459	3,478	3,498	3,517	3,537	3,557	3,577	3,597
Economic	3,115	3,136	3,157	3,174	3,192	3,210	3,229	3,248	3,266	3,285
Theoretical Achievable	68	143	231	335	480	675	907	1,144	1,397	1,633
Alternative Programmatic Achievable	66	138	224	303	389	481	577	679	789	903
Programmatic Achievable	66	138	224	302	387	480	575	677	785	899
Reduced Programmatic Achievable	62	130	210	274	344	421	498	582	673	768
NOP Scenario 1	47	95	144	188	235	284	333	384	436	490

NOP Scenario 2	41	81	121	157	194	233	271	310	351	392

Source: Navigant

The energy efficiency electric results indicate a few noteworthy patterns:

- Savings for the various achievable potential scenarios cumulate to levels that are still quite short of reaching the economic potential. Several factors contribute to this. First, there are always customers who will not adopt energy efficiency measures even though they might be cost-effective and offered virtually for free. Second, the end-use equipment stock in the CECONY service territory includes a large amount of equipment that is long-lived. This is due to the large number of commercial buildings in New York City that typically have equipment with useful lives of 20 or more years. Since this is a 10-year time horizon, equipment has yet to turn over by the time 2026 comes around. It is expected that the achievable potential could eventually trend closer to economic potential in the years following 2026 as more equipment becomes available for efficient replacement.
- Savings accumulation slows slightly in the theoretical achievable scenario between 2019 and 2020 due mainly to changes in lighting baseline standards, and then begins increasing at an even greater rate after 2020, as controls and exterior lighting measures become more prominent and the budget is assumed to increase on an annual basis. Towards 2024, the rate of savings uptake slows again, as the market nears saturation for some measures and savings become more expensive to acquire.
- Naturally occurring potential is over 70% of the programmatic achievable in 2017, declining to more than 50% by 2026. High naturally occurring potential is consistent with recent market research that suggests there is general high interest in energy efficiency – including high organic adoption of some technologies (e.g. LEDs) – but that do not translate into program savings due to relatively low awareness of CECONY program offerings and/or barriers to program participation.

Table 4 and Figure 42 provide the energy efficiency electric programmatic achievable potential estimates by sector. The charts show that annual programmatic achievable potential grows from 289 GWh across sectors in 2017 to 413 GWh in 2026, or 5% per year on average over the potential study time horizon. Values shown below for programmatic achievable potential are termed as annual incremental potential, in that they represent the incremental new potential available in each year. The total cumulative potential (shown in the earlier charts) over the time period would be the sum of each year's annual incremental achievable.

The C&I sectors largely drive the achievable potential, with residential contributing roughly 35-45% of the annual incremental potential prior to the general service lighting standard change in 2020 and closer to 25-30% of the potential after 2020. The reduction in incremental potential after 2020 is due to the change to lighting standards that implies a new more efficient baseline. As such, the potential for high efficiency lighting is reduced since the new baseline is more efficient. As noted in the following section, much of the commercial potential is initially driven by the multi-family common area segment, with large office taking the lead starting in 2019. On a year-over-year basis after 2020, the incremental potential grows steadily, and eventually surpasses the highest level of potential that was observed prior to the change in lighting standards.

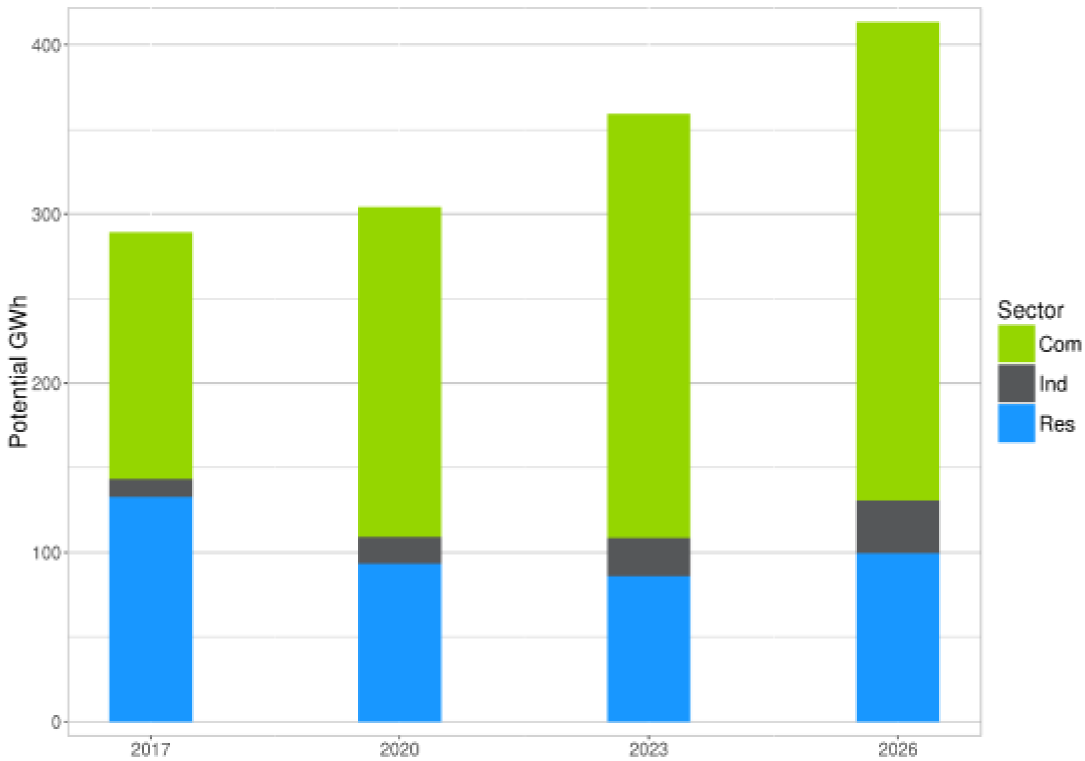
Table 4. Electric Energy Efficiency Annual Incremental Programmatic Achievable Potential by Sector (GWh)

Sector	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Commercial	146	185	241	195	203	217	251	260	272	283

Industrial	11	14	16	16	18	20	23	26	28	31
Residential	133	131	144	93	97	93	86	91	95	100
Total	**289**	**329**	**401**	**304**	**318**	**330**	**360**	**377**	**396**	**413**

Source: Navigant

Figure 6. Electric Energy Efficiency Annual Incremental Programmatic Achievable Potential by Sector (GWh)



Source: Navigant

Energy Efficiency Potential – Gas

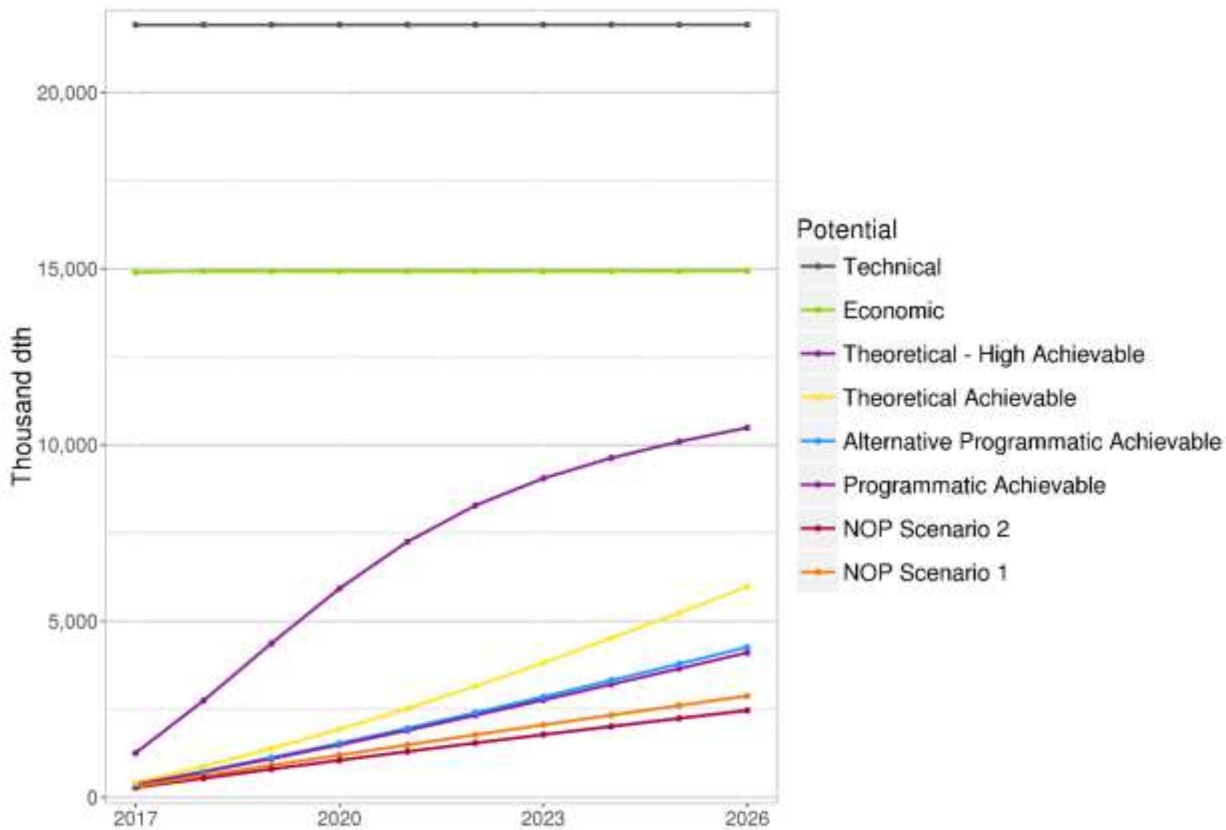
The gas energy efficiency potential results are summarized in Figure 7 and Table 72. The figure highlights the various levels of gas energy efficiency potential for the entire 10-year time horizon of this study. Technical potential is 21,917 thousand dekatherms (thousand dth) in 2017, increases to 21,922 thousand dth by 2026, which represents 12% of the reference forecast. Economic potential is 14,933 thousand dth or 8% of the reference forecast in 2026. Programmatic achievable potential is 352 thousand dth or 0.2% of the reference forecast in 2017, growing to 4,102 thousand dth or 2.3% in 2026.

The results indicate a few noteworthy patterns:

- Much like the electric results, the savings for the various achievable potential scenarios cumulate to levels that are still quite short of reaching the economic potential. Many of the same factors that were pointed out in the electric case contribute to this situation on gas. First, there are always customers who will not adopt energy efficiency measures even though they might be cost-effective and offered virtually for free, as is the case in the theoretical high achievable scenario. Second, the end-use equipment stock in the CECONY service territory includes a large amount of equipment that is long-lived. This is particularly applicable on the gas side where furnaces and boilers tend to last 15-20 or more years. Since this study covers a 10-year time horizon, equipment has yet to turn over by the time 2026 comes around.

- Because of the longer periods of equipment turnover on the gas side, it is expected that the achievable potential would eventually trend closer to economic potential in the years following 2026.
- Scenario 2 of naturally occurring potential is as much as 88% of the programmatic achievable in 2017, declining to 70% by 2026. High naturally occurring potential is consistent with recent market research that suggests there is general high interest in energy efficiency – including high organic purchases of certain efficient technologies (e.g. LEDs) – but that do not translate into program savings due to relatively low awareness of CECONY program offerings and/or barriers to program participation.

Figure 7. Gas Energy Efficiency Cumulative Potential Results Summary



Source: Navigant

Table 5. Gas Energy Efficiency Cumulative Potential Forecast by Scenario (thousand dth)

Potential Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Technical	21,917	21,917	21,918	21,918	21,919	21,920	21,920	21,921	21,921	21,922
Economic	14,897	14,922	14,922	14,922	14,923	14,923	14,923	14,924	14,924	14,933
Theoretical - High Achievable	1,254	2,744	4,368	5,923	7,251	8,281	9,048	9,628	10,091	10,485
Theoretical Achievable	420	880	1,384	1,931	2,520	3,149	3,815	4,513	5,236	5,977
Alternative Programmatic Achievable	362	737	1,126	1,531	1,957	2,399	2,852	3,317	3,785	4,260
Programmatic Achievable	352	718	1,095	1,486	1,898	2,323	2,759	3,204	3,650	4,102
NOP Scenario 1	308	610	906	1,198	1,487	1,772	2,053	2,331	2,604	2,873
NOP Scenario 2	273	538	797	1,050	1,297	1,540	1,777	2,010	2,239	2,463

Source: Navigant

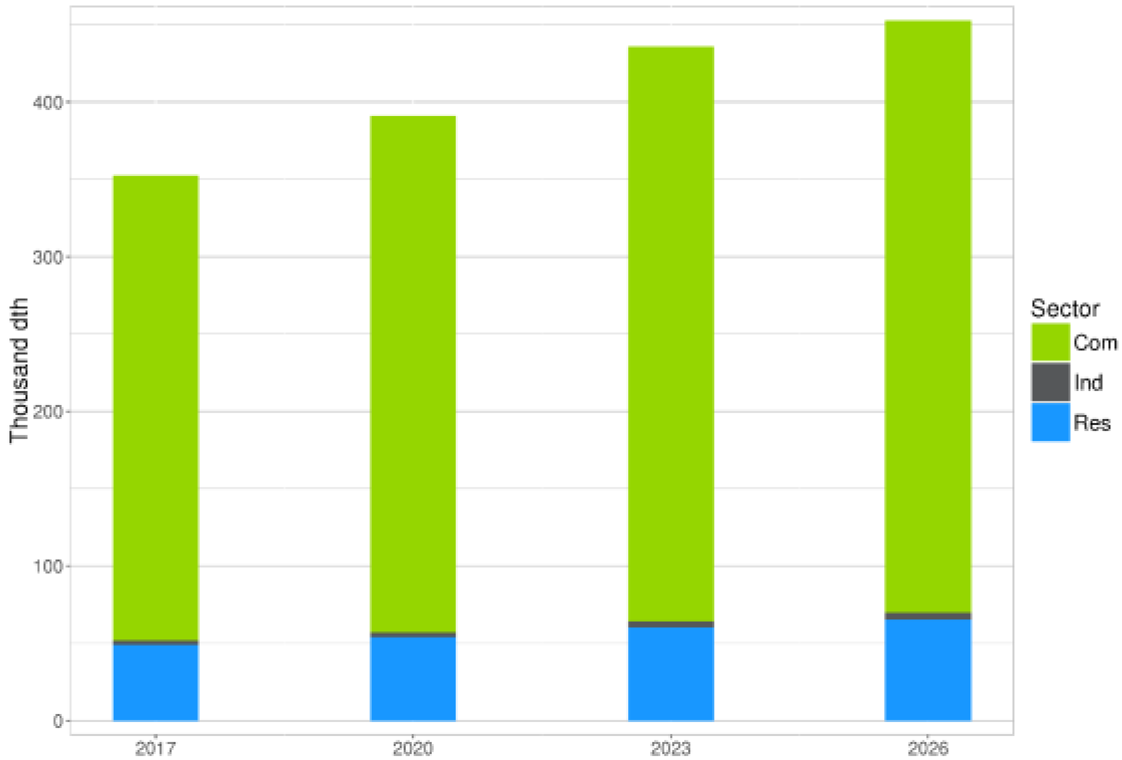
Table 77 and Figure 8 provide the energy efficiency gas programmatic achievable potential estimates by sector. The charts show that annual programmatic achievable potential grows from 353 thousand dth across all sectors in 2017 to 453 thousand dth in 2026, or 3% per year on average over the potential study time horizon. The commercial sector largely drives the achievable potential contributing to over 85% of the total achievable potential. The residential potential contributes to 14% of the sector potential, and industrial contributes to less than 1% of the total achievable potential.

Table 6. Gas Energy Efficiency Annual Incremental Programmatic Achievable Potential by Sector (thousand dth)

Sector	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Commercial	301	311	323	334	353	363	371	379	378	383
Industrial	3	3	3	3	4	4	4	4	4	5
Residential	49	51	51	54	56	58	60	62	64	65
Total	**352**	**366**	**377**	**391**	**412**	**425**	**436**	**445**	**446**	**452**

Source: Navigant

Figure 8. Gas Energy Efficiency Annual Incremental Programmatic Achievable Potential by Sector (thousand dth)



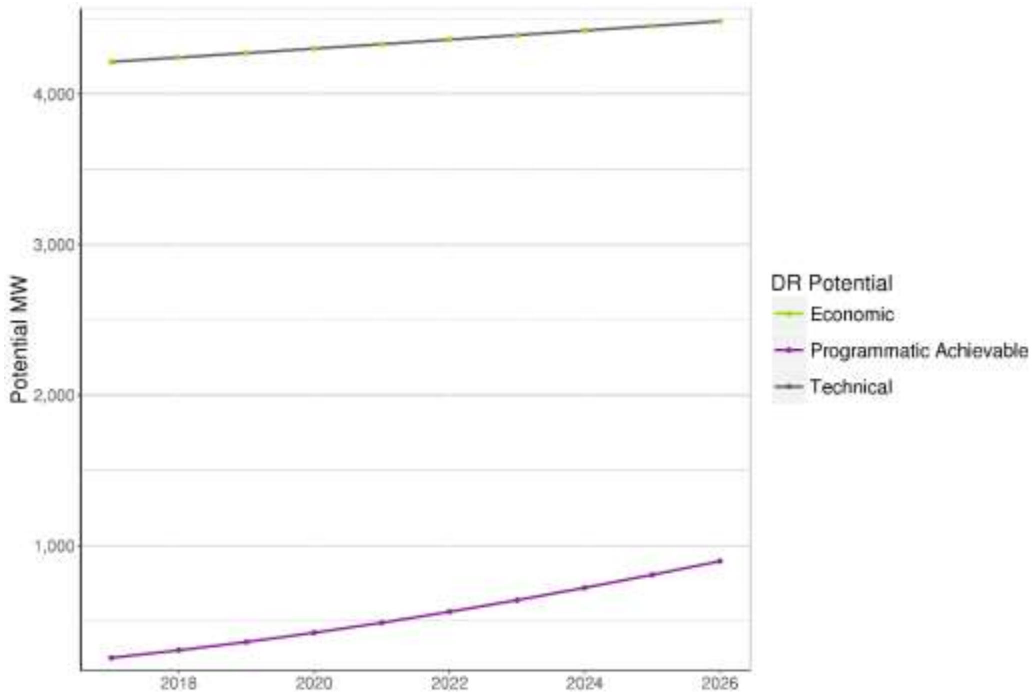
Source: Navigant

Demand Response Potential

The demand response (DR) potential analysis includes estimates of technical, economic, and programmatic achievable potential. DR only exists within a program construct; therefore, the other levels of achievable and naturally occurring potential do not apply to DR. Figure 9 and Table 7 summarize the various estimates of DR potential. The charts highlight that technical and economic potentials are identical. This is due to the fact that all of the DR measures pass the economic screen. The programmatic achievable potential grows steadily over the forecast horizon, mainly due to new participants that are recruited to join the various DR programs every year.

The DR potential analysis includes a variety of DR program types. Time-varying rates (TVR) and direct load control (DLC) program types are projected to have the largest technical potential impacts. TVR programs include elements with and without enabling technologies to prompt load reductions. DLC programs are focused on cooling systems that are controlled either through programmable communicating thermostats or switches installed on the compressor. Auto-DR programs focus on enabling energy management control systems in commercial buildings to allow for adjustments of HVAC settings during DR event calls. Manual HVAC control programs establish procedures for HVAC setting adjustments to be initiated by building operators during DR event calls. Backup generator (BUG) programs including BUG technologies that are fueled by diesel or natural gas and are configured to be dispatched during DR event calls. Finally, lighting control programs are very similar to Auto-DR programs where various lighting control systems in commercial buildings are enabled to allow for dimming or full shutoff during DR event calls.

Figure 9. DR Potential Results Summary



Source: Navigant

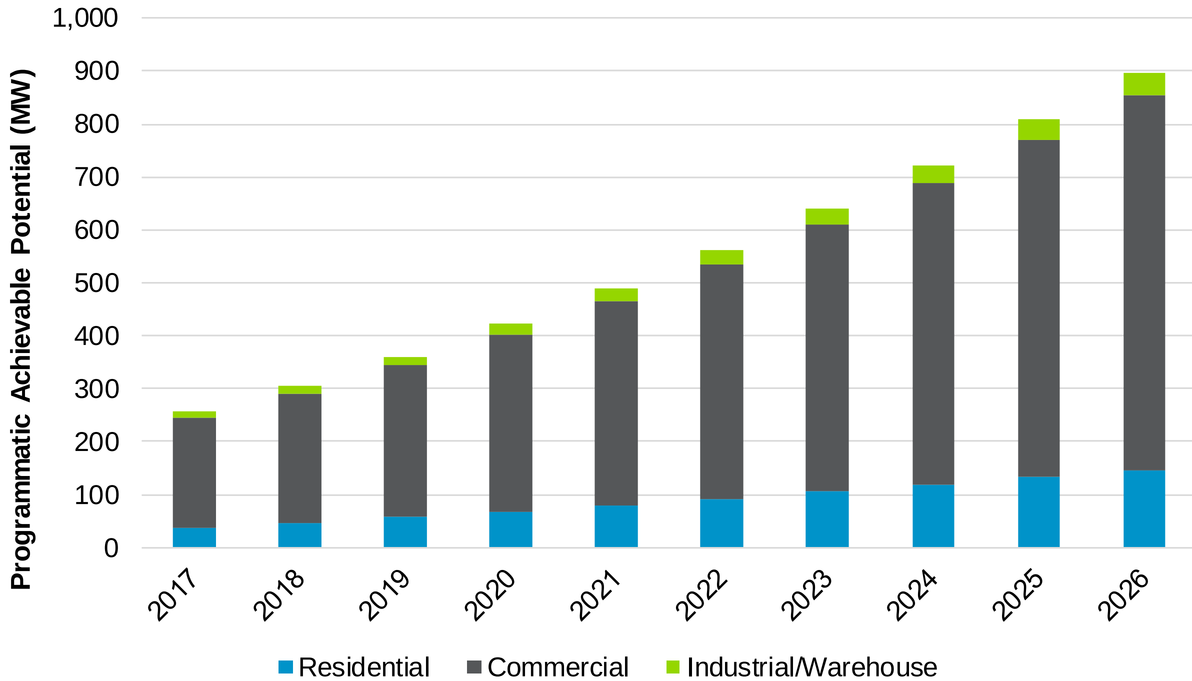
Table 7. DR Potential Results by Scenario (MW)

Potential Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Technical	4,213	4,242	4,271	4,301	4,330	4,360	4,390	4,421	4,451	4,482
Economic	4,213	4,242	4,271	4,301	4,330	4,360	4,390	4,421	4,451	4,482
Programmatic Achievable	256	306	361	423	489	562	639	721	808	898

Source: Navigant

Figure 10 summarizes the programmatic achievable DR potential by segment over the 10-year study time horizon. The total residential programmatic achievable potential is approximately 147 MW in 2026, which represents 16% of the total 2026 potential. The total industrial/warehouse programmatic achievable potential is approximately 42 MW in 2026, which represents another 5% of the total 2026 potential. The remaining nearly 80% potential comes from the commercial sector.

Figure 10. DR Programmatic Achievable Potential Results Summary

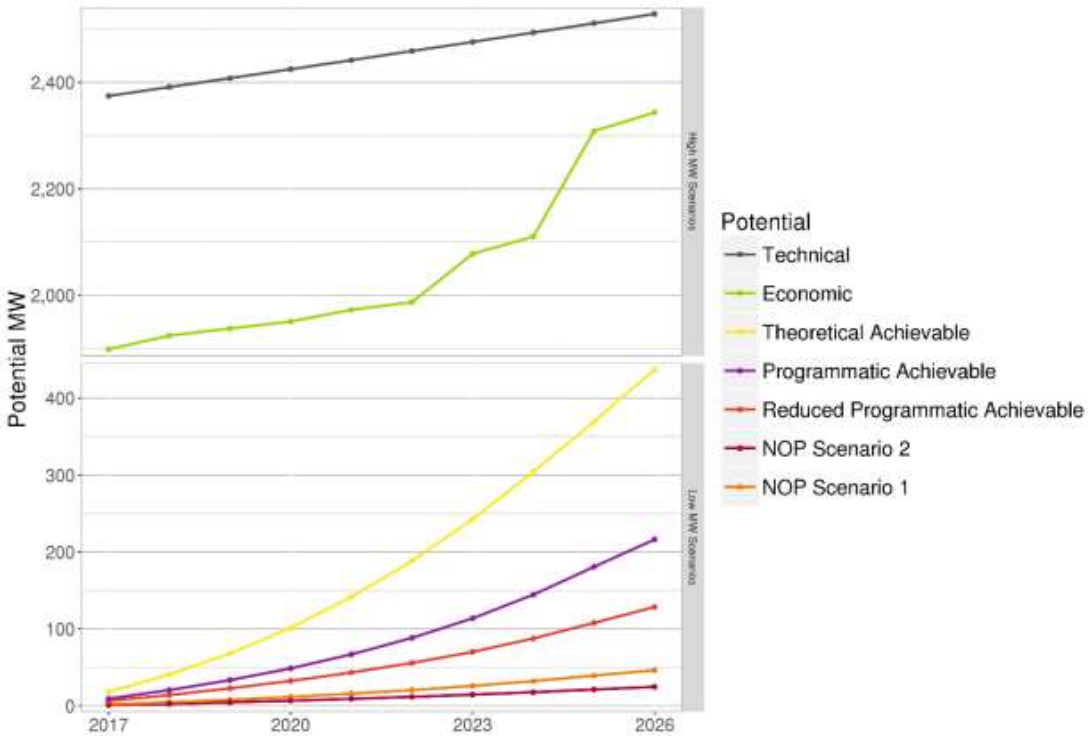


Source: Navigant

Customer-Sited Generation Potential

The customer-sited generation (CSG) analysis addressed the following technology types: solar PV + storage, combined heat and power (CHP), and combined cooling heat and power (CCHP). Figure 11 and Table 98 summarize these results. Within the technical potential of 2,528 MW in 2026, 826 MW comes from solar PV + storage, 1,507 MW from CHP, and 194 MW from CCHP. The utility-wide technical potential for solar PV is approximately 825 MW. The CHP and CCHP results fit within the estimated technical potential of about 12 GW for entire state of New York. The economic potential of 2,343 MW is about 92% of the technical potential, and is reasonable given how much CSG costs have declined in recent years as well as their ability to be dispatched to reduce peak load. The programmatic achievable potential climbs to just over 200 MWs by 2026. From a theoretical perspective, achievable potential could reach levels that are more than double the programmatic potential by 2026. This assumes that customers are offered incentives that represent the full cost of the CSG measures. Naturally occurring potential is very small as natural uptake (absent programs or consumer awareness) for various CSG measures is expected to be very small in the CECONY service territory.

Figure 11. CSG Potential Results Summary



Source: Navigant

Table 8. CSG Cumulative Potential Forecast by Scenario (MW, nameplate capacity)

Potential Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Technical	2,374	2,391	2,408	2,424	2,441	2,459	2,476	2,493	2,511	2,528
Economic	1,899	1,925	1,938	1,951	1,973	1,987	2,078	2,110	2,308	2,343
Theoretical Achievable	18	41	68	102	142	188	243	304	369	437
Programmatic Achievable	9	21	34	49	67	88	114	144	181	216
Reduced Programmatic Achievable	7	14	23	32	43	56	70	88	108	129
NOP Scenario 1	2	5	8	12	16	21	26	32	39	46
NOP Scenario 2	1	3	5	7	9	12	15	18	21	25

Source: Navigant

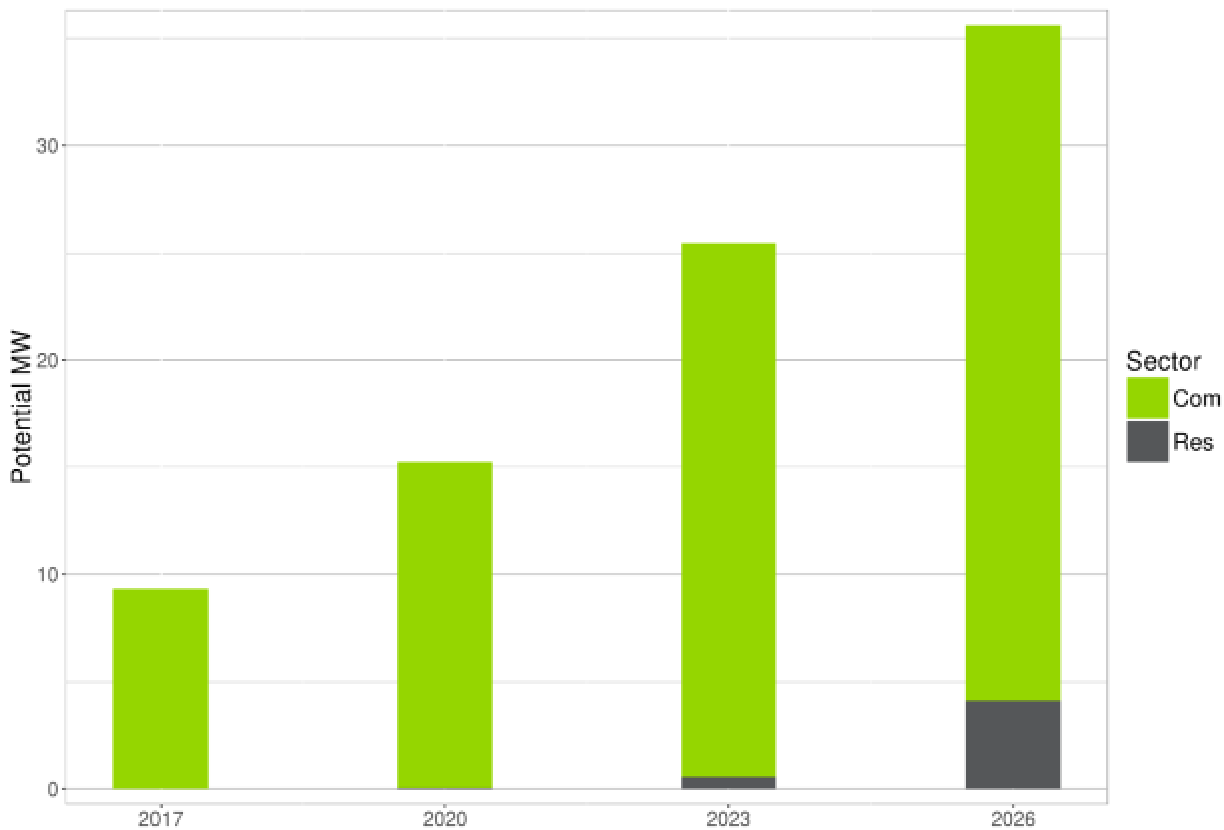
Table 99 and Figure 79 show the incremental programmatic achievable potential for commercial and residential respectively. Most of the programmatic achievable potential is in the commercial sector, which is to be expected because CHP systems are not readily available for the residential sector; thus, the potential for the residential sector is comprised entirely of smaller sized solar PV + energy storage systems.

Table 9. CSG Incremental Annual Programmatic Achievable Potential by Sector (MW, Nameplate)

Sector	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Commercial	9	11	13	15	18	21	25	29	33	31
Residential	0	0	0	0	0	0	1	2	3	4
Total	**9**	**12**	**13**	**15**	**18**	**21**	**26**	**30**	**37**	**35**

Source: Navigant

Figure 12. CSG Incremental Annual Programmatic Achievable Potential by Sector (MW, Nameplate)

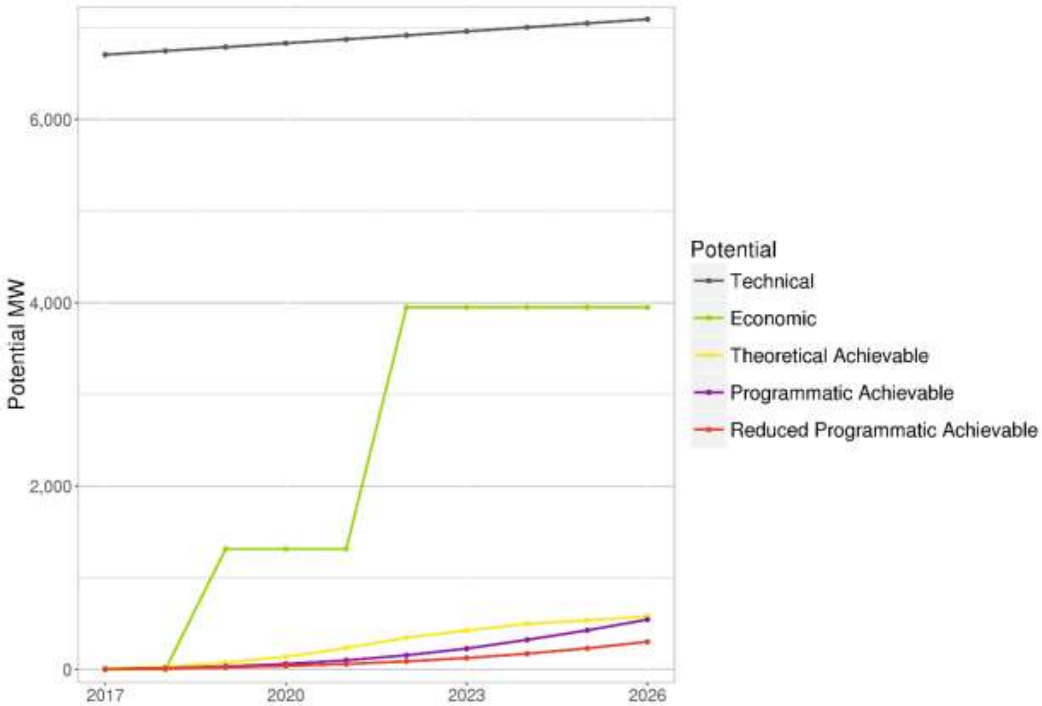


Source: Navigant

Energy Storage Potential

The energy storage analysis addressed the potential for a variety of behind-the-meter storage technologies. Figure 13 and Table 108 summarize the various levels of storage potential. The charts illustrate the fact that from a technical perspective, the storage potential within CECONY's territory is significant, at more than half of CECONY's peak demand. The economic potential is roughly half of the technical potential by 2026 and shows two significant step increases, representing when certain technologies become cost-effective as costs decrease due to increased market activities. Programmatic achievable potential is still less than 10% of the technical potential in 2026, which reflects that the estimated payback period for customers is projected to be high and limit customer adoption for most technologies over the lifetime of the study.

Figure 13. Storage Potential Results Summary



Source: Navigant

Table 10. Storage Cumulative Potential Forecast by Scenario (MW)

Potential Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Technical	6,706	6,747	6,789	6,831	6,873	6,917	6,960	7,004	7,048	7,093
Economic	0	0	1,314	1,314	1,314	3,950	3,950	3,950	3,950	3,950
Theoretical Achievable	12	30	73	139	234	348	425	497	535	582
Programmatic Achievable	6	14	33	61	100	155	229	324	427	545
Reduced Programmatic Achievable	4	9	22	38	60	88	125	172	231	302

Source: Navigant

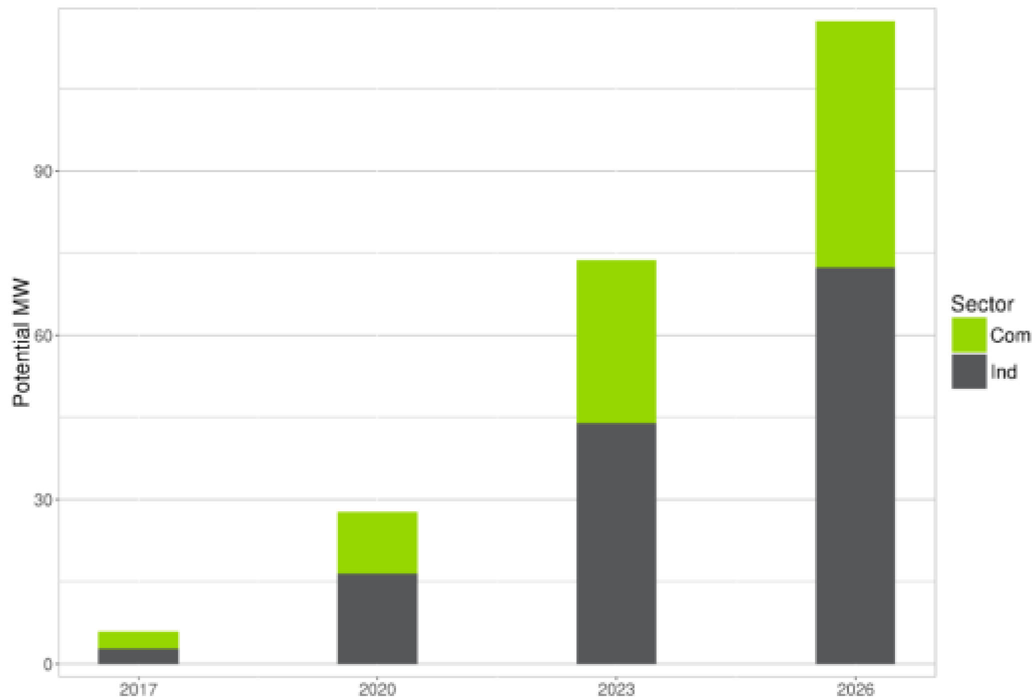
Table 11 and Figure 14 show the incremental achievable potential results by sector. Residential customers did not show any achievable potential, but this is expected because our analysis focused on economically driven installations. Residential customers do not have demand charges to avoid and do not have TOU rates. Most of the potential is in the industrial sector, which is expected because of the prevalence of demand charges and the nature of CECONY's industrial loads is most conducive to storage systems.

Table 11. Storage Incremental Annual Programmatic Potential by Sector (MW)

Sector	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Commercial	3	3	8	11	16	22	30	38	41	45
Industrial	3	4	11	16	23	33	44	57	63	72
Total	**6**	**7**	**19**	**27**	**39**	**55**	**74**	**95**	**104**	**117**

Source: Navigant

Figure 14. Storage Incremental Annual Programmatic Potential by Sector (MW)



Source: Navigant

Conclusions

This project has revealed several important insights. First, there is a significant amount of programmatic achievable potential in the CECONY territory for each of the DER types, particularly for energy efficiency and DR. The abundant opportunities for energy and peak demand savings for energy efficiency and DR relate to CECONY's ability to leverage its existing programmatic infrastructure to harvest new opportunities for participation. Second, there are the potentials to support opportunities for CECONY to initiate and expand CSG and storage programs. Third, the study's estimates of naturally occurring energy efficiency potential is quite high relative to the programmatic achievable potential which may inform future opportunities and strategies to capture and focus natural adoption trends and momentum.

More specific observations by resource type include:

- While significant energy efficiency achievable potential exists in the CECONY service territory, the magnitude of that potential is lower than was predicted in the 2010 potential study. This lower amount relates to the effects of newer codes and standards (local, state and federal) that drives more efficient appliances and equipment as well as the market being more saturated with efficiency due to the work of energy efficiency programs and customers' own energy efficiency adoptions.

- The large multi-family segment has the most potential of any single segment for both electric and gas energy efficiency savings in the CECONY service territory. This is an intuitive result given the significant size of this segment in the service territory (largest single segment of any).
- Large offices, single-family residential, NYPA commercial buildings, small offices, and restaurants provide the next greatest savings opportunities in terms of energy efficiency achievable potential.
- Growth in the energy efficiency potential for the residential segments over the 10-year time horizon starts strong and then tapers off once the lighting standard changes after 2020, whereas the commercial segments have higher levels of growth over the time horizon, relative to the residential segments.
- For DR, the most significant opportunity relates to dispatchable backup generators that are powered by gas or diesel. Other opportunities such as time-varying rates and automated controls show promise but their growth ultimately depends on AMI deployment and policies as well as other market initiatives aimed at increasing building automation.
- For CSG, CHP systems for multi-family common areas in the commercial sector show the largest magnitude of savings potential. The potential for solar PV with energy storage grows over time but has a slow market uptake during the early years.
- For storage, the largest magnitude of achievable potential is for the industrial/warehouse and large retail segments where facilities have the space available to accommodate these systems. Increased achievable potential occurs in the latter years as technology costs come down.

1. INTRODUCTION

This section provides an overview of the potential study, including background and study goals, a discussion of the report's organization, and key caveats and limitations.

1.1 Context and Study Goals

Con Edison Company of New York (CECONY) retained Navigant to complete a distributed energy resources (DER) potential study. Including current market baseline research and analysis as well as market potential outputs for DER by technology and by customer segment, the study follows the 2017-2026 timeframe. DER considered within this study include electric and natural gas energy efficiency, demand response (DR), customer-sited generation (CSG), and storage (STR). Navigant worked with CECONY to develop information on current levels and patterns of DER use in New York City and Westchester County, to characterize potential technologies that could be implemented to increase energy efficiency and demand management within CECONY's service territory, and develop estimates of technical, economic, and achievable DER potentials.

The study will be used as an input into CECONY's energy efficiency and demand management program and portfolio design strategies. Table 12 summarizes the various elements of the project scope.

Table 12. Potential Study Scope

Element	Dimensions
Forms of Energy	• Electricity (kW, kWh) • Natural Gas (Therms)
Types of Resources	• Electric and Natural Gas Energy Efficiency • Demand Response (DR) • Customer-Sited Generation (CSG) • Storage (STR)
Types of Potential	• Technical • Economic • Reduced Achievable (Electric Only) • Programmatic Achievable • Alternative Achievable • Theoretical Achievable • Theoretical – High Achievable (Gas Only) • Naturally Occurring
Sectors	• Residential • Commercial • New York Power Authority (NYPA)
Disaggregation	• Borough/Network
Timeframe	• 10 years (2017- 2026)

Source: Navigant

1.2 Organization of Report

This report is organized as follows:

- Section 2 describes the study approach, including the methodologies Navigant used for estimating potential for each of the resources. More specifically, the section outlines the potential scenario definitions, data collection, market characterization, and technology characterization used in the study.
- Section 3 provides the technical, achievable, and naturally occurring potential savings forecasts as well as the supply curve and budget estimates for electric energy efficiency, including the modeling results by sector, customer segment, end-use, and measure.
- Section 4 provides the technical, achievable, and naturally occurring potential savings forecasts as well as the supply curve and budget estimates for gas energy efficiency, including the modeling results by sector, customer segment, end-use, and measure.
- Section 5 provides the technical and achievable potential savings forecasts as well as the supply curve and budget estimates for demand response, including the modeling results by DR measure, customer segment, and program.
- Section 5 provides the technical, achievable, and naturally occurring potential savings forecasts as well as the supply curve and budget estimates for CSG, including the modeling results by sector, customer segment, and measure.
- Section 7 provides the technical and achievable potential savings forecasts as well as the supply curve and budget estimates for STR, including the modeling results by sector, customer segment, and measure.
- Section 8 offers an analysis of the results from Sections 3-7, including benchmarking and program suggestions for each resource.

The report also includes several Appendices, which provide additional information:

- Overview of Integrated Demand-Side Management (IDSM) Model
- Survey Instruments and Results
- Load Profiles
- Technology Characterization and Results by Resource

Navigant also prepared two separate supplemental reports for CECONY following the completion of this core DER potential study. These supplemental analyses included 1) further assessment of the potential for natural gas energy efficiency and DR and 2) the assessment of the impacts of changes to codes and standards on the energy efficiency electric and gas potential savings estimated in this core DER potential study. The results from this add-on work have not been integrated into the core DER potential study, but are provided in Appendices K and L for reference.

1.3 Caveats and Limitations

There are several caveats and limitations associated with the results of this study, as detailed below.

1.3.1 Program Design

The results of this study provide an overview of the unmet savings potential in CECONY's service territory. However, this potential study is not intended to provide, nor does it have information on, detailed program design. Different program designs and delivery mechanisms would inevitably result in different levels of efficient technologies adoption. This means that the output of this study serves as an estimate of what could be achieved under the specific set of assumptions outlined in this study, rather than an exact prediction of what will occur. Utilities typically design programs as a separate activity; therefore, program design is not included in the scope of this study.

1.3.2 Measure Characterization

The study's scope employed primary data collection techniques and a variety of secondary data sources (e.g., technical reference manuals [TRMs], studies from other jurisdictions, etc.) for estimates of measure savings, costs and market presence (e.g., saturations and densities). Navigant used primary data, specific to CECONY's service territory, wherever possible. Section 2 provides details of primary and secondary data sources relied upon in the study.

Furthermore, the team considered the measure list to appropriately focus on technologies likely to have the highest impact on savings potential over the potential study's horizon. However, several of the DER technologies considered in this study are relatively nascent in their adoption (e.g., behind-the-meter battery storage); therefore, savings, costs, and customer uptake are likely to change over the forecast horizon. Additionally, other emerging or disruptive technologies may arise that could increase savings opportunities over the forecast horizon, and broader societal changes may affect levels of energy use in ways not anticipated in the study. Due to the significant uncertainty associated with emerging technologies, this study reflects the best available view of the current market and does not make assumptions about emerging technologies beyond capturing a range of potential uncertainty through the scenario analysis (Section 2.3.4 details scenario specifics). Similarly, this study does not make assumptions about future code and standard changes beyond those already planned for the study period.

DER potential studies must make assumptions about the adoption of technologies that inevitably come with a degree of uncertainty. While techniques such as the use of payback acceptance curves and technology diffusion models provide reasonable aggregate estimates of savings potential, such techniques (which must be applied to dozens or in some cases hundreds of DER technologies) are limited in their ability to accurately predict adoption for specific measures or in specific customer segments. Model calibration steps (e.g., comparing forecast results with achieved results) seek to ground the forecasts in the real world, but the further one hones in on any particular technology or segment, inaccuracies may exist even if the aggregate results are considered reasonable. For this reason, aggregate results may be more reliable than individual technology or segment results, since forecasting inaccuracies at the measure level exhibit a pooling effect when aggregated up to the portfolio level. The pooling effect results in the offsetting of positive and negative differences at a finer level of aggregation in an aggregate result. While more in-depth technology adoption techniques exist for any given technology (e.g., discrete choice analysis), these techniques are not typically warranted in studies such as this, given that costs would need to dramatically increase to calibrate a different adoption model for each measure.

1.3.3 Measure Interactions

DER technologies in this study are modeled independently.[2] As a result, the total aggregated potential estimates may be different from the actual potential available if a customer installs multiple measures in his or her home or business. For example, if a customer implements an operational program to review and maintain steam traps, but also installs a more efficient boiler, the savings from the efficient boiler may be reduced to the extent that the steam trap program reduces heating requirements at the boiler. Due to the complexity of analyzing this type of interaction at scale, this study does not consider within-end-use interactions or the stacking of various measures.

However, this study did assess the impacts of significant cross end-use interactions. For instance, Navigant examined the effects of a homeowner replacing a number of heat producing incandescent light bulbs with efficient LEDs, which would impact the cooling and heating load of the space by increasing the amount of heat and decreasing the amount of cooling generated by the HVAC system. To account for these interactive effects, Navigant created competition groups to eliminate the potential for double counting savings, where measures compete for the same application (e.g., CFL and LED).

The analysis also assessed the potential for electric and natural gas energy efficiency independently. Thus, Navigant considered appreciable cross end-use interactions for the same fuel technologies (e.g., lighting and electric heating) but did not consider interactions for cross-fuel technologies (e.g., lighting and gas heating), as it was not in the scope of this analysis.

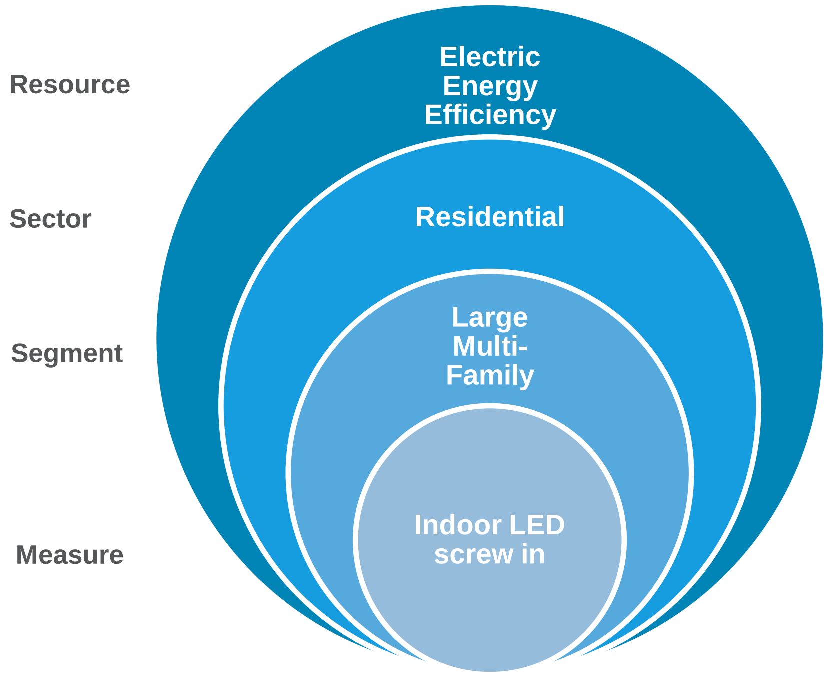
1.3.4 Interpreting Results

This report includes a high level account of savings potential results across CECONY's service territory and focuses largely on aggregated forms of savings potential. Figure 15 provides an example of the granularity of results available for a given resource, which can be disaggregated into potential by customer sector, customer segment, and individual measure. The potential for each resource type is also available through the lens of multiple different scenarios; by end-use; and at the borough-level (see the detailed results provided in Appendix F through Appendix J), as well as the service-territory level.

Navigant has also created an interactive web-based tool that summarizes the outputs for each DER potential scenario assessed as part of this potential study. Along with this final report, which summarizes results aggregated to the service territory level, the web-based 2017 CECONY DER Potential Study Results Viewer (Results Viewer) tool provides access to all detailed results from the IDSM and DSMSim models. The Results Viewer allows users to manipulate and visualize model outputs from the high level service territory standpoint all the way down to the granular borough-specific resource, sector, segment, and measure level. Navigant structured the Results Viewer so users can view summary results as well as detailed model outputs. The research team delivered these results and the viewer to CECONY as part of this study.

[2] A small number of measures, such as lighting measures, accounted for interactions among multiple efficient measures.

Figure 15. Example of DER Potential Results Granularity

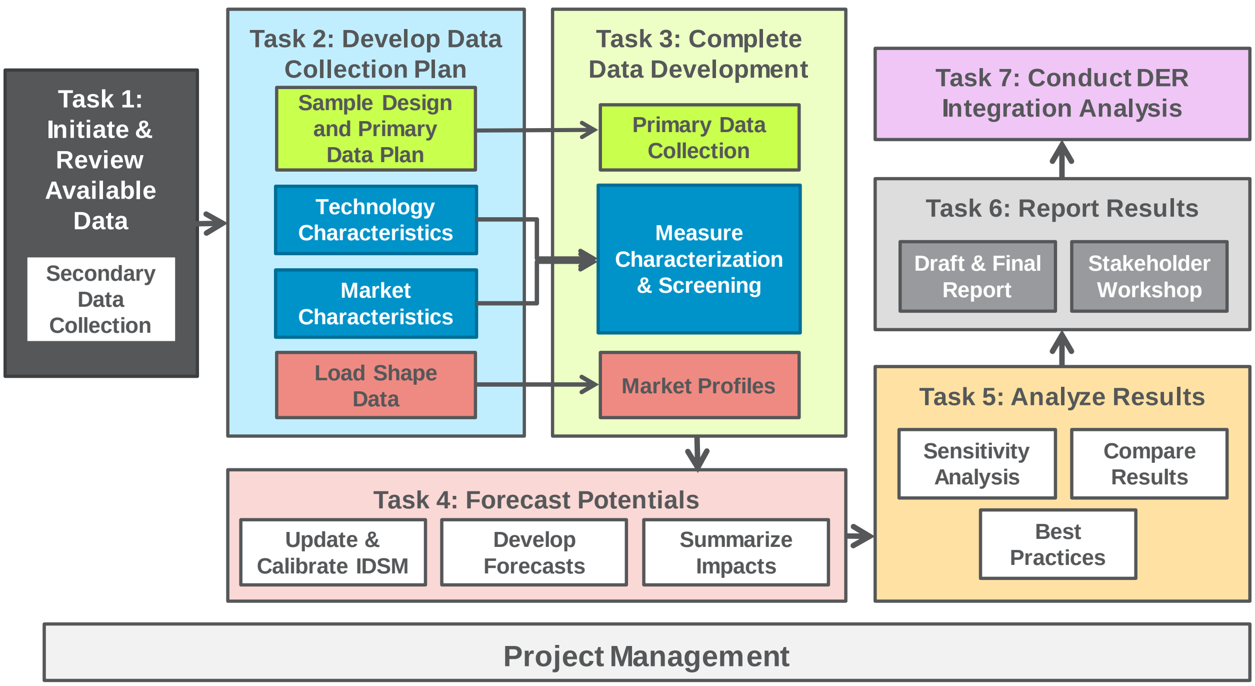


Source: Navigant

2. STUDY APPROACH AND DATA

Figure 16 illustrates the overall approach to the potential study. The potential study began with a detailed assessment of data sources specific to CECONY's service territory. Navigant then supplemented those sources with primary field data collection, including nested onsite validation of phone and online surveys, complemented by secondary sources. Following the primary data collection, the team assessed specific sectors (residential and commercial) and the various segments within those sectors, applied segment-specific load shapes and customer characteristics, and reviewed the impacts for both electric and gas energy efficiency measures, as well as the impacts for DR, STR, and CSG. Navigant imported all of this information into CECONY's IDSM model for electric results and Navigant's DSMSim™ model for gas results to generate borough-level and territory-wide estimates of DER potential.

Figure 16. Overview of DER Potential Estimation Approach



Source: Navigant

The outputs of the study include various potential estimations, including technical, economic, and achievable potential. The broadest estimation, technical potential, is defined as the savings that can be achieved if all installed measures can immediately be replaced with the DER technology, wherever technically feasible, regardless of the cost, market acceptance, or whether a measure has failed (or burned out) and needs replacement. Economic potential is a subset of technical potential, using the same assumptions regarding immediate replacement as in technical potential, but limiting the calculation only to those measures that have passed the benefit-cost test chosen for measure screening, which in this case is the societal cost test (SCT) per version 1.1 of the CECONY Benefit-Cost Analysis (BCA) Handbook methodology and values.[3] Achievable potential is a subset of economic potential, but further considers the likely rate of DER acquisition, which is driven by several factors including the rate of equipment turnover (a function of measure's lifetime), simulated incentive levels, budget constraints, consumer willingness to adopt new technologies, and the likely rate at which marketing activities can facilitate technology adoption.

For this resource assessment, Navigant employed Con Edison's IDSM model to estimate the technical, economic, and achievable potential for electric energy efficiency, DR, CSG, and STR savings and Navigant's DSMSim™ potential model to estimate these potential forecasts for gas energy efficiency savings. Both models are bottom-up technology diffusion models that calculate technical, economic, achievable, and naturally occurring potential by sector, customer segment, and measure.

As agreed upon with CECONY, the results presented in this study are net, rather than gross savings, with net-to-gross (NTG) factors applied to measure savings to account for free ridership and spillover at the measure level. A NTG of 0.9 is being applied to all the energy efficiency measures[4] and 1.0 for all others.[5]

The remainder of this section describes the methodologies Navigant employed for estimating electric and natural gas savings across CECONY's service territory, including the primary data collection techniques, the approach taken in the characterization of CECONY's market, the method for characterizing the DER technologies used in the analysis, and the modeling framework used to estimate various level of DER potential.

2.1 Primary Data Collection

The following section describes Navigant's approach for primary data collection, as well as the method for analyzing the collected customer data. For a discussion of Navigant's market characterization process, see Section 2.2.

2.1.1 Customer Primary Data Collection Approach

Navigant used a combination of customer phone surveys, online surveys, and onsite visits to collect primary data regarding electricity and natural gas usage in CECONY's service territory. Navigant employed a nested double stratified ratio estimation approach to randomly select residential and commercial customers for the surveys and onsite visits. Double ratio nested sampling utilizes two data collection phases. The first phase was used to sample many participants from the population for phone or online surveys. This was augmented by a more involved and detailed second phase applied to a select subset of participants for onsite verification.

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3 CECONY Benefit Cost Analysis Handbook, V1.1, August 19, 2016, https://www.coned.com/-/media/files/coned/documents/dg/dsp/pdf/coned-bcah.pdf?la=en

4 The NTG ratio for energy efficiency is based on New York's deemed NTG value of 0.9. Examining the Net Savings Issue: A National Survey of State Policies and Practices in the Evaluation of Ratepayer-Funded Energy Efficiency Programs. ACEEE. 2014. ,

5 Limited industry data exists on NTG ratios for DR, CSG, and STR; additionally, much of the DER resource uptake is likely to occur through programs, as a direct result of the program, particularly for DR and STR. Thus, the NTG ratios are assumed to be 1.0 for these resources in this study.

In the first phase, Navigant randomly sampled 750 residential and 934 commercial customers for online and phone surveys from the total customer population in CECONY's service territory. Navigant stratified the sample based on building type and designed the sample with the goal of maintaining a confidence level of 90% with a +/-10% margin of error (i.e., "90/10") across each segment.

Navigant determined that the best, most effective and economic method for collecting data from residential customers was to use CECONY's residential customer panel to conduct the residential online surveys. Since CECONY's commercial customer panel primarily consists of smaller businesses, Navigant selected Market Strategies International (MSI) to conduct the commercial phone surveys outside of the panel.[6] Navigant also selected Mad Dash, Inc. to conduct the onsite surveys for both residential and commercial customers.[7] Table 13 provides an overview of the sample targets and number of completes. This section details each data collection approach.

Table 13. Survey and Onsite Sample and Number of Completes

Sector	Stratification	Survey Type	Survey Sample Target	Survey Completes	Onsite Sample Target	Onsite Completes
Residential	Home Type	Online	750	739	75	75
Commercial	Business Segment	Phone	934	372	100	83

Source: Navigant

Navigant, in partnership with CECONY's customer panel, ultimately completed 739 residential online surveys and 75 onsite surveys, reaching 90/10 in the multi-family 5+ unit stratum and just coming in under target for the remaining two strata. The commercial surveys proved more challenging to complete due to several factors. A third of the commercial sample did not result in contact with the customer, there was either no answer, a busy signal, or only voicemail. Over 50% of the sample refused to participate or were uncooperative in completing a survey. An additional 6% of customers were deemed ineligible or had a language barrier and could not complete a survey. The response rate was roughly 5% for this survey. It was also difficult to reach the most informed person about the facility's energy and equipment usage[8] and encouraging commercial customers to participate in a 20-minute or more survey. In some targeted cases (e.g., hospitals), the team tried additional methods, including leveraging CECONY's account representatives for outreach. However, even while applying a multi-prong outreach effort, the commercial completion rates came in below the sample targets for all strata except for one, prohibiting the study from reaching its 90/10 confidence and precision targets. Thus, Navigant used secondary data to complement the surveys. A detailed discussion of all secondary data sources used to inform the electric and gas energy efficiency measure characterization parameters is provided in the Section 2.4.3 Electric Energy Efficiency Technology Characterization Data Sources and Section 2.5.3 Gas Energy Efficiency Technology Characterization Data Sources respectively.

[6] Market Strategies International, "Communications Research," http://www.marketstrategies.com/en/services/communications-research.aspx.

[7] Mad Dash, "Field Survey Connect," http://www.maddash.com/field-survey-connect/.

[8] Navigant also conducted a web-scraping effort that searched for publicly-available contact information for employees with titles like "facility manager" in harder-to-reach stratum. Navigant provided this additional sample to MSI to help supplement the customer contact data from CECONY's billing system and offered the survey to these customers.

Prior to implementing the surveys and onsite visits, Navigant provided all data collection instruments to CECONY for review. Before going into the field to complete these surveys and site visits, Navigant worked with CECONY to draft introductory letters, coordinate contacts with non-residential customers through CECONY Account Managers, and ensure that CECONY's call center staff knew of the study activities. Navigant's team also provided training for subcontractors before they went into the field.

Navigant incorporated quality control (QC) throughout the data collection processes. The team conducted multiple iterations of QC at every step, starting with preparation through the study's completion. The Navigant team also utilized QC tools to ensure that the data collection activities accurately captured site and equipment conditions. Data quality assurance started with the fundamental survey design; questions were identified as either "reasonable as customer reported" and included in the surveys, or "requires third-party verification" and included in the site visits. Once the initial survey design was completed, surveyors and field technicians piloted the data collection tools to ensure the proper data was collected to the project's standards; this feedback and refinement of the survey instrument was conducted by highly experienced staff as well as team management.

Once the final survey instrument was approved, Navigant conducted training for all its subcontractors to ensure a unified approach and quality standard for data collection and data entry. To further ensure data quality, the Navigant data collection tools have requirements for the acceptable data type and response ranges for each question and data point; this enables the team to collect the most accurate data and avoid outliners or errors during data collection and data entry. Once data is collected, it was reviewed daily by an engineer for accuracy and completeness.

Further QC was built into the code used to process the data. In addition to automated QC checks, the survey data was assessed both manually and using statistical approaches. The manual part of this review step involved comparing the survey results to similar data from previous studies and, when available, secondary resources. For instances where this manual review identified data points with significant variances between sources, experienced staff reviewed the data to determine if market shifts could explain the directionality and magnitude of the deviation. If so, then the survey data was allowed to remain in use; if not, the data was excluded from use. Similarly, any results that fell outside of the statistical bounds was also excluded from use and replaced with secondary data sources.

The remaining outputs from the analysis was then subjected to multiple layers of review by senior engineers, team managers, as well as professionals from CECONY that are familiar with the territory as well as the technology assessed. Any items of concern flagged in this stage were then discussed by the Navigant team in order to assess a conservative and defensible path forward.

The final, combined dataset (with survey results as well as secondary data inputs) is further vetted once it is incorporated into the final IDSM model. This is a naturally occurring process as the impacts from any unreasonable inputs are magnified over the multiyear forecast.

These rigorous, multi-stage QC checks enabled Navigant to assure that only the most reliable data is included in the final deliverables. Therefore, even though the achieved sample sizes are smaller than desired, the end result combines the best available data for each individual model input.

2.1.1.1 Residential Online Survey

The primary objectives of the residential online survey included determining CECONY's residential customer characteristics (e.g., home type, size, etc.), energy types used, and equipment characteristics. Navigant then used this information to develop estimates of equipment saturations and densities for residential DER measures. The survey approach focused on questions that residents could realistically answer, rather than more technical questions about efficiency levels. The information gathered on equipment age and characteristics helped to inform estimates of equipment efficiency levels in combination with the secondary data discussed in Sections 0 to 2.8.

Navigant collected primary technology and market characteristic data on CECONY's residential customers through the online survey in the following areas:

- Housing characteristics
- Heating
- Cooling
- Thermostats and Controls
- Water Heating
- Indoor Lighting
- Outdoor Lighting
- Lighting Controls
- Refrigeration
- Stove, Range/Oven
- Clothes Washer/Dryer
- Dishwasher
- Household Electronics
- Insulation
- Load Control/DR
- Distributed Generation
- Energy Storage
- EVs

CECONY employed its residential panel to field the online residential survey and completed 739 surveys.

2.1.1.2 Commercial Phone Survey

The primary objectives of the commercial phone survey included determining firmographics of the businesses in CECONY's service territory (e.g., facility type, size, usage patterns, etc.), equipment saturations, energy types used, and equipment characteristics. As with the residential survey, the commercial survey focused on questions that respondents could confidently answer regarding equipment types, energy sources used, and equipment age, as well as information regarding their firm and facilities.

Navigant collected primary technology and market characteristic data on CECONY's commercial customers through the phone survey in the following areas:

- Building characteristics
- Heating
- Cooling
- Water Heating
- Lighting
- Energy Management Systems
- Computing/Office equipment
- Refrigeration
- Food Preparation
- Motors, Variable Speed Drives, and Pumps
- Back-up Generator
- Load Control/DR
- Distributed Generation
- Energy Storage

While Navigant ultimately used the census of contact information provided to try and reach the target number of completes, commercial customers proved to be difficult to incentivize for a phone survey, as discussed above. Ultimately, Navigant completed 372 commercial phone surveys.

2.1.1.3 Customer Onsite Survey

The Navigant team's residential and commercial onsite approach involved onsite inspection activities to gather specific information on equipment and operating characteristics. Verification activities included the following:

- Collection of nameplate and other performance-related data for all technologies included within the phone/online surveys.
- Observation of control systems and schedules (e.g., occupancy sensors, energy management systems [EMS]).
- Discussions with building operators about building construction features, occupancy schedules, and energy systems characteristics and operation.
- Navigant inspected each technology or area from each site's phone/online survey and also obtained additional detail that either the customer could not supply or that needed to be collected or verified in-person. A thorough QC was completed for each site to ensure the data was suitable for analysis.
- Navigant's onsite protocols developed specific steps and actions to ensure completeness of data collection tasks. The Navigant team reached out to the field crews and/or the customer to verify any missing or questionable information following a site visit.
- The Navigant team reviewed the onsite findings for reasonableness prior to conducting analysis.

2.1.2 Survey Analysis Approach

Navigant leveraged the nested sample design to improve the overall rigor of the survey data collection process. To do this, the team directly compared the data collected through onsite visits with the online and phone survey responses to calculate adjusted saturations and densities. Navigant then used these adjusted values to update and calibrate the measure characterization and select global inputs in the model.

For the purposes of this analysis:

Density is defined as the total number of baseline and efficient measures in a household or per square foot in a commercial building. Some examples of survey questions that yielded density values include:

Q: "For each of the following appliances, how many are in use in your household?"

Q: "Of the following types of refrigeration equipment, how many of each are present at your facility?"

Saturation is defined as the portion of the total number of baseline and efficient measures in a home or per square foot in a commercial building that are efficient. For example, the saturation of residential LED lighting is equivalent to the portion of the total number of baseline and efficient light bulbs in the average household that are LEDs.

Navigant's analysis of primary data included the following steps:

1. Develop statistical analysis of survey responses by question and survey type (phone, online, and onsite).
2. Validate the responses from surveys (i.e., phone and online) with the onsite data for both residential and commercial customers. This step included comparing the survey responses with the onsite data and developing question level adjustment factors based on the differences in survey and onsite responses.[9]
3. Check individual adjustment factors for statistical validity.[10]
4. Aggregate adjusted saturation and density values by strata to determine adjusted, but unweighted, results.
5. Develop and apply a weighting factor to maintain the representativeness of each stratum developed for both residential and commercial customers.
    a. The Residential weighting factor is based on a per home[11] basis.
    b. The Commercial weighting factor is based on a per square foot basis.
6. Updated the saturation and density values used for measure characterization and select global inputs with primary data.

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[9] Navigant calculated the adjustment factors as the median value of the ratio of matched onsite and survey responses; i.e., the sample is reduced to only those participants with a matched pair (onsite plus online or phone), the ratio of this matched pair is determined, then the ratio of all matched pairs are averaged to create the question-specific adjustment factor.

[10] In some cases, sample size for the onsites are too small to calculate statistically valid adjustment factors, either due to incomplete customer responses for particular questions or some of the smaller commercial customer segments having a limited number of onsite visits completed. Only adjustment factors with sufficient supporting data are used. This step ensures that an adjustment factor based on a tiny fraction of responses does not impose undue influence on the larger set of phone or online responses.

[11] For multi-family dwellings, each unit is considered a home.

2.1.2.1 Residential Survey Response Rate

Table 14. Residential Survey Response Rate

Navigant Stratum	Sample Design		Online			Onsite	
	Population	90/10 Online Target	Online Completes vs. Target	Completed	Percentage of Responses	Completed	Percentage of Responses
Single-Family	646,989	162	97%	157	21%	40	53%
Multi-family 5+ units	1,583,123	398	101%	400	54%	29	39%
Multi-family <5 units	678,878	190	96%	182	25%	6	8%
Total	**2,908,990***	**750**	**99%**	**739**	**100%**	**75**	**100%**

** Sample design did not include NYPA customers*
Source: Navigant

2.1.2.2 Commercial Survey Response Rate

Table 15. Commercial Survey Response Rate

Navigant Stratum	Sample Design		Phone			Onsite	
	Population	90/10 Phone Target	Phone Completes vs. Target	Completed	Percentage of Responses	Completed	Percentage of Responses
Education - Higher	5,735	69	22%	15	4%	1	1.2%
Education K-12		69	30%	21	6%	8	9.6%
Miscellaneous/ Entertainment	19,366	73	30%	22	6%	4	4.8%
Grocery	9,659	71	10%	7	2%	1	1.2%
Hospital	997	68	7%	5	1%	1	1.2%
Office	102,149	151	62%	94	25%	21	25.3%
Retail	51,900	146	62%	90	24%	26	31.3%
Multi-Family (common areas)	173,940	73	41%	30	8%	8	9.6%
Nursing Home/Lodging	7,723	70	13%	9	2%	2	2.4%
Restaurant	23,890	72	24%	17	5%	3	3.6%
Warehouse and Industrial	28,000	72	86%	62	17%	8	9.6%
Total	**422,578**	**934**	**40%**	**372**	**100%**	**83**	**100%**

** Sample design did not include NYPA customers; Education - Higher and Education K-12 combined for the overall population*
Source: Navigant

2.1.3 Survey Findings Limitations and Caveats

As seen in the above tables, the commercial survey participation rates were insufficient to achieve the desired 90/10 confidence and precision targets. For this reason, the results for some questions are further supported with additional secondary research. A detailed discussion of all secondary data sources used to inform the electric and gas energy efficiency measure characterization parameters is provided in Section 2.4.3, "Electric Energy Efficiency Technology Characterization Data Sources," and in Section 2.5.3, "Gas Energy Efficiency Technology Characterization Data Sources."

2.2 Market Characterization

This section provides the values used by Navigant for the base case forecast of electric and natural gas customers, square footage, and sales over the study period in CECONY's service territory, including the segmentation by borough (for electric) or account type (for gas), housing or building type, and fuel type. Navigant used the customer count (i.e., "households" for residential segments) to scale the costs, savings, and other characteristics of residential energy efficiency measures and all DR, CSG, and STR measures. Navigant used the amount of square footage to scale commercial energy efficiency measure characteristics. Below the tables, this section also describes Navigant's approach for developing these values.

2.2.1 Electric Households, Square Footage, and Sales Data Values

Table 16, Table 17, Table 18, and Table 19 below summarize the electric households, square footage, and actual sales (i.e., not weather normalized) based on data pulled in mid-August 2017 by customer segment and borough used in the study.[12] The consumption values are based on the previous 12 months from when the data was pulled. Navigant applied growth factors to each of these numbers, as summarized in Section 2.2.4.

Table 16. Residential Electric Households by Borough in 2017

Residential Segment	Bronx	Brooklyn	Manhattan	Queens	Staten Island	Westchester	Totals
Single Family	41,282	127,634	4,786	236,365	91,664	145,258	**646,989**
Small Multi-Family	80,154	284,176	20,432	186,895	53,578	53,643	**678,878**
Large Multi-Family	271,016	381,067	579,734	240,916	14,812	95,578	**1,583,123**
NYPA	57,888	61,353	95,024	15,806	6,644	11,327	**248,043**
Totals	**450,340**	**854,230**	**699,976**	**679,982**	**166,698**	**305,806**	**3,157,033**

Source: Navigant

[12] It is important to note that the values used in this study do not match the official company published numbers and should not be used for other purposes beyond potential study calculations. This is because the numbers below are based upon a data cleaning exercise that was specific to the study for the purposes of scaling measure savings and costs for a particular set of customer segments.

Table 17. C&I Electric Floor Space (1000s Square Feet) by Borough in 2017

C&I Segment	Bronx	Brooklyn	Manhattan	Queens	Staten Island	Westchester	Totals
Education	6,559	10,004	28,473	8,715	1,816	9,507	**65,074**
Grocery	9,348	14,370	19,714	10,827	2,374	7,762	**64,395**
Hospital	2,353	3,203	7,425	4,383	707	5,436	**23,507**
Large Office	12,302	23,948	260,136	16,027	1,853	24,907	**339,172**
Large Retail	5,033	12,802	43,539	12,927	3,019	10,931	**88,251**
Miscellaneous/ Entertainment	13,420	39,996	68,925	35,463	5,655	31,116	**194,575**
Multi-Family - Common Area	87,443	134,761	259,680	84,149	5,027	66,549	**637,609**
Nursing Home/Lodging	8,695	13,203	22,391	9,235	2,958	12,672	**69,154**
NYPA - Com	57,083	88,546	123,679	86,770	20,725	23,137	**399,939**
Restaurant	9,887	20,134	58,294	17,360	2,870	11,027	**119,572**
Small Office	28,854	69,671	161,559	72,083	9,723	52,429	**394,318**
Small Retail	15,647	34,920	49,796	25,682	4,880	14,310	**145,234**
Warehouse/ Industrial	20,659	50,541	57,474	44,710	6,840	38,558	**218,781**
Totals	**277,281**	**516,099**	**1,161,085**	**428,331**	**68,447**	**308,341**	**2,759,583**

Source: Navigant

Table 18. Residential Electric Consumption (MWh) by Borough, August 2016 through July 2017

Residential Segment	Bronx	Brooklyn	Manhattan	Queens	Staten Island	Westchester	Totals
Single Family	255,438	809,660	78,854	1,387,070	694,312	1,513,550	**4,738,884**
Small Multi-Family	400,472	1,336,592	131,090	832,822	308,206	270,877	**3,280,059**
Large Multi-Family	1,216,217	1,634,621	3,663,383	1,031,461	77,927	470,061	**8,093,670**
NYPA	339,614	499,967	527,981	132,322	46,232	52,995	**1,599,111**
Totals	**2,211,741**	**4,280,840**	**4,401,308**	**3,383,675**	**1,126,677**	**2,307,482**	**17,711,724**

Source: Navigant

Table 19. C&I Electric Consumption (MWh) by Borough, August 2016 through July 2017

C&I Segment	Bronx	Brooklyn	Manhattan	Queens	Staten Island	Westchester	Totals
Education	79,206	113,363	413,305	63,479	16,036	78,242	**763,631**
Grocery	188,060	328,173	264,207	268,563	43,876	133,579	**1,226,459**
Hospital	36,931	87,277	174,604	89,536	18,085	54,948	**461,381**
Large Office	221,411	329,344	4,666,556	328,851	50,675	428,872	**6,025,709**
Large Retail	88,797	172,184	752,457	199,160	51,276	213,678	**1,477,551**
Miscellaneous/ Entertainment	83,240	265,394	641,326	237,592	38,004	181,009	**1,446,566**
Multi-Family - Common Area	596,541	741,896	2,744,453	499,772	52,910	317,093	**4,952,665**
Nursing Home/ Lodging	120,624	179,988	540,192	121,598	36,958	117,675	**1,117,036**
NYPA - Com	702,709	939,940	1,570,987	979,454	239,137	252,260	**4,684,486**
Restaurant	189,647	399,699	899,577	365,070	70,913	204,707	**2,129,612**
Small Office	278,561	605,339	1,695,634	558,333	94,690	427,232	**3,659,789**
Small Retail	172,726	331,401	457,136	291,129	59,940	140,095	**1,452,427**
Warehouse/ Industrial	142,355	392,620	771,625	353,042	124,156	217,010	**2,000,808**
Totals	**2,900,809**	**4,886,617**	**15,592,058**	**4,355,579**	**896,655**	**2,766,399**	**31,398,118**

Source: Navigant

As noted in the tables above, the large multi-family segment is the largest consumer of electricity in CECONY's territory, followed by large offices, multi-family common areas, single family homes, and NYPA-commercial. On a square footage basis, multi-family common area is almost twice as large as large offices—suggesting that the electric energy intensity is much higher for large offices than for multi-family common areas, which have higher gas consumption (as discussed below).

For the purposes of this report, sector-level results are presented as residential, commercial, and industrial, where industrial is based on the Warehouse/Industrial segment presented in the tables above and includes customer types like manufacturing, construction, and warehouse.

2.2.2 Gas Households, Square Footage, and Sales Data Values

Table 20, Table 21, Table 22, and Table 23 summarize the natural gas households, square footage, and sales based on data pulled in August 2017 by customer segment and account type used in the study.[13] The consumption values are based on the previous 12 months from when the data was pulled. Navigant

[13] It is important to note that the values used in this study do not match the official company published numbers and should not be used for other purposes beyond potential study calculations. This is because the numbers below are based upon a data cleaning exercise that was specific to the study for the purposes of scaling measure savings and costs for a particular set of customer segments.

did not consider interruptible gas customers in this study. Navigant applied growth factors to each of these numbers, as summarized in Section 2.2.4.

Table 20. Residential Gas Households by Account Type in 2017

Residential Segment	Heating - Firm	Non-Heating Firm	Interruptible	Totals
Single Family - Res	[redacted]			
Small Multi-Family - Res				
Large Multi-Family - Res				
Totals				

Source: Navigant

Table 21. C&I Gas Square Footage by Account Type in 2017

C&I Segment	Heating – Firm	Non-Heating Firm	Interruptible	Totals
Education	[redacted]			
Grocery				
Hospital				
Large Office				
Large Retail				
Miscellaneous/Entertainment				
Multi-Family - Common Area				
Nursing Home/Lodging				
Restaurant				
Small Office				
Small Retail				
Warehouse/Industrial				
Totals				

Source: Navigant

Table 22. Residential Gas Consumption (thousand dth) by Account Type, August 2016 through July 2017

Residential Segment	Heating - Firm	Non-Heating Firm	Interruptible	Totals
Single Family - Res	[redacted]			
Small Multi-Family - Res				
Large Multi-Family - Res				
Totals				

Source: Navigant

Table 23. C&I Gas Consumption (thousand dth) by Account Type, August 2016 through July 2017

C&I Segment	Heating - Firm	Non-Heating Firm	Interruptible	Totals
Education	[redacted]			
Grocery				
Hospital				
Large Office				
Large Retail				
Miscellaneous/Entertainment				
Multi-Family - Common Area				
Nursing Home/Lodging				
Restaurant				
Small Office				
Small Retail				
Warehouse/Industrial				
Totals				

Source: Navigant

The tables above show that the large multi-family segment is the largest consumer of gas in CECONY's territory, followed by multi-family common areas and, to a lesser degree, single family homes, small offices, and small multi-family homes.

For the purposes of this report, sector-level results are presented as residential, commercial, and industrial, where industrial is based on the Warehouse/Industrial segment presented in the tables above and includes customer types like manufacturing, construction, and warehouse.

2.2.3 Households, Square Footage, and Sales 2017 Data Development Methodology

Navigant developed two key global datasets to represent the customers and building stock in CECONY's service territory in 2017. The first, AccountInfo.csv, is a dataset of annual kWh consumption, peak kW demand, and customer counts split by customer segment and network. The second, CTInfo.csv, is a dataset of square footage by customer segment and network. Both datasets are read directly into the IDSM model. To generate these datasets, Navigant cleaned and manipulated two databases (i.e., accounts and buildings) that CECONY provided. Accounts contained one row per customer and included the following data points:

- Customer segment as identified by CECONY
- Network as identified by CECONY
- Annual kWh consumption; note: Navigant included customers that have zero electric consumption
- Peak kW; note: for instances when peak demand was blank, Navigant used an average customer load factor (i.e., peak kW per annual kWh) to infer the peak demand value
- Service classification

The Buildings database contained one row per building with square footage values for each borough-block-lot combination. The team then used borough-block-lot combinations to combine the buildings database with the accounts database. Often, many accounts were mapped to the same borough-block-lot combination. For these cases, Navigant used each account's ratio of kWh consumption to total consumption with the borough-block-lot combination to split the square footage across the accounts. For instances where accounts did not match with any borough-block-lot combination in the "Buildings" database, the team inferred a square footage value using the average kWh per square foot per customer segment from the known values.

The fundamental purpose of the CTInfo and AccountInfo read-in files was to scale the deployment of measures (and thus savings, benefits, and costs). In general, residential energy efficiency measures are scaled by customer count, and commercial measures are scaled by square footage. The remaining DER categories (i.e., DR, CSG, STR) are scaled by customer count.

2.2.4 Growth Factors for Customer Count, Square Footage, and Energy

Navigant applied growth factors to three key parameters in the IDSM and DSMSim models: customer count, square footage, and network energy.

- For customer count and square footage growth factors, Navigant developed average annual growth factors using the Dodge Reports of new construction. These factors scale up or down the number of customers and the building stock in each network. Based on this analysis, Navigant applied the following scaling factors by borough (which map one-to-many to networks without overlap):
    - Brooklyn, 0.63%
    - Queens, 0.96%
    - Westchester, 0.42%
    - Bronx, 0.69%
    - Staten Island, 0.63%
    - Manhattan, 0.63%
- For network energy growth factors, Navigant leveraged load data from the NYISO Gold Book[14] to develop annual growth factors. Because this data is provided by NYISO zone, the team calculated two growth factors: Westchester (i.e., -0.419% per year, based on a weighted average of NYISO zones H and I) and Rest of NYC (i.e., -0.315%, based on NYISO zone J).

2.2.5 Avoided Cost Data Methodology

Avoided energy costs are based on a forecast of hourly locational based marginal prices, or LBMPs, ($/MWh) by the New York Independent System Operator (NYISO) zone from 2016 to 2034 from the CARIS 2 study, and provided to CECONY by the Department of Public Service (DPS) staff. This is per the guidance provided in the BCA Handbook.

[14] New York Independent System Operator, Inc., *2016 Load & Capacity Data*, http://www.nyiso.com/public/webdocs/markets_operations/services/planning/Documents_and_Resources/Planning_Data_and_Reference_Docs/Data_and_Reference_Docs/2016_Load__Capacity_Data_Report.pdf, April 2016, Table 1-2a.

Avoided generation capacity costs in $/kW per year by NYISO zone are based on the DPS ICAP Model which forecasts the NYISO Capacity Market, also per the BCA Handbook.

Avoided transmission and distribution (T&D) costs are based on Table A-3 in the CECONY BCA Handbook.. These are provided on a borough-level in $/kW per year. Per the BCA Handbook, Navigant used three T&D capacity values: transmission, primary distribution, and secondary distribution.

2.2.6 Load Shapes Methodology

Navigant used three types of hourly load shapes in the IDSM model: system, network, and end-use.

- **System:** Navigant developed the system load shapes as a summation of 83 individual network shapes. IDSM calculates peak capacity allocation factors[15] (PCAFs) from the system load shapes and then uses measures' weighted average demand reduction values to calculate avoided generation capacity benefits.
- **Network:** CECONY provided hourly loads for each of the 83 networks. For the IDSM model's potential mode, Navigant used a many-to-one map without overlap of networks-to-borough. The model sums the network loads mapped to each borough to calculate a borough-level hourly load shape. From these borough-level hourly load shapes, IDSM calculates PCAFs and uses measures' weight average demand reduction values associated with those PCAFs to calculate avoided T&D capacity benefits.
- **End-Use:** Navigant developed normalized end-use load shapes (discussed further in the following section) for each customer segment and end-use. The team mapped each energy efficiency measure to an end-use load shape and then used the mappings to spread the annual kWh savings input into kW savings in each hour over the course of the year. The model then used the PCAF method to weight these hourly demand impacts based on when system or network capacity is needed most. This weighted average represents the demand savings of each measure and is discussed in later sections.

2.2.7 Load Profiles and End-Use Load Shape Development

This task represents an extension and update of the end-use load shapes development efforts from the 2014 IDSM study for CECONY. For the 2017 DER potential study, Navigant updated various aspects of the methodology and data sources used to create the end-use load shapes.

Navigant developed an 8,760 normalized, end-use load shape library to support scenario-specific assessments of specific energy efficiency, DR, CSG, and STR technologies that are being included and assessed as part of this project. As part of this task, Navigant created representative end-use load shapes for each customer segment identified by CECONY. Representative end-uses and customer segments are shown below in Table 24 and Table 25.

[15] The PCAF method allocates the capacity cost to hours of the year based on the relative amount that the load in each hour exceeds the threshold. The peak period is defined as the top 100 hours with the highest load; therefore, the threshold is defined as the load in the 101th highest hour.

Table 24. Residential and Commercial Building Segments for Load Shape Development

Residential Segments	Commercial Segments
Single-Family	Large Office
Small Multi-Family	Small Office
Large Multi-Family	Restaurant
NYPA - Residential[16]	Large Retail
	Small Retail
	Grocery
	Warehouse/Industrial
	Education
	Hospital
	Nursing Home/Lodging
	Miscellaneous/Entertainment
	Multi-family – Common Area
	NYPA - Commercial[17]

Source: Navigant

Table 25. End-Use Load Shapes

Load Shape End Uses
Total Facility (Electric)
Lighting Interior (Electric)
Lighting Exterior (Electric)
Plug Loads (Electric)
Cooling (Electric)
Heating (Electric)
Fans/Ventilation (Electric)
Refrigeration (Electric)
Hot Water (Electric)
Total HVAC (Electric)
Total Facility (Gas)
Heating (Gas)
Hot Water (Gas)
Interior Equipment (Gas)

Source: Navigant

A mapping of energy efficiency measures to end-use load shapes can be found in the electric and gas measure input workbooks attached in Appendix F and Appendix G, respectively.

[16] NYPA-Residential load shapes are sourced from the Large Multi-Family segment

[17] NYPA-Commercial load shapes are calculated as the average load shapes from the Small and Large Office segments

2.2.7.1 Load Profiles Development Approach

Navigant used the EnergyPlus building simulation software to run prototypical building energy models for residential and commercial customers. Navigant also used the US Department of Energy (DOE) commercial building reference models to complete the simulations, which were representative of typical building constructions and represent typical energy and demand for buildings within the commercial building stock.[18] Navigant used the single-family residential model developed for the International Energy Conservation Code 2006 energy code baseline for the residential single-family building models.[19]

Navigant also utilized actual meteorological year (AMY) weather data for Central Park, New York in the EnergyPlus modeling environment. Navigant ran the building energy models with both 2013 and 2015 AMY weather files for the purpose of calibrating the building models and ensuring the models reflected load consumption shapes for buildings in the CECONY service territory. In collaboration with CECONY, Navigant selected 2013 as a representative weather year for use in the building energy simulations used to inform the IDSM model. [20]

CECONY provided Navigant with interval data containing hourly building energy consumption for thousands of residential and commercial buildings across the CECONY service territory. Navigant mapped these customers to the appropriate residential or commercial segment based on North American Industry Classification System (NAICS) code for the customer account. Navigant then processed this interval data to develop average daily load shapes for each of the CECONY building segments. The team then used these load shapes to visually calibrate the load shape outputs from the respective building models for both 2013 and 2015 model years.

Navigant then used the average daily load shapes from CECONY interval data to adjust parameter input assumptions in the respective building models. Navigant adjusted building model input parameters to match the on-peak and off-peak energy consumption shapes, and to ensure that the total facility energy peaks developed with the building models lined up temporally with the system peaks represented with the interval meter data.

Navigant made the following key updates to the building energy models and the load shape analysis:

- The team referenced the ERS Brooklyn Queens Demand Management metering study[21] for lighting, HVAC, and other metered end-use load shapes for the multi-family and small business commercial segments. Navigant used the metered load shapes to inform updates to the EnergyPlus building model inputs for lighting and HVAC schedules.
- Navigant made additional efforts to calibrate the building model load shapes to the total segment load shape from the CECONY 2013 and 2015 interval data. This included further calibration of seasonal differences in building energy consumption to key building segments, such as education. In addition, Navigant further calibrated the building model inputs to account for weekday/weekend differences in end-use energy consumption and load shapes.

[18] DOE has developed a series of reference buildings for each of 16 building segments in 16 climate zones around the country, including New York City. https://www.energycodes.gov/development/commercial/prototype_models

[19] http://www.energycodes.gov/development/residential/iecc_models

[20] 2013 data was used as a representative peak demand year given actual peak loads were seen in the Summer of 2013.

[21] Brooklyn Queens Demand Management, Metering and Market Characterization Effort (Draft).*)*, Energy & Resource Solutions, February 2016.

- The 2015 CECONY customer interval data supported updates to specific building segment load shapes. Several of the segments showed later electricity usage peaks than the 2013 interval data. Navigant updated the building model inputs to account for the later peaks evident in the 2015 interval data, as this was the best source for current building operation in the CECONY territory. Through discussions with CECONY, Navigant cited the following explanations for the difference:
    - Different weather in 2013 and 2015, leading to different HVAC loads
    - Participation in energy efficiency and DR programs may have contributed to a shift in customer's consumption profiles[22]
- Navigant performed additional smoothing of lighting, equipment, refrigeration, HVAC, and other building model inputs. The DOE prototype models contain fairly boxy schedules for many of the building-specific end-uses. Navigant conducted additional smoothing of these schedules to more accurately represent average segment load shapes. For example, the DOE prototype temperature setpoint schedules may show a large step change from 65°F to 72°F between 6:00 and 7:00 AM in the residential models, leading to a similarly large step change in heating end-use consumption between the same hours. Navigant smoothed the heating setpoints to raise from 65°F to 72°F over the course of 2 to 3 hours, smoothing the resulting end-use load shape for heating. This allowed the building models to more accurately reflect the end-use load shapes of the entire segment for a particular building type.

2.2.7.2 Load Profiles Results

Navigant delivered a load shapes library and tool to CECONY for review and comment. The file contained the 8,760 normalized load shapes for each building segment and end-use combinations defined for this study. The tool allows the user to select the building segment, end-use, and model year to view the average daily load shapes for each of 12 months throughout the year. Navigant imported the normalized load shapes into the DSM Potential Model for subsequent analysis. (See Appendix E for the load shapes).

2.2.8 End-Use Consumption

To benchmark the analysis, Navigant created a breakdown of electricity and gas consumption by segment, a breakdown of electricity and gas consumption by end-use, and a summary of how those end-uses break out for each of the segments by sector. The team developed these calculations based on the results of the load shaping, 2016 primary data collection survey, and analysis of CECONY's 2017 customer data.

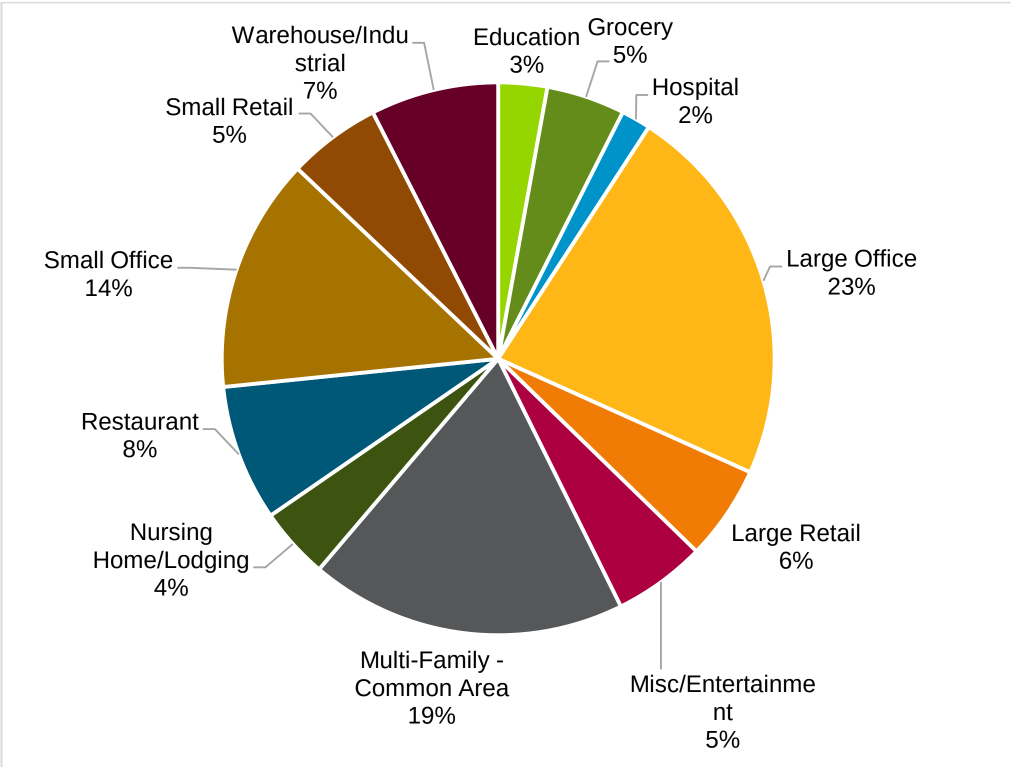
Section 2.2.8.1 below describes the analysis conducted for the commercial sector, followed by Section 2.2.8.2, which describes the residential sector analysis.

[22] During the summer week with the highest drybulb temperature, the overall building load profiles for select building types were slightly flatter, with a peak later in the day, compared to the 2013 data. The overall shifts in consumption profiles were minor and could be caused by DR program participation.

2.2.8.1 Commercial End-Use Consumption

Figure 17 summarizes the current electricity use by customer segment for the commercial sector. This breakdown was derived using customer historical consumption data provided to Navigant by CECONY. The results are somewhat different than what was observed in the 2010 study. Large office, the largest classified segment in 2010 at 29%, is still the largest but now comprises 23% of the total. Multi-family common area represents 19% of consumption, which differs from 9% in the 2010 study. While Navigant has not assessed the basis for these differences in depth, the team believes that much of what is driving the differences relates to segment classification differences between 2010 and now.

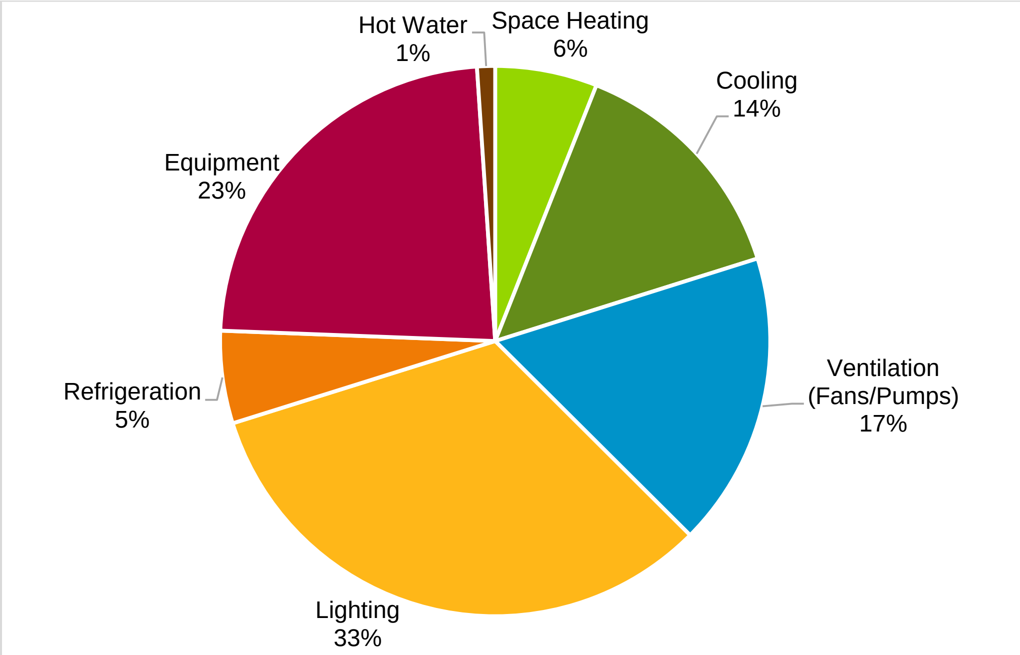
Figure 17. Commercial Electricity Use by Customer Segment, 2017



Source: Navigant

Figure 18 provides an overall breakdown of commercial electricity consumption for each of the seven end-use categories. The end-use shares have changed marginally relative to the 2010 study. Cooling has remained about the same across the two studies. Space heating has increased from 3% in 2010 to 6% in 2017. Lighting, which was 32% (combined indoor and outdoor) in 2010 is now 33%, representing no meaningful change. This study included a large catchall "equipment" category, whereas in the 2010 study, much of that equipment was broken out between ventilation, auxiliary, food service, office equipment, and miscellaneous.

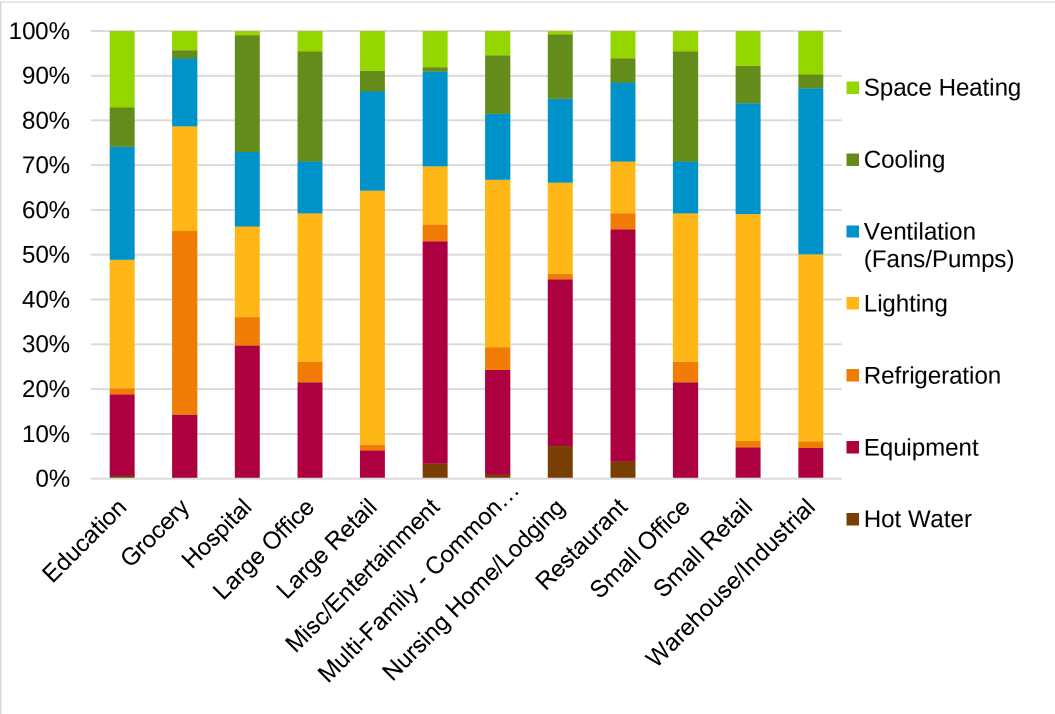
Figure 18. Commercial Electricity Consumption by End-Use, 2017



Source: Navigant

Figure 19 and Table 26 provide the breakdown of end-use electricity shares for each of the commercial segments.

Figure 19. Commercial Electric End-Use Shares by Market Segment, 2017



Source: Navigant

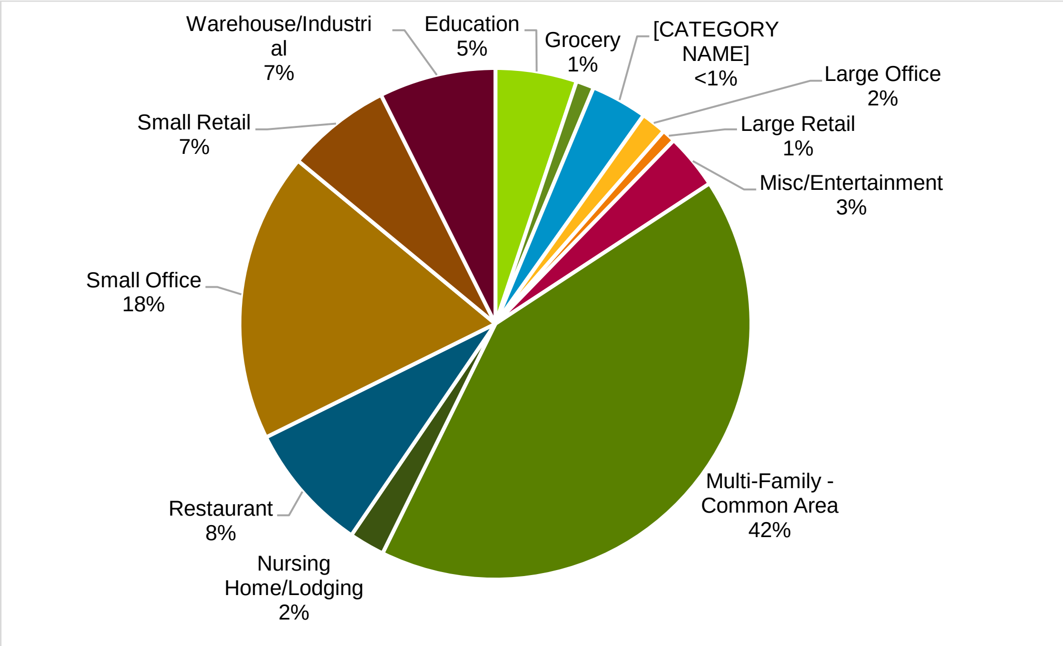
Table 26. Commercial Electric End-Use Shares by Market Segment, 2017

Segment	Space Heating	Cooling	Ventilation (Fans/ Pumps)	Lighting	Refrigeration	Equipment	Hot Water
Education	17%	9%	25%	29%	1%	18%	1%
Grocery	4%	2%	15%	23%	41%	14%	0%
Hospital	1%	26%	17%	20%	6%	30%	0%
Large Office	5%	25%	12%	33%	5%	21%	0%
Large Retail	9%	5%	22%	57%	1%	6%	0%
Misc/ Entertainment	8%	1%	21%	13%	4%	50%	3%
Multi-Family - Common Area	5%	13%	15%	37%	5%	23%	1%
Nursing Home/ Lodging	1%	14%	19%	20%	1%	37%	7%
Restaurant	6%	5%	18%	12%	4%	52%	4%
Small Office	5%	25%	12%	33%	5%	21%	0%
Small Retail	8%	8%	25%	51%	1%	7%	0%
Warehouse/ Industrial	10%	3%	37%	42%	1%	7%	0%

Source: Navigant

Figure 20 summarizes the gas use by customer segment. This breakdown was derived using customer historical consumption data provided to Navigant by CECONY. The results differ from what was observed in the 2010 study. Large office, the largest classified segment in 2010 at 21%, is now 2% of the total. Multi-family common area is now the largest slice at 42%, differing from the 2010 study where that segment was classified as residential for gas energy efficiency. While Navigant has not assessed the basis for these differences in depth, the team believes that much of what is driving the differences relates to segment classification differences between 2010 and now.

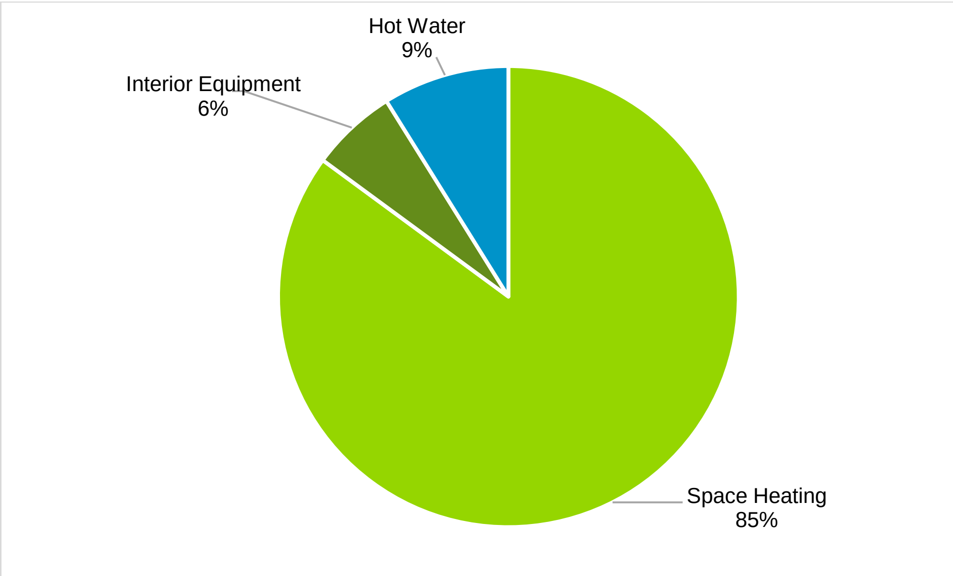
Figure 20. Commercial Gas Use by Customer Segment, 2017



Source: Navigant

Figure 21 provides an overall breakdown of commercial gas consumption for each of three end-use categories. The end-use shares shifted relative to the findings from the 2010 study. Space heating shares increased from 67% to 85%, while water heating decreased from 20% to 9%. Interior equipment (e.g., cooking and misc.) are lower than the 2010 shares, decreasing from 13% to 6%.

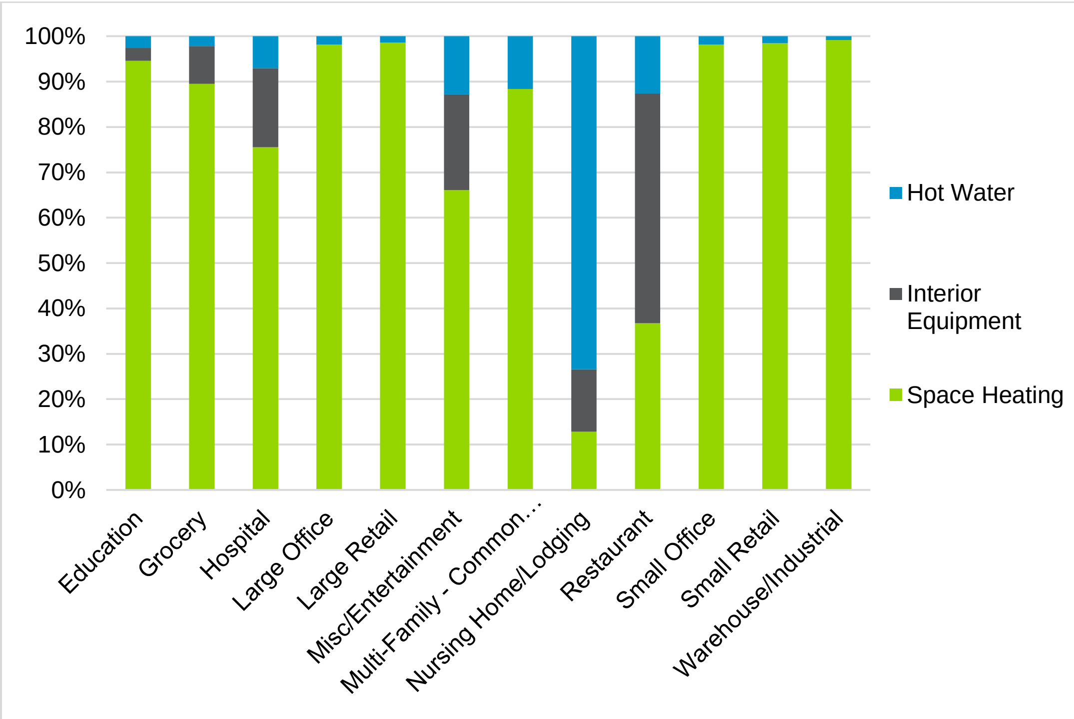
Figure 21. Commercial Gas Consumption by End-Use, 2017



Source: Navigant

Figure 22 and Table 27 provide the breakdown of end-use gas shares for each of the commercial segments. Overall the space heating shares for the key building types have increased significantly relative to the 2010 study.

Figure 22. Commercial Gas End-Use Shares by Market Segment, 2017



Source: Navigant

Table 27. Commercial Gas End-Use Shares by Market Segment, 2017

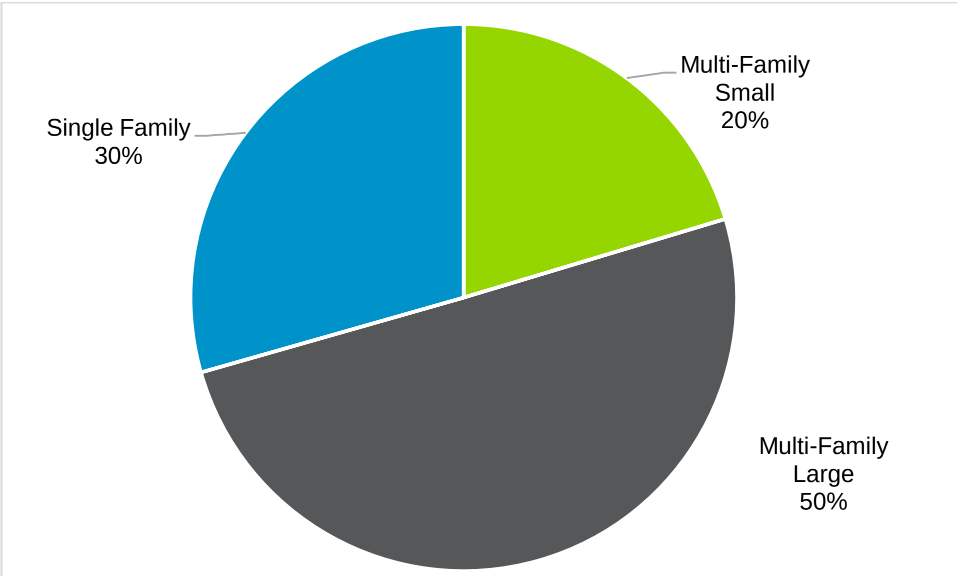
Segment	Space Heating	Interior Equipment	Hot Water
Education	95%	3%	3%
Grocery	90%	8%	2%
Hospital	76%	17%	7%
Large Office	98%	0%	2%
Large Retail	99%	0%	1%
Misc/Entertainment	66%	21%	13%
Multi-Family -Common Area	88%	0%	12%
Nursing Home/Lodging	13%	14%	73%
Restaurant	37%	51%	13%
Small Office	98%	0%	2%
Small Retail	98%	0%	2%
Warehouse/Industrial	99%	0%	1%

Source: Navigant

2.2.8.2 Residential End-Use Consumption

Figure 23 summarizes the current electricity use by customer segment for the residential sector. This breakdown was derived using customer historical consumption data provided to Navigant by CECONY. The breakdown is generally consistent with the 2010 study. The single-family share increased from 28% to 30% and large multi-family increased from 49% to 50%. The small multi-family share decreased from 23% to 20%.

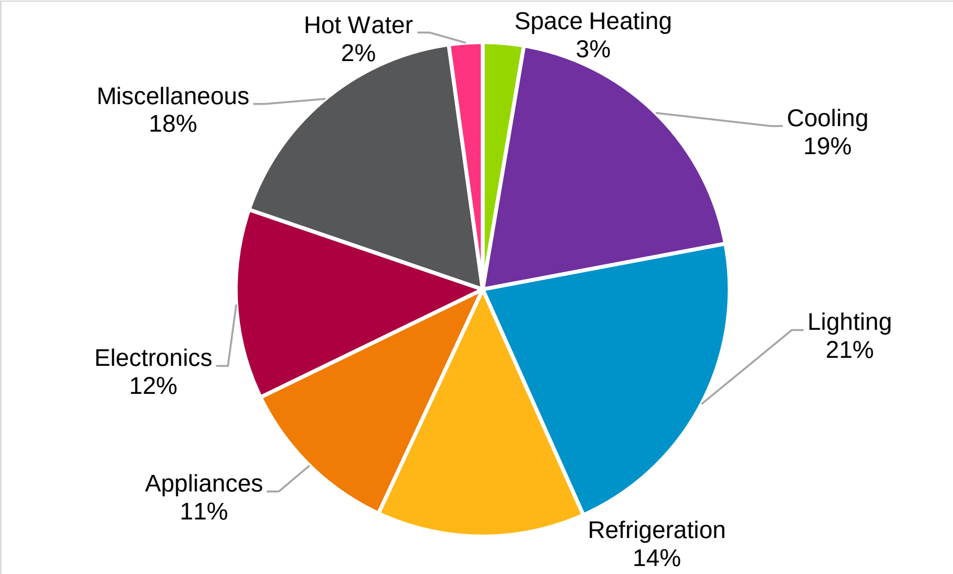
Figure 23. Residential Electricity Use by Customer Segment, 2017



Source: Navigant

Figure 24 provides an overall breakdown of residential electricity consumption for each of eight end-use categories. The end-use shares are largely consistent with the breakdowns from the 2010 study. Of note, refrigeration decreased from 20% to 14%.

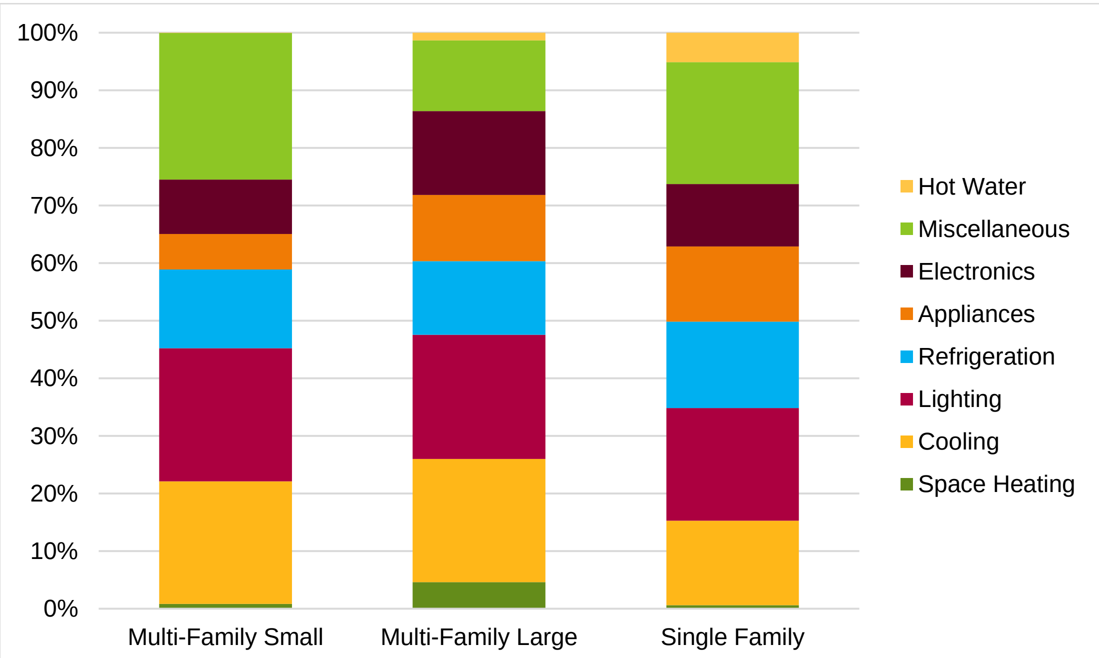
Figure 24. Residential Electricity Consumption by End-Use, 2017



Source: Navigant

Figure 25 and Table 28 provide the breakdown of end-use electricity shares for each of the three residential segments. While most breakdowns are generally consistent with the findings from the 2010 study, of note is a reduction in the water heating percentage for the small multi-family segment compared to the 2010 study (i.e., from roughly 4% down to less than 1%). Refrigeration also generally decreased as a percent of consumption—from roughly 16-20% across all segments in 2010 to 14-15% across all segments in this study, which may indicate a general trend of increasing efficiency for residential refrigeration.

Figure 25. Residential Electric End-Use Shares by Market Segment, 2017



Source: Navigant

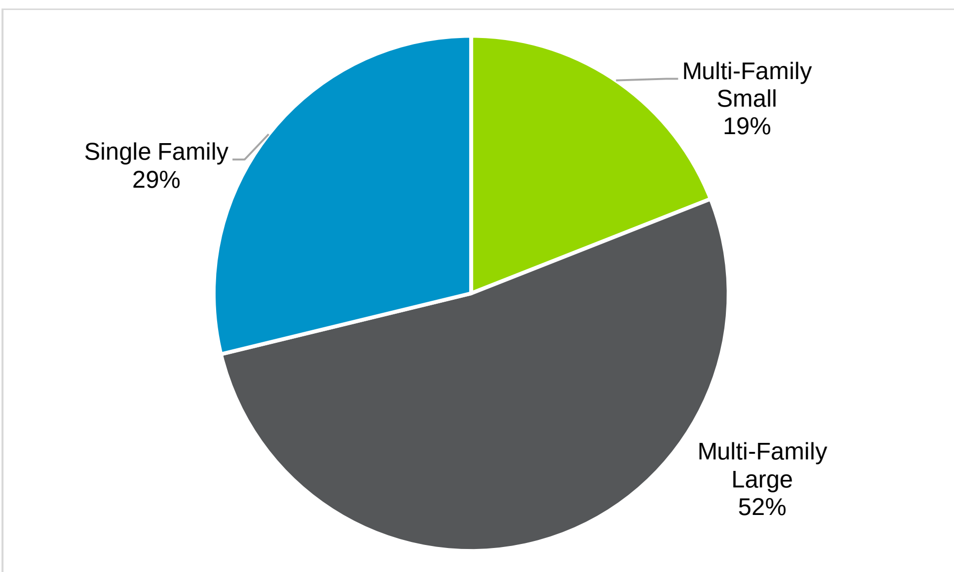
Table 28. Residential Electricity End-Use Shares by Market Segment, 2017

Segment	Multi-Family Small	Multi-Family Large	Single Family
Space Heating	0.8%	5%	0.6%
Cooling	21%	21%	15%
Lighting	23%	22%	20%
Refrigeration	14%	13%	15%
Appliances	6%	12%	13%
Electronics	9%	15%	11%
Miscellaneous[23]	25%	12%	21%
Hot Water	0.1%	1%	5%

Source: Navigant

Figure 26 summarizes the residential gas use by customer segment. This breakdown was derived using customer historical consumption data provided to Navigant by CECONY. The 2010 study grouped together the single family and small multi-family segments, so the studies cannot be directly compared, though the large multi-family segment percentage is comparable to the 2010 study.

Figure 26. Residential Gas Use by Customer Segment, 2017

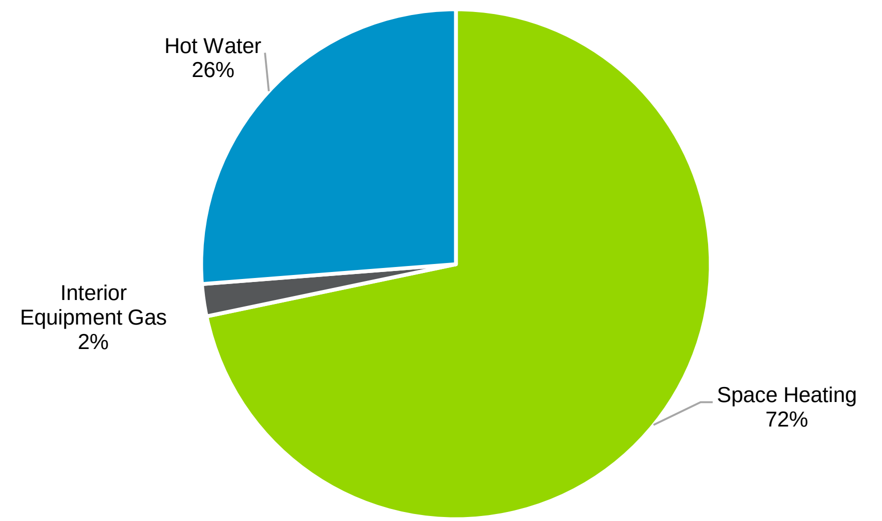


Source: Navigant

Figure 27 provides an overall breakdown of residential gas consumption for each of three end-use categories. Because the 2010 study grouped together the single family and small multi-family segments, the study results cannot be directly compared.

[23] Miscellaneous includes Furnace Fans, Pool Pumps, and Other Miscellaneous. Other Miscellaneous includes all plug loads not elsewhere classified. This study applied the relative breakdowns found in the 2010 study to disaggregate consumption across the Appliances, Electronics, and Miscellaneous categories, given that Space Heating, Cooling, Lighting, Refrigeration, and Hot Water were the key focus of the 2016 primary data collection.

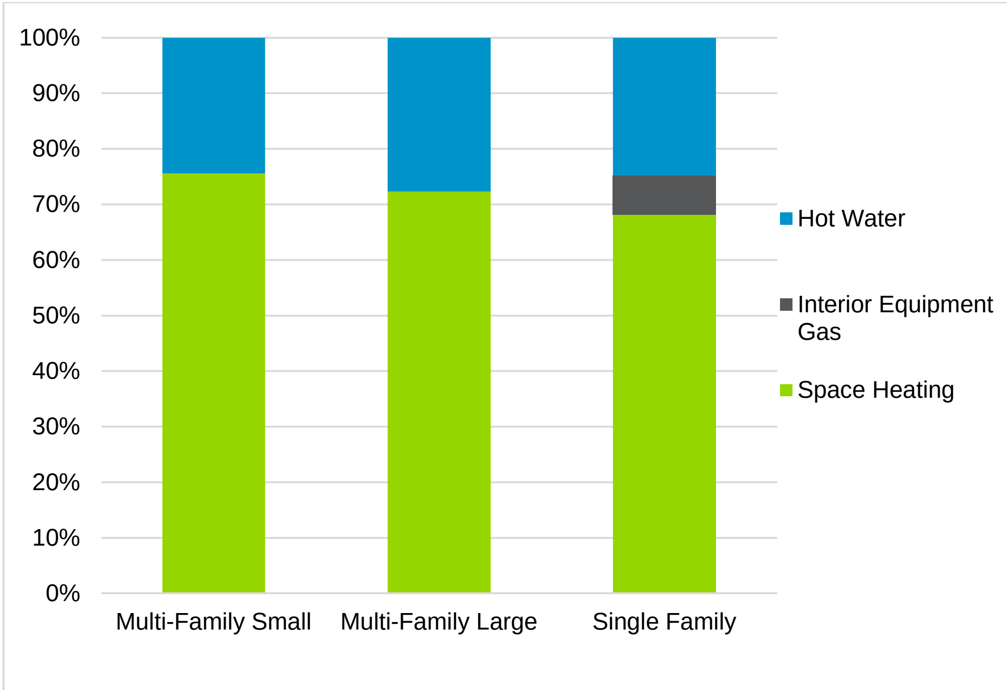
Figure 27. Residential Gas Consumption by End-Use, 2017



Source: Navigant

Figure 28 and Table 29 provide the breakdown of end-use gas shares for each of the residential segments. The 2010 study showed a space heating percentage of 73% for the combined small multi-family and single-family segments, as compared to 76% for small multi-family alone and 68% for single-family alone. However, the 2010 water heating percentage of 19%, compared to 24%-25% in this study, does suggest an overall increase in water heating end-use shares between 2010 and the current study. As noted above, the end-use share for electric water heating in the small multi-family segment decreased since 2010, which may indicate some water heating fuel switching from electric to gas. For large multi-family, water heating remained roughly the same, space heating increased from 58% to 72%, and other interior equipment decreased from around 16% to 7%.

Figure 28. Residential Gas End-Use Shares by Market Segment, 2017



Source: Navigant

Table 29. Residential Gas End-Use Shares by Market Segment, 2017

Segment	Multi-Family Small	Multi-Family Large	Single Family
Space Heating	76%	72%	68%
Interior Equipment	0%	0%	7%
Hot Water	24%	28%	25%

Source: Navigant

2.3 Potential Estimation Approach

This section defines the various levels of potential assessed in the study, and describes Navigant's approach to calculating each type of potential for CECONY's service territory.

2.3.1 Potential Calculation Methodology

Table 30 summarizes the potential type definitions that were built into IDSM during the model update process. Additional details on each of the potential types are discussed in the following sections.

Table 30. Description of Potentials

Potential Type	Definition	Budget Constraints	Adoption Constraints	Cost-Effectiveness Constraints	Existing Conditions Baseline	TRM Baseline

Potential Type	Definition	Budget Constraints	Adoption Constraints	Cost-Effectiveness Constraints	Existing Conditions Baseline	TRM Baseline
Technical	Instantaneous deployment; unconstrained by budget, adoption, and cost-effectiveness.	no	no	no	✓	✓
Economic	Instantaneous deployment; unconstrained by budget and adoption. Only cost-effective measures—measured by societal cost test (SCT)—from the technical potential analysis are included.	no	no	yes	✓	✓
Theoretical Achievable	High achievable. Highest participation with hypothetical higher than current program budgets scenario. Customers receive 100% of incremental cost via incentives.	yes for EE; no for CSG and STR; N/A for DR	yes	yes	✓	✓
Programmatic Achievable	Medium achievable. Medium participation with current program budgets scenario.	yes for EE; no for DR, CSG, and STR	yes	yes	✓	✓
Reduced Programmatic Achievable[24]	Low achievable. Lower participation with hypothetical lower program budgets scenario.	yes for EE; no for CSG and STR; N/A for DR	yes	yes	✓	✓

[24] Gas Energy Efficiency includes a Theoretical High scenario, in lieu of a Reduced Programmatic scenario, as shown in Table 32.

Potential Type	Definition	Budget Constraints	Adoption Constraints	Cost-Effectiveness Constraints	Existing Conditions Baseline	TRM Baseline
Alternative Programmatic Achievable	Same as programmatic achievable, plus operational efficiency and behavioral measures.	yes for EE; no for CSG and STR; N/A for DR	yes	yes	✓	✓
Naturally Occurring Potential Scenario 1	No programs or incentives exist.	N/A	N/A	N/A	✓	✓
Naturally Occurring Potential Scenario 2	Programs or incentives exist, but are not utilized.	N/A	N/A	N/A	✓	✓

Source: Navigant

2.3.2 Technical Potential Definition and Estimation Approach

This study defines technical potential as the total energy savings available assuming all installed measures can immediately be replaced with the efficient or new measure/technology. These replacements occur wherever technically feasible, regardless of the cost, market acceptance, or whether a measure has failed and must be replaced. Technical potential is calculated on a per-measure basis and includes estimates of savings per unit, measure density (e.g., quantity of measures per home), and total building stock (e.g., number of homes in the service territory for residential measures). For commercial measures, the only difference is that the measure density represents the quantity of the measure per square feet of building area and is scaled by square footage of commercial building segment in the service territory. Navigant characterized savings for measures as a fixed amount of savings per measure.

Navigant used the IDSM and DSMSim models to estimate the technical potential for DER across CECONY's five boroughs and Westchester. The modeling approach considers an efficient or new measure to be any change made to a building, piece of equipment, process, or behavior that could save energy and/or reduce demand.

The calculation of energy efficiency technical potential in this study differs depending on the assumed measure replacement type. The study accounts for two replacement types: retrofit measures and replace-on-burnout (ROB) measures.

2.3.2.1 Retrofit and ROB Measures

Retrofit measures, commonly referred to as advancement or early-retirement measures, are replacements of existing equipment before the equipment fails. Retrofit measures can also be efficient processes that are not currently in place and that are not required for operational purposes. Retrofit measures incur the full cost of implementation, rather than incurring a cost incremental to some other baseline technology or process because the customer may choose not to replace the measure and would therefore incur no costs. In contrast, ROB or new construction measures, sometimes referred to as lostopportunity measures, are replacements of existing equipment that have failed and must be replaced or are due to new construction, or are processes that must be renewed. Because the equipment failure or initial investment of the measure requires a capital investment by the customer, the cost of implementing ROB/new construction measures is always incremental to the cost of a baseline (and less efficient) measure.

2.3.2.2 Mutual Exclusivity

IDSM and DSMSim's modeling approaches recognize that some energy efficiency technologies will compete against each other in the calculation of achievable potential. The study defines mutual exclusivity or competition as an efficient measure competing for the same installation as another efficient measure. For instance, a consumer has the choice to install a condensing or a near-condensing water heater, but not both. These efficient technologies compete for the same installation.

General characteristics of competing technologies used to define competition groups in this study include the following:

- Efficient technologies that compete to share the same baseline technology characteristics, including baseline technology densities, costs, and consumption
- Total (baseline plus efficient) measure densities of competing efficient technologies are the same
- Installation of competing technologies is mutually exclusive (i.e., installing one precludes installation of the others for that application)
- Technologies that compete share the same replacement type (retrofit or ROB/new construction)

To address the overlapping nature of measures within a competition group, the models only select one energy efficient measure per competition group to include in the summation of technical potential across measures (e.g., at the end-use, customer segment, sector, service territory, or total level). The measure with the largest energy savings potential in each competition group is used for calculating total technical potential of that competition group. This approach ensures that the aggregated technical potential does not double count savings. However, the model still calculates the technical potential for each individual measure outside of the summations.

2.3.3 Economic Potential Definition and Estimation Approach

Economic potential is a subset of technical potential, using the same assumptions regarding immediate replacement as in technical potential, but including only those measures that have passed the benefit-cost test chosen for measure screening (in this case the SCT test, per the CECONY BCA Handbook). The SCT ratio for each measure is calculated each year and compared against the measure level SCT ratio screening threshold of 1.0. A measure with a SCT ratio greater than or equal to 1.0 is a measure that provides monetary benefits greater than or equal to its costs. If a measure's SCT meets or exceeds the threshold, it is included in the economic potential.

The SCT test is a benefit-cost metric that measures the net benefits of energy efficiency measures from the perspective of society (combined stakeholder viewpoint of the utility, customers, and society). The model calculates the SCT benefit-cost ratio using the following equation:

Equation 1. Benefit-Cost Ratio for SCT[25]

$$SCT = \frac{PV(Avoided\ Costs + O\&M\ Savings + \ Avoided\ Emissions)}{PV(Technology\ Cost + Admin\ Costs)}$$

Where:

- *PV( )* is the present value calculation that discounts cost streams over time;
- *Avoided Costs* are the monetary benefits resulting from gas and electric savings (e.g., avoided costs of infrastructure investments, as well as avoided commodity costs due to gas and/or electric energy conserved by efficient measures);
- *Operations and Maintenance Savings* are utility operation and maintenance cost savings;
- *Avoided Emissions* are benefits due to avoiding emissions of carbon, nitrogen oxides, and sulfur oxides;
- *Technology Cost* is the total incremental equipment and installation cost relative to the baseline unit (i.e., the customer cost plus utility incentives);
- *Admin Costs* are the administrative costs incurred by the utility or program administrator.

Navigant calculated SCT ratios for each measure based on the present value of benefits and costs (as defined above) over each measure's life. Appendix D presents the sources of avoided costs, discount rates, and other key data inputs used in the SCT calculation, and Appendices F through I provide measure-specific inputs.

Although the SCT equation includes administrative costs, the study does not consider these costs during the economic screening process because an individual measure's cost-effectiveness on the margin is the primary focus. Navigant included administrative costs at the portfolio level, rather than the measure level, during the achievable potential estimations, as described below.

Similar to technical potential, only one economic measure (meaning that its SCT ratio meets the 1.0 threshold) from each competition group is included in the summation of economic potential across measures (e.g., at the customer segment level). If a competition group is composed of more than one measure that passes the SCT test, then the economic measure that provides the greatest electric savings potential is included in the summation of economic potential. This approach ensures that double counting is not present in the reported economic potential, though economic potential for each individual measure is still calculated and reported outside of the summation.

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[25] Please refer to the following publication for more information: CECONY, "Benefit Cost Analysis (BCA) Handbook Version 1.1", August 2016. Page 15 details all the benefits and costs considered in the SCT, https://www.coned.com/-/media/files/coned/documents/dg/dsp/pdf/coned-bcah.pdf?la=en .

2.3.4 Achievable Potential Definition and Estimation Approach

Navigant characterized four unique types of achievable potential for electric measures: 1) Theoretical, 2) Programmatic, 3) Alternative, and 4) Reduced. For gas measures, achievable potential is presented in four types: 1) Theoretical – High, 2) Theoretical, 3) Alternative, and 4) Programmatic. Each type is described in detail in the tables below.

Programmatic achievable potential is a subset of economic potential that considers the likely rate of DER acquisition given factors like the rate of equipment turnover (a function of a measure's lifetime), simulated incentive levels, consumer willingness to adopt efficient technologies, and the likely rate at which marketing activities can facilitate technology adoption. The adoption of DER measures is modeled via a Bass Diffusion Model, described in more detail in Section 2.3.4.1.

The programmatic achievable potential approach used in this study represents a broader view of market potential rather than program potential. Market potential does not specifically consider the various delivery mechanisms that can be used by program managers to tailor their approach depending on the specific measure or market. Rather, market potential represents a high level assessment of savings that could be achieved over time, factoring in broader assumptions about customer acceptance and adoption rates that are not dependent on any specific program design. Additional effort is typically undertaken by program designers to develop detailed plans for delivering programs, using the directional guidance from a market potential study.

Table 31 summarizes the key methodology considerations and decision points informing the analysis in this report for each achievable potential type for electric. Navigant and CECONY agreed upon this methodology through discussions about which approach best serves the needs of the utility for understanding market savings potential. Since the study's scope for market potential estimates is not intended to be program specific, and are most reasonable when results are considered in aggregate, the methodology presented in this table focuses primarily on portfolio-level or sector-level approaches. Exact data points or deviation from this are presented in each results section.

Table 31. Achievable Potential Descriptions – Electric Energy Efficiency

Achievable Potential Type	Budgets	Calibration	Adoption	Incentives
Theoretical	• Same as programmatic for 2017-2019. Then 20% annual increase from 2020-2026. • Higher admin budget than current levels focused on program marketing.	• Same as programmatic.	• Higher marketing effect, word-of-mouth effect, and maximum market share due to increased admin budget. Behavioral measures included.	• Same as programmatic.
Programmatic	• Approved budgets for 2017-2019 (see EEDM Program Budgets spreadsheet). Then budgets held at 2019-level for 2020-2026. • Constant admin budget based on current levels.	• Overall first year savings are calibrated to current programmatic savings • First year savings from LEDs calibrated to current LED program savings.	• Standard marketing effect, word-of-mouth effect, and maximum market share. Behavioral measures not included.	• Based on 2-year payback target. Minimum incentives are 40% of incremental cost.
Alternative	• Same as programmatic.	• Same as programmatic.	• Same as programmatic. Behavioral measures included.	• Same as programmatic.
Reduced	• Same as programmatic for 2017-2019. Then budgets held at 2018-level for 2020-2026. • Lower admin budget than current levels.	• Same as programmatic.	• Lower marketing effect, word-of-mouth effect, and maximum market share due to decreased admin budget. Behavioral measures not included.	• Same as programmatic.

Source: Navigant

Table 32 summarizes the key methodology considerations and decision points informing the analysis in this report for each achievable potential type for gas energy efficiency. As noted in the table below, Navigant created custom incentive levels for the gas energy efficiency theoretical achievable scenarios to simulate the effects of CECONY incenting at or greater than 100% of the participant's incremental cost for implementing the measure. The theoretical – high scenario is intended to show the maximum opportunity for carbon reduction, regardless of budget constraints, with the incentives set as 194% of incremental cost to capture the point at which customer adoption relative to incentive levels begins to taper off.

Table 32. Achievable Potential Descriptions – Gas Energy Efficiency

Achievable Potential Type	Budgets	Calibration	Adoption	Incentives
Theoretical - High	• 10% higher than programmatic	• Same as programmatic	• Higher marketing effect, word-of-mouth effect, and maximum market share due to increased admin budget. Behavioral measures included.	• 194% of incremental cost
Theoretical	• Same as Programmatic	• Same as programmatic	• Higher marketing effect, word-of-mouth effect, and maximum market share due to increased admin budget. Behavioral measures included.	• 100% of incremental cost
Programmatic	• Constant admin budget, based on current admin budget	• Calibrated to historic savings and budget	• Standard marketing effect, word-of-mouth effect, and maximum market share. Behavioral measures not included.	• 75% of incremental cost
Alternative	• Same as programmatic	• Same as programmatic	• Same as programmatic. Behavioral measures included.	• 75% of incremental cost

Source: Navigant

2.3.4.1 Calculation of Equilibrium Market Share

The estimation of market adoption by customer and measure type is conducted via three steps:

1. Estimate the payback period (i.e., the period of time before a customer reaches net positive cash flow)
2. Determine the maximum market share using the following equation:

$$MaximumMarketShare = e^{-PaybackCoefficient * PaybackTime}$$

3. Determine the annual adoption in each year, which can be defined in two ways:

- Option A: Employing a payback curve and s-shaped adoption curve based on a Bass Diffusion Model[26]
- Option B: Using a linear annual installation rate

For step 3, option A above, the S-curve Bass Diffusion Model is defined by the following equation:

$$Adoption\ (t) = \frac{1 - e^{-(p+q)T}}{1 + (\frac{q}{p}) * e^{-(p+q)T}}$$

Where:

- Adoption = fraction of total population (dimensionless)
- t = year adoption is calculated (years)
- T = time between t and the first year the measure was introduced (years)
- p = coefficient of innovation or marketing effect (dimensionless)
- q = coefficient of imitation or word-of-mouth effect (dimensionless)

Parameters p and q are determined either by tuning to historical program data or by secondary sources.

The equilibrium market share represents the percentage of individuals choosing to purchase a technology, provided those individuals know of the technology and its relative merits (e.g., its energy- and cost-saving features). For DER measures, a key differentiating factor between the base technology and the new technology is the energy and cost savings associated with the new technology; that additional efficiency often comes at a premium in initial cost. This study calculates an equilibrium market share as a function of the payback time of new DER technology relative to old technology. In effect, measures with more favorable customer payback times will have higher equilibrium market share, which reflects consumers' economically rational decision-making.

2.3.4.2 Calculation of the Approach to Equilibrium Market Share

Navigant used two approaches to calculate the approach to equilibrium market share: one for technologies being modeled as retrofit measures and one for technologies simulated as ROB or new construction.[27] The following section provides a high level overview of each approach.

2.3.4.3 Retrofit Technology Adoption Approach

Retrofit technologies employ an enhanced version of the classic Bass Diffusion Model[28,29] to simulate the s-shaped approach to equilibrium that is observed again and again for technology adoption. The figure below provides a stock/flow diagram illustrating the causal influences underlying the Bass model. In this diagram, market potential adopters "flow" to adopters by two primary mechanisms – adoption from external influences, such as marketing and advertising, and adoption from internal influences, or word-of-

[26] Bass, F.M. (1969). "A New Product Growth for Model Consumer Durables." Management Science (18); pp. 215-227.

[27] Each of these approaches can be better understood by visiting Navigant's technology diffusion simulator, available at: http://forio.com/simulate/navigantsimulations/technology-diffusion-simulation.

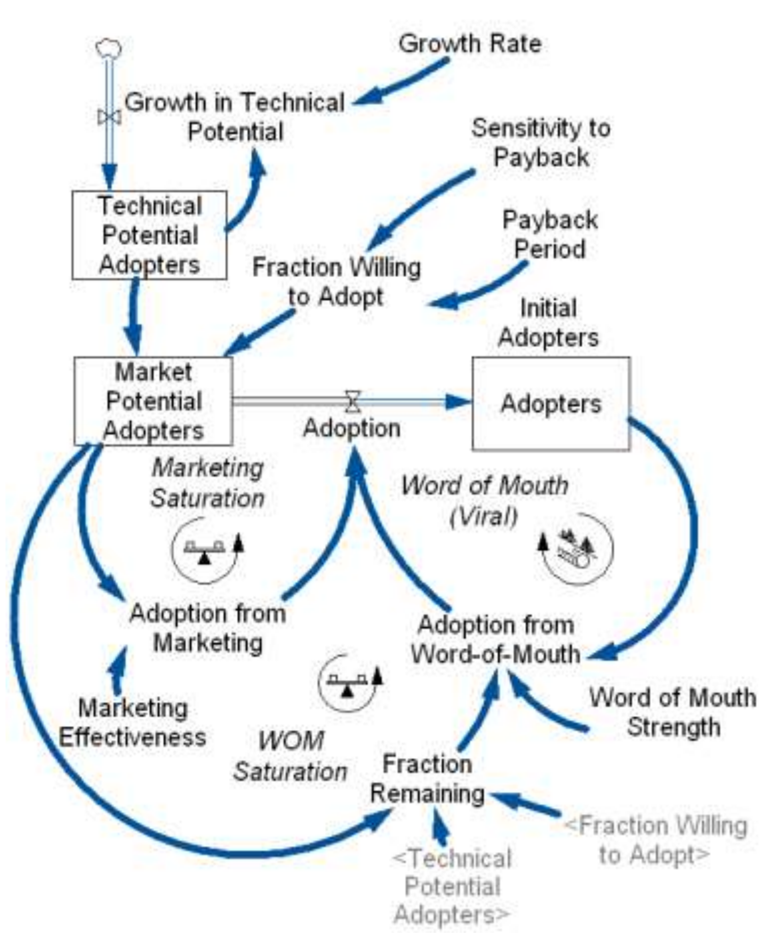
[28] Bass, Frank (1969).), "A new product growth New Product Growth Model for consumer durables". Consumer Durables, Management Science 15 (1969): 5.

[29] Sterman, John D, *Business Dynamics: Systems Thinking and Modeling for a Complex World*, Irwin McGraw-Hill, 2000, p. 332.

mouth. Navigant estimated the "fraction willing to adopt" using the payback acceptance equation shown above.

Navigant estimated the marketing effectiveness and word-of-mouth parameters for this diffusion model by drawing upon case studies where these parameters were estimated for dozens of technologies.[30] Recognition of the positive or self-reinforcing feedback generated by the word-of-mouth mechanism was evidenced by increasing discussion of the concepts such as social marketing, as well as the term viral, which recently has been popularized and strengthened by social networking sites such as Twitter, Facebook and YouTube. However, the underlying positive feedback associated with this mechanism has been ever present and a part of the Bass Diffusion Model of product adoption since its inception in 1969.

Figure 29. Stock/Flow Diagram of Diffusion Model for New Products and Retrofits



Source: Navigant

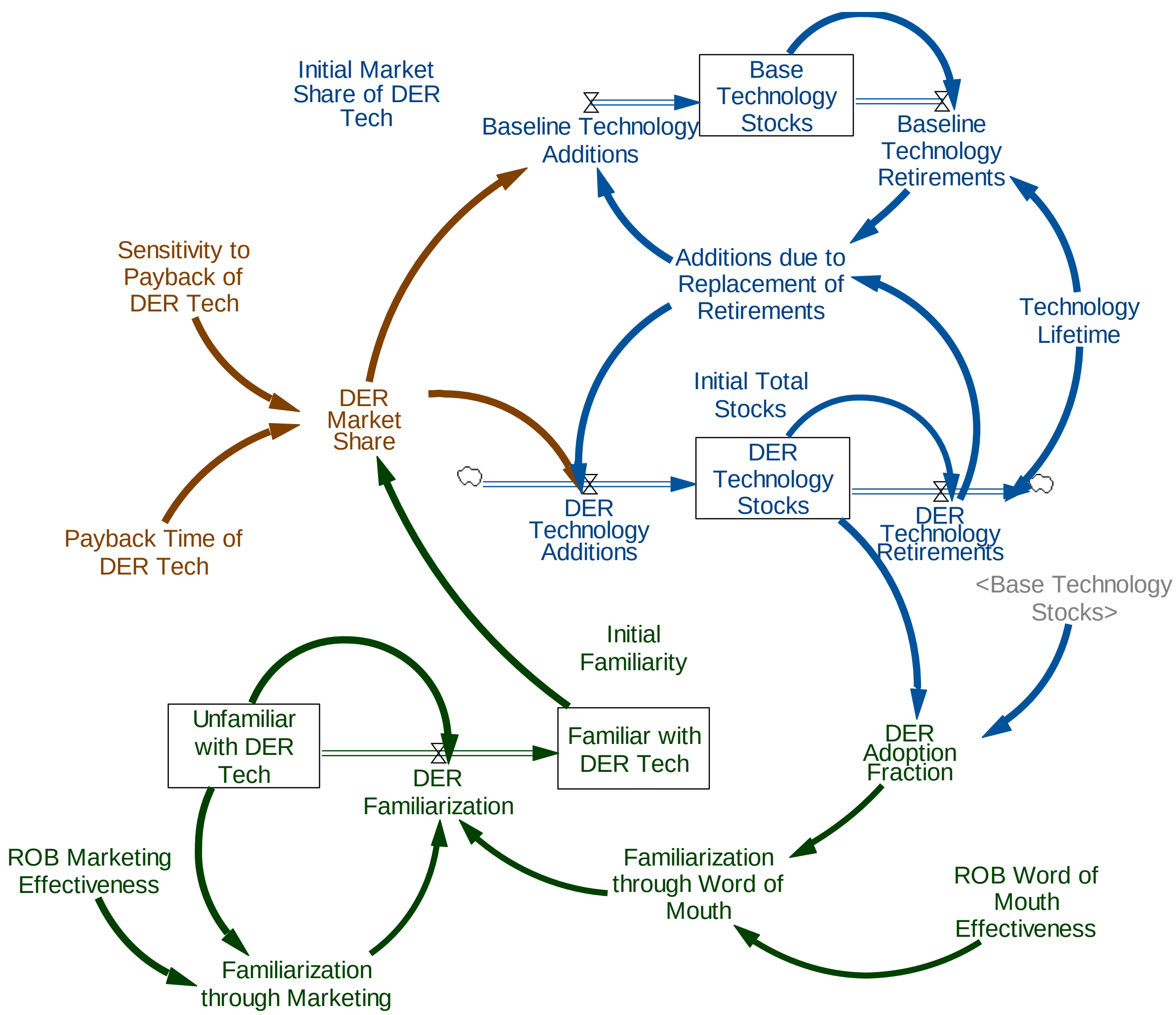
The model illustrated above generates the commonly seen s-shaped growth of product adoption and is a simplified representation of that employed in IDSM.

[30] Mahajan, V., Muller, E., and Wind, Y, New Product Diffusion Models , (Springer., 2000). See Chapter 12 for estimation of the Bass diffusion parameters for dozens of technologies.

2.3.4.4 ROB Technology Adoption Approach

The dynamics of adoption for ROB technologies are somewhat more complex than for new construction/retrofit technologies since it requires simulating the turnover of mostly long-lived technology stocks. The IDSM and DSMSim models track the stock of all technologies, both base and efficient, and explicitly calculates technology retirements and additions consistent with the lifetime of the technologies. Such an approach ensures that technology churn is considered in the estimation of market potential, since only a fraction of the total stock of technologies are replaced each year and this affects how quickly technologies can be replaced. A model that endogenously generates growth in the familiarity of a technology, analogous to the previously described Bass Model Approach, is overlaid on the stock tracking model to capture the dynamics associated with the diffusion of technology familiarity. Figure 30 graphically illustrates a simplified version of the model employed in IDSM and DSMSim.

Figure 30. Stock/Flow Diagram of Diffusion Model for ROB Measures



Source: Navigant

2.3.4.5 Model Calibration

Navigant's calibration approach varied by measure type:

Energy Efficiency

Navigant calibrated LED lighting specifically at the programmatic/measure level, based on CECONY's historic/actual program data, and at portfolio level for the other electric energy efficiency measures, based on CECONY's budget constraints for electric energy efficiency.

For gas energy efficiency, Navigant calibrated the programmatic savings to CECONY's historic savings and budget at the portfolio level.

DR

Navigant used information on existing participants to calibrate expected 2017 adoption. For post 2017, the team used budgets and its expected market growth rates for benchmarking.

CSG

Navigant analysis assumed CECONY creates incentive programs for combined heat and power (CHP) and solar PV + storage as the company does not currently have such programs, and as the driver for potential estimates is market intervention via incentives and marketing. For CHP, many systems have been installed over time, so the team used historical installations as a benchmark to calibrate against, along with data from other parts of the country with CHP programs. For solar PV + storage, the team used data on current PV installations and project economics as a benchmark.

Energy Storage

Navigant analysis assumes CECONY creates a focused energy storage incentive program. Given the lack of a historical program to benchmark against for calibration, the team used its knowledge of how fast energy storage is being adopted in other parts of the country with programs, the City of New York goal of 100 MWh by 2020, and current project economics. Constraints related to the current Fire Department of New York and New York City approvals and permitting issues are still under study. Navigant assumes these will be resolved for 2017 and beyond. Lack of battery project approvals and permitting will significantly reduce battery potentials, a scenario that was not modeled in this study.

2.3.5 Naturally Occurring Potential Definition and Estimation Approach

Estimating the naturally occurring potential (NOP) of behind-the-meter efficiencies outside of utility-funded programs is a known challenge. Navigant addressed this challenging question by bounding the problem based on two scenarios:

- **Scenario 1:** Assuming no programs or incentives exist.
- **Scenario 2:** Assuming programs or incentives exist, but are not utilized (e.g., residential customer buys LEDs at a hardware store outside of a program).

Each of these scenarios is defined based on a combination of three different "sources" of NOP:

1. Natural Non-Programmatic Market Adoption – customers that adopt the efficient technology, despite being unaware of the program and not receiving an incentive, based on independent market effects not attributable to utility programs. This is calculated using the same adoption models that were used for achievable potential, but with zero incentives and lower marketing and word-of-mouth effects to simulate adoption in the market in the absence of utility programs.
2. Influenced Non-Programmatic Market Adoption – customers that adopt the efficient technology without receiving an incentive, even though they were influenced by the utility program. Navigant used a factor of 5% (or 0.05) for this value, which is a value used in some jurisdictions to estimate

the market adoption that occurs as a result of the program's influence (for example, through exposure to the program), but not directly through the program.[31,32]

3. Natural Programmatic Market Adoption – customers who participate in the program and would have adopted the efficient technology on their own in the absence of the program. Navigant used a factor of 15% (or 0.15) for this value, based on New York's current NTG ratio of 0.90. This estimation assumes 0.15 (Natural Programmatic Market Adoption) = 1.00 – 0.90 (NTG) + 0.05 (Influenced Non-Programmatic Market Adoption).

Navigant defined the two NOP scenarios as a summation of these different NOP sources, as defined below in Table 33.

Table 33. Naturally Occurring Potential Definitions by Scenario

NOP Source	NOP Scenario 1	NOP Scenario 2
Natural Non-Programmatic Market Adoption	✓	✓
Influenced Non-Programmatic Market Adoption		✓
Natural Programmatic Market Adoption	✓	

Source: Navigant

The results of the NOP calculations can be found in Sections 3.3, 4.3, and 6.3.

2.4 Electric Energy Efficiency Technology Characterization

Starting with a broad list of energy efficiency technologies, developed based on CECONY's 2014 IDSM study and Navigant's experience with potential assessments in other jurisdictions, Navigant screened each measure for viability of use within the CECONY service territory. The five screening criteria used in this study are 1) technical viability, 2) applicability to the service territory, 3) technology availability, 4) data availability, and 5) customer attitudes toward technology. Technologies that pass these screens were included in a database of technologies summarizing performance, cost, and potential characteristics—all of which are inputs to the IDSM model.

Navigant fully characterized more than 70 electric technologies across CECONY's residential and commercial sectors. The team prioritized measures with high impact, data availability, and most likely to be cost-effective as thresholds for inclusion into IDSM.

[31] Decision Approving 2013-2014 Energy Efficiency Programs And Budgets. Decision 12-11-015 November 8, 2012. http://docs.cpuc.ca.gov/publisheddocs/published/g000/m034/k299/34299795.pdf.

[32] Current Methods in Free Ridership and Spillover Policy and Estimation. PWP, Inc. and Evergreen Economics. February 2017. https://www.energytrust.org/wp-content/uploads/2017/07/FR_Spillover_170206.pdf

2.4.1 Electric Energy Efficiency Technology Characterization Approach

Navigant developed a comprehensive measure list of energy efficiency measures likely to contribute to technical and economic potential. The team reviewed CECONY's previous potential studies, the New York TRM, and potential model measure lists from other jurisdictions to identify energy efficiency measures with the highest expected technical and economic impact. The team supplemented the measure list using potential studies and TRMs from Pennsylvania, British Columbia, Colorado, Arkansas, and Illinois. Navigant selected the Pennsylvania, Illinois and British Columbia studies due to relative similarities in service territory and weather. The Arkansas and Colorado studies are other recent studies that provided up-to-date data, including primary data, to inform the measure characteristics.

Navigant worked with CECONY to finalize the measure list and ensure it contained technologies viable for future CECONY program planning activities. In total, Navigant reviewed 100 measures and, through discussions with CECONY, moved forward with 72 measures applicable to 17 different customer segments within the residential and commercial sector, for analysis. Table 34 shows the number of measures by sector for electric energy efficiency, while Appendix F provides the final full measure list.

Table 34. Number of Electric Energy Efficiency Measures by Sector

Sector	Measures
Residential	27
Commercial	45
Total	**72**

Source: Navigant

2.4.2 Electric Energy Efficiency Technology Characterization Key Parameters

The measure characterization effort defined 30 individual parameters for each of the 72 measures included in this study. This section defines the top 12 key parameters and how they impact technical and economic potential savings estimates. Appendix F provides the measure level data used in the analysis for each of the parameters discussed below.

1. **Measure Name:** Defines the efficient technology of the measure.
2. **Account Units:** Specifies the actual value of the quantity that will be used to scale per-measure results up to the entire service territory. In this model, the number of customer counts provides the scaling factor for residential. For commercial, the number of square feet is the scaling factor. This is a constant number that is included in the model.
3. **Units per Account Units:** Also referred to as the ***density*** of a measure, this is the total number of baseline and efficient measure units per account unit. For the residential sector, this is the number of measure units in a customer's household. For the commercial sector, this is the number of measures per square feet. For example, for an efficient screw-in bulb residential measure, the units per account is the total number of screw-in bulbs in a house irrespective of whether they are the baseline measure or efficient measure.
4. **Annual kWh Savings/Unit Relative to Standard Unit:** Annual kWh savings of the efficient measure compared to the standard code-compliant measure.
5. **Annual kWh Savings/Unit Relative to Existing Unit:** Annual kWh savings of the efficient measure compared to the inefficient existing unit.

6. **Replacement Type:** Replacing the baseline technology with the efficient technology can occur in two variations:
    - **Retrofit:** Where the model considers the baseline to be the existing equipment, and uses the energy and demand savings between the existing equipment and the efficient technology during technical potential calculations. Retrofit also applies the full installed cost of the efficient equipment during the economic screening.
    - **ROB/New Construction:** the model considers the baseline to be the standard code-compliant technology option and uses the energy and demand savings between the current code option and the efficient technology during technical potential calculations. ROB also applies the incremental cost between the efficient and standard code-compliant equipment during the economic screening.
7. **Customer Type:** The team mapped each measure to the appropriate customer segment. Navigant characterized measures for 4 residential and 13 commercial segments as stated in the list below:
    - Education
    - Grocery
    - Hospital
    - Large Office
    - Large Retail
    - Miscellaneous/Entertainment
    - Multi-Family - Common Area
    - Nursing Home/Lodging
    - New York Power Authority (NYPA) – Commercial
    - Restaurant
    - Small Office
    - Small Retail
    - Warehouse/Industrial
    - Large Multi-Family – Residential
    - NYPA – Residential
    - Single-Family – Residential
    - Small Multi-Family – Residential
8. **Measure Estimated Useful Life:** The lifetime in years for the energy efficient technologies.
9. **Costs:**
    - **Cost of Efficient Unit:** This defines the cost of the energy efficient unit
    - **Installation Cost, Efficient Unit:** This defines the installation cost of the efficient unit
    - **Cost of Standard Unit:** This defines the cost of the standard code-compliant unit
    - **Installation cost: Standard Unit** This defines the installation cost of the standard code-compliant unit
10. **Current Market Participation Rate:** Also referred to as the ***saturation*** of a measure, this is the penetration of the efficient equipment for a given customer segment.

11. **Technical Potential:** The percentage of the base technology that can be reasonably and practically replaced with the specified efficient technology. For instance, EMS are only practical for some building segments, while all existing incandescent light bulbs can be replaced with efficient LED bulbs.
12. **Mutual Exclusivity Code:** The team combined efficient measures competing for the same baseline technology and applied a mutual exclusivity code to avoid the double counting of savings in the model.

2.4.3 Electric Energy Efficiency Technology Characterization Data Sources

This section provides approaches and sources for the main measure characterization variables. Industry practice in developing market characterizations for demand-side management assessments include using utility-specific primary data, baseline analysis, and studies where possible. Where such information was not available, Navigant used comparable data from utilities located in neighboring states or other secondary sources, such as TRMs and the Database for Energy Efficient Resources (DEER).

2.4.3.1 Energy Savings

Navigant took two general bottom-up approaches to analyzing measure energy and demand savings:

1. **TRM Standard Algorithms:** Navigant used New York TRM's standard algorithms for unit energy savings and demand savings calculations for majority of the measures.
2. **Engineering Analysis:** Navigant used appropriate engineering algorithms and industry standard assumptions from experience on other potential studies to calculate energy savings for any measures not included in the New York TRM.

2.4.3.2 Costs

Navigant primarily relied on publicly available cost data sources for cost data, such as the DEER cost database and ENERGY STAR, 2013 NYSERDA Residential Baseline Study, Itron Measure Ex-Ante Cost study, GEP CECONY EE Potential Report-Volume 2 - 2010, Heat-Pumps-Potential study by NYSERDA, and Illinois TRM. Navigant researched NYSERDA reports for individual measures and leveraged that to fill in gaps for measure costs. Navigant also used other potential study data in absence of available cost data from the above-mentioned sources.

2.4.3.3 Building Stock and Densities

The primary data collection effort by Navigant, Mad Dash, Inc., and MSI provided measure density and saturation data for most the residential and commercial measures. Navigant also used the 2013 NYSERDA Vol-3-HVAC-Res-Baseline, CECONY Resource Planning Summer Survey CECONY Report 9-12-16, and GEP CECONY EE Potential Report-Volume 2 - 2010 to inform density and the 2013 NYSERDA saturation values for a portion of the residential measures. If the research team could not obtain measure information from those sources, Navigant leveraged other jurisdiction TRMs and previously conducted potential studies in Pennsylvania, Arkansas, and Colorado, as the density data from these studies was the most recent and relevant amongst all other available data sources after leveraging CECONY's past studies. The Pennsylvania study was used for weather sensitive measures and Arkansas and Colorado studies were used for developing measure characteristics of non-weather sensitive measures.

2.4.4 Existing Conditions and Standard Baseline

This study incorporates savings from the existing inefficient baseline and savings from the standard code-compliant baseline for the study period. The existing baseline is an inefficient device and the standard baseline is defined in the New York TRM or industry standard practice.

Additionally, as future codes and standards take effect and become more stringent, the energy savings from existing measures impacted by codes and standards diminishes. Navigant accounts for the impact of codes and standards by baseline energy and cost multipliers, which reduce the energy savings from the standard and the existing equipment starting from the year a code or standard takes effect. Savings potential presented in the model results includes savings potential from codes and standards, and measure level results show their contribution to overall potential. The existing conditions baseline data is available in the data viewer Navigant created.

For the purposes of this study, Navigant excluded CFL lighting measures and focused instead on the potential from LED lighting to reflect the focus of energy efficiency efforts within New York state and current customer technology preferences. Although CFL lighting is technically still available on the market until the Energy Independence and Security Act (EISA) federal standard for general service lighting takes effect in 2020, this study assumes that LEDs will primarily drive the adoption of efficient general service lighting until that time. This approach is also consistent with Navigant's observations of current trends in customer adoption of efficient lighting technologies in other jurisdictions.

The DOE's technical support documents[33] contain information on energy and the cost impact of each appliance standard. Technologies that will be affected by foreseeable standards include general service lamps, clothes washers, and packaged terminal air conditioners, with the complete list available in Appendix F.

The results presented within this report are based on the code baseline.

2.5 Gas Energy Efficiency Technology Characterization

Starting with a broad list of energy efficiency technologies, developed based on CECONY's 2014 IDSM study and Navigant's experience with potential assessments in other jurisdictions, Navigant screened each measure for viability of use within the CECONY service territory. The five screening criteria used in this study are 1) technical viability, 2) applicability to the service territory, 3) technology availability, 4) data availability, and 5) customer attitudes toward technology. Technologies that pass these screens were included in a database of technologies summarizing performance, cost, and potential characteristics—all of which are inputs to the DSMSim™ model.

Navigant fully characterized 24 gas technologies across CECONY's residential and commercial sectors. The team prioritized measures with high impact, data availability, and cost-effectiveness as thresholds for inclusion into DSMSim™.

[33] Appliance standards rulemaking notices and technical support documents can be found at: http://energy.gov/eere/buildings/current-rulemakings-and-notices. See Chapter 5 for the engineering analysis, Chapter 7 for the energy use analysis, and Chapter 8 for the cost impact referenced in this study.

2.5.1 Gas Energy Efficiency Technology Characterization Approach

Navigant developed a comprehensive measure list of gas efficiency measures likely to contribute to technical and economic potential. The team reviewed CECONY's previous potential studies, the New York TRM, and potential model measure lists from other jurisdictions to identify gas energy efficiency measures with the highest expected technical and economic impact. The team supplemented the measure list using potential studies and TRMs from British Columbia, Arkansas, and Illinois. These studies had the most recent and relevant data for gas measures and metrics from these studies could be directly applied in CECONY's service territory. Measure data from the potential study done in Arkansas was used for non-weather sensitive measures and British Columbia and Illinois were used for weather sensitive measures.

Navigant worked with CECONY to finalize the measure list and ensure it contained technologies viable for future CECONY program planning activities. In total, Navigant reviewed many measures and, through discussions with CECONY, moved forward with 24 measures applicable to 17 different customer segments within the residential and commercial sector for analysis. Table 35 shows the number of measures by sector and fuel type, while Appendix G provides the final measure list.

Table 35. Number of Measures by Sector

Sector	Measures
Residential	11
Commercial	13
Total	**24**

Source: Navigant

2.5.2 Gas Energy Efficiency Technology Characterization Key Parameters

The measure characterization effort consisted of defining nearly 50 individual parameters for each of the 24 measures included in this study. This section defines the top 10 key parameters and how they impact technical and economic potential savings estimates. Appendix G provides the measure level data used in the analysis for each of the parameters discussed below.

1. **Measure Definition:** The team used the following variables to qualitatively define each characterized measure:
   - ***Replacement Type:*** Replacing the baseline technology with the efficient technology can occur in three variations:
     i. **Retrofit:** Where the model considers the baseline to be the existing equipment, and uses the energy and demand savings between the existing equipment and the efficient technology during technical potential calculations. Retrofit also applies the full installed cost of the efficient equipment during the economic screening.
     ii. **ROB:** Where the model considers the baseline to be the code-compliant technology option, and uses the energy and demand savings between the current code option and the efficient technology during technical potential calculations. ROB also applies the incremental cost between the efficient and code-compliant equipment during the economic screening.
     iii. **New Construction:** Where the model considers the baseline to be the least cost, code-compliant option, and uses the energy and demand savings between this specific current code option and the efficient technology during technical potential calculations. New

construction also applies the incremental cost between the efficient and code-compliant equipment during the economic screening.

- ***Baseline Definition:*** Describes the baseline technology.
- ***Demand-Side Management (DSM) Definition:*** Describes the efficient technology set to replace the baseline technology.
- ***Unit Basis:*** The normalizing unit for energy, demand, cost, and density estimates.

2. **Customer Segment and End-Use Mapping:** The team mapped each measure to the appropriate customer segments and sectors. The measures were characterized for four residential and 13 commercial segments as stated in the list below:
    - Education
    - Grocery
    - Hospital
    - Large Office
    - Large Retail
    - Miscellaneous/Entertainment
    - Multi-Family - Common Area
    - Nursing Home/Lodging
    - NYPA – Commercial
    - Restaurant
    - Small Office
    - Small Retail
    - Warehouse/Industrial
    - Large Multi-Family – Residential
    - NYPA – Residential
    - Single-Family – Residential
    - Small Multi-Family – Residential
3. **Annual Energy Consumption:** The annual energy consumption in therms for each of the base and energy efficient technologies.
4. **End-Use Categories:** The gas measures are mapped to four end-uses, heating, hot water, interior equipment, total facility.
5. **Fuel Type Applicability Multipliers:** Defines the percentage of stock that is applicable to a measure, given a specified heating configuration depending on whether they are a firm customer or not. For example, if the fuel type multiplier is assigned “Space Heat Gas Only” for a given customer segment, stock for the measure is only gas customers that have space heating.
6. **Measure Lifetime:** The lifetime in years for the base and energy efficient technologies.

7. **Costs:** The cost between the assumed baseline and efficient technology, using the following variables:
    - ***Base Costs:*** The cost of the base equipment, including both material and labor costs
    - ***Energy Efficiency Costs:*** The cost of the energy efficient equipment

    The model applies the incremental cost (difference between base and efficient material cost) for ROB measures. For retrofit measures, the model applies the full cost including material and labor costs.
8. **Technology Densities**: This study defines density as the penetration or saturation of the baseline and efficient technologies across CECONY's gas territory. For residential, the model calculates these saturations on a per home basis; for commercial, per square foot of building space; and for industrial, energy consumption.
    - ***Base Initial Saturation:*** The saturation of the baseline equipment in a territory for a given customer segment.
    - ***Energy Efficiency Initial Saturation:*** The saturation of the efficient equipment in a territory for a given customer segment.
    - ***Total Maximum Density:*** The total number of both the baseline and efficient units in a territory for a given technology.
9. **Technology Applicability:** The percentage of the base technology that can be reasonably and practically replaced with the specified efficient technology.
10. **Competition Group:** The team combined efficient measures competing for the same baseline technology density into a single competition group to avoid the double counting of savings.

2.5.3 Gas Energy Efficiency Technology Characterization Data Sources

This section provides approaches and sources for the main measure characterization variables.

Industry practice in developing market characterizations for DSM assessments is to utilize utility-specific primary data, baseline analysis, and studies where possible. Where Navigant did not have such information available, the team used comparable data from utilities located in neighboring states or other secondary sources, such as TRMs and DEER.

2.5.3.1 Gas Energy Savings

Navigant took two general bottom-up approaches to analyzing measure therm savings:

1. **TRM Standard Algorithms:** Navigant used NY TRM's standard algorithms for unit therm savings calculations for majority of the measures.
2. **Engineering Analysis:** Navigant used appropriate engineering algorithms to calculate therm savings for any measures not included in the NY TRM.

2.5.3.2 Costs

Navigant primarily relied on publicly available cost data sources, such as the DEER and ENERGY STAR, 2013 NYSERDA Residential Baseline Study, Itron Measure Cost study, and other potential studies for all cost data, including incremental costs. Navigant also researched NYSERDA reports for individual measures and leveraged that to fill in gaps for measure costs.

2.5.3.3 Building Stock and Densities

The primary data collection effort by Navigant, MadDash, Inc., and MSI provided measure density and saturation data for a majority of the residential and a portion of the commercial measures. Navigant also used the 2013 NYSERDA Residential Baseline Study and CECONY Resource Planning Summer Survey Report for informing density and saturation values for a few residential measures. If the team could not obtain measure level data from the sources, Navigant leveraged other jurisdiction's TRMs and previously conducted potential studies in Pennsylvania, Arkansas, and Colorado, as the density data from these studies was the most recent and relevant amongst all other available data sources after leveraging CECONY's past studies. The Pennsylvania study was used for weather sensitive measures and Arkansas and Colorado studies were used for developing measure characteristics of non-weather sensitive measures.

2.5.4 Existing Conditions and Code Baseline

This study incorporates savings from existing inefficient baseline and savings from standard code-compliant baseline for the study period. The existing baseline represents an inefficient device while the standard baseline represents updated standards as defined in the NY TRM or industry standard practice.

The results presented within this report are based on the code baseline.

2.6 DR Technology Characterization

Navigant developed technical, economic, and achievable potential forecasts for DR in CECONY's service region from 2017 to 2026. These potential forecasts relied on a set of detailed technology characteristics for a comprehensive list of DR options targeting specific end-uses in residential customer homes and commercial buildings. Navigant developed a comprehensive list of relevant DR technology for CECONY'S service territory and characterized these technologies in terms of their load reduction potential and costs. This section details Navigant's approach to technology characterization.

2.6.1 DR Technology Characterization Approach

Navigant first selected a list of DR technologies for further characterization to complete a screen of the potential DR measures to include in this study. Only the measures that passed would be characterized. Table 36 and Table 37 outline the technologies that passed and failed.

Table 36. DR Technologies that Passed Screen

Sector	End Use	DR Measure Name	Brief Description
Commercial	**Cooling (Electric)**	Manual HVAC Control[35]	Manual control of HVAC load in response to DR signals

[35] Applies to all commercial building types, other than small retail and small office.

Sector	End Use	DR Measure Name	Brief Description
	Fans/ Ventilation (Electric)[34]	Auto-DR+HVAC[36]	Automated response of HVAC systems in response to DR signals, executed through pre-programmed responses in a building's management response. Assumes auto-DR architecture set up at the facility.
		Direct Load Control - Switch[37]	Direct control of air conditioning load through a load control switch.
		Direct Load Control - Thermostat[38]	Direct control of air conditioning load through a programmable communicating thermostat (PCT)
	Lighting	Standard Lighting Control	Manual and semi-automated lighting control technologies.
		Advanced Lighting Control	Auto-DR enabled lighting control and/or decentralized advanced lighting controls.
	Refrigeration	Auto-DR+Refrigeration	Auto-DR enabled control of refrigeration loads.
	Total Facility	Dispatchable Back-Up Generation (BUG) - Diesel[39]	Shifting of partial or entire facility load to BUGs during DR events
		Dispatchable BUG- Natural Gas[40]	
		Time Varying Rates (without enabling technology)	Time varying rate offer (e.g., critical peak pricing) to customers.
		Time Varying Rates (with enabling technology)	Enabling technology refers to communicating thermostats for small retail and small office and to Auto-DR for all other commercial building types.
Residential		Direct Load Control-Switch	Direct control of air conditioning load through a load control switch.
		Direct Load Control-Thermostat	Direct control of air conditioning load through a programmable communicating thermostat (PCT)
		Time Varying Rates (without enabling technology)	Time varying rate offer (e.g., critical peak pricing) to customers.
		Time Varying Rates (with enabling technology)	Enabling technology refers to communicating thermostats.

Source: Navigant

[34] These technologies passed because they are proven and commercially available, applicable to CECONY service territory, cost scalable, applicable to customer-sited installations, and characteristic data are available from reliable sources.

[36] Applies to all commercial building types, other than small retail and small office.

[37] Applies to all commercial building types other than large office and large retail.

[38] Applies to all commercial building types other than large office and large retail.

[39] Applies to all commercial building types other than small office and small retail.

[40] Applies to all commercial building types other than small office and small retail.

Table 37. DR Technologies that Failed Screen

Technology	Reasoning
Dispatchable Distributed Generation (DG) Engine/Turbine: Bio Fuel	Navigant screened out all biofuel technologies because: a) the costs for onsite processing put it at a disadvantage to natural gas technologies, b) the higher emissions create a barrier, and c) the competition for using biofuels in transportation will likely constrain supply for CHP applications
Dispatchable DG Engine: Oil	For the purposes of this study, Navigant did not distinguish between diesel and fuel oil; the team omitted fuel oil to avoid double counting.
Dispatchable DG Turbine: Coal	Regulatory and infrastructure challenges with coal-powered DG limit the applicability within CECONY service territory. In most cases, other fuel types will be preferred. Exceptions can be treated as they arise, however these lie outside the scope of this model.
Dispatchable DG Turbine: Other	This was a general category for other fuel types (e.g., hydrogen, propane, and landfill gas). Navigant assumes any economic source of other fuel types has already been tapped and is not available.
EV Battery Controller: With or Without Inverter	CECONY expects to see approximately 144,000 plug-in light duty EVs between 2015 and 2019 (cumulative) in its service territory. While the team recommends this for future consideration in callable load programs, Navigant expects the penetration within the next 3-5 years to be too low for consideration in this study.
Electric Water Heater Controller	Not applicable to CECONY's territory since 5% or less of residential end-use consumption is from electric water heaters (depending on the customer segment). While a greater portion of commercial buildings have electric water heaters, water heating consumption is only 1% of all commercial electric consumption.
Pool Pump Controller	Not applicable to CECONY's territory, since only 4% of dwellings have pool pumps and pool pump-related consumption is expected to decline by 2% by 2018.[41]
Smart Appliances (Clothes Washer, Dishwasher, Microwave, Oven, Refrigerator)	Not anticipated to be a market-ready, cost-effective technology for full-scale rollout in 3-5 years, based on input from Navigant's in-house expertise.
Window AC Control Kit	This includes a smart plug and thermostat, as offered by ThinkEco through CECONY's coolNYC program. CECONY successfully deployed this pilot. Industry expertise indicates that large-scale commercialization and deployment opportunities remain limited in the short-term. This technology is not at the same state of market readiness as thermostats for central AC control.
Window AC with Integrated Controls	An emerging technology, there was minimal performance and cost data available for its inclusion.
IR Blaster (Intesis/Tado) CECONY pilot	Infrared-based remote control device that could possibly enable easier control of multiple devices. It does not directly provide load reductions, hence not relevant for this study.

[41] Ibid.

Technology	Reasoning
Automated DR + Behind-the-Meter Batteries	Represents locally-sited, behind-the-meter energy storage that provides highly flexible responses. Batteries equipped with the right telemetry, control, and intelligence can provide a wide range of services. Navigant included this under STR for this study.

Source: Navigant

2.6.2 DR Technology Characterization Key Parameters

Navigant characterized the DR technologies at different capacities for 17 different building types/customer segments for a total of 165 technology combinations. The team characterized each segment/technology combination using various primary and secondary data sources.

Table 38 summarizes the DR technology characterization fields followed by a discussion of the process used to characterize the technologies.

Table 38. DR Technology Characterization Fields

No.	Field	Data Inputs	Outputs
1.	**Average Coincident Peak Demand by Building Type and End-Use**	8,760 system load data, load profiles by building type, end-use load shapes, electricity sales by building type.	Average coincident peak demand by building type and end-use.
2.	**Eligible Load by DR Technology**	Residential and commercial survey findings that help assess end-use eligibility (e.g., saturation data by end-use, end-use equipment shares, penetration of control systems such as energy management systems [EMS], penetration of BUGs).	Eligible end-use load by DR measure by building type (kW/square foot for commercial; kW/customer for residential).
3.	**Shed Factors by DR Technology and End-Use**	Percentage of eligible end-use load that can be reduced through a DR measure (based on best available industry estimates and from CECONY program information, wherever applicable).	Eligible curtailable end-use load by DR measure and by building type (kW/square foot for commercial; kW/customer for residential).
4.	**Unit Cost Assumptions**	Capital and installation costs, fixed and variable operations and maintenance (O&M) costs for DR technologies by sector and end-use, technology lifetime.	Annualized capital and installation costs ($/kW-year) and annual O&M costs ($/kW-year) for each DR technology/customer type/end-use combination.
5.	**Maximum Feasible Participation Rate**	Maximum feasible participation rates based on survey findings, benchmarking with similar programs.	Maximum feasible participation rate for each DR technology/customer type/end-use combination.

Source: Navigant

Average Coincident Peak Demand by Building Type and End-Use

The team began the DR technology characterization by estimating the average coincident peak demand for each end-use and building type combination that applies to the list of selected DR technologies. [42] Navigant started with the 8,760 load profiles and end-use shapes by customer segment developed for this study and then scaled these up using the customer segment-level sales data developed for this study. This provided an estimate of the hourly load by customer segment/building type and end-use for residential and commercial customers. Navigant took an average of the hourly load over the top 100 system peak hours to estimate the average coincident peak demand for the different building type and end-use combinations.

Eligible Loads by DR Measure

Following the average peak demand estimation, the team calculated the eligible curtailable load for each combination of DR technology, building type, and end-use. For commercial customers, the team developed technology inputs in terms of kW/square foot, and for residential, in terms of kW/customer. Navigant primarily used the survey findings to determine the eligible portion of the total stock to which a DR technology would apply. For example, for cooling load control, Navigant determined from survey findings what percentage of the total stock (square feet) of a specific building type (e.g., office) is cooled. Of this percentage, the team estimated that only a certain fraction of the cooling load could be centrally controlled through an EMS and, therefore, eligible for auto-DR. Navigant used survey findings on the share of different cooling equipment types by building type to assess this fraction. This helped the team determine the amount of eligible load available for curtailment during a DR event for each DR technology, building type, and end-use combination.

Shed Factors by DR Technology and End-Use

After determining the eligible load, Navigant applied shed factors from the best available industry sources to determine what fraction of the eligible load could be shed on an average during each hour of a DR event.[43] The shed factor varies by DR technology and by end-use. Wherever applicable, Navigant calibrated the data to CECONY program performance data. For instance, for technologies such as direct load control (DLC)-thermostat, Navigant calibrated to actual program results from CECONY in terms of load reduction per thermostat. For load shifting using back-up generators (BUGs), the team calibrated input assumptions to CECONY's Distribution Load Relief Program (DLRP) and Commercial System Relief Program (CSRP) program performance data in terms of the percentage of a facility's load that could be shifted to BUGs during a DR event. Navigant then applied the results to the eligible load to calculate the available curtailable load for each DR technology/customer segment/end-use combination.

Cost Inputs

Finally, the research team developed cost inputs for the DR technologies. Navigant sourced cost assumptions from best available industry sources and from Navigant's internal databases. For example, the recently published 2015 California DR potential study and other similar reports[44] provide cost input assumptions for the DR technologies included in this assessment. In addition, Navigant has specific DR technology vendor cost estimates through ongoing engagements. Cost inputs were specified in terms of capital, installation, and O&M costs for each DR technology/customer segment/end-use combination.

[42] The average coincident peak demand refers to the average demand during CECONY's top 100 system peak load hours during which DR events are likely to be called.

[43] Navigant primarily leaned on DR research conducted by the Lawrence Berkeley National Lab (LBNL) in this area. LBNL study reports present shed factors by end-use for different DR technologies.

[44] 2015 California Demand Response Potential Study; Page 2 Appendices A-J; November 14, 2016; PacifiCorp Demand-Side Resource Potential Assessment for 2015-2034; Volume 5: Class 1 and 3 DSM Analysis Appendix; January 13, 2015.

Current Participation and Maximum Feasible Participation Rate

Navigant developed current DR program participation rates (an input to the IDSM model) to calibrate to CECONY's current DR program achievements. In addition, the team developed maximum feasible participation rate estimates, which represent the upper limit on the percentage of eligible load that could participate in a DR program. This was primarily based on residential and commercial survey findings that indicated customer willingness to participate in DR programs, as well as benchmarking with similar programs offered by other utilities[45].

2.6.3 DR Technology Characterization Data Sources

Navigant used a combination of primary and secondary data sources for DR technology characterization. Navigant used residential and commercial survey data, wherever applicable, for characterization. Also, as mentioned previously, Navigant relied on load profiles and end-use shapes developed as part of this study to estimate coincident peak demand. The team reviewed CECONY's DR program data and used that to develop unit assumptions wherever applicable. Where primary (survey-based) and CECONY-specific data were not available, Navigant relied on publicly available industry reports or Navigant's internal data sources to inform assumptions.

Table 39 lists the key data sources for DR technology characterization.

[45] For time varying rates, which are assumed to be critical peak pricing in this study, participation estimates are based on the Brattle Group's Pricing Program Database, sourced from "PacifiCorp Demand-Side Resource Potential Assessment for 2015-2034; Volume 5: Class 1 and 3 DSM Analysis Appendix; January 13, 2015."

Table 39. Key Sources for DR Characterization

Parameter	Sources
Average Coincident Peak Demand by Building Type and End-Use	• Building type load profiles and end-use load shapes developed by Navigant for CECONY
End-Use Eligibility for DR Technology by Building Type and End-Use	• CECONY survey results[46] • CECONY Resource Planning Summer Survey CECONY Report 9-12-16[47]
Shed Factors by DR Technology	• Secondary information sources, which primarily include DR research conducted by the Lawrence Berkeley National Lab that provide end-use impact estimates from DR technologies through various field experiments[48] • CECONY Program Data[49]
Cost Assumptions	• Navigant's internal database
Maximum Feasible Participation	• Survey results[50] • Navigant's internal database and secondary data sources[51]

Source: Navigant

2.7 CSG Technology Characterization

Navigant developed technical, economic, and potential forecasts for the installation of CSG in CECONY's service region from 2018 to 2026. These potential forecasts relied on a set of detailed measure characteristics for a comprehensive list of measures including; solar PV and energy storage, CHP and combined cooling heat and power (CCHP) driven by engines, combustion turbines, microturbines, molten carbonate fuel cells (MCFC), and phosphoric-acid fuel cells (PACF). This section details Navigant's approach to measure characterization.

[46] These were primarily drawn from the following questions in the survey: a) Commercial Survey Q27. What percentage of your business space is cooled?; b) Commercial Survey Q28. What type of main cooling system is used to cool your business space? C) Q54. Which of the following energy savings measures are used for lighting in your business space?; d) Q55. Does this facility have a centralized building control system, also known as an energy management system or a building automation system, which discovers, reports, and/or corrects undesired control issues? e) Q.76. Do you have a back-up generator on site for your facility?; f) Q79. What kind of fuel is used in the back-up generator?

[47] Sourced Central Air Conditioning (CAC) saturation data for Multi-Family Residential units from this report.

[48] Primarily includes the following sources: a) 2015 California Demand Response Potential Study; Phase 2 Appendices A-J; November, 2016; Grid Integration of Aggregate Demand Response, Part I: Load Availability Profiles and Constraints for the Western Interconnection; September 2013;

[49] CECONY Direct Load Control (DLC) program data was used for load reduction per thermostat from residential and commercial customers. For Back Up Generators, Navigant relied on CSRP and DLRP program data to assess what percentage of a facility load could be shifted to BUGs during a DR event.

[50] Q.87 in the commercial survey: "If your business does not participate in any program, would you be interested in participating in one in the future?"

[51] Primarily includes benchmarking data for similar programs drawn from the FERC National DR survey and program reports,

2.7.1 CSG Technology Characterization Approach

Navigant completed a screen of the potential technologies to include in this study. The team only characterized the technologies that passed the screen. The tables below highlight the technologies that passed and failed.

Table 40. CSG Technologies that Passed Screen

DG Type	DG Technology	Fuel	Reasoning
PV	PV with Energy Storage	N/A	These technologies passed because they are proven and commercially available, applicable to CECONY service territory, cost scalable, applicable to customer-sited installations, and characteristic data are available from reliable sources.
CHP	Combustion Turbine	Natural Gas	
CHP	Engine	Natural Gas	
CHP	Fuel Cell	Natural Gas	
CHP	Microturbines	Natural Gas	
CCHP	Combustion Turbine	Natural Gas	
CCHP	Engine	Natural Gas	

Source: Navigant

Table 41. CSG Technologies that Failed Screen

DG Type	DG Technology	Fuel	Reasoning
CHP/CCHP	Combined Cycle Turbines	Natural Gas	Large systems, not applicable to customer-sited installations.
CHP/CCHP	Combustion Turbine, Fuel Cell, Microturbine	Biogas	All biogas technologies screened out because higher cost for onsite reformation, higher emissions, and almost identical economics and performance to a natural gas system.
CHP/CCHP	Engine	Biofuel	All biofuel technologies screened out for similar reasons to biogas. Tthe competition for using biofuels in transportation will likely constrain supply for CHP applications.
CHP/CCHP	Engine	Diesel	For a CHP application, the team assumed that customers would not accept diesel.
CHP/CCHP	Steam Turbine	Natural Gas	Using a boiler or steam turbine is a lower efficiency option relative to other CHP options. The few steam turbine CHP projects in CECONY service territory are old for large applications.
Other	Small Hydro	N/A	A recent DOE study showed that a few dams in CECONY service territory could be repowered but not enough to build a utility program around. [52]
Other	Small Wind	N/A	CECONY's service territory does not have the average wind speeds to support small wind, per an assessment by National Renewable Energy Lab.[53]

Source: Navigant

[52] US Department of Energy, "Powering up America's Waterways," 2012, http://energy.gov/articles/powering-america-s-waterways.

[53] http://www.windpoweringamerica.gov/windmaps/residential_scale.asp

2.7.2 CSG Technology Characterization Key Parameters

Navigant characterized the solar PV and the CHP and CCHP technologies included in this study at different capacities for 16 different customer types for a total of 211 measure combinations. The team characterized each measure using various research outlets to find inputs for key parameters. Table 42 details some of the key parameters for the present analysis.

Table 42. Key Parameters for CSG

Key Parameters		
Max Feasible Participation Rate	Current Market Participation Rate	Technical Potential per Square Foot
Incremental Capital Cost	State and Federal Rebate	Heat Rate
Installation Cost	Generator Life	Annual Degradation
Variable O&M	Annual Capital Cost Inflation	Power-to-Heat Ratio
Fixed O&M	Annual Installation Cost Inflation	(NOx, PM 2.5, VOC) Emissions Factors

Source: Navigant

For this study, CECONY asked Navigant to focus on solar PV + dispatchable storage as opposed to standalone PV to study a firm resource.

Some parameters were only required for CHP and CCHP measures and are prime-mover dependent. The list below outlines the prime movers included in this study.

- **Engine:** Piston or heat engine
- **Combustion turbine:** Combustion engine
- **Microturbines:** Micro-combustion engine, fewer moving parts
- **Fuel cells:** Anode, cathode, and electrolyte
    - MCFC: Molten carbonate electrolyte
    - PACF: Liquid phosphoric-acid electrolyte

The model assumes that natural gas fuels all CHP and CCHP measures.

2.7.3 CSG Technology Characterization Data Sources

Navigant used publicly available industry reports, internal data, and CECONY data for CSG technology characterization.

Table 43. Key Sources for CSG Characterization

Parameter	PV Sources	CHP Sources
Technical Potential per Square Foot	New York Solar Map[54]	See details below this table
Max Feasible Participation Rate	New York Solar Map	Commercial survey results to Q90
Current Market Participation Rate	Navigant analysis of CECONY data NREL Solar Map[55]	Commercial survey results to Q88
Incremental Capital Cost	Navigant internal solar cost data	US Environmental Protection Agency Catalog of CHP Technologies[56]
Installation Cost		
Variable O&M	N/A	
Fixed O&M	Navigant internal solar cost data	
State and Federal Rebate	New York Solar Map[57] NC Clean Energy State Incentives Database[58]	NC Clean Energy State Incentives Database[59]
Generator Life	Navigant/ industry standard	EPA Catalog of CHP Technologies, March 2015
Annual Capital Cost Inflation	Navigant internal solar cost data	CECONY data
Annual Installation Cost Inflation		
Heat Rate	N/A	EPA Catalog of CHP Technologies, March 2015
Annual Degradation	NREL/industry standard	The Cadmus Group Report to PacifiCorp[60]
Power-to-Heat Ratio	N/A	EPA Catalog of CHP Technologies, March 2015
(NOx, PM 2.5, VOC) Emissions Factors		

Source: Navigant

The team defined the technical potential per square foot for PV as a capacity value (kW) provided by the CECONY network that can be found within the IDSM model. It is based upon the New York Solar Map.[61]

[54] City University of New York (CUNY), NY Solar Map, 2017, https://www.nysolarmap.com/.

[55] National Renewable Energy Laboratory (NREL), Solar Maps, https://maps.nrel.gov/.

[56] US Environmental Protection Agency (EPA), Catalog of CHP Technologies, March 2015, https://www.epa.gov/chp/catalog-chp-technologies.

[57] NY Solar Map, 2017.

[58] NC Clean Energy Technology Center, Database of State Incentives for Renewables & Efficiency, http://www.dsireusa.org/.

[59] Ibid.

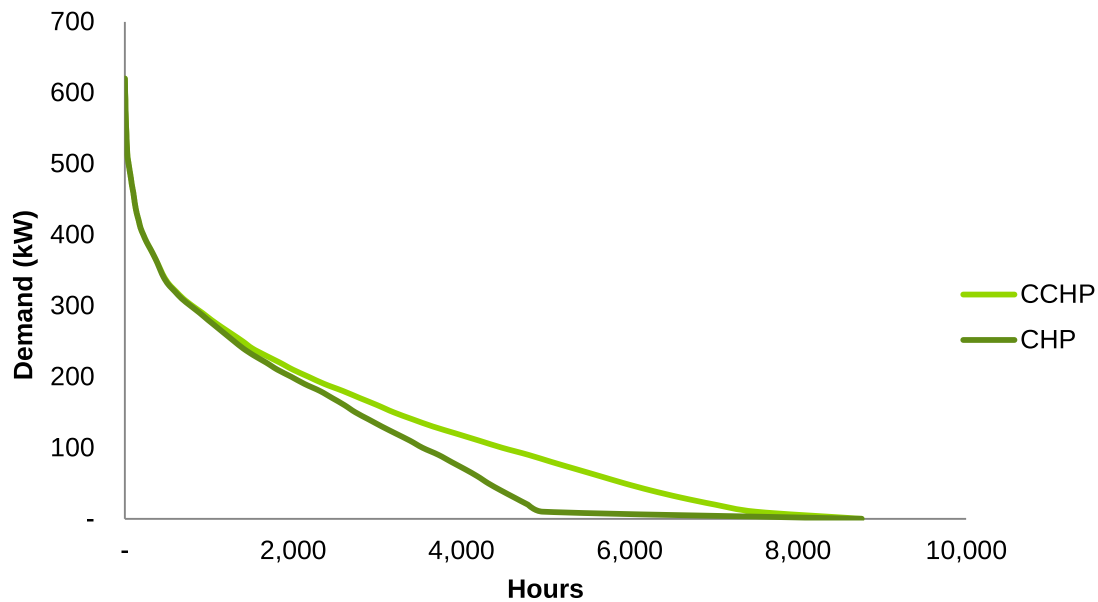
[60] The Cadmus Group, "Revised Overview of CHP Inputs, Data Sources, and Potential Study Results to PacifiCorp," October 4, 2012, http://www.pacificorp.com/content/dam/pacificorp/doc/Energy_Sources/Integrated_Resource_Plan/2013IRP/2013IRP_CHP-Memo-LCOEexcel_10-04-12.pdf.

The technical potential per square foot for CHP and CCHP was analyzed based on the load shapes discussed in Section 2.2.

- For CHP, using the load shapes, Navigant assumed one-third the max thermal load or the thermal load at 5000 hours on the thermal load duration curve, whichever was lower, as the equivalent to the thermal kW/square foot for each building type.
- For CCHP, using the load shapes, Navigant assumed one-third the max thermal plus cooling load or the thermal load at 5000 hours on the thermal plus cooling load duration curve, whichever was lower, as the equivalent to the thermal kW/square foot for each building type.

Figure 31 shows an example output of the technical potential per square foot analysis for grocery.

Figure 31. Example Thermal Load Duration Curve - Grocery



Source: Navigant

The maximum feasible participation rate and current market participation rate for CHP and CCHP are from commercial survey results to questions 90 and 88, respectively. Note that CHP and CCHP technologies were not characterized for residential customer types in this project, because while products are available, no vendors are targeting the residential sector; customer awareness is negligible; and there is no industry infrastructure to support installations.

- Q90: In your utility room or other areas of your property, do you have room for more utility equipment such as something ranging in size from a large refrigerator to a boiler?
- Q88: Which of the following generation technologies are currently used in your business?

[61] NY Solar Map, 2017.

The max feasible and current market participation rate is the sum of the weighted frequency of the participants who answered *yes* for the specific customer type and technology for questions 90 and 88, respectively.

2.8 Storage Technology Characterization

Navigant developed technical, economic, and potential forecasts for the installation of storage technologies in CECONY's service region from 2018 to 2026. These potential forecasts relied on a set of detailed measure characteristics for a comprehensive list of storage technologies including; lithium ion (Li-ion) batteries, lead-acid batteries, and zinc bromide (ZBR), vanadium redox, aqueous hybrid ion, and zinc airflow batteries. This section details Navigant's approach to measure characterization.

2.8.1 Storage Technology Characterization Approach

Navigant completed a screen of the potential technologies to include in the study. Only technologies that passed would be characterized. The tables below highlight the technologies that passed and failed, and why.

Table 44. STR Technologies that Passed Screen

Storage Type	Storage Technology	Reasoning
Battery	Lithium Ion (Li-ion)	Li-ion products for customer-sited energy storage are available from many vendors and costs and performance are known.
Battery	Advanced Lead-Acid	Lead-acid products are available for energy storage and their cost and performance is characterized.
Battery	ZBR	Multiple vendors are producing ZBR product.
Battery	Vanadium Flow	Vendors are producing commercially available products.
Battery	Zinc Air	A single company is making this type of battery and it is currently developing commercial products.

Source: Navigant

Table 45. STR Technologies that Failed Screen

Storage Type	Storage Technology	Reasoning
Battery	Fe-CR	Primary technology developer just went out of business and no other vendors are near commercialization.
Battery	NaS	Any technology that contains sulfur requires special Department of Environmental Protection (DEP) review under LL26 (sulfuric acid is considered highly hazardous in New York City).
Battery	Super Capacitors	Super capacitors are for utility-scale applications for grid support.
Battery	Aqueous Hybrid Ion	Main technology developer just went out of business.
Battery	Liquid Metal	This is an early stage technology and likely not available in 3-5 years.

Storage Type	Storage Technology	Reasoning
Battery	Energy Storage with EVs (V2G)	Products and business models for this application of EVs are not available and likely will not be in 3-5 years, and the costs and performance are unknown.
Mechanical	Flywheels	Flywheel technology is designed for grid support applications.
Mechanical	Compressed Air Storage (CAES)	CAES resources are not present in CECONY service territory and are geared toward large, utility-scale applications.
Mechanical	Pumped Hydro	Resources are not present in CECONY service territory and are geared toward large, utility-scale applications.
Battery	Ni-Zn	Unlikely to be commercially available in 3-5 years and the costs and performance are unknown.
Battery	NaMX	These technologies are mostly geared toward microgrid applications.
Battery	Metal Air	Metal air technologies are too early stage and cost and performance are not yet verified.
Battery	Zinc-Nickel Oxide	Technology is still in the pilot stage.

Source: Navigant

2.8.2 Storage Technology Characterization Key Parameters

Navigant characterized the storage technologies included in this study at different capacities for 15 different customer types for a total of 162 measure combinations. The team characterized each measure using various research outlets to find inputs for key parameters.

Table 46 details some of the key parameters for the present analysis.

Table 46. Key Parameters for STR

Key Parameters		
Max Feasible Participation Rate	Fixed O&M	Annual Capital Cost Inflation
Current Market Participation Rate	State and Federal Rebate	Annual Installation Cost Inflation
Capital Cost	Battery Replacement Cost	Maximum Useful Life
Duration	Installation Cost	Battery Replacement Year
Capacity	Variable O&M	Round-Trip Efficiency

Source: Navigant

Some parameters are technology-dependent. The following list defines the technologies included in this study:

- **Li-ion batteries:** Batteries that utilize the flow of Li-ion between the cathode and anode of the battery to charge and discharge.

- **Flow batteries:** Single-celled battery cells that transform the electron flow from activated electrolyte into electric current. The spent electrolyte can then be recharged from external electricity and used again.
- **Advanced lead-acid batteries:** Batteries that utilize carbon doping of the electrodes to allow for a more durable and efficient battery when compared to traditional lead-acid batteries.

2.8.3 Storage Technology Characterization Data Sources

Navigant mainly used publicly available industry reports, internal data, and data provided by CECONY for the STR technology characterization. Table 47 identifies the sources for the key parameters used.

Table 47. Key Sources for STR Characterization

Parameter	STR Sources
Capacity	CECONY's virtual power plant (VPP) pilot[62] and Navigant assumptions based on public cost benefit studies, Navigant's database of existing projects, and public feasibility studies
Duration	CECONY's VPP pilot and Navigant assumptions based on public cost benefit studies, Navigant's database of existing projects, and public feasibility studies
Maximum Capacity per Site	Navigant database on current installations
Max Feasible Participation Rate	Commercial survey results to Q90; residential survey results Q71
Current Market Participation Rate	Commercial survey results to Q91; CECONY's VPP
Capital Cost	Navigant internal energy storage cost data
Installation Cost	
Battery Replacement Cost	
Annual Capital Cost Inflation	
Annual Installation Cost Inflation	
State and Federal Rebate	CECONY
Fixed O&M	Navigant assumption
Variable O&M	N/A
Maximum Useful Life	Navigant internal energy storage performance data sourced from DOE studies and vendor specification sheets
Battery Replacement Year	
Round-trip Efficiency	

Source: Navigant

[62] CECONY is piloting a clean virtual power plant (VPP) program in which solar PV and storage are installed at customer's homes and dispatched by the utility.

The commercial survey results for questions 90 and 91 provided the basis for the maximum feasible participation rate and current market participation rate for commercial STR customers, respectively. Likewise, the residential survey results from questions 70 and 71 provided the basis for the maximum feasible participation rate and current market participation rate for residential STR customers.

- ComQ90: In your utility room or other areas of your property, do you have room for more utility equipment such as something ranging in size from a large refrigerator to a boiler?
- ComQ91: Do you use energy storage technologies in your business or building? (100% answered no)
- ResQ71: Do you have space outside your home for a storage unit (such as something the size of a small refrigerator)?

Navigant calculated the maximum feasible and current market participation rate by summing the weighted frequency of the participants who answered yes for the specific customer type and technology for question 71, 90, and 91, respectively.

3. ELECTRIC ENERGY EFFICIENCY POTENTIAL FORECAST

This section provides the electric energy efficiency potential for the years 2017 through 2026 for the CECONY markets in New York City (five boroughs) and Westchester County. Navigant estimated seven scenarios for energy efficiency potential for the residential and commercial and industrial (C&I) sectors. Navigant also developed potential estimates by specific customer segment and measure within each sector. Table 48 and Figure 32 present cumulative energy efficiency potential across all sectors. Technical potential is 14,940 GWh in 2017, growing to 15,734 GWh by 2026, which represents 24.8% of the reference forecast. Economic potential is 13,529 GWh or 21.4% of the reference forecast in 2026. Programmatic achievable potential grows from 289 GWh and 0.5% of the reference forecast in 2017 to 3,517 GWh cumulatively and 5.6% of the reference forecast in 2026. In 2026, programmatic achievable potential is roughly 25% of the economic potential.

The results indicate a few noteworthy patterns:

- Savings for the various achievable potential scenarios cumulate to levels that are still quite short of reaching the economic potential. Several factors contribute to this. First, there are always customers who will not adopt energy efficiency measures even though they might be cost-effective and offered virtually for free. Second, the end-use equipment stock in the CECONY service territory includes a large amount of equipment that is long-lived. Since this is a 10-year time horizon, equipment has yet to turn over by the time 2026 comes around. It is expected that the achievable potential could eventually trend closer to economic potential in the years following 2026.
- The budgets are more or less the same across the achievable scenarios from 2017-2019,[63] as described in Section 2.3.4, which is why the different achievable potential scenarios do not vary significantly during the early years prior to 2020. After 2019, two things slow the rate of savings accumulation for the programmatic achievable scenarios: 1) the budget is held constant at 2019 levels through 2026 and 2) the federal standard for general service lighting takes effect in 2020, which significantly diminishes the available savings from lighting.
- Savings accumulation slows slightly in the theoretical achievable scenario between 2019 and 2020, and then begins increasing at an even greater rate after 2020, as controls and exterior lighting measures become more prominent and the budget is assumed to increase on an annual basis. Towards 2024, the rate of savings uptake slows again, as the market nears saturation for some measures and savings become more expensive to acquire.
- Naturally occurring potential is over 70% of the programmatic achievable in 2017, declining to more than 50% by 2026. High naturally occurring potential is consistent with recent market research that suggests there is general high interest in energy efficiency – including high organic adoption of some technologies (e.g. LEDs) – but that do not translate into program savings due to relatively low awareness of CECONY program offerings and/or barriers to program participation.

Table 49 and Figure 33 show the corresponding demand savings for electric energy efficiency. The demand results are fairly consistent with energy in terms of percentages relative to forecasts. This

[63] With the assumption that the Reduced Achievable scenario budget drops back to the 2018 budget level in 2020, the model does not assume deployment up to the full budget constraint in 2019; thus, there is a slight variation in the 2019 budget for Reduced Achievable potential.

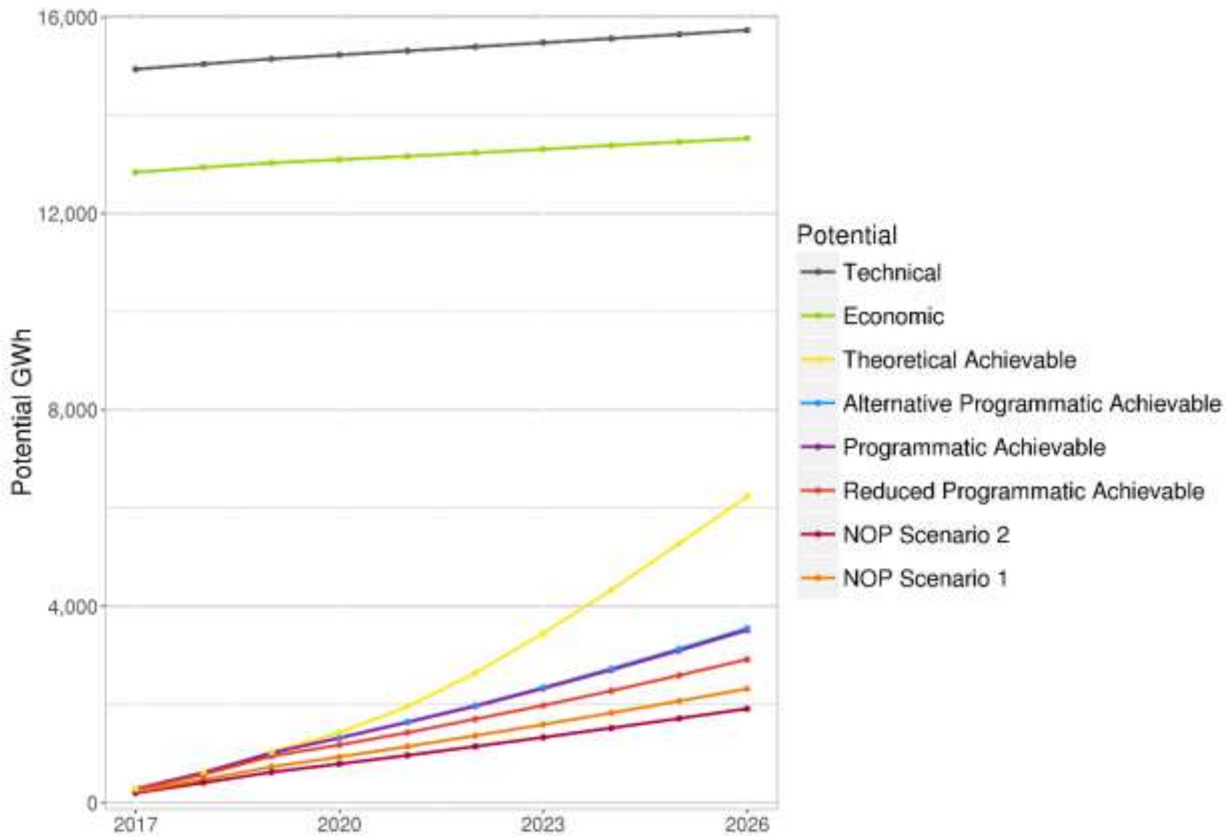
suggests that for the mix of measures assessed in this study, they tend to contribute to peak load reductions in the same proportion as the corresponding energy reductions over the course of each year.

Table 48. Electric Energy Efficiency Cumulative Potential Forecast by Scenario (GWh)

Potential Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Technical	14,940	15,044	15,148	15,230	15,312	15,395	15,479	15,563	15,648	15,734
Economic	12,840	12,940	13,032	13,099	13,168	13,236	13,309	13,388	13,458	13,529
Theoretical Achievable	286	630	1,031	1,433	1,963	2,646	3,457	4,335	5,284	6,240
Alternative Programmatic Achievable	289	618	1,022	1,329	1,651	1,985	2,350	2,733	3,136	3,556
Programmatic Achievable	289	618	1,019	1,323	1,641	1,971	2,331	2,708	3,104	3,517
Reduced Programmatic Achievable	272	579	954	1,181	1,431	1,708	1,986	2,283	2,598	2,922
NOP Scenario 1	234	476	735	938	1,150	1,370	1,598	1,833	2,076	2,325
NOP Scenario 2	204	412	627	795	970	1,151	1,336	1,526	1,720	1,919

Source: Navigant

Figure 32. Electric Energy Efficiency Cumulative Potential Forecast by Scenario (GWh)



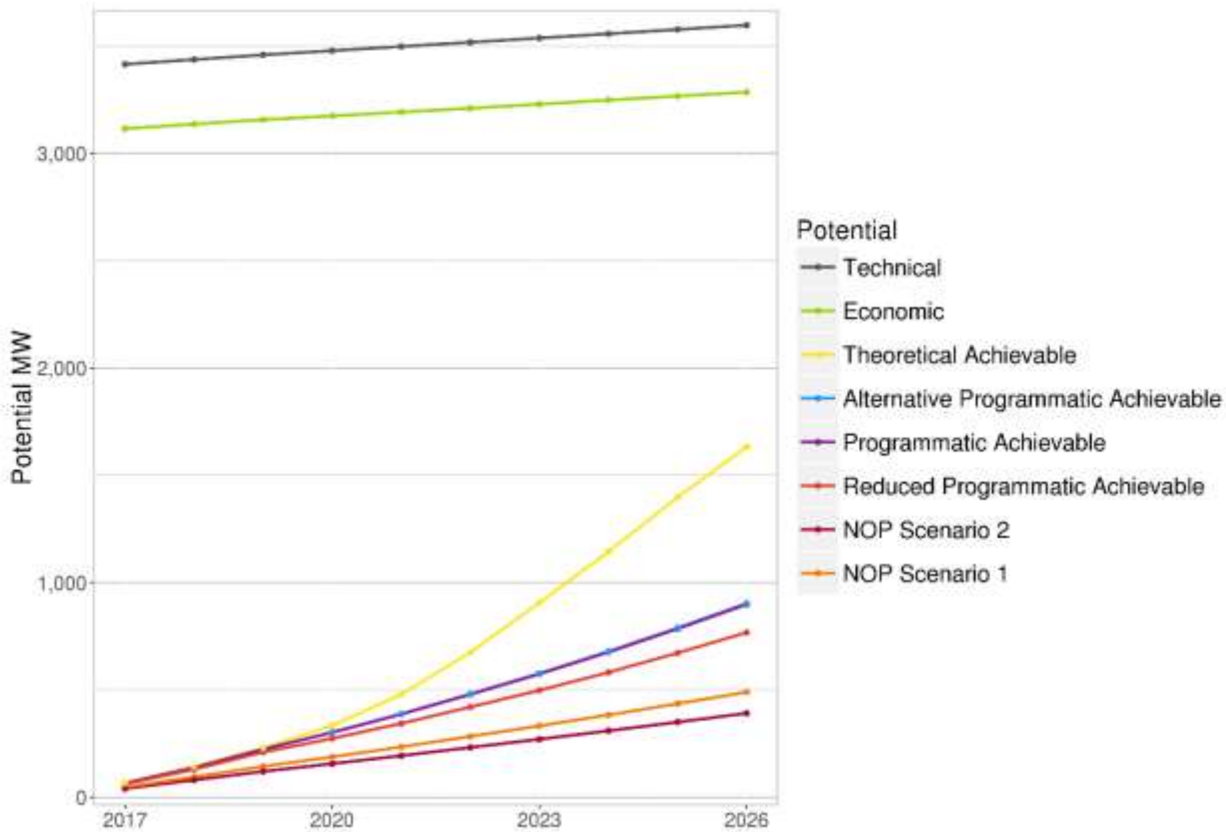
Source: Navigant

Table 49. Electric EE Cumulative Potential Forecast by Scenario (MW)

Potential Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Technical	3,415	3,437	3,459	3,478	3,498	3,517	3,537	3,557	3,577	3,597
Economic	3,115	3,136	3,157	3,174	3,192	3,210	3,229	3,248	3,266	3,285
Theoretical Achievable	68	143	231	335	480	675	907	1,144	1,397	1,633
Alternative Programmatic Achievable	66	138	224	303	389	481	577	679	789	903
Programmatic Achievable	66	138	224	302	387	480	575	677	785	899
Reduced Programmatic Achievable	62	130	210	274	344	421	498	582	673	768
NOP Scenario 1	47	95	144	188	235	284	333	384	436	490
NOP Scenario 2	41	81	121	157	194	233	271	310	351	392

Source: Navigant

Figure 33. Electric EE Cumulative Potential Forecast by Scenario (MW)



Source: Navigant

3.1 Technical Potential Results

This section provides the technical savings potential calculated through IDSM at varying levels of aggregation. Results are shown by sector, customer segment, and highest impact measures. Technical potential is defined as the theoretical upper limit of energy efficiency potential. It assumes that all feasible measures are adopted by customers, regardless of cost. Technical potential is obtained by setting all new equipment purchases at the time of equipment failure to the most efficient available option.

3.1.1 Results by Sector

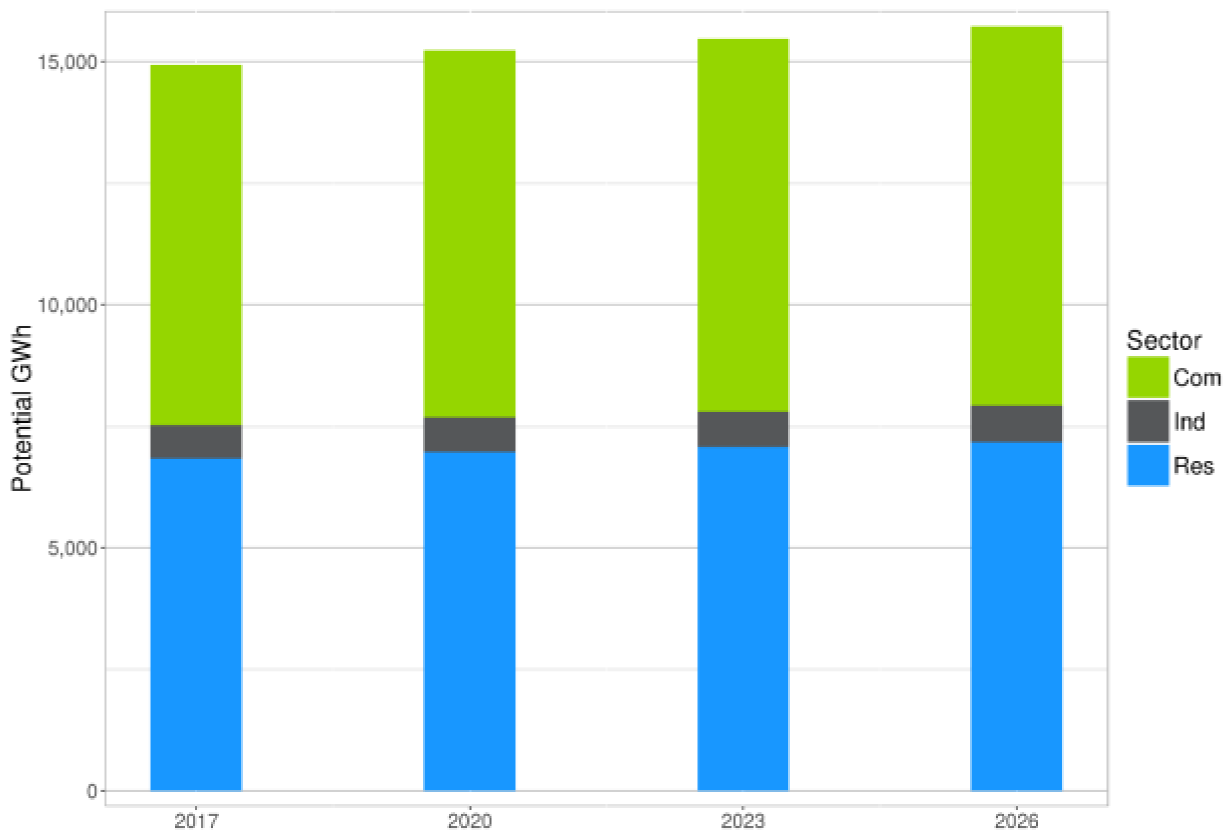
Table 50 and Figure 34 show the total technical savings potential split by sector for electric energy savings. The residential, commercial, and industrial sectors contribute to 46%, 49%, and 5% of technical potential in 2017, respectively. The allocation of technical potential among sectors is comparable with the allocation of forecast sales among sectors, although the residential sector contributed to higher technical potential as a percentage of its forecasted sales (37%) as compared to the commercial sector (24%). This is the result of the significant contribution of lighting potential from interior screw-in LEDs in the residential sector. As shown in Figure 14, the annual incremental potential begins to drop in 2020 (i.e., from about 100 GWh of new potential added each year to about 80 GWh added each year) due to changes in the federal standards for general service lighting,[64] which is discussed more in Section 2.4.4. The decreased growth rate in the commercial sector at the same time also stems largely from these general service lighting federal standard changes. Specifically, the potential associated with interior screw-in LEDs decreased significantly after the implementation of the standard. After 2020, the distribution of the technical potential among the sectors more closely aligns with the distribution of residential and commercial sales.

Table 50. Electric Energy Efficiency Cumulative Technical Potential by Sector (GWh)

Sector	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Commercial	7,407	7,458	7,509	7,552	7,596	7,640	7,684	7,728	7,773	7,819
Industrial	686	691	696	701	705	710	715	720	725	730
Residential	6,846	6,894	6,944	6,977	7,011	7,046	7,080	7,115	7,150	7,186

Source: Navigant

Figure 34. Electric Energy Efficiency Cumulative Technical Potential by Sector (GWh)



Source: Navigant

Table 51 and Figure 35 show the corresponding demand savings for the energy efficiency technical potential by sector.

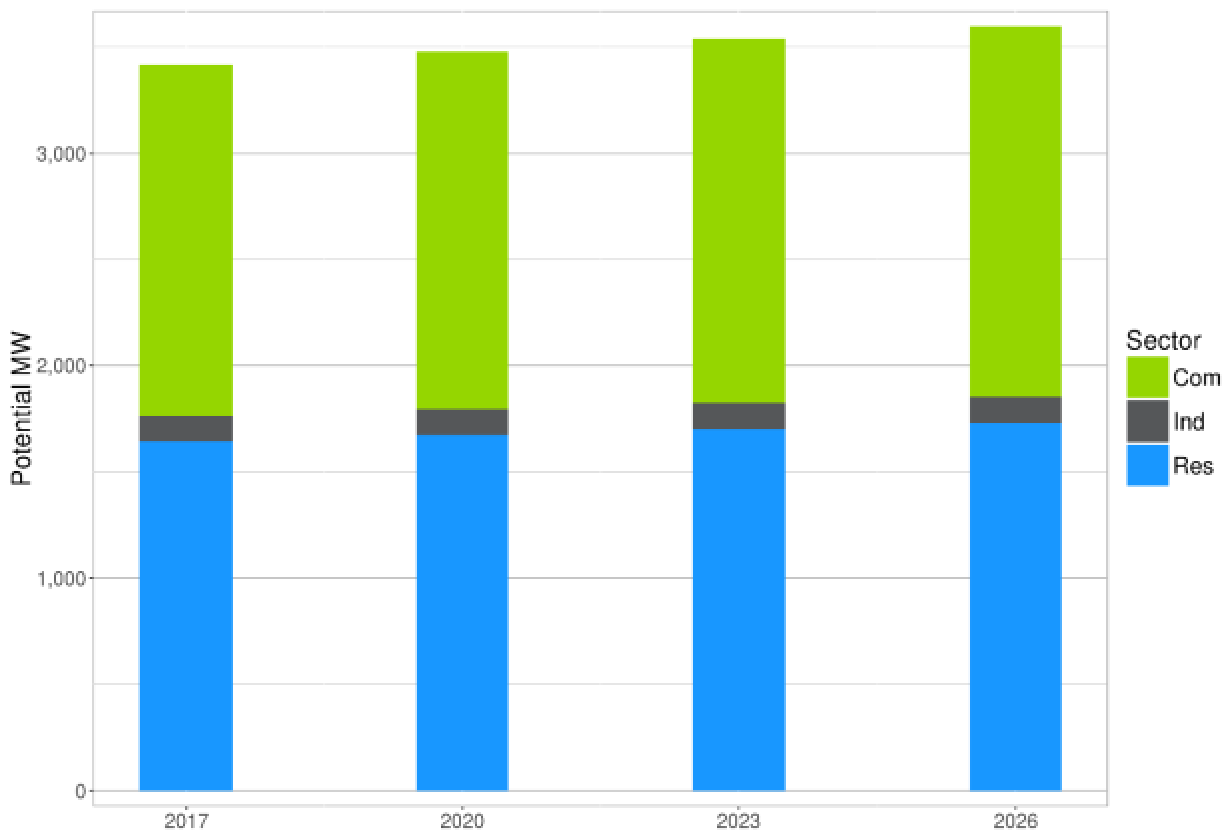
64 https://www.energystar.gov/ia/products/lighting/cfls/downloads/EISA_Backgrounder_FINAL_4-11_EPA.pdf

Table 51. Electric Energy Efficiency Cumulative Technical Potential by Sector (MW)

Sector	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Commercial	1,654	1,665	1,675	1,685	1,695	1,705	1,714	1,724	1,734	1,744
Industrial	114	115	115	116	117	118	119	119	120	121
Residential	1,647	1,658	1,668	1,677	1,686	1,695	1,704	1,713	1,722	1,731

Source: Navigant

Figure 35. Electric EE Cumulative Technical Potential by Sector (MW)



Source: Navigant

3.1.2 Results by Customer Segment

Table 52 and Figure 36 show the electric energy technical potential for each customer segment, and Appendix F provides the associated data. These results highlight the large savings potential of the residential single-family and multi-family home customer segments, relative to other customer segments. These two segments alone contribute to 35% of the total technical potential in 2017. The high technical savings potential for the single-family residential segment reflects both the overall size of that segment (with the third-highest square footage of any segment within CECONY's service territory), as well as the high potential for indoor LED screw-in bulbs in this segment, particularly prior to the lighting standard change in 2020. Navigant's primary data collection efforts revealed that there are roughly 49 bulbs per home in an average single-family home within CECONY's service territory[65] and the current saturation of LEDs (approximately 25%) translates to significant potential in the single-family residential market for indoor LEDs. After the application of the EISA code in 2020, the annual incremental increase in technical savings potential decreases this segment relative to the large multi-family segment.

On the commercial side, while the technical savings are more evenly distributed across the commercial segments, large office, small office, and NYPA building segments stand out as the greatest opportunities, driven by control measures. Restaurants, warehouse/industrial, and multi-family common area are the next highest contributors to technical potential in the commercial sector. This distribution of savings is roughly proportional to the distribution of these small commercial building segments within CECONY's service territory.

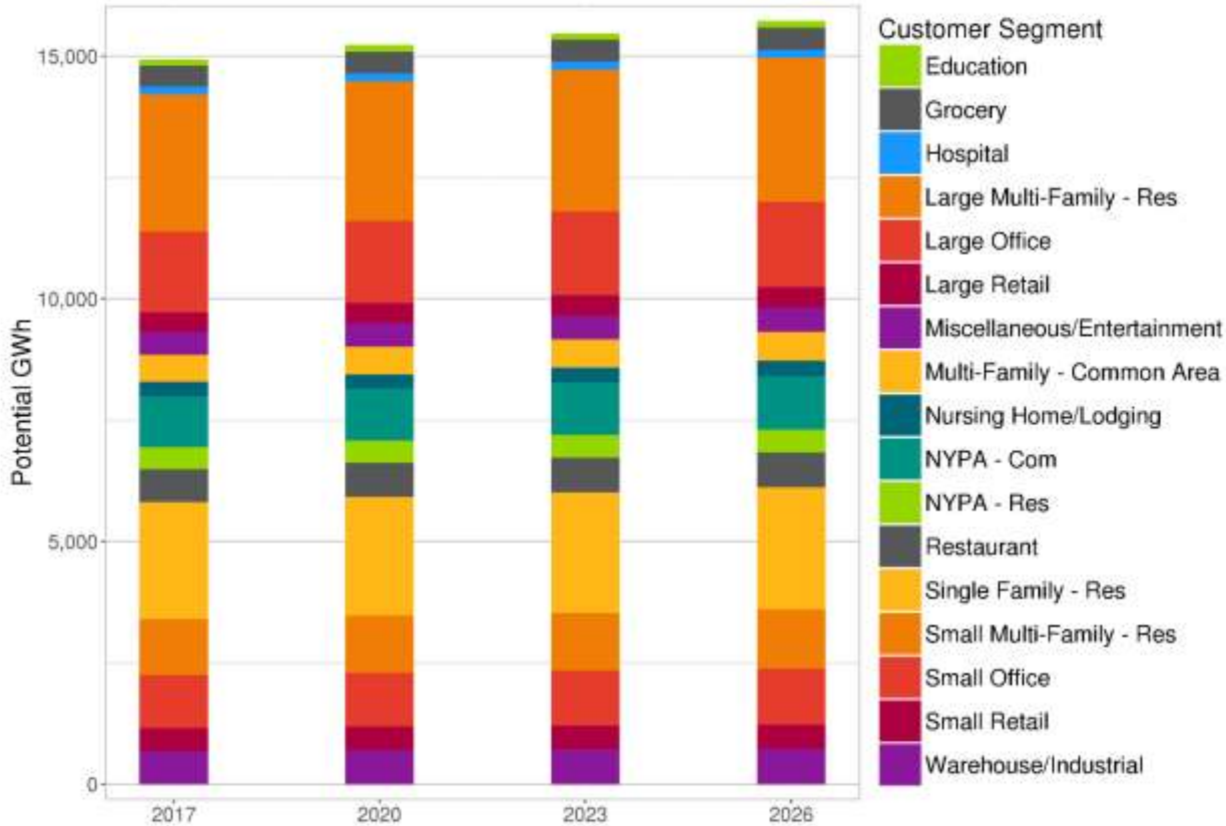
[65] This finding is consistent with the average number of lamps per household estimated for New York by the U.S. Department of Energy: https://www1.eere.energy.gov/buildings/publications/pdfs/ssl/2012_residential-lighting-study.pdf.

Table 52. Electric Energy Efficiency Cumulative Technical Potential by Segment (GWh)

Customer Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Education	136	137	138	139	139	140	141	142	143	143
Grocery	428	431	434	437	440	443	445	448	451	454
Hospital	160	162	163	163	164	165	166	167	168	168
Large Multi-Family - Res	2,833	2,853	2,873	2,887	2,901	2,916	2,930	2,945	2,959	2,974
Large Office	1,657	1,668	1,679	1,688	1,698	1,707	1,717	1,726	1,736	1,746
Large Retail	408	410	413	416	419	421	424	427	430	433
Miscellaneous/Entertainment	469	472	475	478	482	485	488	491	494	497
Multi-Family - Common Area	560	564	568	571	573	576	579	582	584	587
Nursing Home/Lodging	300	302	304	306	308	309	311	313	315	317
NYPA - Com	1,039	1,047	1,054	1,061	1,067	1,074	1,080	1,086	1,093	1,100
NYPA - Res	457	460	463	466	468	470	472	475	477	479
Restaurant	681	686	691	694	698	702	706	710	714	718
Single Family - Res	2,405	2,422	2,440	2,451	2,463	2,474	2,486	2,498	2,510	2,522
Small Multi-Family - Res	1,150	1,159	1,167	1,173	1,179	1,185	1,192	1,198	1,204	1,210
Small Office	1,090	1,098	1,105	1,111	1,118	1,124	1,131	1,137	1,144	1,151
Small Retail	478	481	484	487	490	493	496	499	502	505
Warehouse/Industrial	686	691	696	701	705	710	715	720	725	730

Source: Navigant

Figure 36. Electric Energy Efficiency Cumulative Technical Potential by Segment (GWh)



Source: Navigant

Table 53 and Figure 37 show the corresponding demand savings for the energy efficiency technical potential by segment.

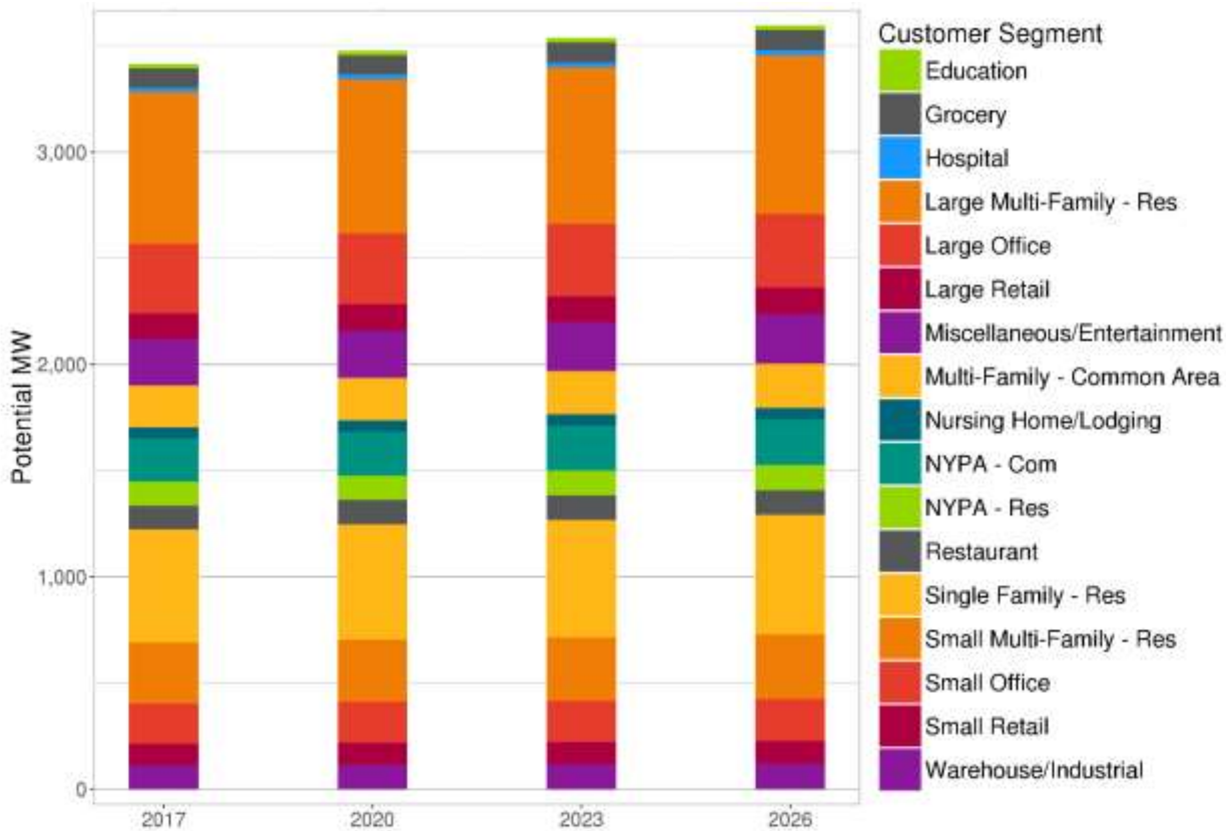
Table 53. Electric Energy Efficiency Cumulative Technical Potential by Segment (MW)

Customer Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Education	21	21	21	21	21	22	22	22	22	22
Grocery	91	91	92	92	93	94	94	95	95	96
Hospital	22	22	22	22	22	22	22	22	23	23
Large Multi-Family - Res	713	717	722	725	729	733	737	741	745	748
Large Office	329	331	334	335	337	339	341	343	345	347
Large Retail	118	119	120	120	121	122	123	123	124	125
Miscellaneous/ Entertainment	221	222	223	225	226	227	229	230	231	233
Multi-Family - Common Area	197	198	199	200	201	203	204	205	206	207
Nursing Home/Lodging	52	52	53	53	53	54	54	54	55	55
NYPA - Com	203	205	206	207	208	210	211	212	214	215
NYPA - Res	113	114	114	115	115	116	116	117	118	118

Customer Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Restaurant	112	112	113	114	114	115	116	116	117	117
Single Family - Res	534	538	541	544	547	550	553	556	560	563
Small Multi-Family - Res	287	289	291	292	294	296	297	299	301	302
Small Office	189	190	192	193	194	195	196	197	198	200
Small Retail	99	100	101	101	102	103	103	104	104	105
Warehouse/Industrial	114	115	115	116	117	118	119	119	120	121

Source: Navigant

Figure 37. Electric Energy Efficiency Cumulative Technical Potential by Segment (MW)



Source: Navigant

3.1.3 Results by End-Use

The technical potentials shown in Table 54 and Figure 38 are broken out for each of the end-uses assessed through the load shaping analysis.

The charts indicate a few noteworthy patterns:

- Interior lighting is by far the largest contributor to electric technical potential in the near-term. Savings for lighting measures appear to jump significantly from 2017 to 2020 due to significant penetration of LEDs replacing the baseline incandescent bulbs before they become the baseline after 2020 due to planned changes to EISA standards at that time. After the standard change, the incremental new potential from lighting is greatly reduced.

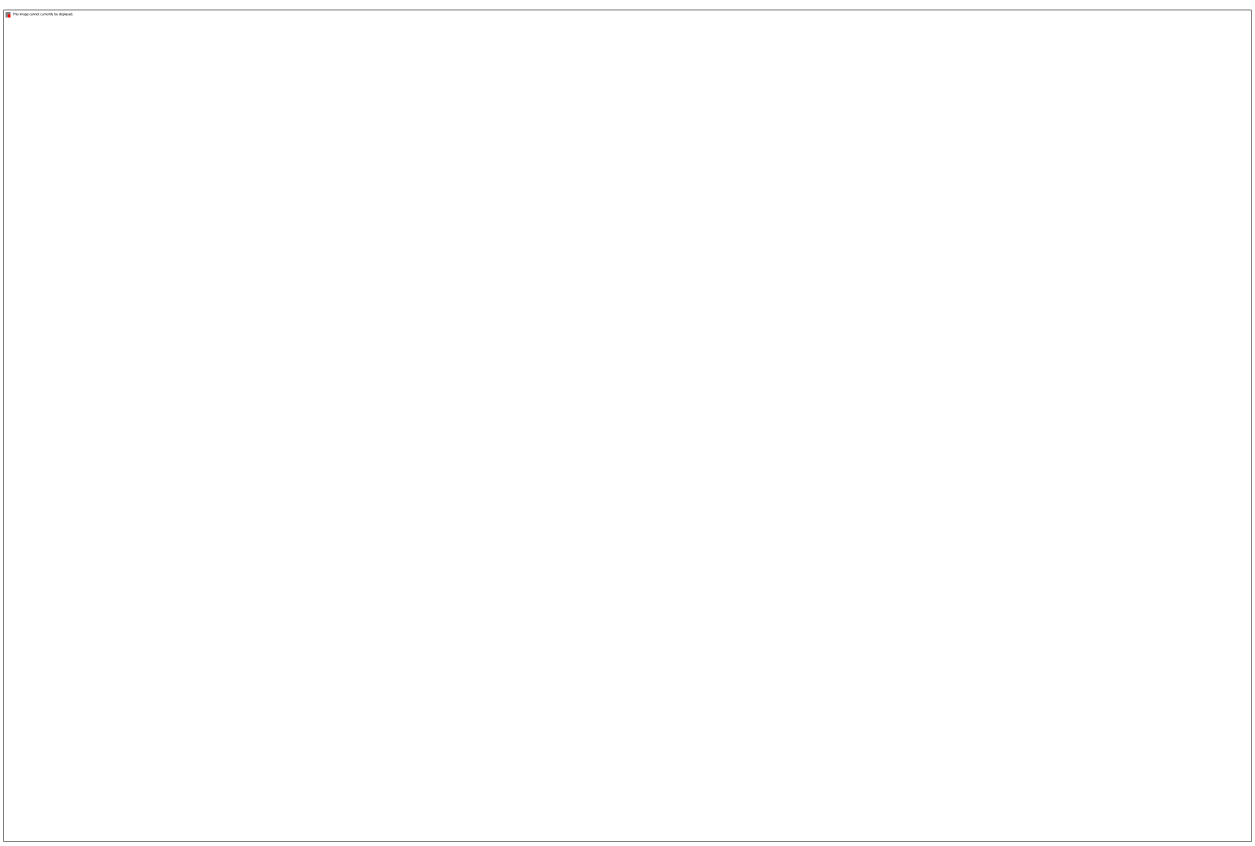
- Combined space cooling potential, including both general cooling and VSD cooling fans, has the next largest share. While the total cumulative technical potential for space cooling never exceeds lighting, the potential for space cooling grows more rapidly than lighting after the standard change and begins to bridge the gap.

Table 54. Electric Energy Efficiency Technical Potential by End-Use (GWh)

End Use	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Cooling (Electric)	2,496	2,514	2,531	2,549	2,567	2,585	2,604	2,622	2,641	2,659
Hot Water (Electric)	76	76	77	78	78	79	79	80	80	81
Lighting Exterior (Electric)	489	493	496	499	503	506	510	513	517	520
Lighting Interior (Electric)	5,865	5,907	5,948	5,966	5,985	6,003	6,022	6,041	6,060	6,079
Plug Loads (Electric)	598	602	606	610	614	618	622	626	630	634
Refrigeration (Electric)	747	753	758	763	768	774	779	784	790	795
Total Facility (Electric)	1,392	1,402	1,412	1,421	1,431	1,441	1,451	1,461	1,471	1,481
Total HVAC (Electric)	1,243	1,252	1,260	1,269	1,278	1,286	1,295	1,304	1,313	1,322
VSD (Electric)	1,556	1,567	1,577	1,588	1,599	1,610	1,621	1,633	1,644	1,655

Source: Navigant

Figure 38. Electric Energy Efficiency Technical Potential by End-Use (GWh)



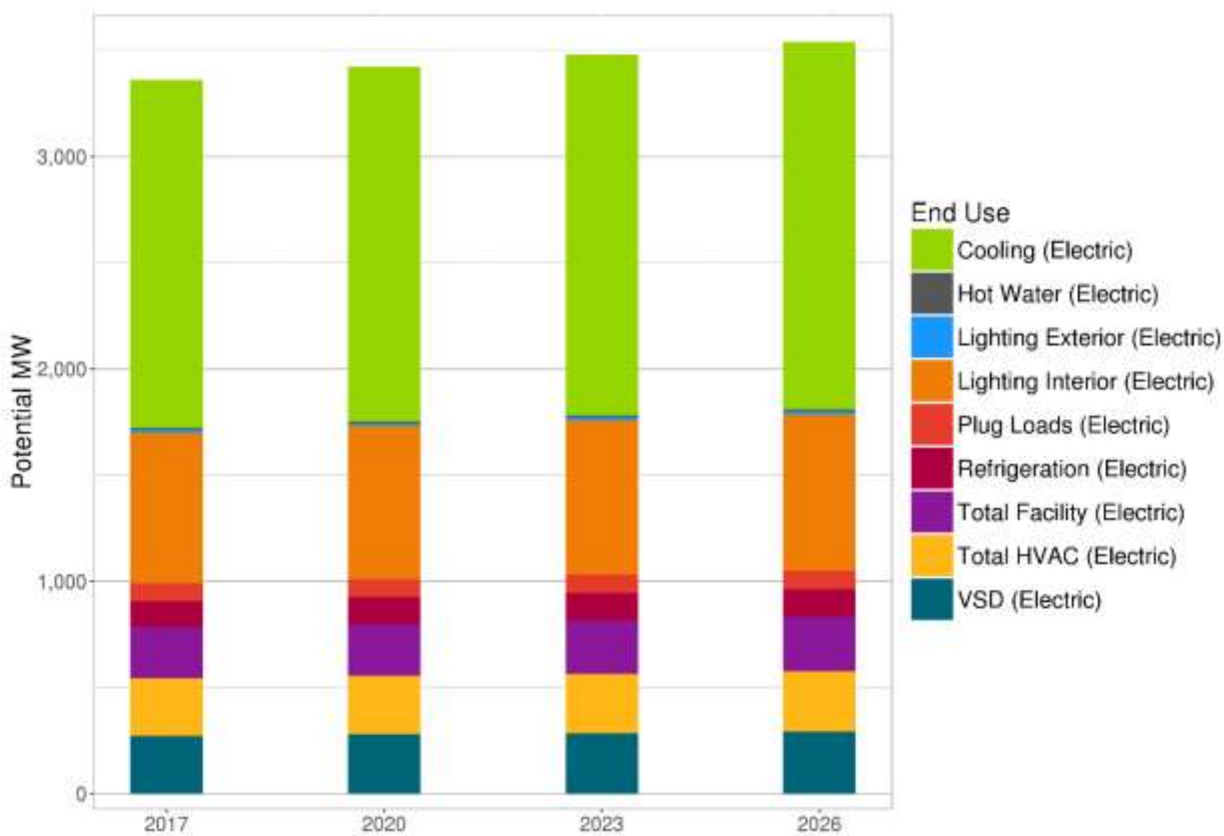
Source: Navigant

Table 55 . Electric Energy Efficiency Technical Potential by End-Use (MW)

End Use	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Cooling (Electric)	1,639	1,649	1,659	1,669	1,679	1,689	1,699	1,709	1,720	1,730
Hot Water (Electric)	8	8	8	8	8	8	8	8	8	8
Lighting Exterior (Electric)	14	14	14	14	14	14	14	14	14	14
Lighting Interior (Electric)	709	714	718	721	723	725	727	730	732	734
Plug Loads (Electric)	83	84	84	85	85	86	86	87	87	88
Refrigeration (Electric)	124	124	125	126	127	128	129	130	131	132
Total Facility (Electric)	241	243	245	246	248	249	251	253	254	256
Total HVAC (Electric)	269	270	272	274	276	277	279	281	283	284
VSD (Electric)	274	276	278	280	282	284	286	287	289	291

Source: Navigant

Figure 39. Electric Energy Efficiency Technical Potential by End-Use (MW)



Source: Navigant

3.1.4 Results by Measure

Figure 40 shows the measure level savings potential after adjusting for mutual exclusivity among measures. This is explained in detail in Section 2.4.2. This figure presents the top 13 measures that contribute 65% to the overall technical potential. Navigant consolidated the potential of all other measures under the other measures category to produce a more succinct view at the measure level.

When code-change measures become applicable, they steal savings potential from other related measures that may display significant savings in the absence of the code. In this way, the sum of the total savings potential between the code and the related energy efficient measure is the same before and after a code takes effect. This ensures there is no double counting of savings from codes and the energy efficient measures impacted by the code. This can be seen in Figure 40 by the reduction of annual incremental contribution of the interior LED screw-in measure as compared to the other high contributing measures. The annual incremental contribution of this measure drops from 21% to 7% when the code is applied in 2020.

Prior to 2020, the top five measures for electric energy technical potential come from lighting, cooling, and control measures with the highest potential contribution from the indoor LED screw-in and ductless mini-split heat pump measures, both in the residential sector. After 2020, ductless mini-split heat pumps in the residential sector and variable speed drive (VSD) cooling fans in the commercial sector are the highest contributors to the overall technical potential. All the top measures indicated in Figure 17 can be categorized as lighting, cooling, HVAC controls, and energy management measures. The energy management measures include two behavioral measures: home energy report and energy management behavioral on the residential and commercial side, respectively. Except for indoor LED measures in the residential and the commercial sectors, the potential contribution for all other measures increases after 2020 as indicated above.

Measures such as residential room ACs are not shown in this chart, as they have lower potential than another measure in the same competition group (i.e., ductless mini-split heat pumps), and as detailed above, technical potential assumes that each installation is completed with the measure with the highest technical potential.

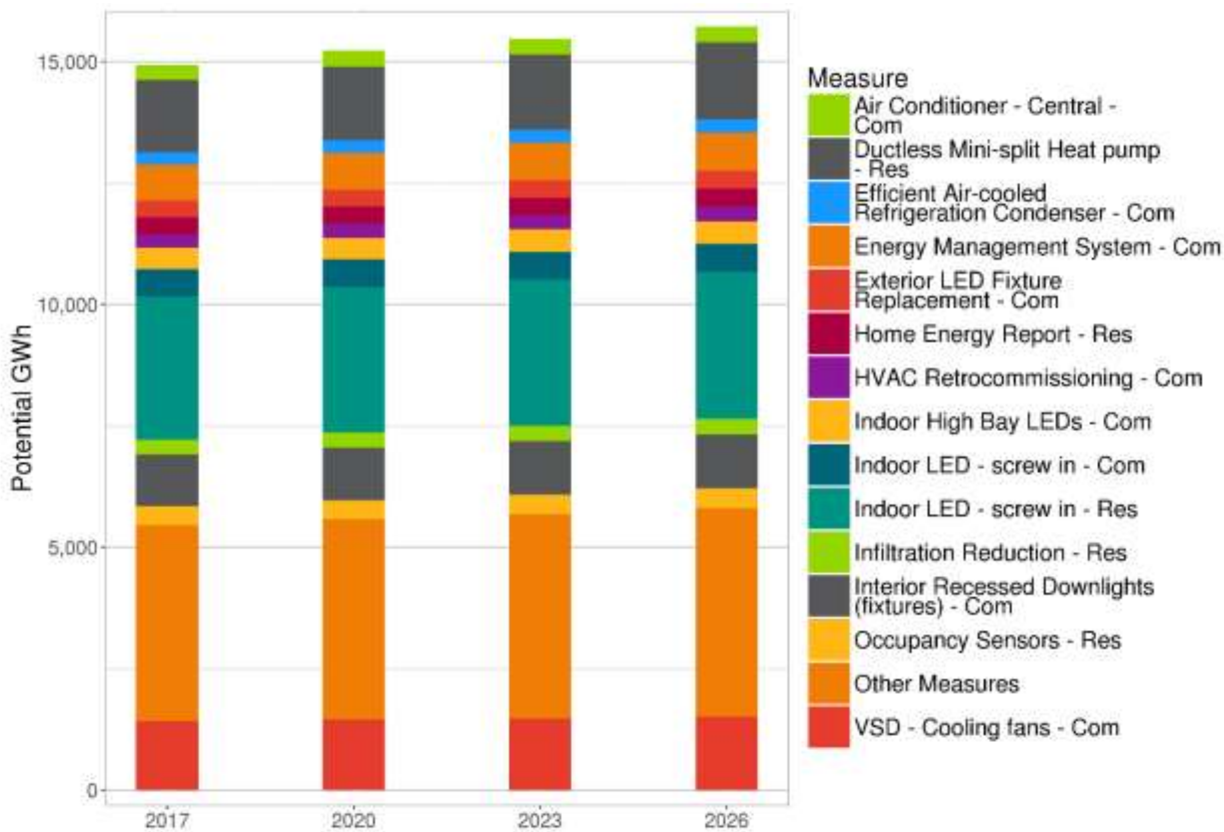
Table 56. Electric Energy Efficiency Cumulative Technical Potential by Measure (GWh)

Measure	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Air Conditioner - Central - Com	316	319	321	323	325	327	330	332	334	337
Ductless Mini-split Heat pump - Res	1,485	1,496	1,507	1,517	1,528	1,539	1,550	1,561	1,572	1,583
Efficient Air-cooled Refrigeration Condenser - Com	258	259	261	263	265	267	268	270	272	274
Energy Management System - Com	742	747	752	757	762	767	773	778	783	788
Exterior LED Fixture Replacement - Com	340	342	345	347	349	352	354	357	359	362
Home Energy Report - Res	348	351	353	356	359	361	364	366	369	372
HVAC Retrocommissioning - Com	283	284	286	288	290	292	294	296	298	301
Indoor High Bay LEDs - Com	435	438	441	444	447	450	454	457	460	463
Indoor LED - screw in - Com	565	569	573	574	575	576	577	578	579	580

Measure	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Indoor LED - screw in - Res	2,947	2,968	2,989	2,995	3,001	3,007	3,013	3,019	3,025	3,031
Infiltration Reduction - Res	302	304	306	308	310	313	315	317	319	322
Interior Recessed Downlights (fixtures) - Com	1,072	1,079	1,086	1,089	1,091	1,093	1,096	1,098	1,100	1,103
Occupancy Sensors - Res	384	387	390	392	395	398	401	404	407	409
Other Measures	4,039	4,067	4,095	4,123	4,151	4,179	4,208	4,237	4,266	4,295
VSD - Cooling fans - Com	1,424	1,434	1,444	1,454	1,464	1,474	1,484	1,494	1,504	1,515

Source: Navigant

Figure 40. Electric Energy Efficiency Cumulative Technical Potential by Measure (GWh)



Source: Navigant

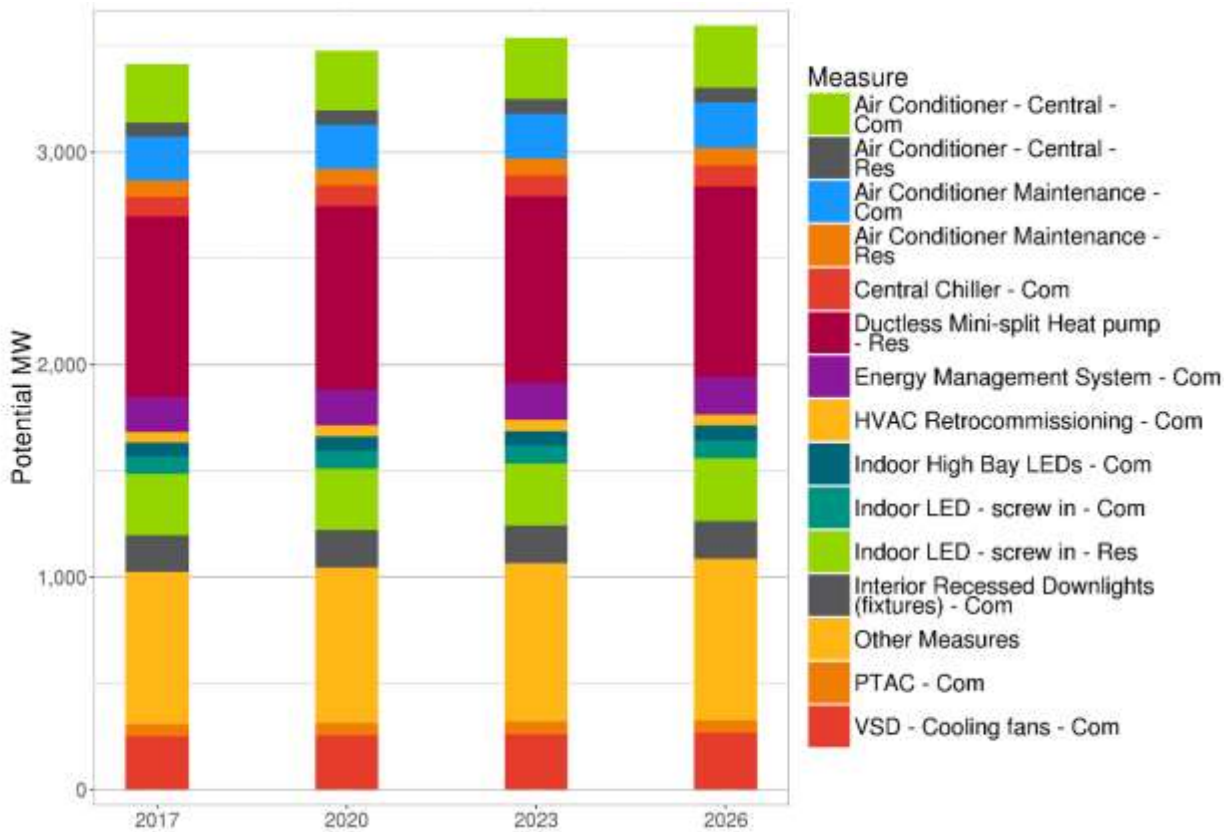
Table 57 and Figure 41 show the corresponding demand savings for the energy efficiency technical potential by measure.

Table 57. Electric Energy Efficiency Cumulative Technical Potential by Measure (MW)

Measure	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Air Conditioner - Central - Com	277	279	281	283	284	286	288	290	291	293
Air Conditioner - Central - Res	66	66	66	67	67	68	68	69	69	69
Air Conditioner Maintenance - Com	204	205	206	208	209	210	212	213	214	216
Air Conditioner Maintenance - Res	78	78	79	79	80	80	81	81	82	82
Central Chiller - Com	93	94	94	95	96	96	97	97	98	99
Ductless Mini-split Heat pump - Res	850	855	860	865	870	876	881	886	891	897
Energy Management System - Com	165	166	167	168	169	170	172	173	174	175
HVAC Retrocommissioning - Com	50	50	51	51	51	52	52	52	53	53
Indoor High Bay LEDs - Com	66	66	66	67	67	68	68	69	69	70
Indoor LED - screw in - Com	82	82	83	83	83	83	83	84	84	84
Indoor LED - screw in - Res	288	290	292	292	293	293	294	294	295	295
Interior Recessed Downlights (fixtures) - Com	172	173	174	175	175	175	176	176	176	177
Other Measures	716	721	726	730	735	740	745	750	754	759
PTAC - Com	58	58	59	59	59	60	60	60	61	61
VSD - Cooling fans - Com	251	253	254	256	258	260	261	263	265	267

Source: Navigant

Figure 41. Electric Energy Efficiency Cumulative Technical Potential by Measure (MW)



Source: Navigant

3.2 Achievable Potential Results

This section provides the results for electric energy efficiency achievable potential at different levels of aggregation. Results are shown by sector, customer segment, and by highest impact measures.

The figures and tables within this section focus on programmatic achievable, with the more detailed results for the other achievable scenarios available in Appendix F.

3.2.1 Results by Sector

As shown in Table 52 and Figure 42, annual achievable potential, which accounts for the rate of energy efficiency acquisition, grows from 289 GWh across sectors in 2017 to 413 GWh in 2026, or 5% per year on average over the potential study time horizon,[66] under the programmatic achievable scenario.

Values shown below for achievable potential are termed as annual incremental potential, in that they represent the incremental new potential available in each year. The total cumulative potential over the time period would be the sum of each year's annual incremental achievable. Economic potential, as

[66] The time horizon for the Potential Study is 2017-2026 (10 years).

defined in this study, can be thought of as a bucket of potential from which programs can draw over time. Achievable potential represents the draining of that bucket, the rate of which is governed by a number of factors including the lifetime of measures (for ROB technologies), market effectiveness, incentive levels, and customer willingness to adopt, among others. If the cumulative achievable potential ultimately reaches the economic potential, it would signify that all economic potential in the bucket had been drawn down, or harvested. However, achievable potential levels generally do not reach the full economic potential level due to a variety of market and customer constraints that inhibit full economic adoption.[67]

The C&I sectors largely drive the achievable potential, with residential contributing roughly 35-45% of the annual incremental potential prior to the general service lighting standard change in 2020 and closer to 25-30% of the potential after 2020. The reduction in incremental potential after 2020 is due to the change to lighting standards that implies a new more efficient baseline. As such, the potential for high efficiency lighting is reduced since the new baseline is more efficient. As noted in the following section, much of the commercial potential is initially driven by the multi-family common area segment, with large office taking the lead starting in 2019.

On a year-over-year basis after 2020, the incremental potential grows steadily, and eventually surpasses the highest level of potential that was observed prior to the change in lighting standards.

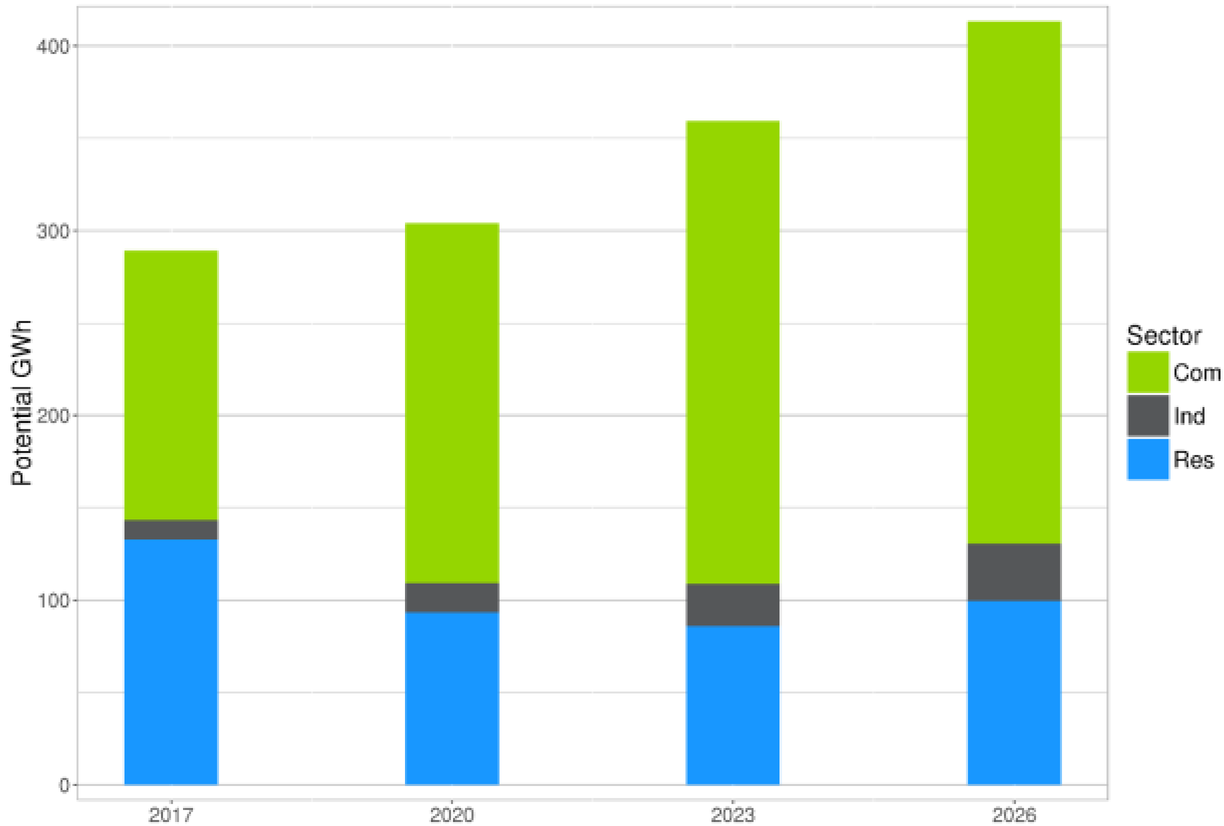
Table 58. Electric Energy Efficiency Annual Incremental Programmatic Achievable Potential by Sector (GWh)

Sector	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Commercial	146	185	241	195	203	217	251	260	272	283
Industrial	11	14	16	16	18	20	23	26	28	31
Residential	133	131	144	93	97	93	86	91	95	100

Source: Navigant

[67] Constraints on achievable potential that inhibit realization of the full economic potential include the rate at which homes and businesses will adopt efficient technologies, as well as the word-of-mouth and marketing effectiveness for the technology. If a technology already has high saturation at the beginning of the study, it may theoretically be possible be possible to fully saturate the market and achieve 100% of the economic potential.

Figure 42. Electric Energy Efficiency Annual Incremental Programmatic Achievable Potential by Sector (GWh)



Source: Navigant

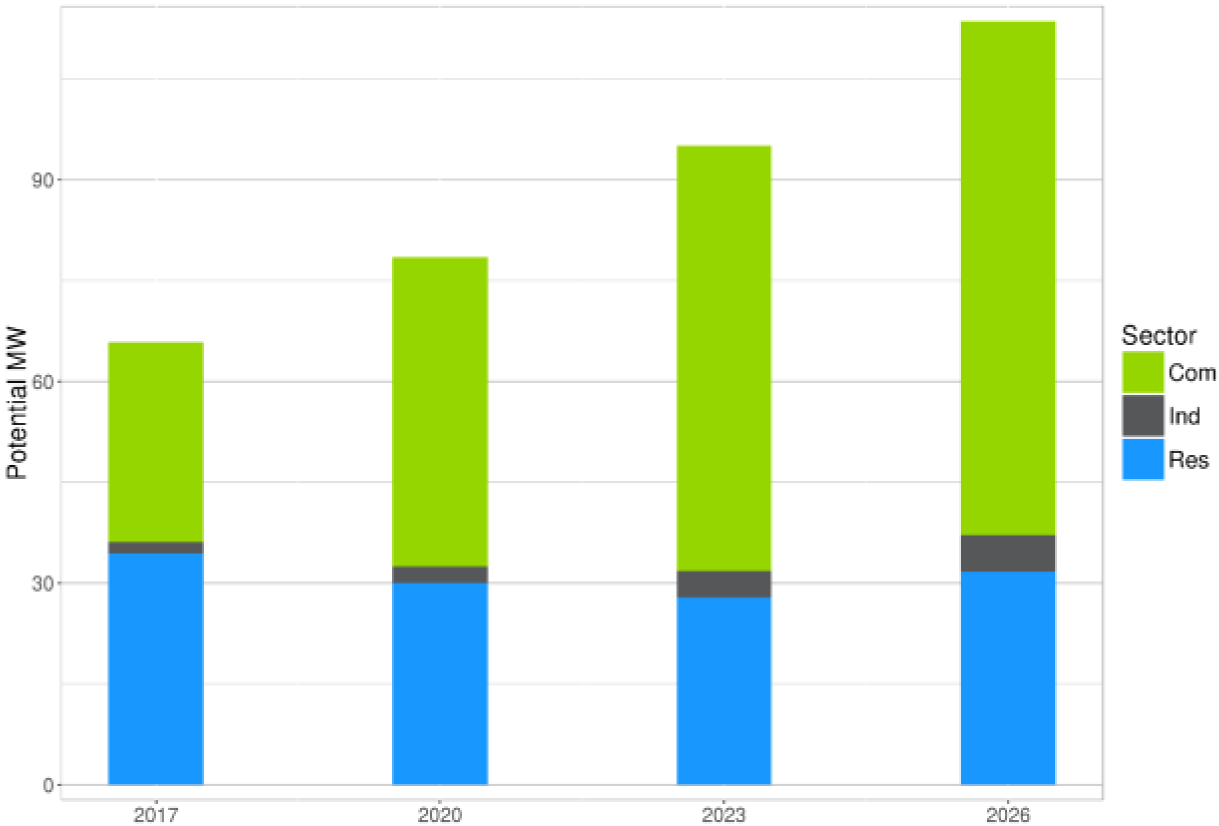
Table 59 and Figure 43 show the corresponding demand savings for the energy efficiency incremental programmatic achievable potential by sector. The total potential in 2017 is 66 MW, and grows steadily until 2020 when the lighting standards take effect. After that point, the incremental demand savings grow steadily to 114 MW by 2026, driven primarily by the commercial sector.

Table 59. Electric Energy Efficiency Annual Incremental Programmatic Achievable Potential by Sector (MW)

Sector	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Com	30	37	50	46	50	55	63	68	72	76
Ind	2	2	2	3	3	3	4	4	5	6
Res	34	33	33	30	33	34	28	30	31	32

Source: Navigant

Figure 43. Electric Energy Efficiency Annual Incremental Programmatic Achievable Potential by Sector (MW)



Source: Navigant

3.2.2 Results by Customer Segment

The achievable potentials shown in Figure 44 are broken out for selected years in the forecast for each of the customer segments.

The charts indicate a few noteworthy patterns:

- The large multi-family segment has the most potential for energy efficiency savings in the CECONY service territory from a single segment.
- Large offices, single-family residential, NYPA commercial buildings, small offices, and restaurants provide the next greatest savings opportunities in terms of achievable potential.
- In aggregate, the large and small multi-family segments provide just over a quarter of the potential in 2017. More than 30% of the savings in 2017 are from multi-family accounts when the multi-family common area is also considered. The dominance of the multi-family segments within the achievable potential corresponds to their larger share of baseline energy usage.
- Growth in the potential for the residential segments over the 10-year time horizon tapers off after the lighting standard change in 2020, whereas the commercial segments have higher levels of growth over the time horizon, relative to the residential segments.

Table 60. Electric EE Annual Incremental Programmatic Achievable Potential by Segment (GWh)

Customer Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Education	4	4	5	3	3	4	4	4	4	4
Grocery	10	12	13	14	16	16	17	18	19	20
Hospital	8	10	11	6	7	7	7	6	6	4
Large Multi-Family – Res	53	52	52	40	42	42	33	36	38	41
Large Office	18	23	39	35	36	41	48	49	54	58
Large Retail	7	9	11	11	12	13	15	16	18	18
Miscellaneous/Entertainment	9	12	14	14	15	17	19	20	22	24
Multi-Family - Common Area	22	26	28	13	14	15	16	17	18	19
Nursing Home/Lodging	7	10	11	9	10	11	12	12	13	13
NYPA - Com	16	20	33	27	28	30	37	37	38	41
NYPA - Res	10	10	10	8	9	8	5	6	6	7
Restaurant	19	25	27	20	22	23	25	26	26	24
Single Family - Res	49	46	55	26	27	27	32	33	34	33
Small Multi-Family - Res	21	23	27	19	20	16	15	16	17	19
Small Office	16	21	34	28	27	27	37	38	38	40
Small Retail	9	13	15	12	13	13	16	17	17	17
Warehouse/Industrial	11	14	16	16	18	20	23	26	28	31

Source: Navigant

Figure 44. Electric Energy Efficiency Annual Incremental Programmatic Achievable Potential by Sector (GWh)

Source: Navigant

Table 61 and Figure 45 show the corresponding demand savings for the energy efficiency incremental programmatic achievable potential by segment.

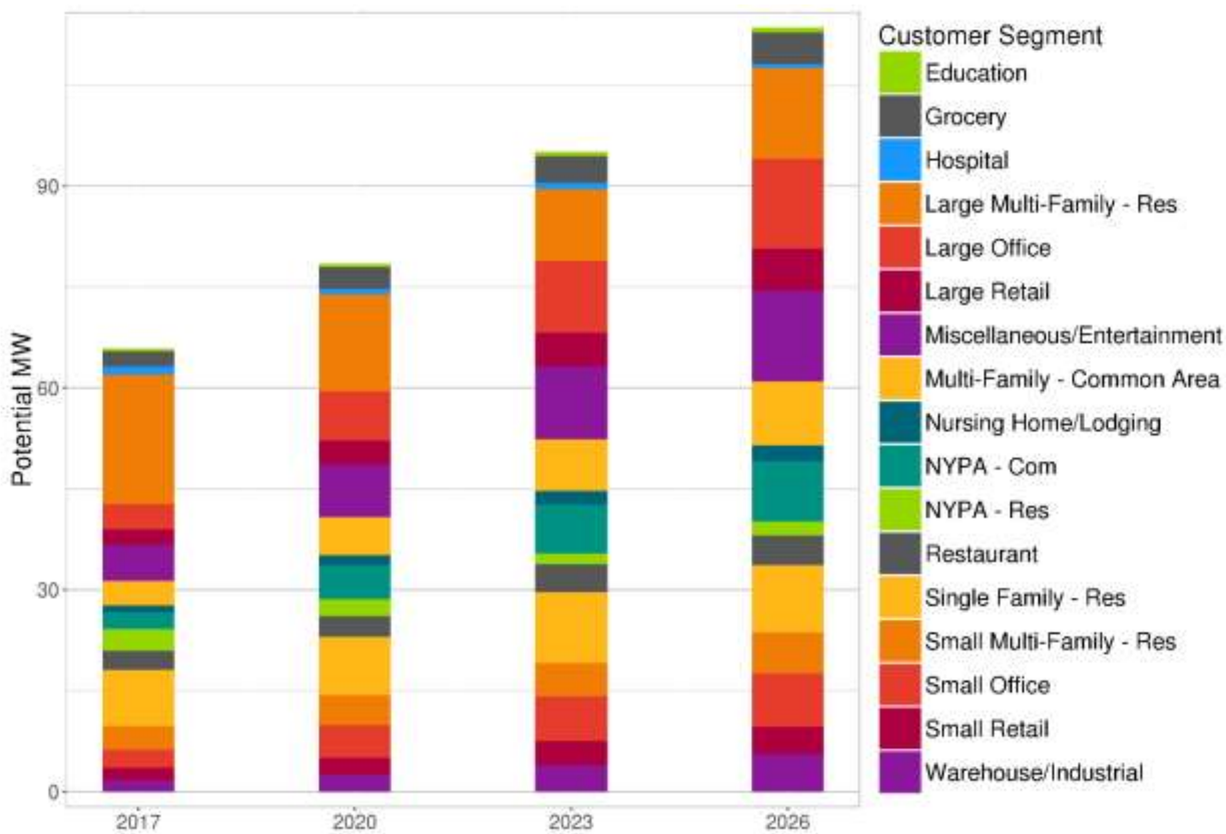
Table 61. Electric Energy Efficiency Annual Incremental Programmatic Achievable Potential by Segment (MW)

Customer Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Education	0	1	1	1	0	0	1	1	1	1
Grocery	2	3	3	3	4	4	4	4	4	5
Hospital	1	1	1	1	1	1	1	1	1	1
Large Multi-Family - Res	19	17	14	14	16	17	11	12	12	13
Large Office	4	4	8	7	8	9	11	11	12	13
Large Retail	2	3	3	4	4	4	5	5	6	6
Miscellaneous/Entertainment	5	6	7	8	9	10	11	12	13	13
Multi-Family - Common Area	4	6	7	6	6	7	8	8	9	10
Nursing Home/Lodging	1	2	2	2	2	2	2	2	2	2
NYPA - Com	2	3	6	5	5	6	7	8	8	9
NYPA - Res	3	3	3	3	3	3	2	2	2	2

Customer Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Restaurant	3	4	4	3	3	4	4	4	5	4
Single Family - Res	8	9	11	9	9	10	11	11	11	10
Small Multi-Family - Res	4	4	5	5	5	5	5	5	6	6
Small Office	3	3	6	5	5	5	7	7	7	8
Small Retail	2	2	3	3	3	3	4	4	4	4
Warehouse/Industrial	2	2	2	3	3	3	4	4	5	6

Source: Navigant

Figure 45. Electric Energy Efficiency Annual Incremental Programmatic Achievable Potential by Segment (MW)



Source: Navigant

3.2.3 Results by End-Use

The achievable potentials shown in Table 62 and Figure 46 are broken out for each of the end-uses assessed through the load shaping analysis.

The charts indicate a few noteworthy patterns:

- Interior lighting is by far the largest contributor to electric achievable potential in the near-term. Savings for lighting measures appear to jump significantly from 2017 to 2020 due to significant penetration of LEDs replacing the baseline incandescent bulbs before they become the baseline after 2020 due to planned changes to EISA standards at that time. After the standard change, incremental potential from lighting is greatly reduced.

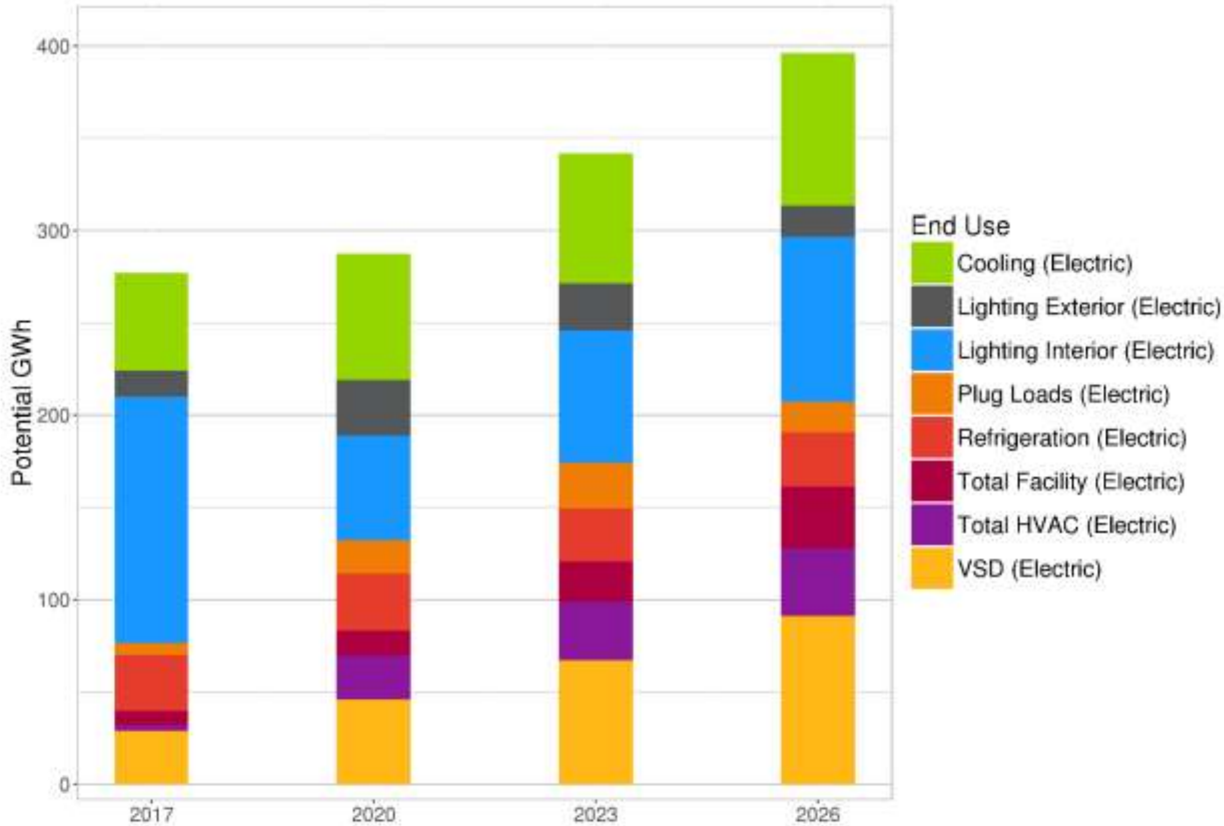
- Combined space cooling potential (for example, VSD cooling fans) grows significantly over the latter part of the forecast, eventually supplanting lighting.
- Exterior lighting and refrigeration measures are also significant contributors and remain relatively stable over the time horizon, which mirrors the assumption that CECONY building stock remains relatively constant over time.

Table 62. Electric Energy Efficiency Annual Incremental Programmatic Achievable Potential by End-Use (GWh)

End Use	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Cooling (Electric)	53	55	60	68	77	85	70	76	81	83
Lighting Exterior (Electric)	14	29	30	30	29	28	25	23	20	17
Lighting Interior (Electric)	134	149	167	57	61	66	72	77	83	89
Plug Loads (Electric)	6	0	21	18	8	0	25	18	14	16
Refrigeration (Electric)	30	33	35	31	32	32	29	31	32	29
Total Facility (Electric)	8	9	11	14	16	19	22	26	29	33
Total HVAC (Electric)	3	6	21	24	24	22	32	34	35	37
VSD (Electric)	29	34	40	46	53	61	67	75	84	91

Source: Navigant

Figure 46. Electric Energy Efficiency Annual Incremental Programmatic Achievable Potential by End-Use (GWh)



Source: Navigant

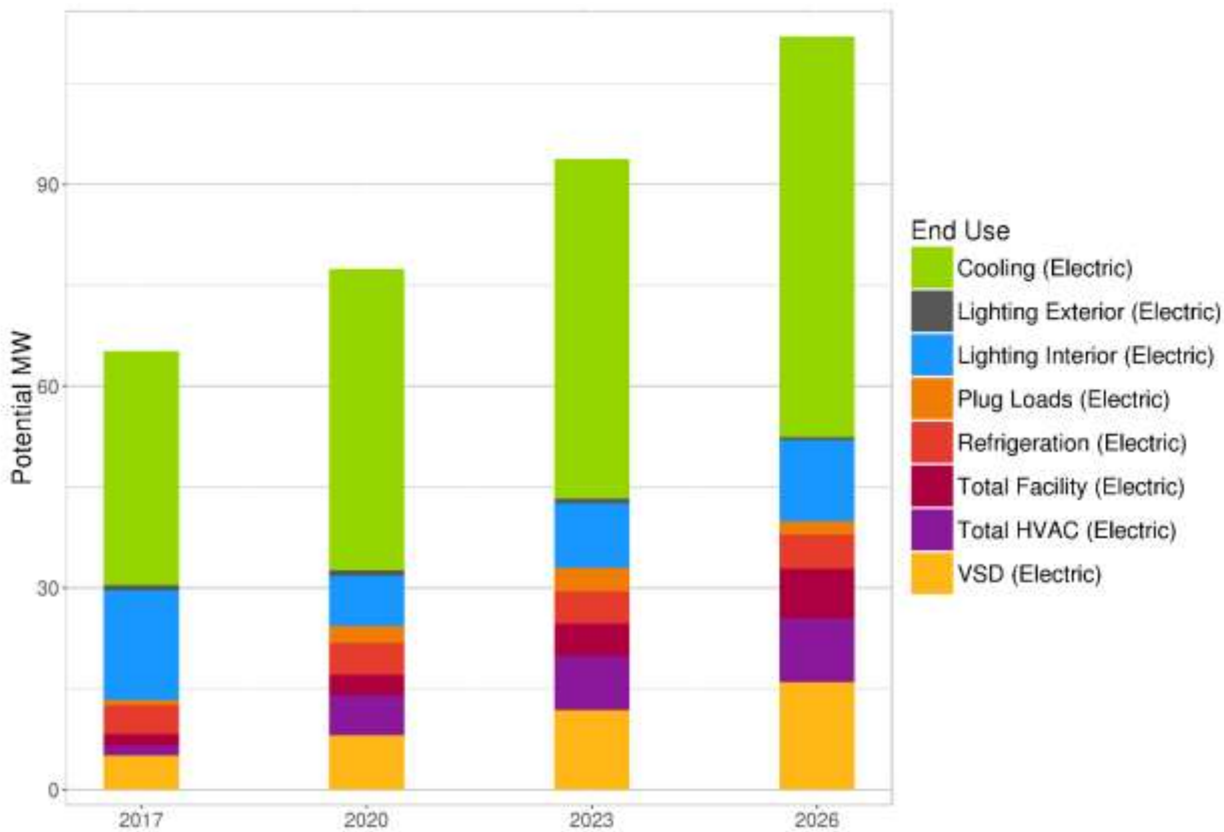
Table 63 and Figure 47 show the corresponding demand savings for the energy efficiency incremental programmatic achievable potential by end-use.

Table 63. Electric Energy Efficiency Annual Incremental Programmatic Achievable Potential by End-Use (MW)

End Use	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Cooling (Electric)	35	37	40	45	50	55	51	54	58	60
Lighting Exterior (Electric)	1	1	1	1	1	1	1	1	0	0
Lighting Interior (Electric)	16	18	21	7	8	9	10	10	11	12
Plug Loads (Electric)	1	0	3	3	1	0	4	2	2	2
Refrigeration (Electric)	4	5	5	5	5	5	5	5	6	5
Total Facility (Electric)	2	2	3	3	4	4	5	6	6	7
Total HVAC (Electric)	1	3	5	6	6	6	8	9	9	9
VSD (Electric)	5	6	7	8	9	11	12	13	15	16
Hot Water (Electric)	1	1	1	1	1	1	1	1	2	2

Source: Navigant

Figure 47. Electric Energy Efficiency Annual Incremental Programmatic Achievable Potential by End-Use (MW)



Source: Navigant

3.2.4 Results by Measure

Table 64 and Figure 48 show the top-ranking electric energy efficiency measures along with their incremental achievable potential for each year through 2026. The top achievable electric measures include commercial VSD cooling fans, commercial and residential indoor LED screw-in bulbs, LED fixtures in the commercial sector, and air conditioner upgrades for both the residential and commercial sectors. Navigant consolidated the potential of the individual measures with lower savings potential under other measures to produce a more succinct view at the measure level, as referenced in Appendix F.

Given the rapid growth in customer adoption of LED screw-in bulbs and CECONY's strategic interest in this significant market opportunity, Navigant took additional measure level steps to develop a more robust LED forecast. In addition to using CECONY-specific saturation and density information collected through the primary data collection effort, Navigant also calibrated LED lighting specifically at the programmatic/measure level based on CECONY's historic/actual program data. The significant near-term potential shown in this study for indoor LED lighting, particularly in the residential sector, align with Navigant's experience in other jurisdictions.

As these figures illustrate, the relative savings potential of measures changes over time. For example, the relative ranking of indoor LEDs decreased significantly over the period, reflecting the changing baseline.

Once the annual incremental potential for LEDs declines in 2020 after the standard federal standard change, VSD cooling fans become the single largest measure in terms of annual potential.

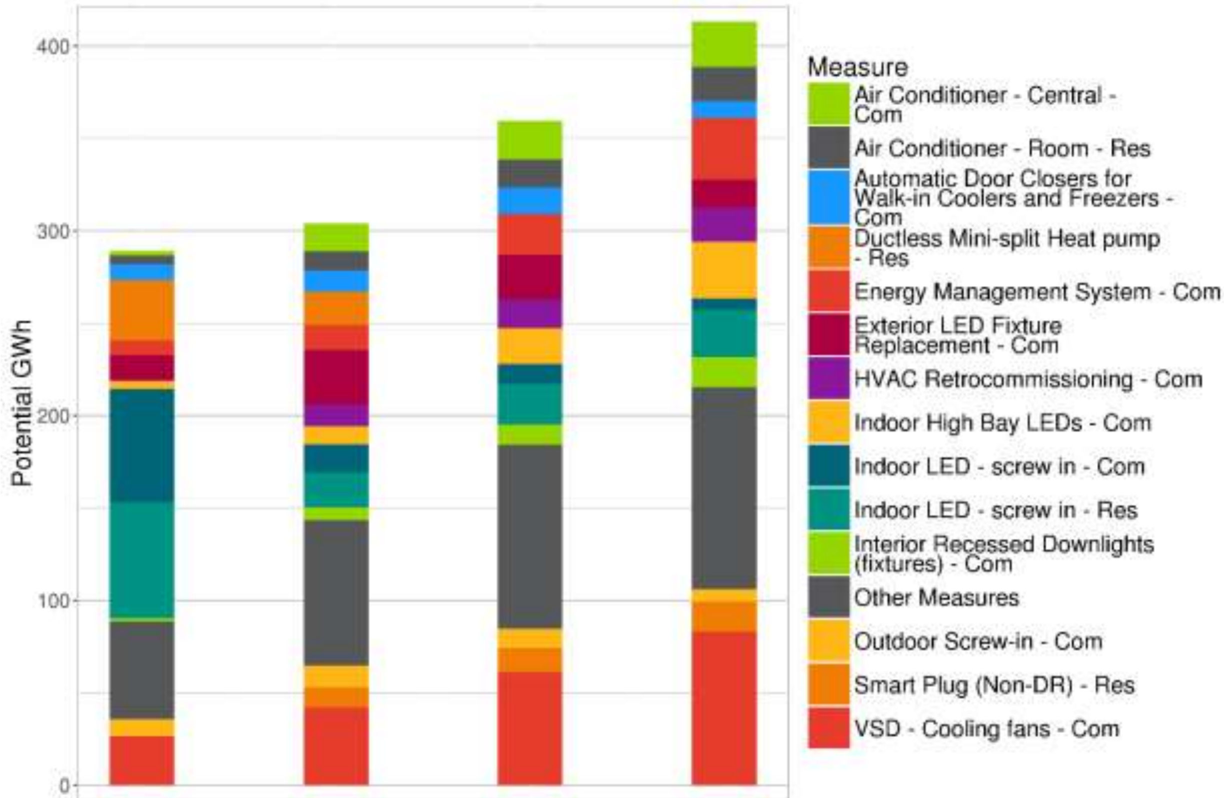
Ductless mini-split heat pumps also see significant near-term potential, which corresponds to CECONY's current residential portfolio, where ductless mini-split heat pumps provide the bulk of savings. It should be noted that this study considered ductless mini-split heat pumps as a direct competitor to room A/C measures and only considered the cooling savings within the potential calculations. In 2023, room A/C becomes more cost-effective across all boroughs, so the potential for ductless mini-split heat pumps shifts to room A/C units.

Table 64. Electric Energy Efficiency Annual Incremental Programmatic Achievable Potential by Measure (GWh)

Measure	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Air Conditioner - Central - Com	2	6	14	16	17	19	21	23	24	25
Air Conditioner - Room - Res	5	7	9	10	11	13	15	17	18	19
Automatic Door Closers for Walk-in Coolers and Freezers - Com	9	10	11	12	13	13	14	15	14	9
Ductless Mini-split Heat pump - Res	33	25	16	18	20	22	0	0	0	0
Energy Management System - Com	8	9	11	14	16	19	22	26	29	33
Exterior LED Fixture Replacement - Com	14	28	29	30	29	27	24	21	18	15
HVAC Retrocommissioning - Com	1	1	10	12	12	9	16	17	18	19
Indoor High Bay LEDs - Com	4	6	7	10	12	16	19	23	27	30
Indoor LED - screw in - Com	61	65	66	15	14	13	11	9	8	6
Indoor LED - screw in - Res	63	66	70	19	20	21	22	23	24	26
Interior Recessed Downlights (fixtures) - Com	2	7	18	7	8	9	11	13	14	16
Other Measures	53	57	82	79	78	83	100	99	103	109
Outdoor Screw-in - Com	9	10	11	12	12	11	10	9	8	7
Smart Plug (Non-DR) - Res	0	0	10	11	8	0	13	14	14	16
VSD - Cooling fans - Com	27	31	36	42	49	56	61	69	77	83

Source: Navigant

Figure 48. Electric Energy Efficiency Annual Incremental Programmatic Achievable Potential by Measure (GWh)



Source: Navigant

Table 65 and Figure 49 show the corresponding demand savings for the energy efficiency incremental programmatic achievable potential by measure.

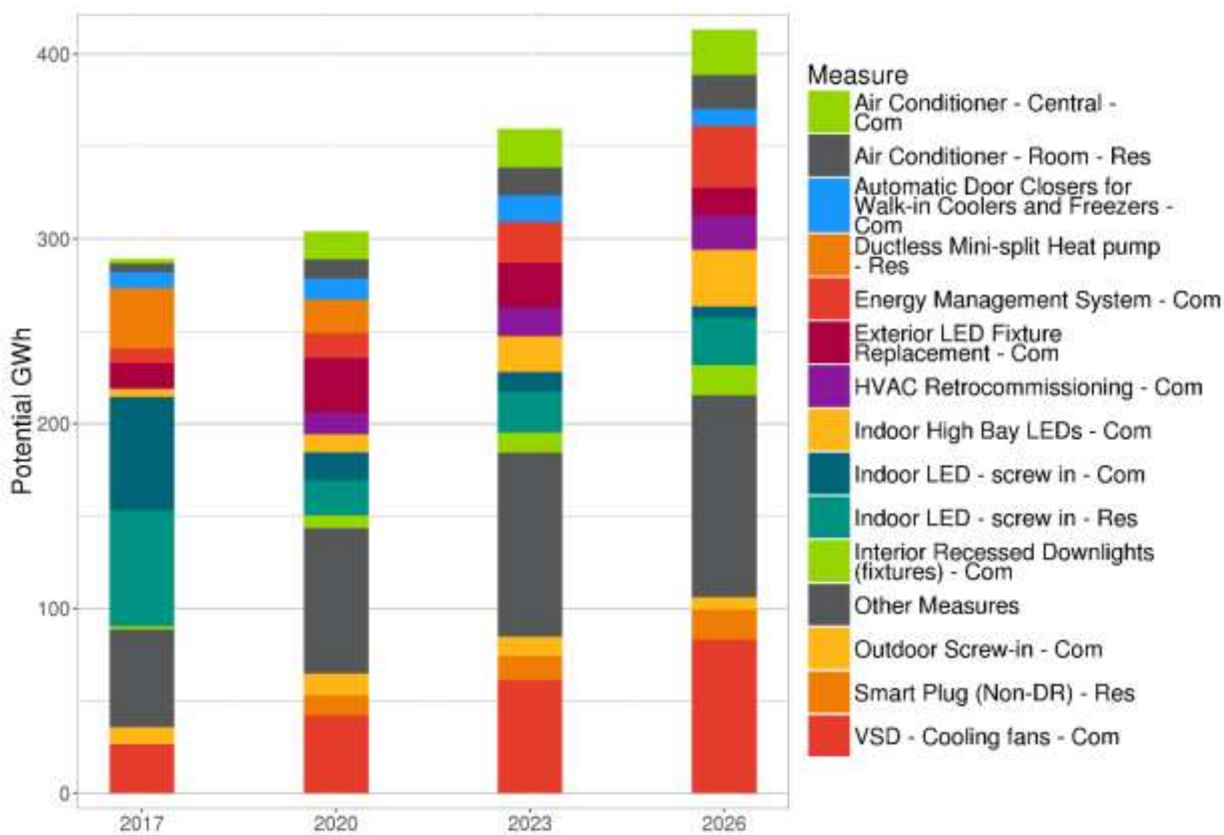
Table 65. Electric Energy Efficiency Annual Incremental Programmatic Achievable Potential by Measure (MW)

Measure	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Air Conditioner - Central - Com	5	8	13	14	16	17	19	20	21	22
Air Conditioner - Central - Res	0	1	2	3	3	3	4	4	5	5
Air Conditioner - Room - Res	3	4	5	6	7	7	9	10	10	11
Air Conditioner Maintenance - Com	3	3	4	5	5	6	7	8	8	9
Air Conditioner Maintenance - Res	3	3	4	4	4	5	5	5	5	5
Central Chiller - Com	2	2	3	3	4	4	5	5	5	6
Dehumidifier - Res	1	2	2	2	2	2	3	3	3	3
Ductless Mini-split Heat pump - Res	18	13	7	8	9	10	0	0	0	0

Measure	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Energy Management System - Com	2	2	3	3	4	4	5	6	6	7
HVAC Retrocommissioning - Com	0	1	2	2	2	2	3	3	3	4
Indoor High Bay LEDs - Com	1	1	1	1	2	2	3	4	4	5
Indoor LED - screw in - Com	9	9	10	2	2	2	2	1	1	1
Indoor LED - screw in - Res	6	6	7	2	2	2	2	2	2	2
Other Measures	9	10	17	15	15	15	19	19	20	21
VSD - Cooling fans - Com	5	6	6	7	9	10	11	12	13	15

Source: Navigant

Figure 49. Electric Energy Efficiency Annual Incremental Programmatic Achievable Potential by Measure (MW)



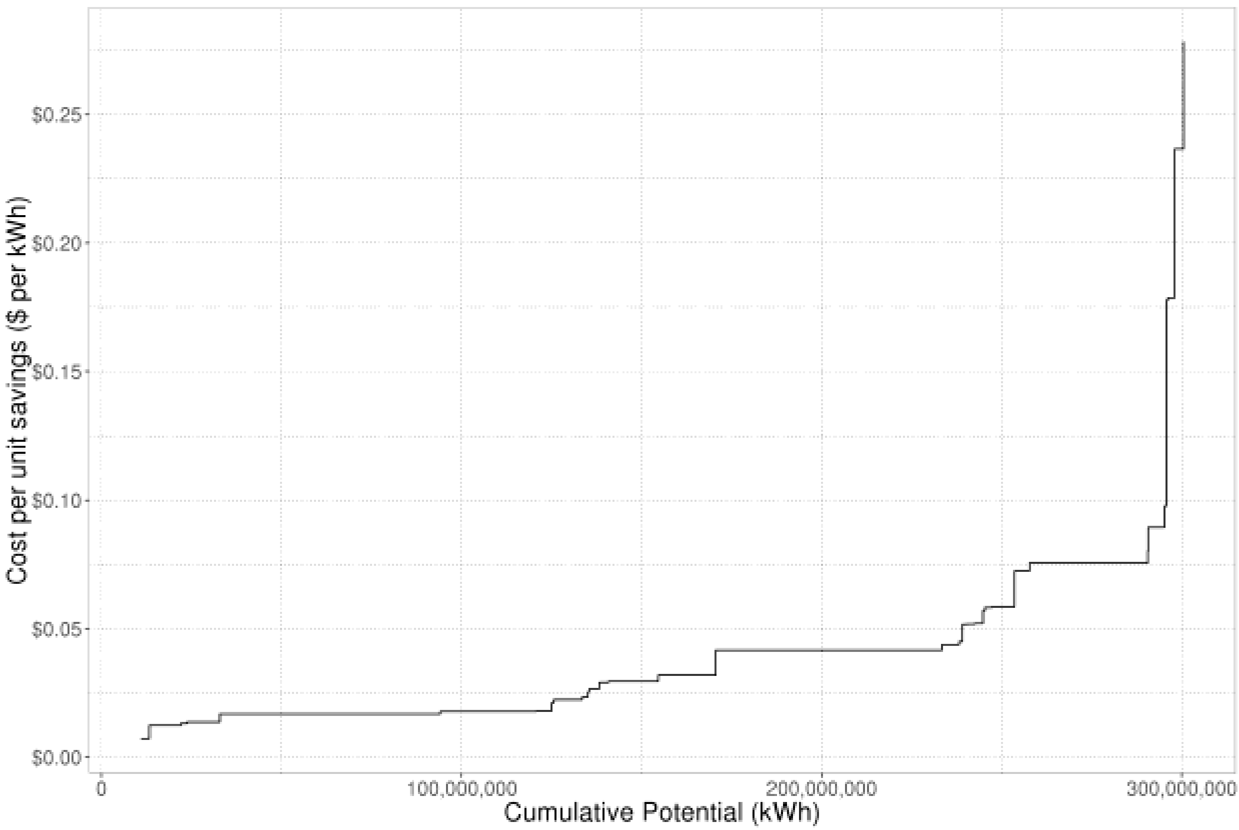
Source: Navigant

3.2.5 Supply Curves

The achievable potential supply curves are provided in this section. Levelized costs include the discounted lifetime savings for a given measure, and thus account for variable measure lifetimes and savings persistence. An energy efficiency resource potential supply curve illustrates the cumulative amount of achievable potential at various price points along a range of levelized cost. All measures were plotted with corresponding cumulative potential and the corresponding levelized cost to achieve that potential. The lowest cost measures appear on the left-hand side of the chart. Each next highest cost measure is stacked on top of the previous measures in ranked order.

Figure 50 provides the supply curve results for the first-year electric energy results of the programmatic achievable potential scenario under the SCT. As can be seen from the chart, the majority of the electric achievable potential savings can be achieved for a first-year levelized cost of near or under $0.05/kWh. The remaining potential requires significantly higher costs for achievement.

Figure 50. Electric Energy Efficiency Achievable Potential Supply Curve ($ per kWh)



** Based on first-year (i.e., 2017) savings*
Source: Navigant

To put the supply curve into better context, we have identified the highest saving measures that fall into five levelized cost categories: 0-5 cents/kWh, 5-10 cents/kWh, 10-15 cents/kWh, 15-20 cents/kWh and greater than 20 cents/kWh. The results of that analysis are provided in Table 66 below. The table identifies the top measures for each category. As can be seen, there are several measures in the first two cost buckets that are relatively low cost (i.e., less than 10 cents/kWh) that bring about the vast majority of savings. Once we are above 10 cents, fewer measures are available and less savings is possible.

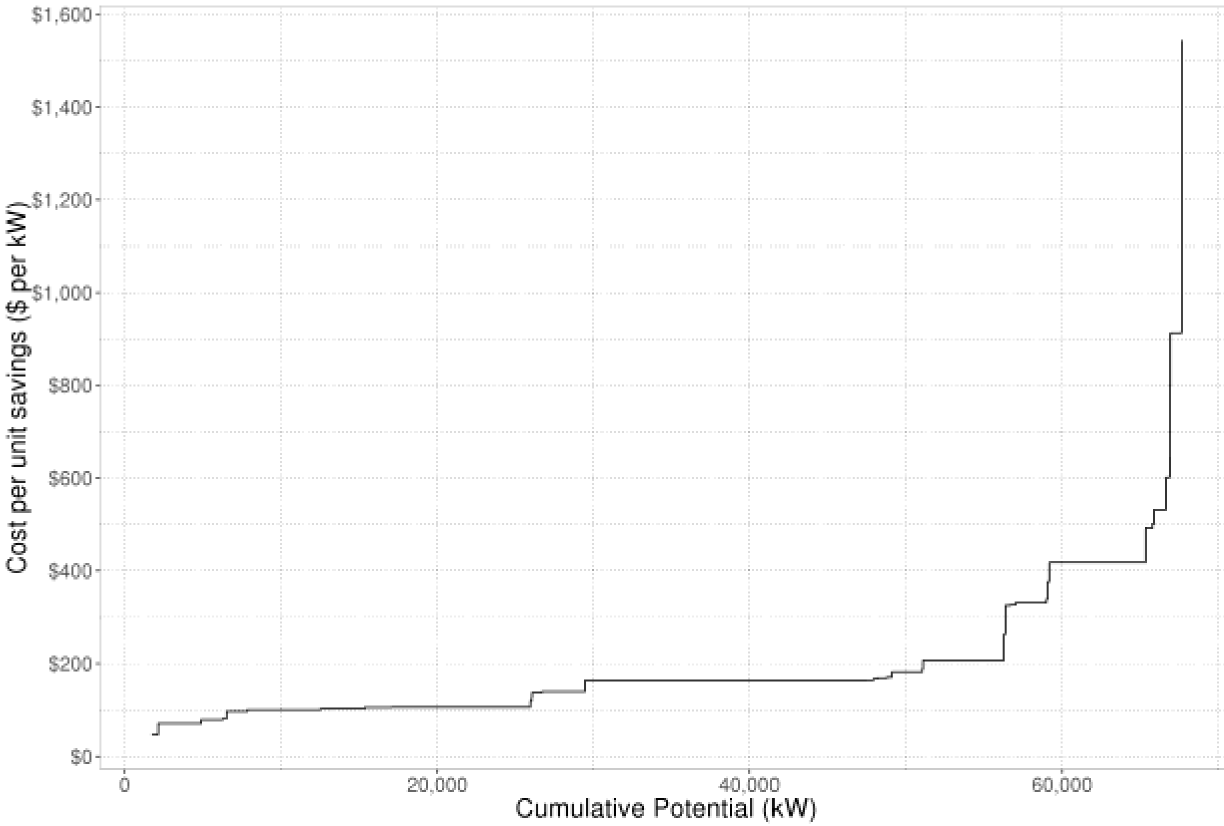
Table 66. Top Measures from the Electric Energy Efficiency Achievable Potential Supply Curve ($ per kWh)

Levelized Cost of Energy	
0-5 cents/kWh	**10-15 cents/kWh**
Indoor LED - screw in - Res	Central Chiller - Com
Indoor LED - screw in - Com	PTAC - Com
Refrigerator/Freezer Upgrade Energy Star or better - Res	HVAC Retrocommissioning - Com
VSD - Cooling fans - Com	High efficiency Printers and Copiers - Com
Energy Management System - Com	Heat pump - Com
Automatic Door Closers for Walk-in Coolers and Freezers - Com	Air Conditioner - Central - Com
Air Conditioner Maintenance - Res	**15-20 cents/kWh**
Exterior LED Fixture Replacement - Com	Ceiling Insulation - Com
Interior Recessed Downlights (fixtures) - Com	**> 20 cents/kWh**
Floating Head Pressure Controls - Com	Wall Insulation - Com
LED Exit Lighting - Com	Smart Thermostat - Com
5-10 cents/kWh	Smart Thermostat - Res
Ductless Mini-split Heat pump - Res	Air Conditioner - Central - Res
Clothes Washer Energy Star or better - Res	
Air Conditioner - Room - Res	
Efficient Air-cooled Refrigeration Condenser - Com	
Air Conditioner Maintenance - Com	
Dehumidifier - Res	
Range and Oven Electric High Efficiency - Com	
Indoor Fluorescent - Res	
PTAC - Res	

Source: Navigant

Figure 51 shows the supply curve results for the first-year electric demand results of the programmatic achievable potential scenario under the SCT. The supply curve for demand savings mirrors the shape of the energy savings supply curve for energy efficiency. As can be seen from the chart, the majority of the electric demand achievable potential savings can be achieved for a first-year levelized cost of near or under $250/kW.

Figure 51. Electric Energy Efficiency Achievable Potential Supply Curve ($ per kW)



** Based on first-year (i.e., 2017) savings*
Source: Navigant

Table 67 identifies the measures that fall into four levelized cost categories: 0-250 $/kW, 250-500 $/kW, 500-750 $/kW, and greater than 750 $/kW. As with the energy supply curve above, tthere are several measures in the first two cost buckets that are relatively low cost (i.e., less than $500/kW) that bring about the vast majority of demand savings. Once we are above $500/kW, fewer measures are available and less demand savings is possible.

Table 67. Top Measures from the Electric Energy Efficiency Achievable Potential Supply Curve ($ per kW)

Cost per unit savings	
0-250 $/kW	**250-500 $/kW**
LED Exit Lighting - Com	Wall Insulation - Com
Dehumidifier - Res	PTAC - Com
VSD - Cooling fans - Com	Efficient Air-cooled Refrigeration Condenser - Com
Air Conditioner Maintenance - Com	Clothes Washer-Energy Star or better - Com
Energy Management System - Com	Range and Oven - Electric High Efficiency - Com
Indoor LED - screw in - Com	Air Conditioner - Central - Res
Air Conditioner - Room - Res	**500-750 $/kW**
Ductless Mini-split Heat pump - Res	HVAC Retrocommissioning - Com
Floating Head Pressure Controls - Com	Indoor Fluorescent - Res
Refrigerator/Freezer Upgrade-Energy Star or better - Com	Heat pump - Com
PTAC - Res	Smart Thermostat - Res
Interior Recessed Downlights (fixtures) - Com	**> 750 $/kW**
Central Chiller - Com	High efficiency Printers and Copiers - Com
	Ceiling Insulation - Com
	Exterior LED Fixture Replacement - Com
	Smart Thermostat - Com

3.2.6 Budget Estimates

Table 68 presents the estimates of energy efficiency program funding needed to support the various levels of achievable potential to be obtained during the study period, including both administrative and incentive costs. These estimates were calculated in the IDSM model and reflect the budget constraints and incentive levels described in Section 2.3.4, where the estimated spending for each programmatic scenario initially aligns with CECONY's approved energy efficiency portfolio budget.

As can be seen from the table, Table 68 displays the total simulated funding that corresponds with each of the achievable potential scenarios.

For programmatic achievable, the budget is $85 million in 2017, growing to a budget level of $156 million in 2019. This budget is then held constant at the 2019 level for 2020-2026. Incentives comprise about 70% of the total budget in the programmatic achievable scenario, with the remainder allocated to administrative spend.

Table 68. Electric Energy Efficiency Achievable Potential Budget by Year ($M)

Potential Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Alternative Programmatic Achievable	$85	$106	$156	$156	$156	$156	$156	$156	$156	$156
Programmatic Achievable	$85	$106	$156	$156	$156	$156	$156	$156	$156	$156
Reduced Programmatic Achievable	$85	$106	$151	$106	$106	$106	$106	$106	$106	$106
Theoretical Achievable	$85	$106	$156	$205	$261	$317	$371	$382	$397	$381

Source: Navigant

3.3 NOP Results

The NOP results within this section represent estimates of naturally occurring market adoption, under the two scenarios described in Section 2.3.5. These scenarios should be viewed as high-level approximations with a significant range of uncertainty, due to the limited availability of data on customer adoption in the absence of a program and market uptake outside of program activity.

Table 69, Figure 52, Table 70, and Figure 53 present the electric energy efficiency NOP results for each scenario in terms of both energy and demand. These NOP results are between 71% and 81% of the programmatic achievable potential in 2017, declining to between 55% and 66% of the cumulative programmatic achievable potential in 2017. These results suggest that significant naturally occurring adoption of efficient technologies may be occurring in the marketplace, particularly through the lens of scenario 1 (i.e., assuming no programs or incentives exist), even when factoring in significant uncertainty bounds. This result aligns with CECONY's recent customer awareness study, which found that greater than 80% of residential customers were interested in energy efficiency, but awareness of CECONY's energy efficiency offerings was low (about 25%) and only about 20% of program aware customers actually converted to program participation.[68]

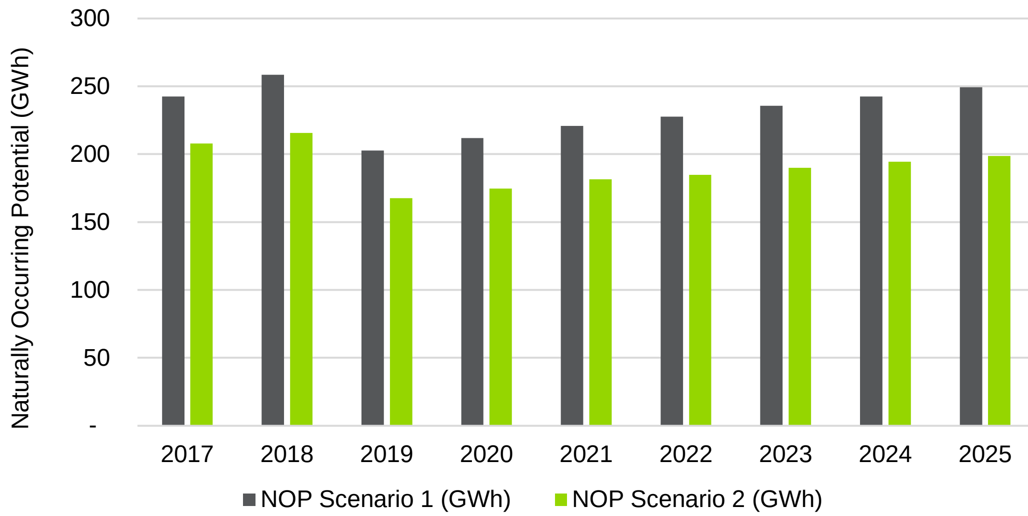
Table 69. Electric Energy Efficiency Annual Incremental NOP (GWh)

Scenario	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
NOP Scenario 1	234	242	259	203	212	221	228	236	243	249
NOP Scenario 2	204	208	216	168	175	181	185	190	194	199

Source: Navigant

[68] "Residential Awareness Study - Spring 17 Report For Meeting 5-30.pptx"

Figure 52. Electric Energy Efficiency Annual Incremental NOP (GWh)



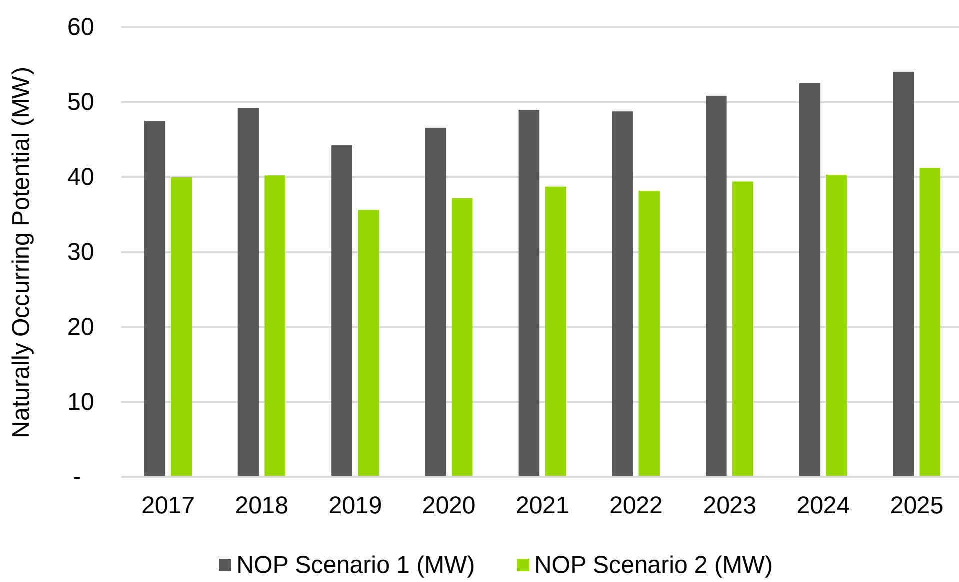
Source: Navigant

Table 70. Electric Energy Efficiency Annual Incremental NOP (MW)

Scenario	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
NOP Scenario 1	47	48	49	44	47	49	49	51	53	54
NOP Scenario 2	41	40	40	36	37	39	38	39	40	41

Source: Navigant

Figure 53. Electric Energy Efficiency Annual Incremental NOP (MW)



Source: Navigant

3.4 Comparison to 2010 Results

This section provides a high-level comparison of the results of the 2010 study to this study. These results are not directly comparable as the assumptions made in both studies vary in terms of descriptions of different potential types, baselines of measures, calculations of density and saturation values, and forecast sales for different sectors and segments. There have been many changes to the energy efficiency market in New York due to implementation of various federal and state codes, as well as market shifts with the implementation of many energy efficient measures in recent years. This comparison does not consider the NYPA residential and commercial segments, as these were not a part of the 2010 study.

3.4.1 Technical Potential

The 2010 and 2017 studies used different approaches for presenting cumulative technical potential; thus, a direct comparison of technical potential over the lifetime of the two studies is not presented here.[69]

One meaningful point of comparison, however, is the overall projected technical potential in the first year of each study: Year 1 (2010) of 14,574 GWh from the 2010 study is roughly the same as the overall potential in Year 1 (2017) of 14,939 GWh from the 2017 study, with slightly higher potential found in Year 1 of the 2017 study. This suggests that the total technical potential available (i.e., assuming instantaneous replacement of base measures with new measures) is somewhat higher in the 2017 study, which is likely due to differences in the measure mix considered.

The other meaningful point of comparison is that roughly 70% of the potential was attributed to the commercial and industrial sectors over the lifetime of the 2010 study, whereas the technical potential was closer to 55% for the commercial and industrial sectors in the 2017 study, with more potential from residential measures like lighting and HVAC.

3.4.2 Achievable Potential

Error! Reference source not found. shows the sector wise comparison of the cumulative achievable potential between the 2010 study and the current study. This analysis compares programmatic achievable potential in this study to the realistic achievable potential in the 2010 study. As seen in the table below, the commercial sector drives the achievable potential in both studies. In the 2017 study, the potential for the residential segments over the 10-year time horizon tapers off after the lighting standard change in 2020, whereas the commercial segments have higher levels of growth over the time horizon, relative to the residential segments.

[69] Whereas the 2010 study added the technical potential from the prior year to each consecutive year, the 2017 study calculated cumulative technical potential as the total overnight potential that could be achieved in each year of the study over time. Thus, comparisons of technical potential should be considered with this in mind.

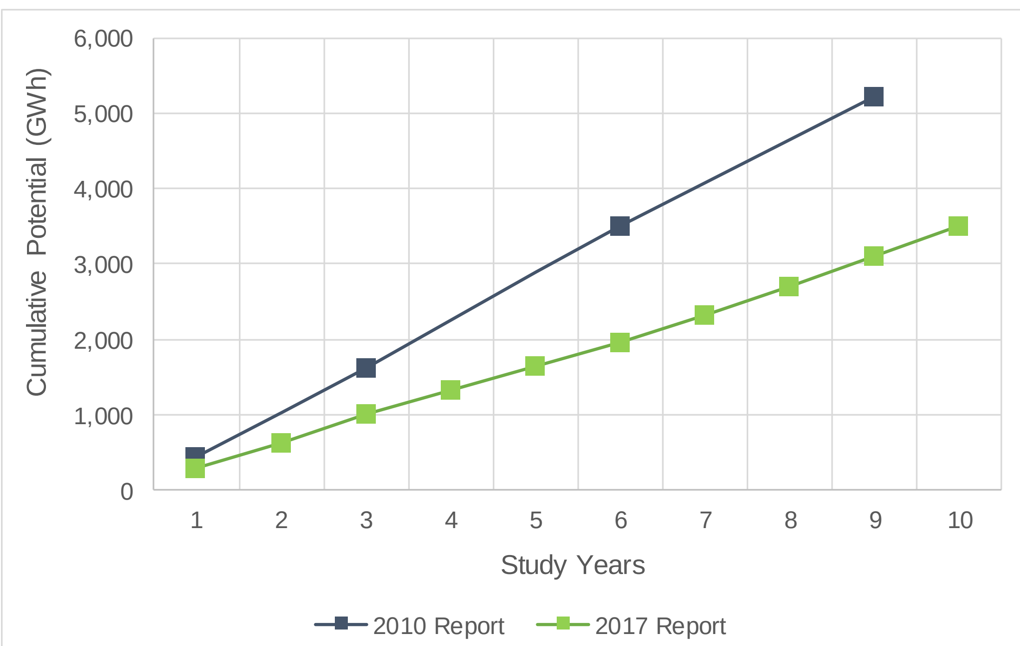
Table 71. Comparison of Cumulative Achievable Potential 2010-2026 (GWh and % by sector)

Sector	Achievable Potential Years							
2010 Report	**Year 1 (2010)**		**Year 3 (2012)**		**Year 6 (2015)**		**Year 9 (2018)**	
Residential	141	32%	455	28%	842	24%	1,114	21%
Commercial	292	67%	1,163	71%	2,646	75%	4,068	78%
Industrial	3	1%	10	1%	23	1%	35	1%
Overall	**436**	**N/A**	**1,628**	**N/A**	**3,511**	**N/A**	**5,217**	**N/A**
2017 Report	**Year 1 (2017)**		**Year 4 (2020)**		**Year 7 (2023)**		**Year 10 (2026)**	
Residential	133	46%	501	38%	777	33%	1,063	30%
Commercial	146	51%	767	58%	1,438	62%	2,253	64%
Industrial	11	4%	57	4%	118	5%	203	6%
Overall	**289**	**N/A**	**1,323**	**N/A**	**2,331**	**N/A**	**3,517**	**N/A**

Source: Navigant

Figure 54 compares the cumulative achievable potential from the 2010 report to the 2017 report by study year (e.g., year 1, year 3, etc.). The 2010 study sees a steady and significant growth in the achievable potential over the years. In the current study, growth is more measured, which likely reflects the assumed budget constraints for the programmatic achievable scenario over time in the 2017 study (see Section 2.3.4).

Figure 54. Comparison of Cumulative Achievable Potential in 2010 and 2017 Reports by Study Year (GWh)



Source: Navigant

4. GAS ENERGY EFFICIENCY POTENTIAL FORECAST

This section provides the gas energy efficiency potential for the years 2017 through 2026 for the CECONY markets in New York City and Westchester County. Navigant estimated seven scenarios for energy efficiency potential for the residential and C&I sectors. Navigant also developed potential estimates by specific customer segment and measure within each sector. Table 72 presents cumulative energy efficiency potential across all sectors, based on the scenarios defined for gas energy efficiency in Table 32 of Section 2.3.4. Technical potential is 21,917 thousand dekatherms (thousand dth) in 2017, increases to 21,922 thousand dth by 2026, which represents 12% of the reference forecast. Economic potential is 14,933 thousand dth or 8% of the reference forecast in 2026. Programmatic achievable potential is 352 thousand dth or 0.2% of the reference forecast in 2017, growing to 4,102 thousand dth or 2.3% in 2026.

The results indicate a few noteworthy patterns:

- Much like the electric results, the savings for the various achievable potential scenarios cumulate to levels that are still quite short of reaching the economic potential. Many of the same factors that were pointed out in the electric case contribute to this situation on gas. First, there are always customers who will not adopt energy efficiency measures even though they might be cost-effective and offered virtually for free, as is the case in the theoretical high achievable scenario. Second, the end-use equipment stock in the CECONY service territory includes a large amount of equipment that is long-lived. This is particularly applicable on the gas side where furnaces and boilers tend to last 15-20 or more years. Since this study covers a 10-year time horizon, equipment has yet to turn over by the time 2026 comes around.
- Because of the longer periods of equipment turnover on the gas side, it is expected that the achievable potential would eventually trend closer to economic potential in the years following 2026.
- Scenario 2 of naturally occurring potential is as much as 88% of the programmatic achievable in 2017, declining to 70% by 2026. High naturally occurring potential is consistent with recent market research that suggests there is general high interest in energy efficiency – including high organic purchases of certain efficient technologies (e.g. LEDs) – but that do not translate into program savings due to relatively low awareness of CECONY program offerings and/or barriers to program participation.

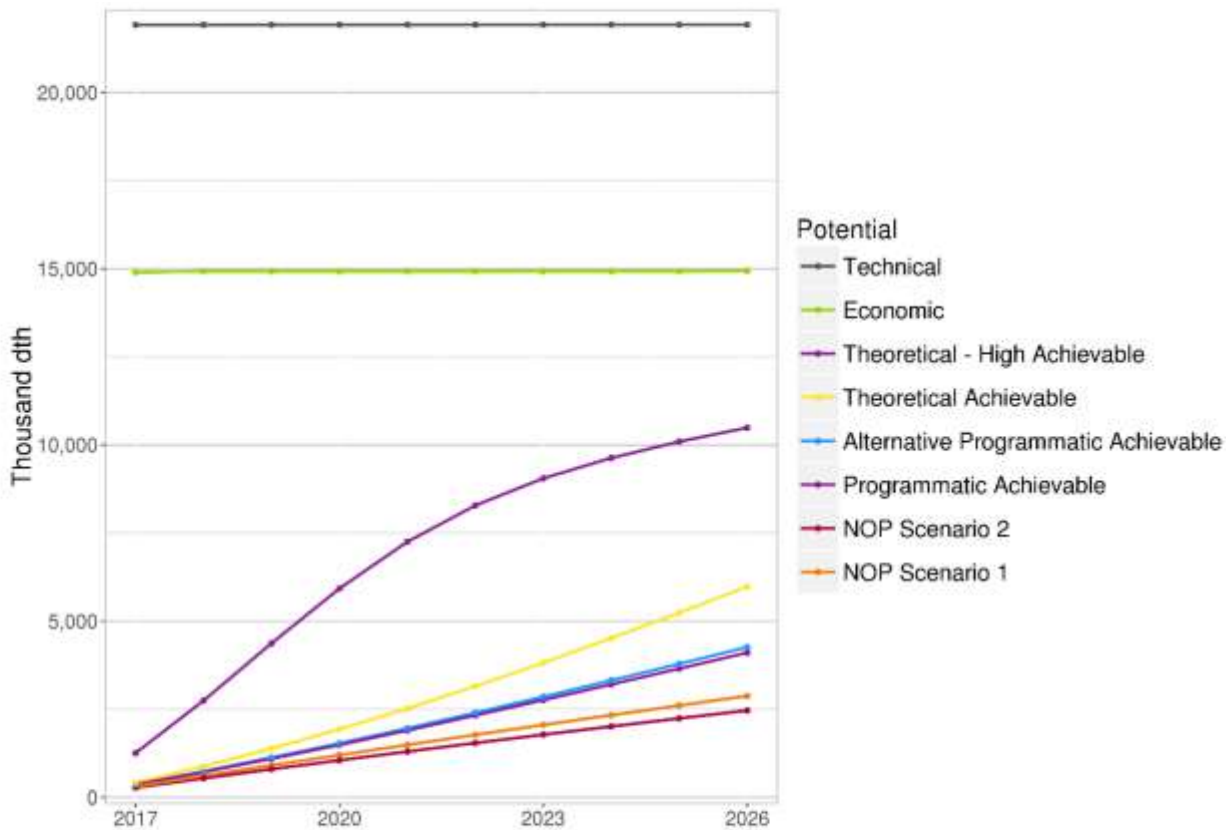
Table 72. Gas Energy Efficiency Cumulative Potential Forecast by Scenario (thousand dth)

Potential Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Technical	21,917	21,917	21,918	21,918	21,919	21,920	21,920	21,921	21,921	21,922
Economic	14,897	14,922	14,922	14,922	14,923	14,923	14,923	14,924	14,924	14,933
Theoretical - High Achievable	1,254	2,744	4,368	5,923	7,251	8,281	9,048	9,628	10,091	10,485
Theoretical Achievable	420	880	1,384	1,931	2,520	3,149	3,815	4,513	5,236	5,977
Alternative Programmatic Achievable	362	737	1,126	1,531	1,957	2,399	2,852	3,317	3,785	4,260

Programmatic Achievable	352	718	1,095	1,486	1,898	2,323	2,759	3,204	3,650	4,102
NOP Scenario 1	308	610	906	1,198	1,487	1,772	2,053	2,331	2,604	2,873
NOP Scenario 2	273	538	797	1,050	1,297	1,540	1,777	2,010	2,239	2,463

Source: Navigant

Figure 55. Gas EE Cumulative Potential Forecast by Scenario (thousand dth)



Source: Navigant

4.1 Technical Potential Results

This section provides the technical savings potential calculated through DSMSim™ at varying levels of aggregation. Results are shown by sector, customer segment, and highest impact measures.

4.1.1 Results by Sector

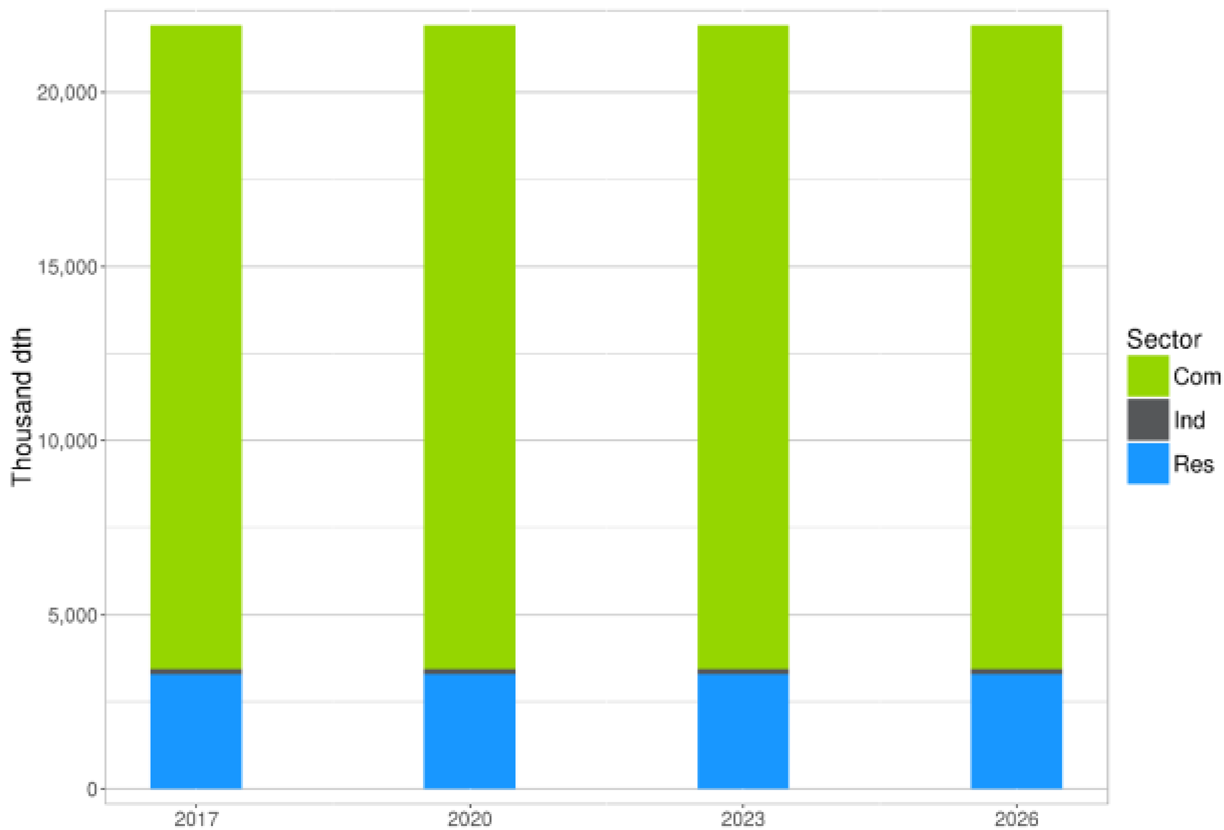
Figure 56 shows the total technical savings potential split by sector for gas energy. The allocation of technical potential among sectors is comparable with the allocation of forecasted sales among sectors, with commercial contributing to the highest gas technical potential. Technical potential grows slightly and steadily over time due to new stock additions to the territory. Residential measures contribute to 15% of overall technical potential, with the bulk of the contribution from the commercial measures. This commercial potential is primarily from the multi-family common area building segment, which includes common areas from residential buildings classified as commercial accounts.

Table 73. Gas EE Cumulative Technical Potential by Sector (thousand dth)

Sector	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Commercial	18,483	18,483	18,484	18,484	18,484	18,485	18,485	18,486	18,486	18,487
Industrial	149	149	149	149	149	149	150	150	150	150
Residential	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285	3,285

Source: Navigant

Figure 56. Gas Energy Efficiency Cumulative Technical Potential by Sector (thousand dth)



Source: Navigant

4.1.2 Results by Customer Segment

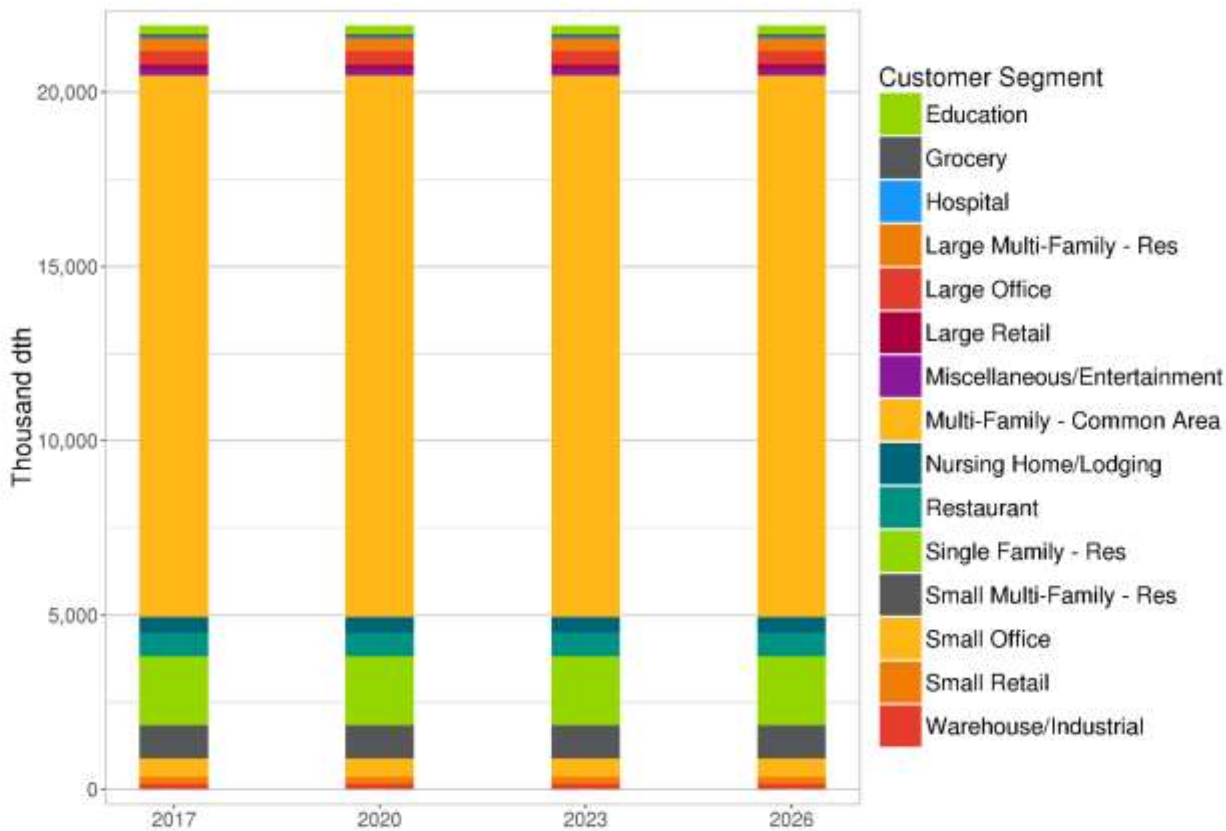
Figure 57 shows the gas energy efficiency technical potential broken out for each of the customer segments, and Appendix F provides the associated data. This figure highlights the large savings potential of the multi-family common area segment followed by the residential single-family home customer segment, relative to other customer segments. The multi-family common area segment alone contributes to 71% of the total technical potential. This finding correlates with the significant proportion of multi-family building stock in CECONY's service territory and, as described more below, is largely driven by shared gas water and space heating measures in multi-family buildings. On the commercial side, technical savings are relatively evenly split across buildings segments, not counting the multi-family common area segment. The distribution of technical potential across all of the segments in both the residential and commercial sectors align relatively closely with the forecasted gas sales of these individual sectors.

Table 74. Gas EE Energy Efficiency Cumulative Technical Potential by Segment (thousand dth)

Customer Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Education	265	265	266	266	266	266	266	266	266	266
Grocery	61	61	61	61	61	61	61	61	61	61
Hospital	62	62	62	62	62	62	62	62	62	62
Large Multi-Family - Res	358	358	358	358	358	358	358	358	358	358
Large Office	382	382	382	382	382	382	382	382	382	382
Large Retail	108	108	108	108	108	108	108	108	108	108
Miscellaneous/Entertainment	202	202	202	202	202	202	202	202	202	202
Multi-Family - Common Area	15,533	15,533	15,533	15,534	15,534	15,535	15,535	15,535	15,536	15,536
Nursing Home/Lodging	454	454	454	454	454	454	454	454	454	454
Restaurant	686	686	686	686	686	686	686	686	686	686
Single Family - Res	1,967	1,967	1,967	1,967	1,967	1,967	1,967	1,967	1,967	1,967
Small Multi-Family - Res	960	960	960	960	960	960	960	960	960	960
Small Office	526	526	526	526	526	526	526	526	526	526
Small Retail	203	203	203	203	203	203	203	203	203	203
Warehouse/Industrial	149	149	149	149	149	149	150	150	150	150

Source: Navigant

Figure 57. Gas Energy Efficiency Cumulative Technical Potential by Segment (thousand dth)



Source: Navigant

4.1.3 Results by End-Use

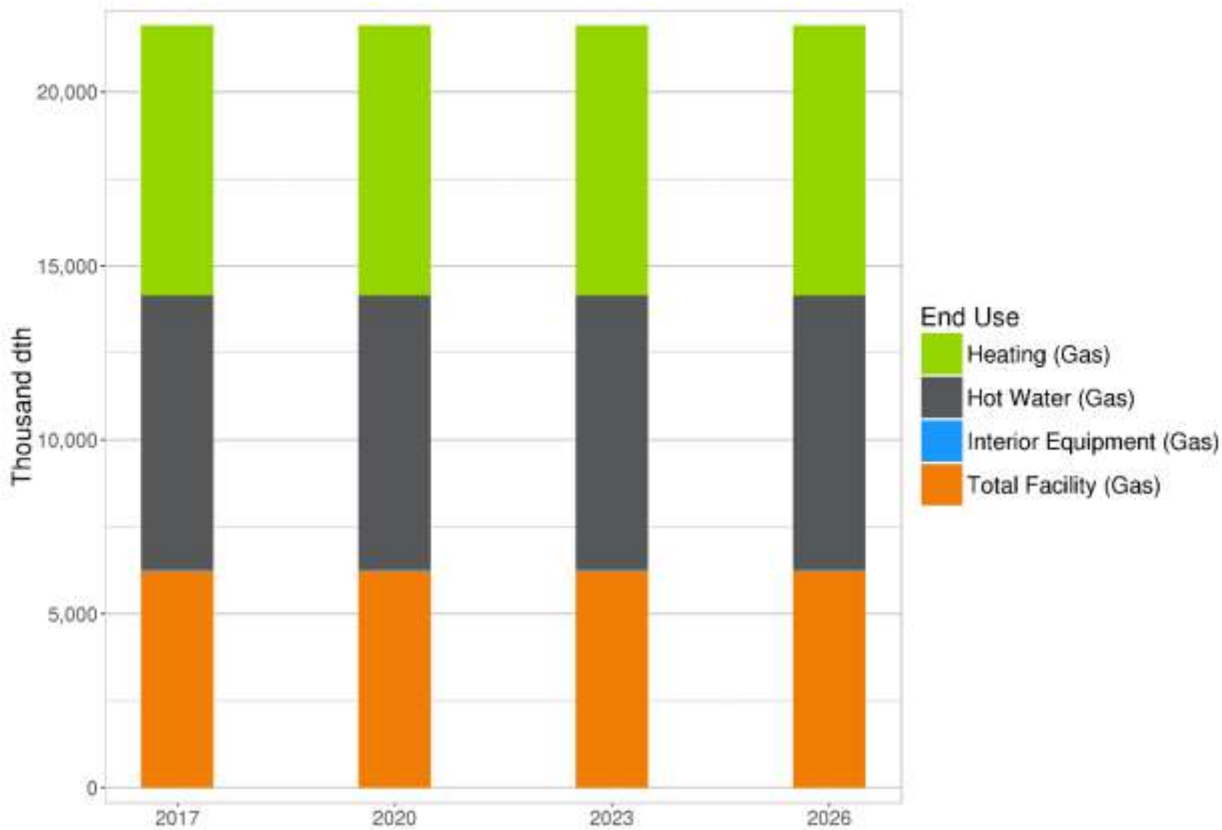
Table 75 and Figure 58 show the technical potential broken out by end-use. Space heating and water heating each contribute roughly 35% of the overall technical potential, with the rest of the potential driving primarily from total facility measures (e.g., HVAC retrocommissioning and energy management measures).

Table 75. Gas Energy Efficiency Cumulative Technical Potential by End-Use (thousand dth)

End Use	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Heating (Gas)	7,758	7,759	7,759	7,759	7,759	7,760	7,760	7,760	7,761	7,761
Hot Water (Gas)	7,887	7,888	7,888	7,888	7,888	7,889	7,889	7,889	7,889	7,890
Interior Equipment (Gas)	24	24	24	24	24	24	24	24	24	24
Total Facility (Gas)	6,247	6,247	6,247	6,247	6,247	6,247	6,247	6,247	6,247	6,247

Source: Navigant

Figure 58. Gas Energy Efficiency Cumulative Technical Potential by End-Use (thousand dth)



Source: Navigant

4.1.4 Results by Measure

Table 76 and Figure 59 show the measure level savings potential after adjusting for competition groups. This figure presents all of the gas measures, with their contributions to the overall potential presented in color-coded bars.

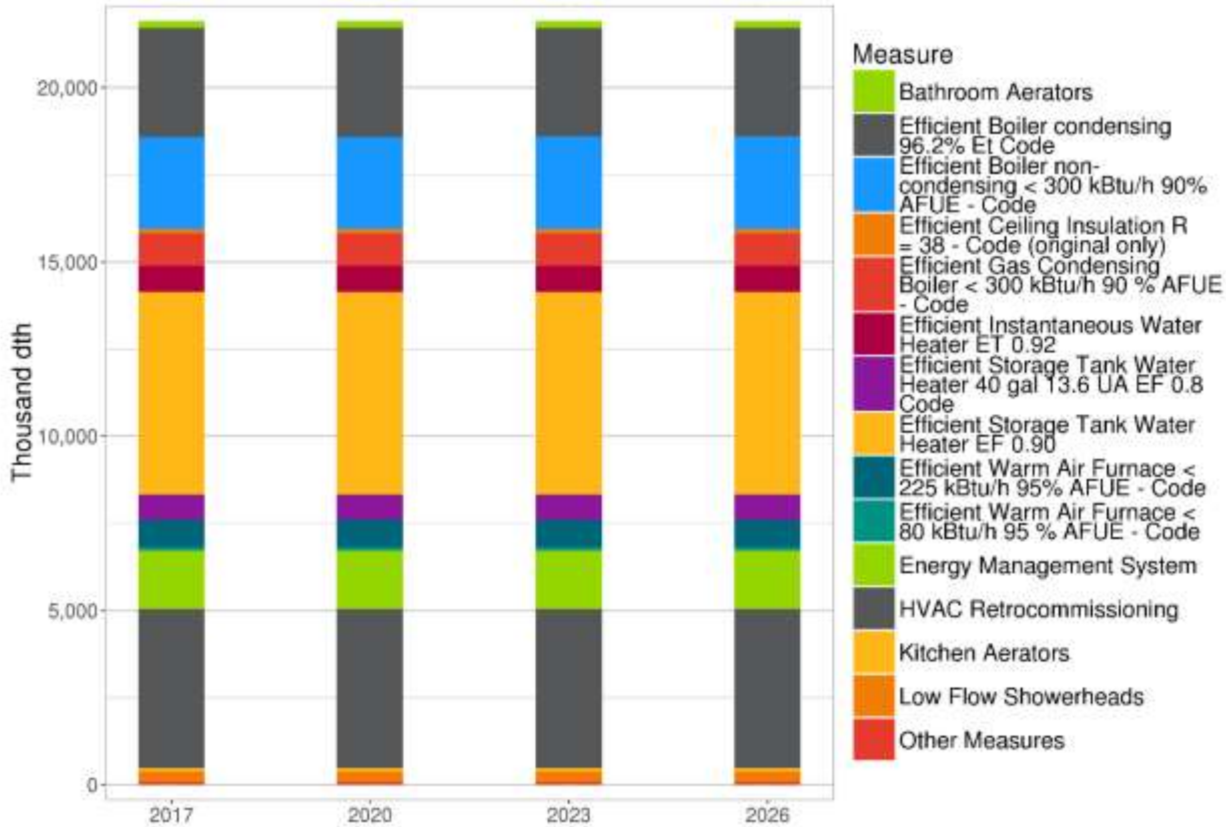
As shown in the Table 76 and Figure 59, efficient storage tank water heaters are the highest contributing measures to the overall technical potential. This measure is followed closely by the efficient boilers and HVAC retro commissioning measures. Commercial measures contribute the majority of the savings, due to the common space and water heating measures under the multi-family common area segment. The remaining potential is almost evenly split among the rest of the measures. Some commercial measures, such as faucet aerators, gas clothes dryer, and wall insulation, are contributing to near zero potential.

Table 76. Gas Energy Efficiency Cumulative Technical Potential by Measure (thousand dth)

Measure	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Bathroom Aerators	208	208	208	208	208	208	208	208	208	208
Efficient Boiler condensing 96.2% Et Code	3,119	3,119	3,119	3,119	3,119	3,119	3,119	3,119	3,119	3,120
Efficient Boiler non-condensing < 300 kBtu/h 90% AFUE - Code	2,643	2,643	2,643	2,643	2,644	2,644	2,644	2,644	2,644	2,644
Efficient Ceiling Insulation R = 38 - Code (original only)	126	126	126	126	126	126	126	126	126	126
Efficient Gas Condensing Boiler < 300 kBtu/h 90 % AFUE - Code	935	935	935	935	936	936	936	936	936	936
Efficient Instantaneous Water Heater ET 0.92	751	751	751	751	751	751	751	751	751	751
Efficient Storage Tank Water Heater EF 0.90	5,805	5,805	5,805	5,806	5,806	5,806	5,806	5,807	5,807	5,807
Efficient Storage Tank Water Heater 40 gal 13.6 UA EF 0.8 Code	726	726	726	726	726	726	726	726	726	726
Efficient Warm Air Furnace < 225 kBtu/h 95% AFUE - Code	770	770	770	770	770	770	770	770	770	770
Efficient Warm Air Furnace < 80 kBtu/h 95 % AFUE - Code	116	116	116	116	116	116	116	116	116	116
Energy Management System	1,681	1,681	1,681	1,681	1,681	1,681	1,681	1,681	1,681	1,681
HVAC Retrocommissioning	4,567	4,567	4,567	4,567	4,567	4,567	4,567	4,567	4,567	4,567
Kitchen Aerators	84	84	84	84	84	84	84	84	84	84
Low Flow Showerheads	301	301	301	301	301	301	301	301	301	301
Other Measures	85	85	85	85	85	85	85	85	85	85

Source: Navigant

Figure 59. Gas Energy Efficiency Cumulative Technical Potential by Measure (thousand dth)



Source: Navigant

4.2 Achievable Potential Results

This section provides the results for gas energy efficiency achievable potential at different levels of aggregation. Results are shown by sector, customer segment, and by highest impact measures.

The figures and tables within this section focus on programmatic achievable, with the more detailed results for the other achievable scenarios available in Appendix G.

4.2.1 Results by Sector

As shown Table 77 and Figure 60, the annual incremental achievable potential for gas energy efficiency, which accounts for the rate of energy efficient gas acquisition, grows from 353 thousand dth across all sectors in 2017 to 453 thousand dth in 2026, or 3% per year on average over the potential study time horizon.[70]

Values shown for achievable potential are termed annual incremental potential in that they represent the incremental new potential available in each year. The total cumulative potential over the time period is the

[70] The time horizon for the potential study is 2017-2026 (10 years).

sum of each year's annual incremental achievable. Economic potential, as defined in this study, can be thought of as a bucket of potential from which programs can draw over time. Achievable potential represents the draining of that bucket, the rate of which is governed by a number of factors, including the lifetime of measures (for ROB technologies), market effectiveness, incentive levels, and customer willingness to adopt, among others. If the cumulative achievable potential ultimately reaches the economic potential, it would signify that all economic potential in the bucket had been drawn down, or harvested. However, achievable potential levels generally do not reach the full economic potential level due to a variety of market and customer constraints that inhibit full economic adoption.[71]

The commercial sector largely drives the achievable potential contributing to over 85% of the total achievable potential. The residential potential contributes to 14% of the sector potential, and industrial[72] contributes to less than 1% of the total achievable potential.

Table 77. Gas Energy Efficiency Annual Incremental Programmatic Achievable Potential by Sector (thousand dth)

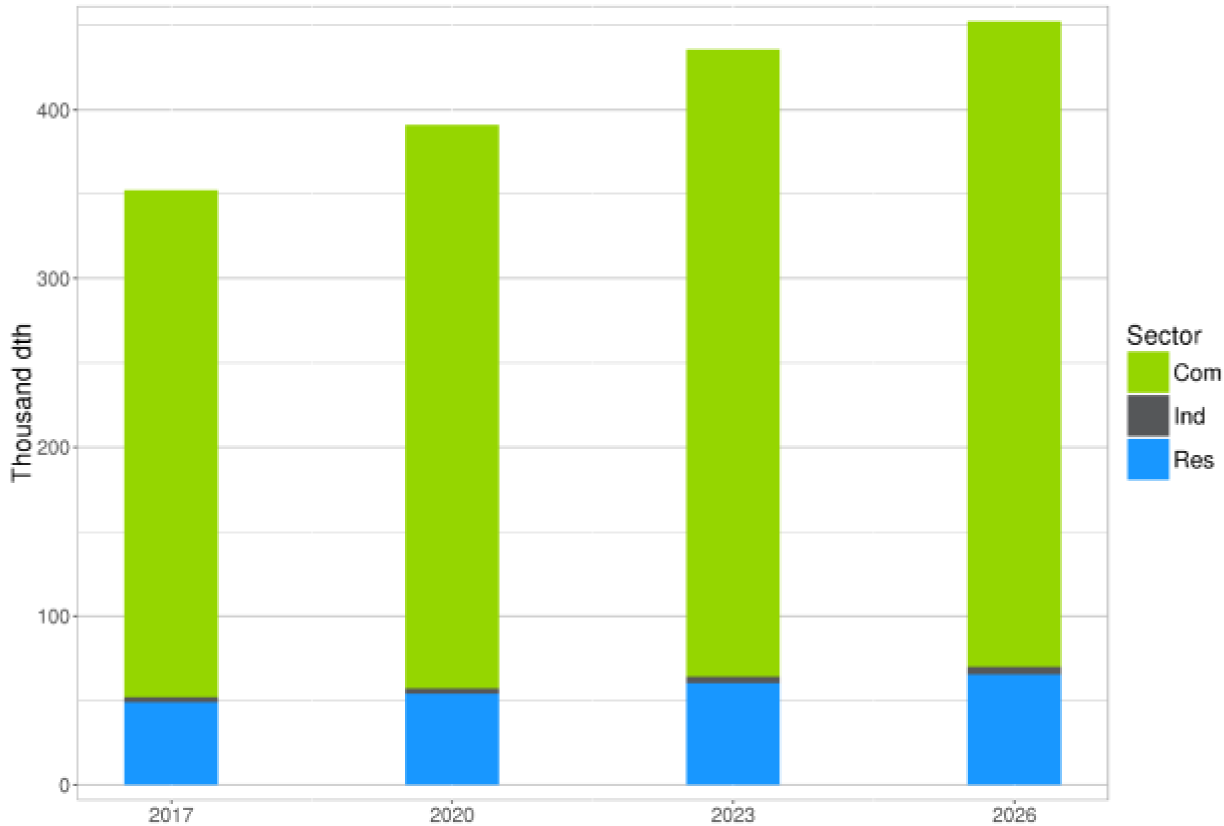
Sector	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Commercial	301	311	323	334	353	363	371	379	378	383
Industrial	3	3	3	3	4	4	4	4	4	5
Residential	49	51	51	54	56	58	60	62	64	65

Source: Navigant

[71] Constraints on achievable potential that inhibit realization of the full economic potential include the rate at which homes and businesses will adopt efficient technologies, as well as the word-of-mouth and marketing effectiveness for the technology. If a technology already has high saturation at the beginning of the study, it may theoretically be possible be possible to fully saturate the market and achieve 100% of the economic potential.

[72] The industrial sector includes the Warehouse/Industrial customer segment only.

Figure 60. Gas Energy Efficiency Annual Incremental Programmatic Achievable Potential by Sector (thousand dth)



Source: Navigant

4.2.2 Results by Customer Segment

The achievable potentials shown in Table 78 and Figure 61 are broken out for selected years in the forecast for each of the customer segments.

The charts indicate a few noteworthy patterns:

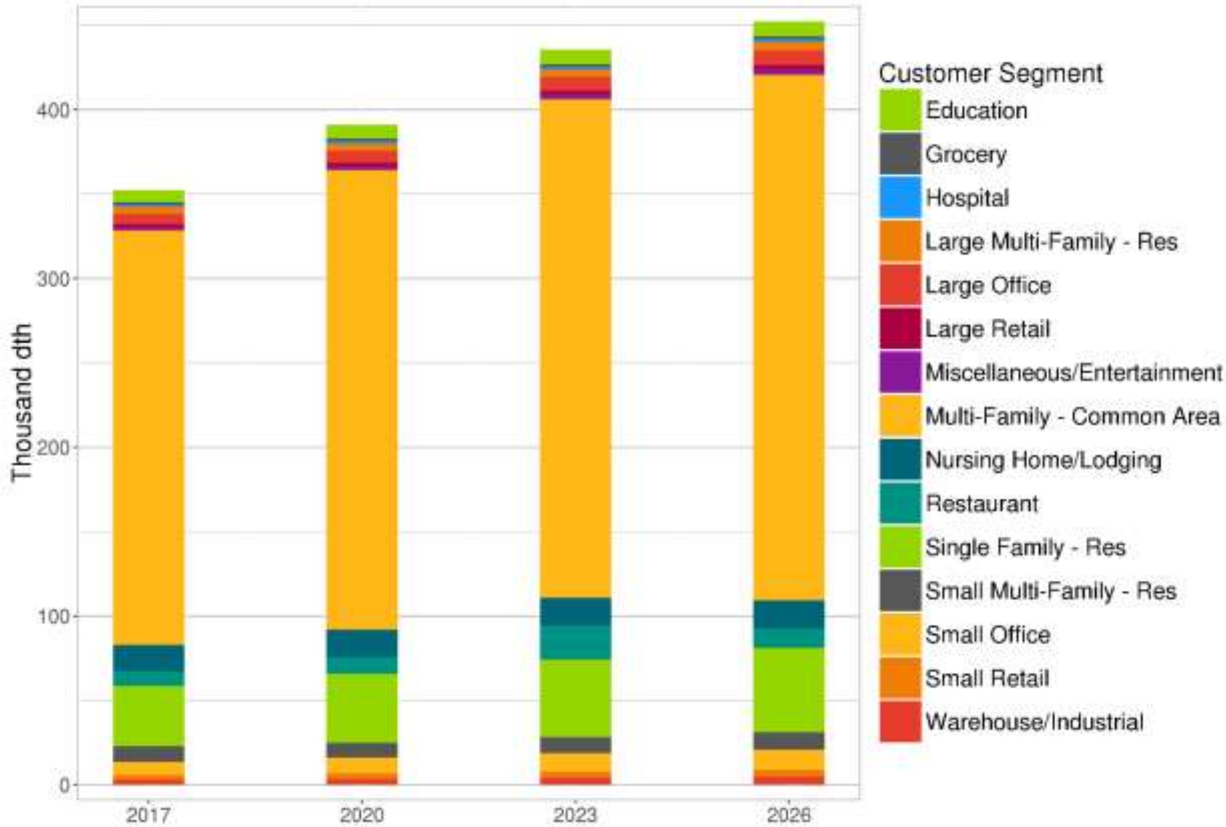
- The multi-family common area segment has the most potential for energy efficiency gas savings in the CECONY service territory from a single segment, with roughly 70% of the potential in 2017. The dominance of the multi-family common area segment within the achievable potential corresponds to its large share of baseline energy usage (see Section 2.2.2). Additionally, the analysis assumes that the multi-family common area segment centrally provides much of the space and water heating for the individual large and small multi-family units.
- In aggregate, the single-family, large and small multi-family segments provide roughly 14% of the potential in 2017, not including the multi-family common area segment.
- Nursing homes/lodging, restaurants, small office, and education commercial buildings provide the next greatest savings opportunities in terms of achievable potential.

Table 78. Gas Energy Efficiency Annual Incremental Programmatic Achievable Potential by Segment (thousand dth)

Customer Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Education	7	8	8	8	8	9	9	9	9	9
Grocery	1	1	1	1	1	1	2	2	2	2
Hospital	1	1	2	2	2	2	2	2	2	2
Large Multi-Family - Res	4	4	4	4	4	4	4	4	5	5
Large Office	6	7	7	7	8	8	8	8	8	9
Large Retail	2	2	2	2	2	2	2	2	2	2
Miscellaneous/ Entertainment	2	2	2	2	3	3	3	3	3	3
Multi-Family - Common Area	246	254	263	272	281	288	295	302	307	311
Nursing Home/Lodging	15	16	16	16	16	17	17	17	17	17
Restaurant	9	9	10	10	19	20	20	20	13	12
Single Family - Res	36	37	39	41	43	45	46	48	49	50
Small Multi-Family - Res	9	9	8	9	9	9	10	10	10	10
Small Office	8	8	9	9	10	10	11	11	11	12
Small Retail	3	3	3	4	4	4	4	4	4	4
Warehouse/Industrial	3	3	3	3	4	4	4	4	4	5

Source: Navigant

Figure 61. Gas Energy Efficiency Annual Incremental Programmatic Achievable Potential by Segment (thousand dth)



Source: Navigant

4.2.3 Results by End-Use

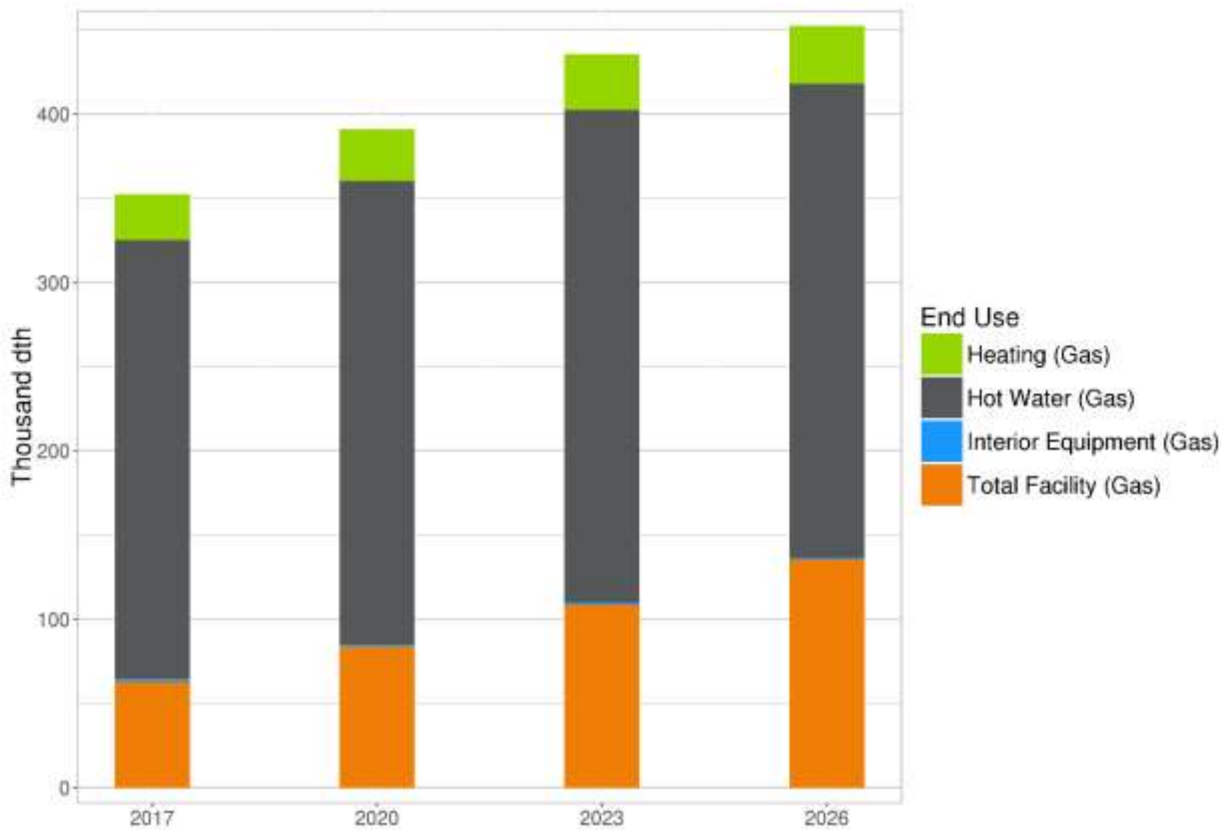
Table 79 and Figure 62 show the achievable potential broken out by end-use. Initially, almost three-quarters of the gas energy efficiency achievable potential in 2017 is from water heating. Over time, this transitions to roughly 60%, as the relative contributions from total facility measures like HVAC retrocommissioning and energy management measures grow over time.

Table 79. Gas Energy Efficiency Annual Incremental Programmatic Achievable Potential by End-Use (thousand dth)

End Use	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Heating (Gas)	27	28	30	31	32	33	33	34	34	34
Hot Water (Gas)	261	266	270	275	287	291	292	292	284	281
Interior Equipment (Gas)	1	1	1	1	1	1	1	1	1	1
Total Facility (Gas)	63	69	76	84	92	100	109	118	127	136

Source: Navigant

Figure 62. Gas Energy Efficiency Annual Incremental Programmatic Achievable Potential by End-Use (thousand dth)



Source: Navigant

4.2.4 Results by Measure

Table 80 and Figure 63 show the top-ranking gas energy efficiency measures along with their incremental achievable potential for each year through 2026. The top measure, by far, is the efficient storage tank water heater with an energy factor (EF) of 0.90. This measure dominates the gas energy efficiency achievable potential because it has significant per-unit savings and is the only water heating measure for the larger commercial building types, including multi-family common area. Thus, because multi-family common area comprises such a significant share of CECONY’s gas consumption, this measure dominates the water heating market for the multi-family common area segment and, as a result, the overall potential.

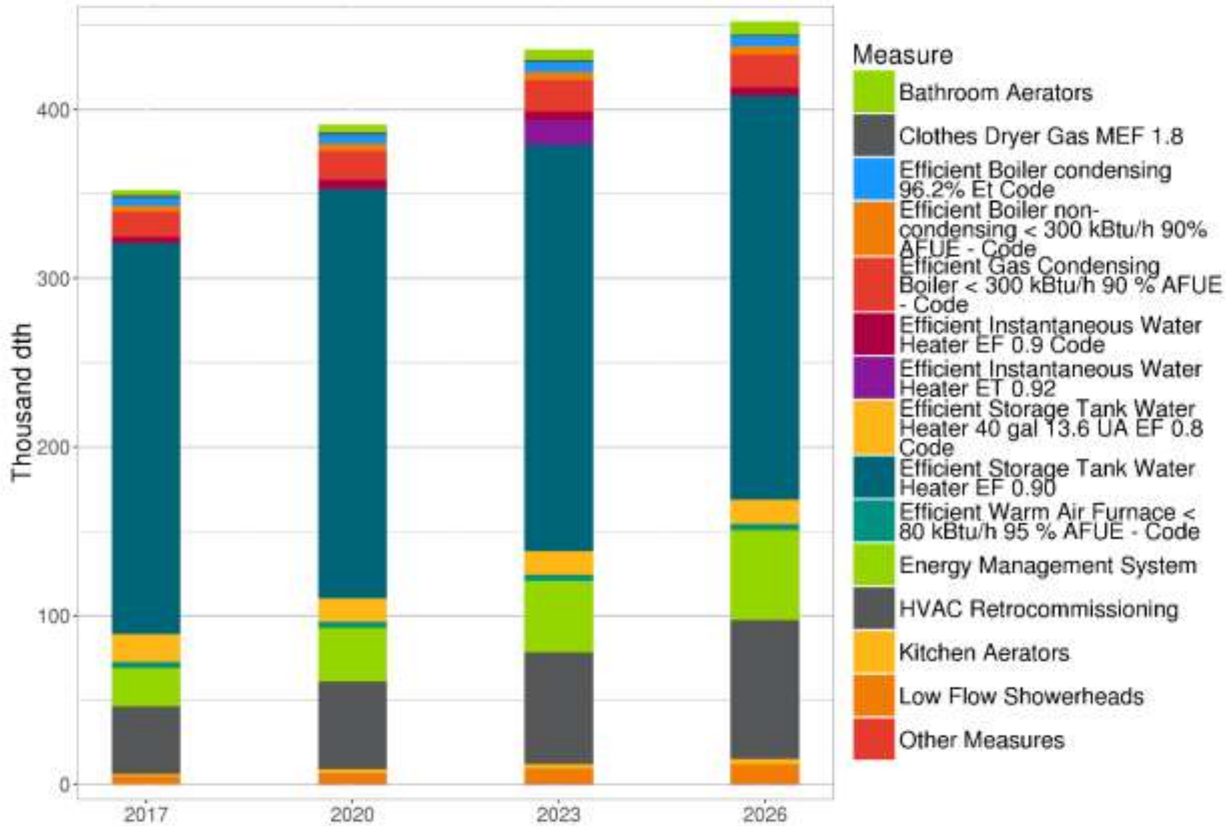
The measures with the next highest potential, following the storage tank water heater, are HVAC retrocommissioning and energy management systems. Aerators, low flow showerheads, gas clothes dryers, and insulation measures provide relatively little achievable potential savings opportunity.

Table 80. Gas Energy Efficiency Annual Incremental Programmatic Achievable Potential by Measure (thousand dth)

Measure	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Bathroom Aerators	3	4	4	4	5	6	6	7	7	8
Clothes Dryer Gas MEF 1.8	1	1	1	1	1	1	1	1	1	1
Efficient Boiler condensing 96.2% Et Code	5	5	5	5	6	6	6	6	6	6
Efficient Boiler non-condensing < 300 kBtu/h 90% AFUE - Code	4	4	4	4	5	5	5	5	5	5
Efficient Gas Condensing Boiler < 300 kBtu/h 90 % AFUE - Code	15	16	16	17	18	18	19	19	19	19
Efficient Instantaneous Water Heater EF 0.9 Code	4	4	5	5	5	5	5	5	5	5
Efficient Instantaneous Water Heater ET 0.92	0	0	0	0	13	15	15	14	2	0
Efficient Storage Tank Water Heater EF 0.90	232	235	240	243	240	241	241	239	242	240
Efficient Storage Tank Water Heater 40 gal 13.6 UA EF 0.8 Code	17	17	14	14	14	14	14	14	14	14
Efficient Warm Air Furnace < 80 kBtu/h 95 % AFUE - Code	3	3	4	4	4	4	4	4	4	4
Energy Management System	23	25	28	32	35	39	42	46	50	54
HVAC Retrocommissioning	40	44	48	52	57	62	67	72	77	82
Kitchen Aerators	1	1	2	2	2	2	2	3	3	3
Low Flow Showerheads	4	5	6	6	7	8	9	10	10	11
Other Measures	0	0	0	0	0	1	1	1	1	1

Source: Navigant

Figure 63. Gas Energy Efficiency Annual Incremental Programmatic Achievable Potential by Measure (thousand dth)



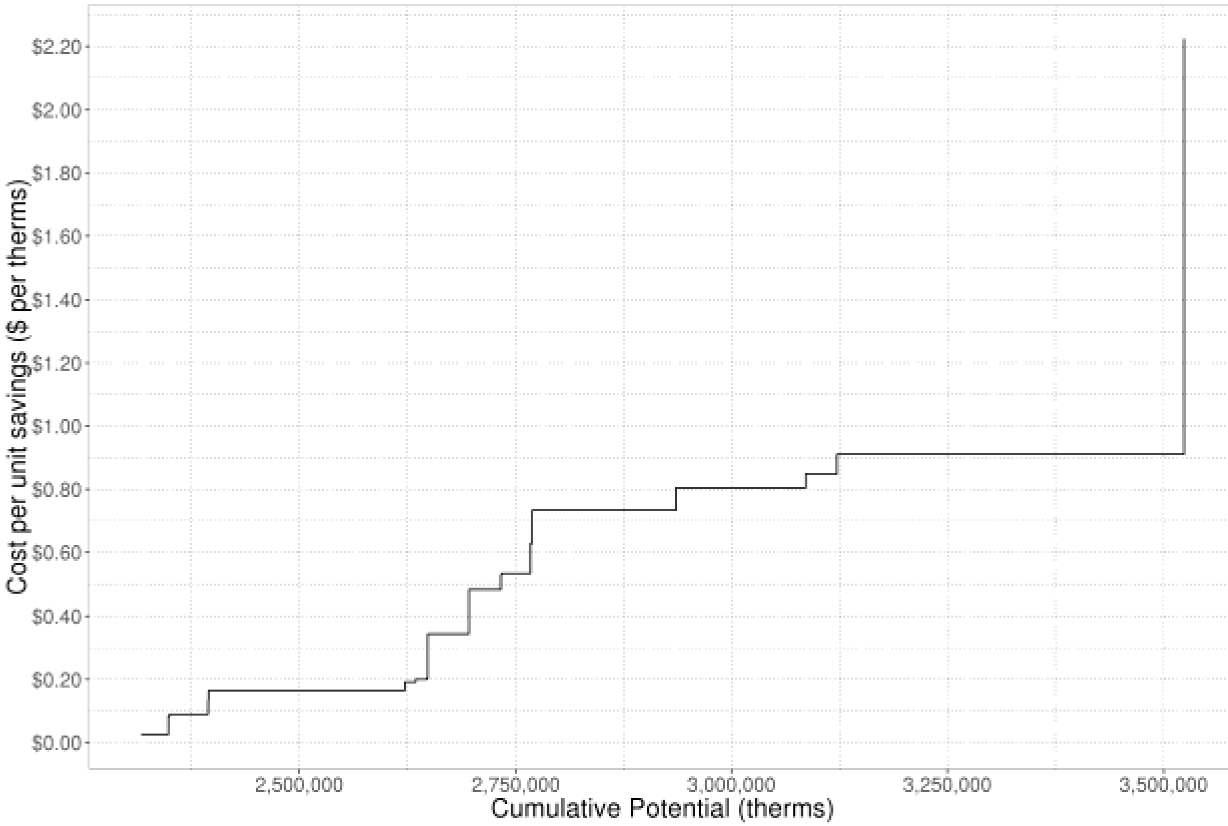
Source: Navigant

4.2.5 Supply Curves

The achievable potential supply curves are provided in this section. Levelized costs include the discounted lifetime savings for a given measure, and account for variable measure lifetimes and savings persistence. An energy efficiency resource potential supply curve illustrates the cumulative amount of achievable potential at various price points along a range of levelized cost. All measures are plotted with their corresponding cumulative potential and the corresponding levelized cost to achieve that potential. The lowest cost measures appear on the left-hand side of the chart. Each next highest cost measure is stacked on top of the previous measures in ranked order.

Figure 64 provides the supply curve results for the gas results of the programmatic achievable potential scenario under the SCT. As can be seen from the chart, the majority of the gas achievable potential savings can be achieved for a lifetime levelized cost of near or under $1 therm/year. The remaining potential requires significantly higher costs for achievement.

Figure 64. Gas Energy Efficiency Achievable Potential Supply Curves ($/therm)



** Based on first-year (i.e., 2017) savings*
Source: Navigant

To put the supply curve into better context, we have identified the highest saving measures that fall into six levelized cost categories: 0-10 cents/therm, 10-20 cents/therm, 20-40 cents/therm, 40-60 cents/therm, 60-100 cents/therm, and greater than 100 cents/therm. The results of that analysis are provided in Table 81 below. The table identifies the top measures for each category. As can be seen, there are several measures in the first two cost buckets that are relatively low cost (i.e., less than 20 cents/therm), but the majority of savings is between 20 and 100 cents/therm. Only HVAC retrocommissioning appears within the achievable potential at greater than 100 cents/therm.

Table 81. Top Measures from the Gas Energy Efficiency Achievable Potential Supply Curve

Cost per unit savings	
0-10 cents/therm	**40-60 cents/therm**
Com | Efficient Storage Tank Water Heater EF 0.90	Com | Efficient Boiler condensing 96.2% Et Code
Res | Bathroom Aerators	Com | Efficient Boiler non-condensing < 300 kBtu/h 90% AFUE - Code
Com | Faucet Aerators	Com | Low Flow Showerheads
10-20 cents/therm	**60-100 cents/therm**
Res | Low Flow Showerheads	Res | Efficient Warm Air Furnace < 80 kBtu/h 95 % AFUE - Code
Com | Efficient Instantaneous Water Heater ET 0.92	Com | Efficient Warm Air Furnace < 225 kBtu/h 95% AFUE - Code
Com | Energy Management System	Res | Efficient Storage Tank Water Heater 40 gal 13.6 UA EF 0.8 Code

Res | Kitchen Aerators	Res | Efficient Gas Condensing Boiler < 300 kBtu/h 90 % AFUE - Code
Res | Clothes Dryer Gas MEF 1.8	Res | Efficient Instantaneous Water Heater EF 0.9 Code
20-40 cents/therm	**>100 cents/therm**
Com | Clothes Dryer Gas MEF 1.8	Com | HVAC Retrocommissioning

4.2.6 Budget Estimates

Table 82 presents the estimates of energy efficiency program funding needed to support the various levels of achievable potential to be obtained during the study period, including both administrative and incentive costs. These estimates were calculated in the DSMSim model and reflect the budget constraints and incentive levels described in Section 2.3.4, where the estimated budgets for the alternative and programmatic achievable scenarios initially align with the current spending for CECONY's energy efficiency gas portfolio.

A key difference to note across the achievable scenarios is that Navigant created custom incentive levels for the gas energy efficiency theoretical achievable scenarios to simulate the effects of CECONY incenting at or greater than 100% of the participant's incremental cost for the implementing the measure. The theoretical–high scenario is intended to show the maximum opportunity for carbon reduction, regardless of budget constraints.

As seen in Table 82, the total simulated funding that corresponds with the programmatic achievable potential is close to $14 million in 2017, growing to a maximum of almost $20 million in 2026 as program activity increases. The total simulated funding for the theoretical high scenario, however, actually decreases over time as the market becomes saturated and less cost effective potential is available.

Table 82. Gas Energy Efficiency Achievable Potential Budget by Year ($)

Potential Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Alternative Programmatic Achievable	$14	$14	$15	$16	$17	$18	$20	$21	$22	$23
Programmatic Achievable	$14	$14	$15	$16	$17	$18	$20	$21	$22	$23
Theoretical - High Achievable	$171	$206	$226	$218	$184	$138	$96	$66	$48	$38
Theoretical Achievable	$22	$25	$28	$32	$36	$40	$44	$49	$52	$56

Source: Navigant

4.3 NOP Results

The NOP results within this section represent estimates of naturally occurring market adoption, under the two scenarios described in Section 2.3.5. These scenarios should be viewed as high-level approximations with a significant range of uncertainty, due to the limited availability of data on customer adoption in the absence of a program and market uptake outside of program activity.

Table 69, Figure 52, Table 70, and Figure 53 present the gas energy efficiency NOP results for each scenario. These NOP results are between 78% and 88% of the programmatic achievable potential in 2017, declining to between 60% and 70% of the cumulative programmatic achievable potential in 2017.

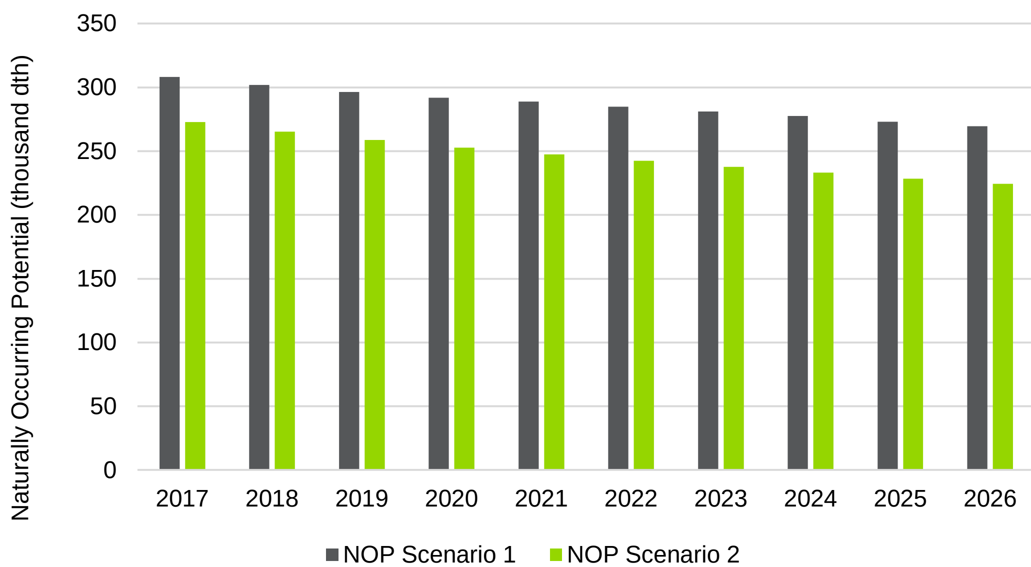
These results suggest that significant naturally occurring adoption of efficient technologies may be occurring in the marketplace, particularly through the lens of scenario 1 (i.e., assuming no programs or incentives exist), even when factoring in significant uncertainty bounds.

Table 83. Gas Energy Efficiency Annual Incremental NOP (thousand dth)

Scenario	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
NOP Scenario 1	308	302	296	292	289	285	281	278	273	270
NOP Scenario 2	273	265	259	253	248	242	238	233	228	224

Source: Navigant

Figure 65. Gas Energy Efficiency Annual Incremental NOP (thousand dth)



Source: Navigant

4.4 Comparison to 2010 Report

This section provides a high-level comparison of the gas energy efficiency results of the 2010 study to this study. These results are not directly comparable as the assumptions made in both studies vary in terms of descriptions of different potential types, baselines of measures, calculations of density and saturation values, and forecast sales for different sectors and segments. There have been many changes to the energy efficiency market in New York due to implementation of various federal and state codes, as well as market shifts with the implementation of many energy efficient measures in recent years. This comparison does not consider the NYPA residential and commercial segments or single-family segment for gas measures, as these were not a part of the 2010 study.

4.4.1 Technical Potential

The 2010 and 2017 studies used different approaches for presenting cumulative technical potential; thus, a direct comparison of technical potential over the lifetime of the two studies is not presented here.[73]

One meaningful point of comparison, however, is the overall projected technical potential in the first year of each study: Year 1 (2010) of 5,720 thousand dth from the 2010 study is roughly one-quarter of the overall potential in Year 1 (2017) of 21,917 thousand dth from the 2017 study, which is likely due to differences in the measure mix considered.

More importantly, the difference in the sector level potential between the two studies is significant. Per the 2010 study, roughly 30-50% of the potential was attributed to the commercial and industrial sectors, with around 33% in Year 1 (2010) and 46% in Year 9 (2018). In this study, the technical potential was driven by the commercial and industrial sectors, with these sectors contributing 85% of the overall potential across the study's time horizon. This is likely due to the classification of the multi-family common area segment within the commercial sector in the 2017 study, whereas the 2010 study classified the multi-family common area segment within the residential sector for gas.

4.4.2 Achievable Potential

Table 84 shows the sector level comparison of the cumulative achievable potential between the 2010 study and the current study. This analysis compares programmatic achievable potential in this study to the realistic achievable potential in the 2010 study.

As noted above for technical potential and in the table below, the commercial and industrial sectors drive more than 85% of the achievable potential in the 2017 study, but only comprise 30-40% of the 2010 study's achievable potential. As noted above, this is likely due to the change in classification of the multi-family common area segment between the two studies.

[73] Whereas the 2010 study added the technical potential from the prior year to each consecutive year, the 2017 study calculated cumulative technical potential as the total overnight potential that could be achieved in each year of the study over time. Thus, comparisons of technical potential should be considered with this in mind.

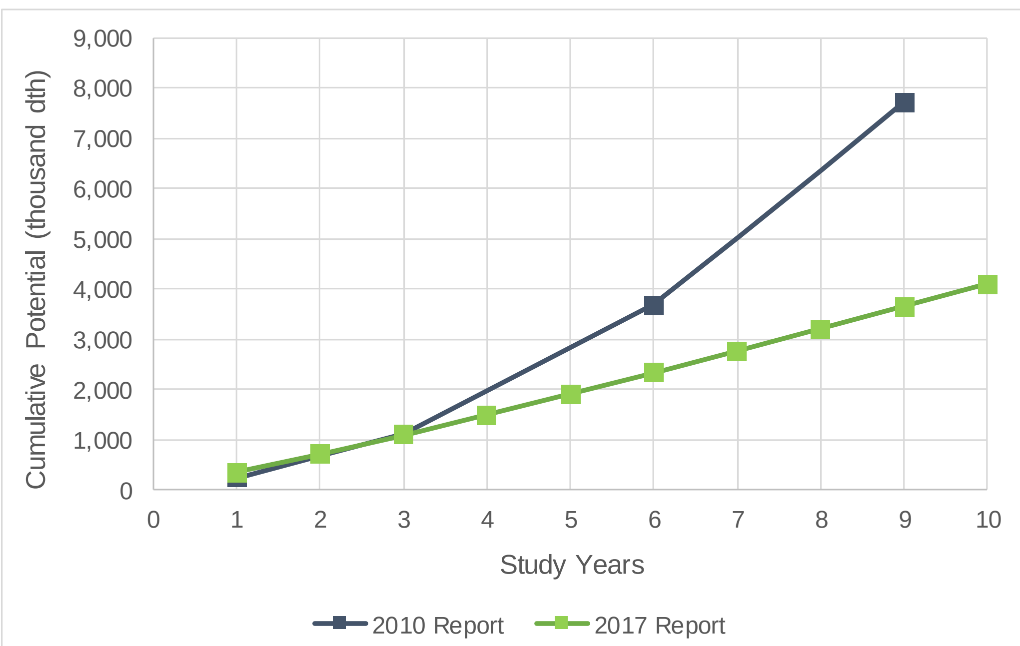
Table 84. Comparison of Cumulative Achievable Potential 2010-2026 (thousand dth and % by sector)

Sector	Achievable Potential							
2010 Report	**Year 1 (2010)**		**Year 3 (2012)**		**Year 6 (2015)**		**Year 9 (2018)**	
Residential	160	70%	760	68%	2,400	65%	4,860	63%
Commercial & Industrial	70	30%	350	32%	1,280	35%	2,860	37%
Overall	**230**	**N/A**	**1,110**	**N/A**	**3,680**	**N/A**	**7,720**	**N/A**
2017 Report	**Year 1 (2017)**		**Year 4 (2020)**		**Year 7 (2023)**		**Year 10 (2026)**	
Residential	49	14%	205	14%	379	14%	570	14%
Commercial & Industrial	304	86%	1,281	86%	2,380	86%	3,533	86%
Overall	**352**	**N/A**	**1,486**	**N/A**	**2,759**	**N/A**	**4,102**	**N/A**

Source: Navigant

Figure 66 compares the cumulative achievable potential from the 2010 report to the 2017 report by study year (e.g., year 1, year 3, etc.). The 2010 study sees a steady and significant growth in the achievable potential over the years. In the current study, growth is more measured, which likely reflects the assumed budget constraints for the programmatic achievable scenario over time in the 2017 study (see Section 2.3.4).

Figure 66. Comparison of Cumulative Achievable Potential in 2010 and 2017 Reports by Study Year (thousand dth)



Source: Navigant

5. DR POTENTIAL FORECAST

This section presents DR potential and cost results for the DR measures discussed in Section 2.6. This study estimated technical, economic, and programmatic achievable potential for DR. DR only exists within a program construct; therefore, the other levels of achievable and naturally occurring potential do not apply to DR.

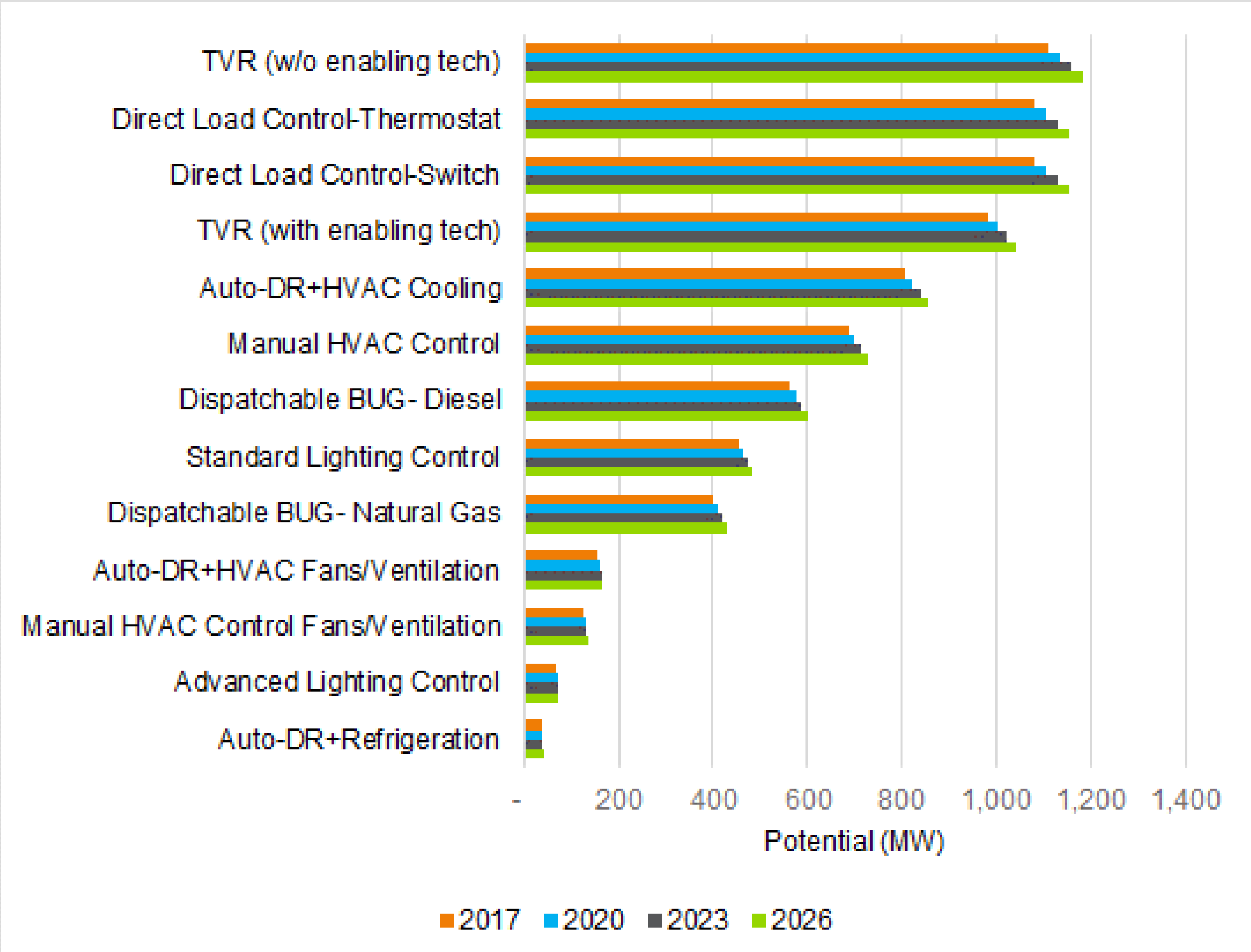
5.1 Technical Potential Results

Technical potential for DR refers to the theoretical maximum potential under 100% participation of the eligible load. This study calculated standalone technical potential for each DR measure, which assumed 100% participation of the eligible load in that measure. It is calculated by multiplying the eligible load/customers with the unit impact. An important caveat is that technical potential calculation does not include mutually exclusive loads and therefore cannot be summed across the DR measures to provide a total technical potential. Therefore, the technical potential estimates for each DR measure should be considered independently.

Figure 67 and Table 85 show the standalone technical potential for DR measures from 2017 to 2026. Figure 68 and Table 86 show a breakdown of the 2026 potential by both measure and customer segments. The technical potential results indicate that there is little growth in technical potential of DR measures over time, as technical potential assumes 100% participation of eligible load in each year without consideration of the rate of customer adoption. The growth in technical potential reflects changes in eligible load over time with growth in customer and building stock.

Our analysis showed that all DR measures are cost-effective and therefore economic potential is the same as technical potential for all DR measures.

Figure 67. DR Technical Potential by Measure (MW)



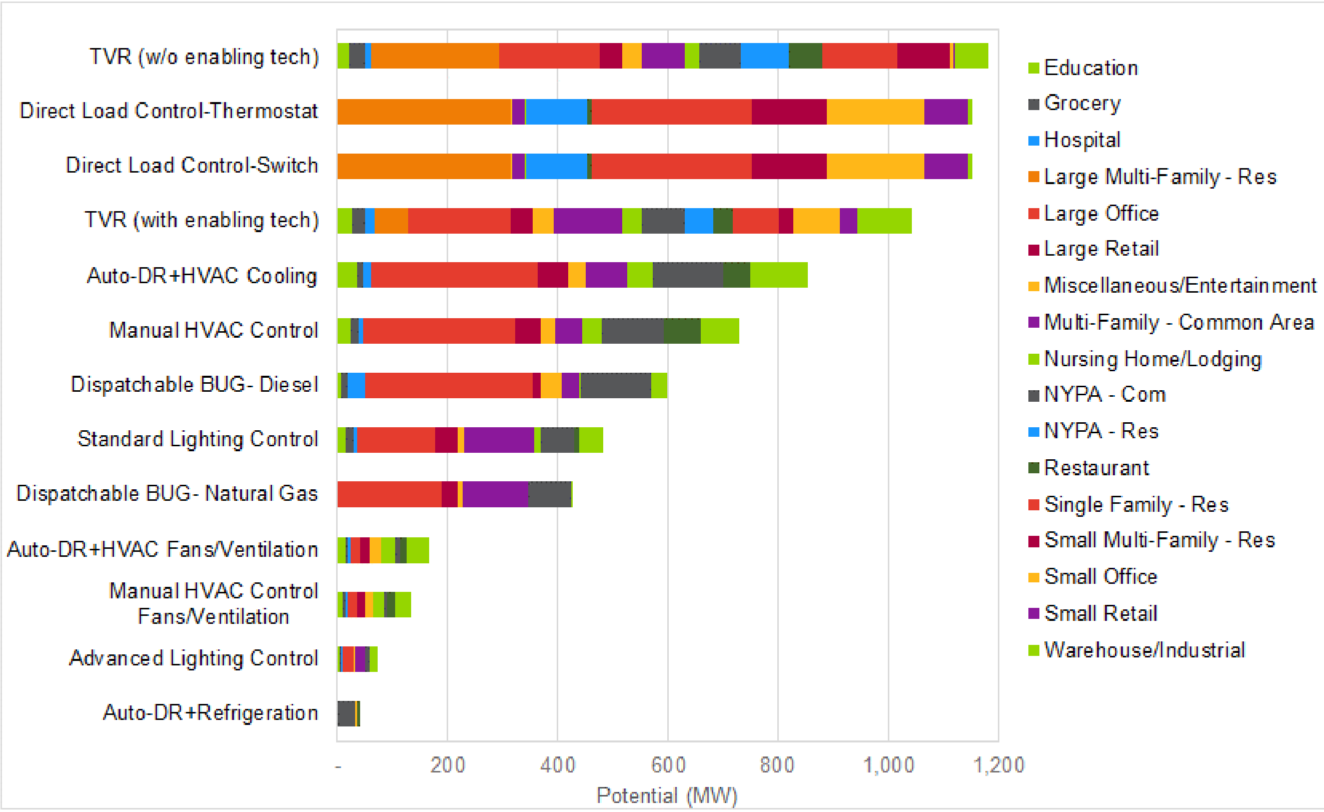
Source: Navigant

Table 85. DR Technical Potential (MW)

DR Measures	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
TVR (w/o enabling tech)	1,112	1,120	1,128	1,136	1,144	1,152	1,160	1,168	1,176	1,184
DLC – Thermostat Cooling	1,083	1,090	1,098	1,106	1,114	1,122	1,129	1,137	1,146	1,154
DLC - Switch Cooling	1,083	1,090	1,098	1,106	1,114	1,122	1,129	1,137	1,146	1,154
TVR (with enabling tech)	981	988	994	1,001	1,008	1,015	1,022	1,029	1,036	1,043
Auto-DR+HVAC Cooling	805	811	816	822	827	833	839	844	850	856
Manual HVAC Control Cooling	687	692	697	701	706	711	716	720	725	730
Dispatchable BUG- Diesel	564	568	572	576	579	583	587	591	595	599
Standard Lighting Control	453	457	460	463	466	469	472	475	479	482
Dispatchable BUG- Natural Gas	402	405	408	411	413	416	419	422	425	428
Auto-DR+HVAC Fans/Ventilation	157	158	159	160	161	162	164	165	166	167
Manual HVAC Control Fans/Ventilation	128	128	129	130	131	132	133	134	135	136
Advanced Lighting Control	68	69	69	69	70	70	71	71	72	72
Auto-DR + Refrigeration	38	38	39	39	39	39	40	40	40	40

Source: Navigant

Figure 68. 2026 DR Technical Potential by Measure and Segment (MW)



Source: Navigant

Table 86. 2026 DR Technical Potential by Measure (MW)

DR Measure	Education	Grocery	Hospital	Large MF	Large Office	Large Retail	Miscellaneous/ Entertainment	MF Common Area	Nursing Home/ Lodging	NYPA - Com	NYPA - Res	Restaurant	Single Family - Res	Small MF-Res	Small Retail	Small Office	Warehouse/Industrial	Total
TVR (w/o enabling tech)	20.2	31.5	9.5	234.4	181.1	42.5	33	78.6	27.2	75.5	86.4	59.4	137.7	96.1	2.5	5.5	62.9	1,184
Direct Load Control-Thermostat	0.5	1.4	0	311.7	-	-	3.1	24.6	2.2	-	111.4	7.2	292.2	135.3	78	177.1	9.1	1,154
Direct Load Control-Switch	0.5	1.4	0	311.7	-	-	3.1	24.6	2.2	-	111.4	7.2	292.2	136.3	78	177.1	9.1	1,154
TVR (with enabling tech)	26.5	23.3	16.9	62.4	185.8	41.2	37	124	35.2	77.5	52.5	36.1	83.7	25.6	30.7	85.9	99.2	1,043
Auto-DR+HVAC Cooling	34.5	11.8	17.1	-	300.9	55.1	31.3	76.8	46.3	125.5	-	51.8	-	-	-	-	104.8	856
Manual HVAC Control Cooling	25.6	12.8	10.4	-	273.2	48.6	25.1	49.9	34.3	113.9	-	65.6	-	-	-	-	70.9	730
Dispatchable BUG- Diesel	7	12.3	30.7	-	306	14.9	36.3	33	1.4	127.6	-	-	-	-	-	-	30.2	599
St. Lighting Control	14.8	14.8	5.4	-	142.8	41.8	9.9	127.4	13.3	59.5	-	9.8	-	-	-	-	42.4	482
Dispatchable BUG- Natural Gas	2.1	-	-	-	188.3	29.7	7.3	118	-	78.5	-	-	-	-	-	-	3.8	428
Auto-DR+HVAC Fans/Ventilation	14.9	4.6	5.2	-	17.2	16.4	19.7	-	27.6	7.2	-	11.7	-	-	-	-	42.3	167
Manual HVAC Control	11.1	5	3.2	-	15.6	14.5	15.8	-	20.5	6.5	-	14.8	-	-	-	-	28.6	136
Advanced Lighting Control	4.7	3	1.9	-	19.8	1.7	2.6	15.3	1.3	8.3	-	2	-	-	-	-	11.9	72
Auto-DR+Refriger.	0.1	32.8	-	-	-	-	3.9	-	0	-	-	4.2	-	-	-	-	-	40

Source: Navigant

Key takeaways from the DR technical potential results are:

- Time varying rates (TVR) without enabling technology, followed by DLC of cooling via thermostats/switches for residential and small/medium commercial customers, have the highest technical potential, followed by TVR with enabling technology. Each of these measures has greater than 1,000 MW of technical potential.

  For TVR, the analysis considered a critical peak pricing rate with an 8:1 critical peak to off-peak price ratio. TVR with enabling technology refers to thermostats for residential and small/medium commercial customers and to Auto-DR enabled curtailment for large commercial customers. The impacts for TVR without enabling technology represent load reductions that could be realized through rates only, without considering enabling technologies. For the TVR measures, large offices and the residential segments have highest share in potential.

  For the DLC measures, single-family and large multi-family customers have the highest share in total potential. The other significant contributors to DLC technical potential are small offices and small multi-family customers.

- Technical potential from Auto-DR enabled control of HVAC load in large commercial facilities is approximately 850 MW in 2026. This applies to facilities that have an EMS that can respond to signals coming from a DR automation server and is programmed to reduce load per pre-defined curtailment strategies. The technical potential for manual HVAC control at 730 MW in 2026 is lower than Auto-DR HVAC control. Manual HVAC control applies to all commercial cooling load, but the unit impacts are lower than Auto-DR HVAC, which translates into lower potential than Auto-DR HVAC potential. Large offices are the highest contributor to this potential followed by NYPA-commercial.
- Other DR measures with significant technical potential are both diesel-based and natural gas-based dispatchable BUGs, with a combined potential of greater than 1,000 MW in 2026. Approximately half of the potential from these measures is from large offices.
- The potential from standard control of interior lighting is substantial, with 480 MW in 2026. Large offices and multi-family common area have the highest share of this potential at 30% and 25% respectively.
- Technical potential for manual and Auto-DR enabled fans/ventilation load range from about 135 MW to 165 MW in 2026.
- Technical potential from advanced lighting control is approximately 70 MW in 2026. Advanced lighting control only applies to commercial facilities with centrally controllable lighting systems. Based on commercial survey responses, this applies to a small fraction of the total commercial building stock and hence has low technical potential.
- Technical potential from Auto-DR enabled refrigeration load control is only 40 MW in 2026, with 80% of the potential from groceries.

5.2 Achievable Potential Results

This section presents DR achievable potential results at various levels of disaggregation—by DR measures, customer segments, and program types. Only programmatic achievable potential applies to DR; therefore, all achievable potential results are for the programmatic achievable case. Note that the achievable potential incorporates the dispatchability of the DR measures by type of program, which is calibrated to CECONY's program performance data.[74] DR potential and cost calculations are based off the key inputs discussed earlier in Section 2.6 under DR measure characterization. In Section 2.6, participation, unit impact and cost assumptions are based on primary market research conducted as part of this study (residential and non-residential surveys), best available secondary information sources, and Navigant's industry expertise. Navigant calibrated key assumptions to CECONY's DR program performance data.[75]

5.2.1 Results by Measure

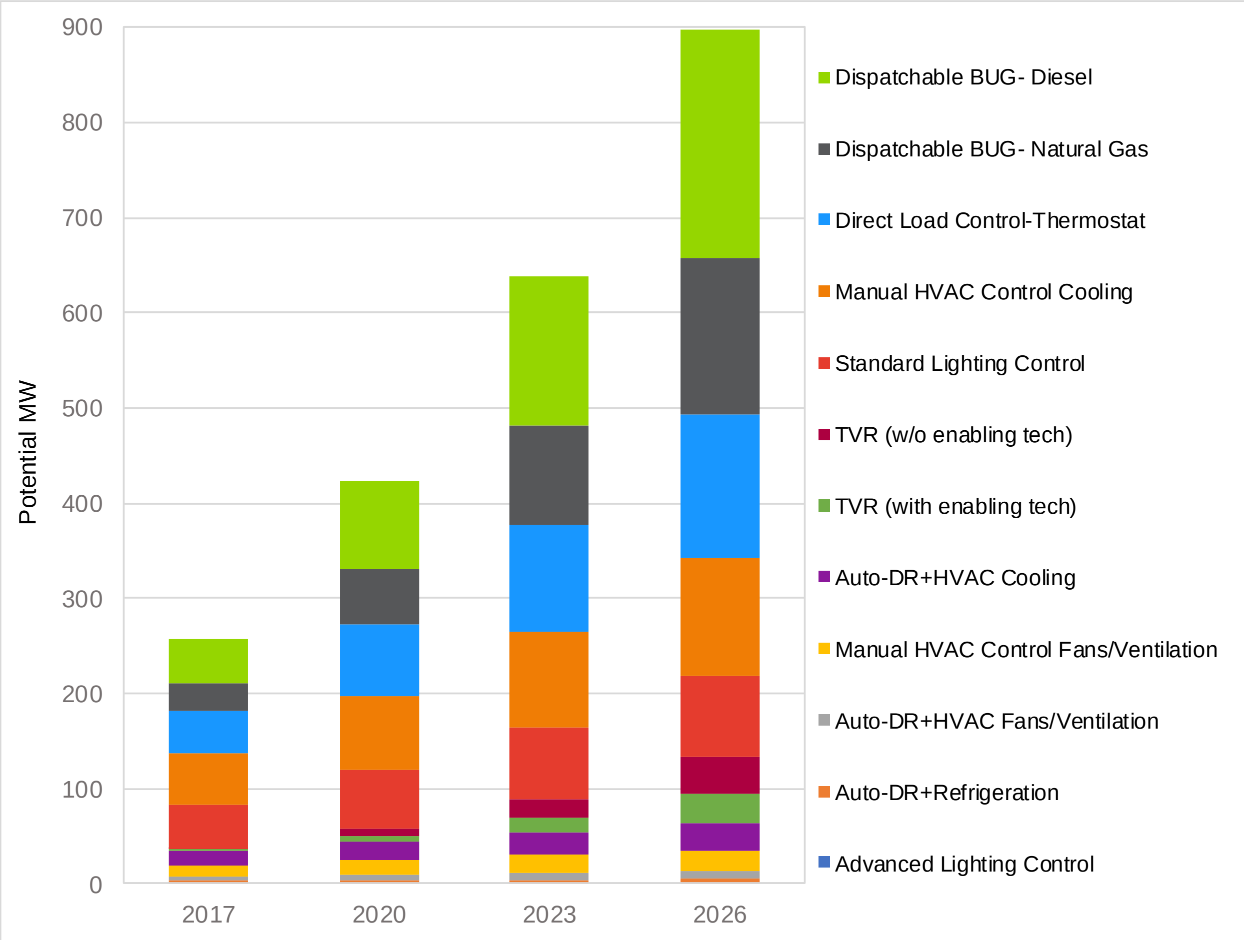
Figure 69 and

[74] For example, the DLC-thermostat measure has 82% dispatchability, based on CECONY program performance data. For the C&I measures, the team assumed 100% dispatchability for CSRP and 76% for DLRP, based on program performance data. For TVR, which could be dispatched in the form of critical peak pricing signals, the team assumed the same level of dispatchability as DLRP at 76%.

[75] For e.g., the current mix of participants and the load reductions from programs is factored into the start year's (2017) potential estimates. Also, Navigant assumed participants continue to receive the same incentive levels through the planning period.

Table 87 show the achievable potential by DR measure for the duration of the study.[76] Achievable potential is forecast to grow from about 250 MW in 2017 to almost 900 MW in 2026. In 2026, this represents about 6.4%[77] of CECONY's system peak forecast.

Figure 69. DR Programmatic Achievable Potential by Measure (MW)



Source: Navigant

[76] The program mix associated with this potential is DLC-Thermostat, CSRP, and TVR.

[77] 2026 achievable potential at generator = 898*106.17% (line loss factor) = 953.4 MW. 2026 peak load forecast under base (from the "Strategic Planning 2014 LRP Scenario Super Summary_v2.xls") = 14,814 MW; This translates into 2026 achievable potential as percent of peak= 6.4%.

Table 87. DR Programmatic Achievable Potential by Measure (MW)

DR Measures	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Dispatchable BUG- Diesel	45.6	58.8	74	91.3	110.9	132.7	156.7	182.7	210.7	240.2
Dispatchable BUG- Natural Gas	28.2	37.1	47.4	59.3	72.8	88	105	123.5	143.6	164.9
Direct Load Control- Thermostat	45	54.3	64.6	75.7	87.6	100	112.8	125.7	138.4	150.8
Manual HVAC Control Cooling (Electric)	54.8	62	69.5	77.3	85.1	93	100.8	108.4	115.8	122.7
Standard Lighting Control	45.7	50.6	55.5	60.4	65.3	70	74.6	79	83.1	86.9
TVR (w/o enabling tech)	1.5	3.3	5.5	8.1	11.2	15	19.3	24.4	30.2	36.8
TVR (with enabling tech)	1.3	2.9	4.8	7.2	9.9	13.2	17	21.5	26.6	32.5
Auto-DR+HVAC Cooling	14.6	15.7	17	18.4	19.8	21.5	23.2	25	27	29
Manual HVAC Control Fans/Ventilation	11.7	12.8	13.8	14.8	15.8	16.8	17.6	18.5	19.3	20
Auto-DR+HVAC Fans/Ventilation	5	5.6	6.1	6.6	7.1	7.6	8.1	8.6	9	9.5
Auto-DR+ Refrigeration	2.9	3.1	3.2	3.4	3.6	3.7	3.8	3.9	4	4.1
Advanced Lighting Control	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3
Grand Total	**256**	**306**	**361**	**423**	**489**	**562**	**639**	**721**	**808**	**898**

Source: Navigant

Load shifting to diesel-based and natural gas-based BUGs during DR events can potentially achieve the highest load reductions. The total potential from these two measures at 400 MW in 2026 is slightly less than half of the total achievable potential in that year. Cooling load control using thermostats in residential and small/medium business customers has 150 MW of potential in 2026, which translates to 17% of the total potential. Manual and Auto-DR enabled control of HVAC loads (including both cooling and fans/ventilation) have a combined share of 20% in the total potential at 180 MW in 2026, with greater potential from manual HVAC control than Auto-DR HVAC control. The applicability of Auto-DR enabled load control is restricted to buildings with EMS and therefore has lower potential than manual control of HVAC load which applies to a much larger building stock. Total potential from lighting control measures is approximately 90 MW in 2026, with the majority of the potential from standard lighting control. The total potential from TVR measures is around 70 MW in 2026, which constitutes 8% of the total programmatic achievable potential from DR in that year.

5.2.2 Results by Segment

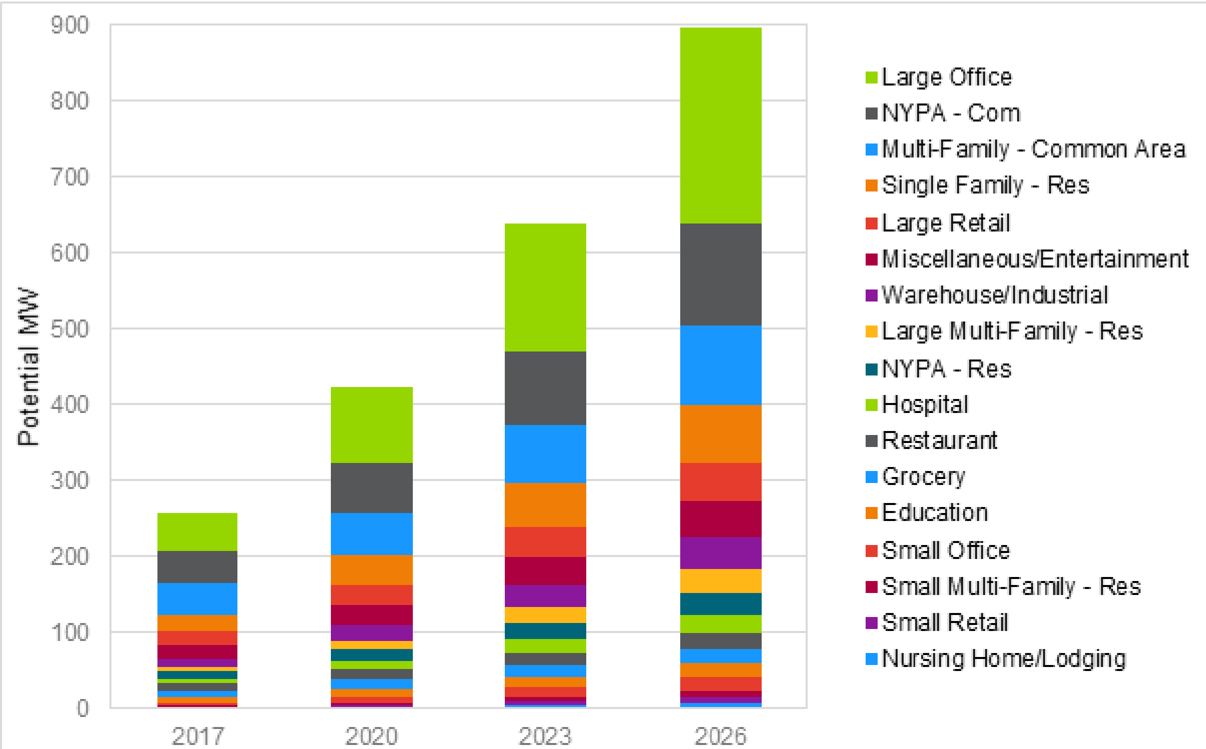
Figure 70 and Table 88 display the achievable potential by customer segment[78] over the study's time horizon. The total potential from all residential segments combined is approximately 147 MW in 2026, which represents 16% of the total 2026 potential. The remaining 84% potential is from all commercial segments combined.

Single-family residential customers account for 52% of the total residential sector potential in 2026, followed by large multi-family residential customers at around 20% share of the total residential DR potential. NYPA-residential also constitutes approximately 20% of the total residential sector potential. Small multi-family residential customers have the least contribution in the total residential sector potential at approximately 6%.

Among the commercial customers, the highest contribution is from large offices at approximately 260 MW potential in 2026, or 35% share in the total C&I potential in 2026. The next highest share in potential is from NYPA-commercial at approximately 134 MW in 2026, or 18% of the total C&I potential. DR potential in multi-family common areas is approximately 104 MW in 2026, which represents 14% of the total C&I potential. Large retail, miscellaneous/entertainment, and warehouse/industrial segments individually have 6-7% share in the total commercial sector potential. The remaining commercial segments individually have 3% or less contribution in the total commercial potential.

[78] The program mix associated with this potential is DLC-Thermostat, CSRP and TVR.

Figure 70. DR Programmatic Achievable Potential by Segment (MW)



Source: Navigant

Table 88. DR Programmatic Achievable Potential by Segment (MW)

Customer Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Large Office	49.0	63.3	79.7	98.3	119.3	142.7	168.5	196.6	226.8	258.8
NYPA - Com	42.2	49.5	57.4	66.1	75.5	85.7	96.8	108.5	121.0	134.0
Multi-Family - Common Area	42.1	46.6	51.6	57.1	63.3	70.1	77.6	85.8	94.7	104.1
Single Family - Res	22.0	26.7	31.9	37.5	43.6	49.9	56.4	63.0	69.7	76.2
Large Retail	17.0	20.2	23.7	27.5	31.5	35.6	39.8	43.9	48.1	52.1
Miscellaneous/Entertainment	17.7	20.6	23.7	26.9	30.2	33.5	36.8	40.0	43.2	46.2
Warehouse/Industrial	11.7	14.0	16.6	19.5	22.6	26.0	29.7	33.5	37.6	41.9
Large Multi-Family – Res	6.3	8.1	10.1	12.4	15.0	17.8	20.8	24.1	27.5	31.2
NYPA - Res	8.5	10.4	12.5	14.7	17.2	19.8	22.5	25.2	28.0	30.8
Hospital	6.6	8.0	9.6	11.4	13.2	15.2	17.3	19.4	21.5	23.6
Restaurant	9.8	10.9	12.0	13.1	14.3	15.4	16.5	17.6	18.7	19.9
Grocery	8.9	9.8	10.8	11.8	12.9	13.9	15.0	16.2	17.3	18.4
Education	7.1	8.2	9.3	10.5	11.8	13.0	14.3	15.6	16.9	18.1
Small Office	3.6	4.6	5.7	7.1	8.5	10.2	12.0	13.9	15.9	18.0
Small Multi-Family - Res	1.4	1.9	2.5	3.1	3.8	4.6	5.5	6.5	7.6	8.7
Small Retail	1.9	2.4	2.9	3.5	4.2	5.0	5.8	6.6	7.4	8.3
Nursing Home/Lodging	0.5	0.9	1.3	1.8	2.4	3.1	3.9	4.9	6.0	7.2
Grand Total	**256**	**306**	**361**	**423**	**489**	**562**	**639**	**721**	**808**	**898**

Source: Navigant

5.2.3 Results by Measure and Segment

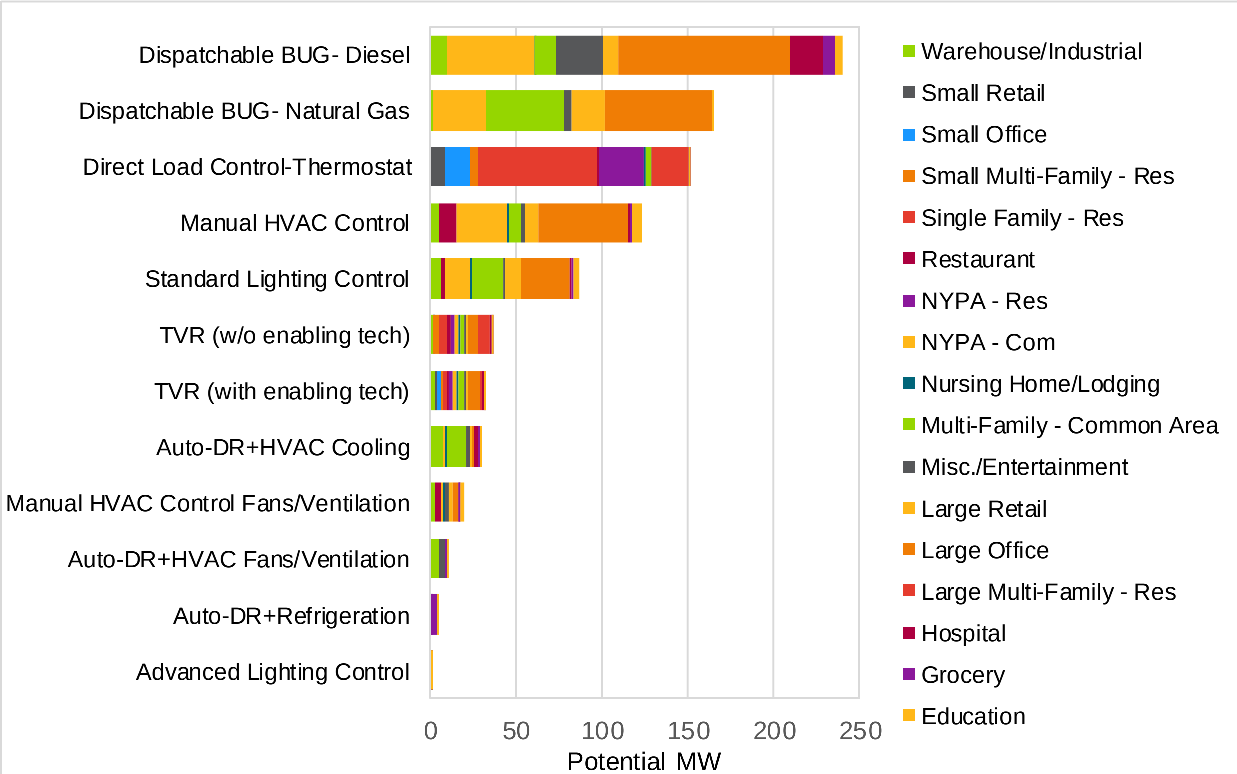
Figure 71 and Table **89** show the 2026 achievable potential by both measure and segment.[79] The highest potential is from diesel-based dispatchable BUGs and natural gas based dispatchable BUGs in large offices. Other significant contributors to the load shifting potential from BUGs are NYPA-commercial, multi-family common area, and the miscellaneous/entertainment segments.

The other top contributor to the potential is thermostat control of cooling in single-family, NYPA-residential, and multi-family residential customers.[80] The main contributors to HVAC control in the commercial sector are large offices and NYPA-commercial. Lighting control potential is primarily associated with large offices, multi-family common area, and NYPA-commercial. For TVR, top contributors are single-family and large multi-family residences, as well as large offices.

[79] The program mix associated with this potential is DLC-thermostat, CSRP, and TVR.

[80] The potential presented here for thermostat-based DR is independently estimated from the potential for thermostat-based energy efficiency. However, depending on the program design, there may be opportunities for DR and energy efficiency programs to jointly offer smart thermostats to customers to achieve both energy and demand savings at a lower program cost.

Figure 71. 2026 DR Programmatic Achievable Potential by Measure and Segment (MW)



Source: Navigant

Table 89. 2026 DR Programmatic Achievable Potential by Measure and Segment (MW)

Customer Type	Dispatchable BUG-Diesel Total Facility (Electric)	Dispatchable BUG-Natural Gas Total Facility (Electric)	Direct Load Control-Thermostat Cooling (Electric)	Manual HVAC Control Cooling (Electric)	Standard Lighting Control Lighting Interior (Electric)	TVR (w/o enabling tech) Total Facility (Electric)	TVR (with enabling tech) Total Facility (Electric)	Auto-DR+HVAC Cooling (Electric)	Manual HVAC Control Fans/Ventilation (Electric)	Auto-DR+HVAC Fans/Ventilation (Electric)	Auto-DR+Refrigeration Refrigeration (Electric)	Advanced Lighting Control	Total
Warehouse/Industrial	9.5	1.2	0.8	4.6	6.2	2.0	3.1	7.1	2.9	4.5		0.1	**41.9**
Small Retail			7.3			0.1	1.0						**8.3**
Small Office			15.2			0.2	2.7						**18.0**
Small Multi-Family - Res			4.9			3.0	0.8						**8.7**
Single Family - Res			69.4			4.3	2.6						**76.2**
Restaurant			0.7	11.2	1.8	1.8	1.1	0.2	2.8	0.1	0.0	0.0	**19.9**
NYPA - Res			26.5			2.7	1.6						**30.8**
NYPA - Com	51.1	31.5		28.6	15.6	2.3	2.4	0.7	1.7	0.0		0.0	**134.0**
Nursing Home/Lodging	0.3		0.3	1.1	0.4	0.8	1.1	1.5	0.7	0.9	0.0	0.0	**7.2**
Multi-Family - Common Area	12.5	44.7	3.4	7.4	18.3	2.4	3.9	11.4				0.0	**104.1**
Miscellaneous/ Entertainment	26.7	5.3	0.3	2.2	1.5	1.0	1.2	2.8	2.1	2.6	0.4	0.0	**46.2**
Large Retail	9.6	19.3		8.1	9.1	1.3	1.3	0.2	3.1	0.1		0.0	**52.1**
Large Office	100.0	61.5		52.0	28.6	5.6	5.8	1.7	3.3	0.1		0.1	**258.8**
Large Multi-Family – Res			21.9			7.3	1.9						**31.2**
Hospital	18.6		0.0	1.0	0.6	0.3	0.5	1.7	0.3	0.6		0.0	**23.6**
Grocery	7.5		0.1	1.4	1.7	1.0	0.7	1.3	0.5	0.5	3.6	0.0	**18.4**
Education	4.3	1.3	0.0	5.0	3.1	0.6	0.8	0.2	2.5	0.1	0.0	0.0	**18.1**
Total	**240.2**	**164.9**	**150.8**	**122.7**	**86.9**	**36.8**	**32.5**	**29.0**	**20.0**	**9.5**	**4.1**	**0.3**	**898**

5.2.4 Results by Program

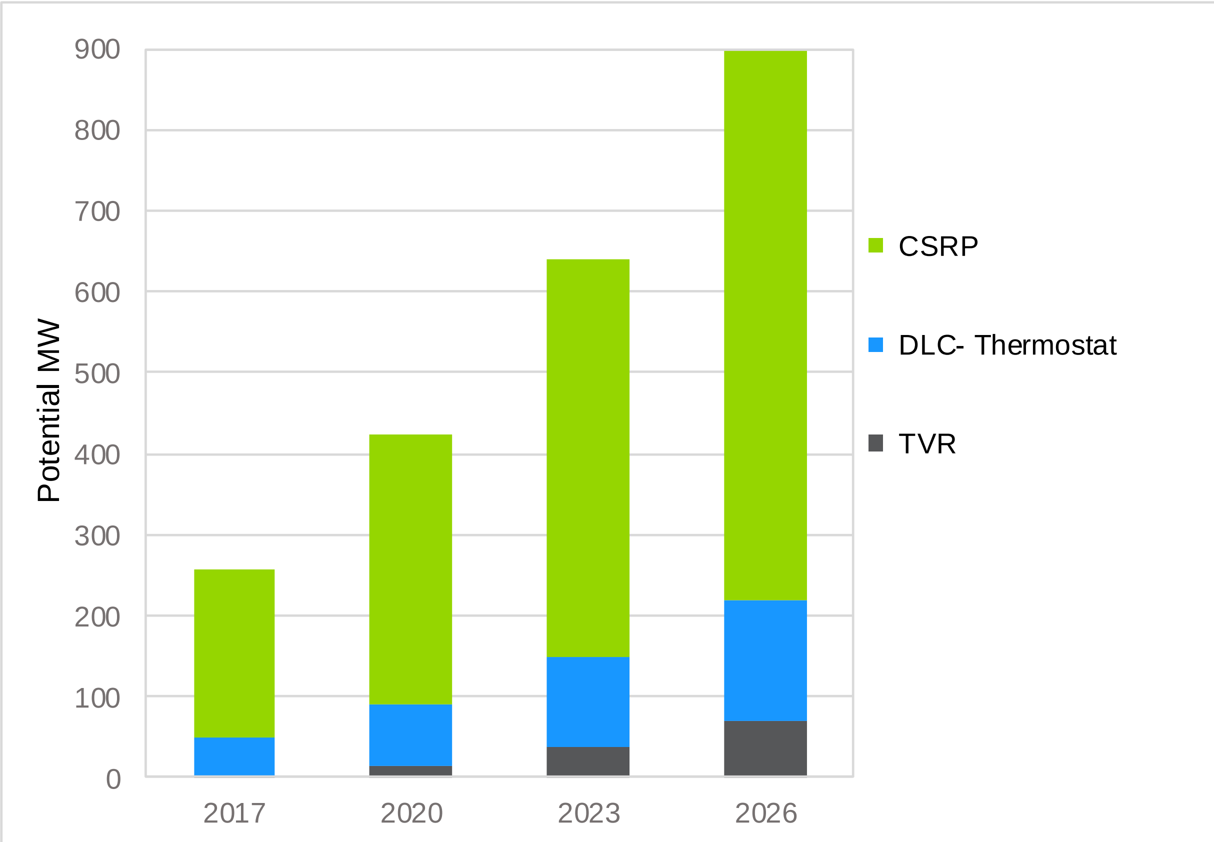
Figure 72 and

Table 90 show programmatic achievable potential by DR program type from 2017-2026. Navigant considered separate combinations of CSRP and DLRP since the same commercial loads can enroll in both programs and to avoid double-counting of potential. The other two program types are DLC-thermostat and TVR.

Figure 72 and

Table 90 display the achievable potential with CSRP in the program mix, while Figure 73 and Table 91 show the achievable potential with DLRP in the program mix. The technical potential for CSRP and DLRP is the same. The only difference was due to contrasting dispatchability between these two programs.[81]

Figure 72. DR Programmatic Achievable Potential by Program Type (with CSRP) (MW)



Source: Navigant

[81] Based on CECONY's program performance data, Navigant assumed 100% dispatchability for CSRP and 76% dispatchability for DLRP.

Table 90. DR Programmatic Achievable Potential by Program Type (with CSRP) (MW)

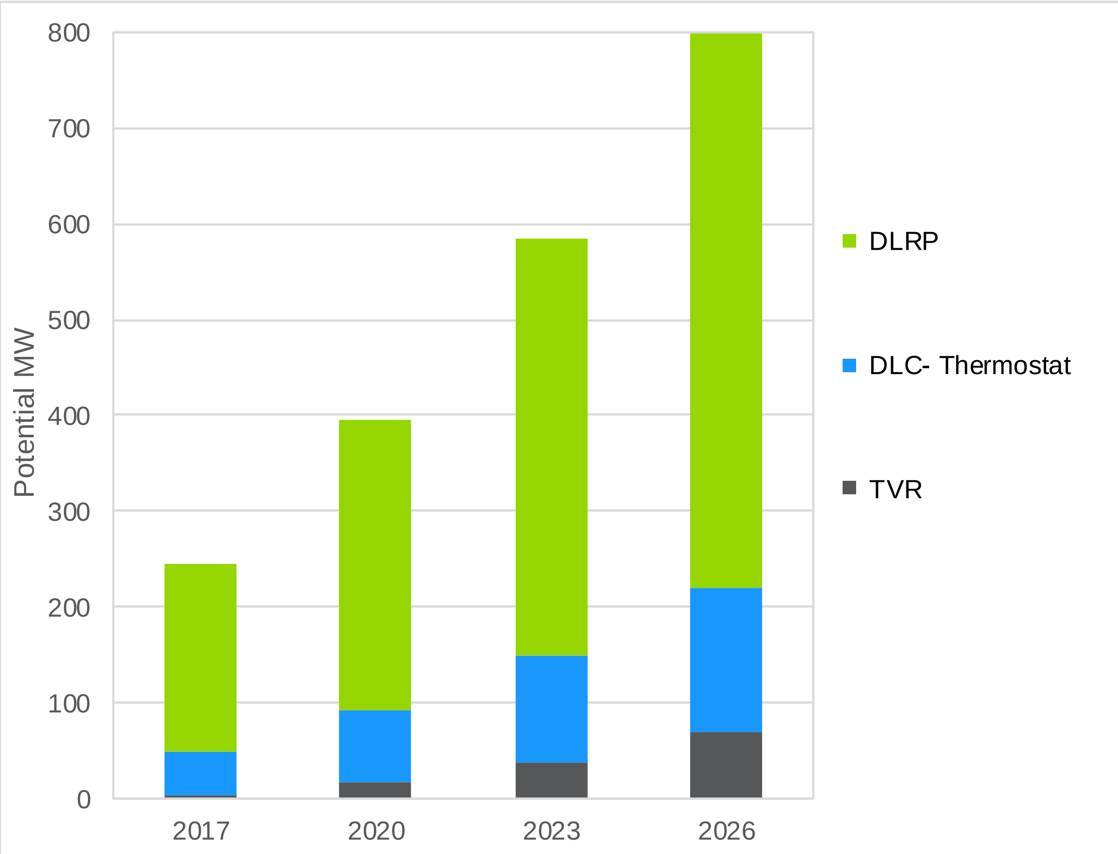
Program Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
CSRP	208	246	287	332	381	433	490	550	613	678
DLC – Thermostat	45	54	65	76	88	100	113	126	138	151
TVR	3	6	10	15	21	28	36	46	57	69
Total	**256**	**306**	**361**	**423**	**489**	**562**	**639**	**721**	**808**	**898**

Source: Navigant

With CSRP in the program mix, the achievable potential is projected to grow from approximately 256 MW to 898 MW from 2017 to 2026. CSRP has the highest achievable potential, with approximately 680 MW potential in 2026 (75% share in total). DLC-thermostat based control of cooling load for residential and small/medium commercial customers is projected at 150 MW potential in 2026, which represents approximately 17% share in total 2026 achievable potential. TVR has less than 10% share in the total 2026 achievable potential from DR.

With a DLRP combination in the program mix, the achievable potential is projected to grow from approximately 244 MW to 799 MW from 2017 to 2026 (shown in Figure 73 and Table 91). DLRP potential is projected to grow from approximately 196 MW in 2017 to 579 MW in 2026. As discussed earlier, the difference between CSRP and DLRP programs is driven by their dispatchability values, benchmarked to CECONY's DR program performance data, which is reflected in the achievable potential estimates. The technical potential for both program types is the same since the same customer segments and end-use loads qualify to participate in both programs.

Figure 73. DR Programmatic Achievable Potential by Program Type (with DLRP) (MW)



Source: Navigant

Table 91. DR Programmatic Achievable Potential by Program Type (with DLRP) (MW)

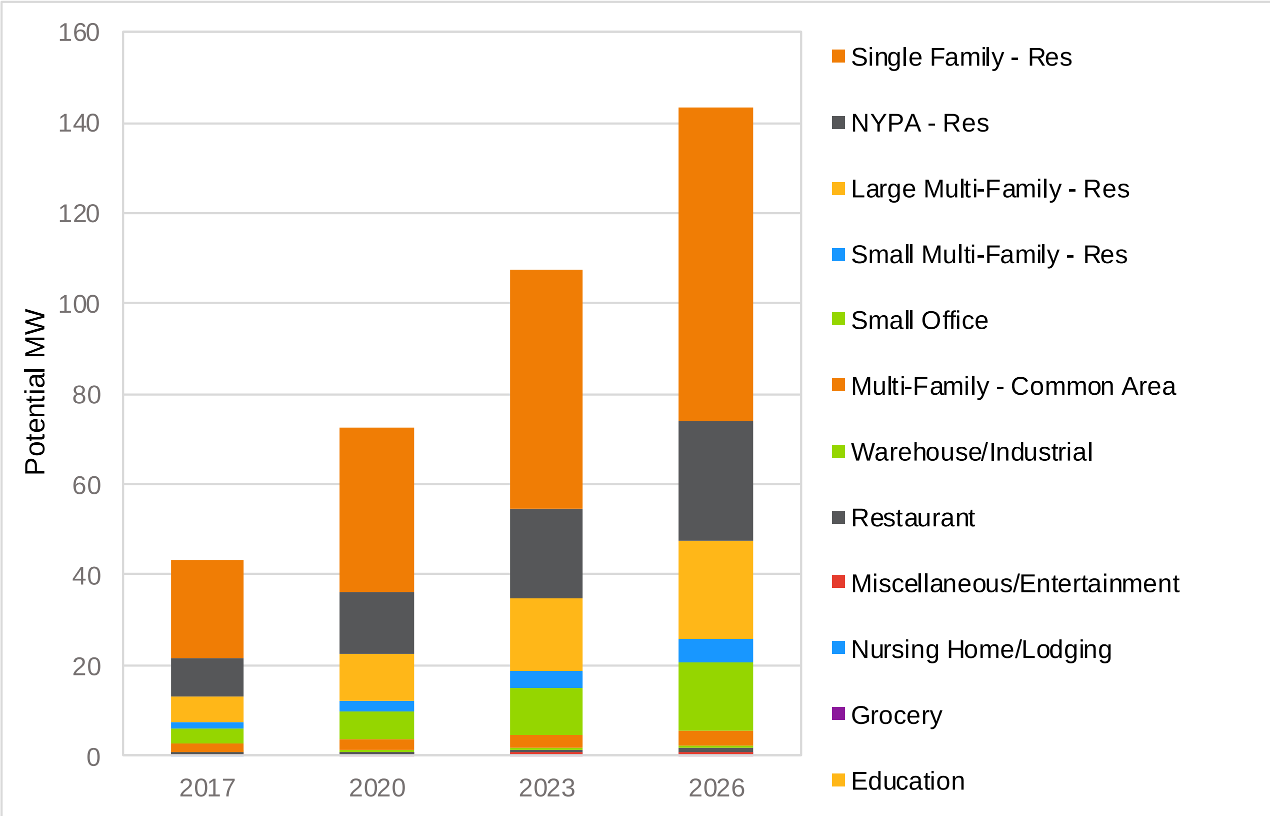
Program Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
DLRP	196	229	265	304	345	389	435	482	530	579
DLC – Thermostat	45	54	65	76	88	100	113	126	138	151
TVR	3	6	10	15	21	28	36	46	57	69
Total	**244**	**290**	**340**	**395**	**454**	**517**	**584**	**654**	**726**	**799**

Source: Navigant

5.2.4.1 DLC-Thermostat Achievable Potential

Figure 74 and Table 92 show DLC-thermostat achievable potential projections from 2017-2026. DLC-thermostat potential is projected to grow from 45 MW in 2017 to 150 MW in 2026. Approximately half of the total potential is from single-family residential customers. NYPA-residential customers have 17.5% share in the total 2026 potential, followed by large multi-family customers with 15%. Small multi-family residential customers have less than 5% share in the total DLC-thermostat potential. Among commercial customers, small office and small retail combined have approximately 15% share in the total potential.

Figure 74. DLC-Thermostat Programmatic Achievable Potential by Segment (MW)



Source: Navigant

Table 92. DLC-Thermostat Programmatic Achievable Potential by Segment (MW)

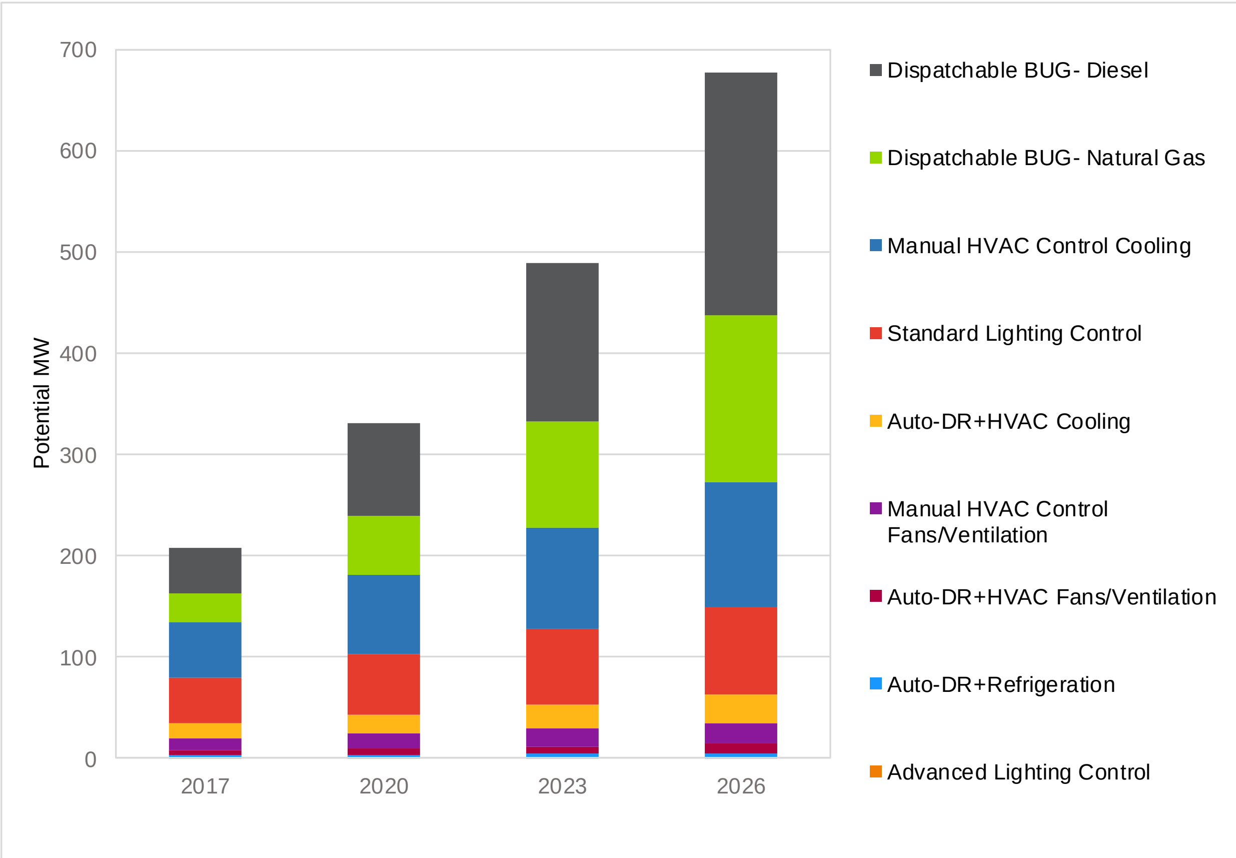
Customer Segment	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Single Family - Res	21.7	26.1	30.9	36.0	41.5	47.1	52.8	58.5	64.0	69.4
NYPA - Res	8.3	10.0	11.8	13.8	15.9	18.0	20.2	22.4	24.5	26.5
Large Multi-Family - Res	5.9	7.3	8.8	10.4	12.2	14.0	16.0	18.0	20.0	21.9
Small Multi-Family - Res	1.3	1.6	1.9	2.3	2.7	3.1	3.5	4.0	4.5	4.9
Small Office	3.4	4.3	5.3	6.4	7.7	9.0	10.5	12.0	13.6	15.2
Multi-Family - Common Area	1.7	1.9	2.1	2.3	2.5	2.7	2.9	3.1	3.2	3.4
Warehouse/Industrial	0.2	0.2	0.3	0.3	0.4	0.5	0.5	0.6	0.7	0.8
Restaurant	0.2	0.2	0.3	0.3	0.4	0.5	0.5	0.6	0.7	0.7
Miscellaneous/Entertainment	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.3	0.3
Nursing Home/Lodging	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Grocery	0.03	0.04	0.05	0.06	0.07	0.08	0.10	0.11	0.12	0.13
Education	0.01	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.04	0.04
Grand Total	**45.0**	**54.3**	**64.6**	**75.7**	**87.6**	**100.0**	**112.8**	**125.7**	**138.4**	**150.8**

Source: Navigant

5.2.4.2 CSRP Achievable Potential

Figure 75 and Table 93 show CSRP achievable potential projections by DR measure from 2017-2026. As discussed earlier, CSRP potential is projected to grow from about 208 MW in 2017 to 678 MW in 2026. Approximately 60% of the total potential is associated with dispatchable BUGs. HVAC load control has 25% share and lighting control has 15% share in the total CSRP potential.

Figure 75. CSRP Programmatic Achievable Potential by Measure (MW)



Source: Navigant

Table 93. CSRP Programmatic Achievable Potential by Measure (MW)

DR Measure	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Dispatchable BUG- Diesel	45.6	58.8	74.0	91.3	110.9	132.7	156.7	182.7	210.7	240.2
Dispatchable BUG- Natural Gas	28.2	37.1	47.4	59.3	72.8	88.0	105.0	123.5	143.6	164.9
Manual HVAC Control Cooling	54.8	62.0	69.5	77.3	85.1	93.0	100.8	108.4	115.8	122.7
Standard Lighting Control	45.7	50.6	55.5	60.4	65.3	70.0	74.6	79.0	83.1	86.9
Auto-DR+HVAC Cooling	14.6	15.7	17.0	18.4	19.8	21.5	23.2	25.0	27.0	29.0
Manual HVAC Control Fans/Ventilation	11.7	12.8	13.8	14.8	15.8	16.8	17.6	18.5	19.3	20.0
Auto-DR+HVAC Fans/Ventilation	5.0	5.6	6.1	6.6	7.1	7.6	8.1	8.6	9.0	9.5
Auto-DR+Refrigeration	2.9	3.1	3.2	3.4	3.6	3.7	3.8	3.9	4.0	4.1
Advanced Lighting Control	0.01	0.03	0.04	0.07	0.09	0.12	0.16	0.20	0.25	0.30
Total	**209**	**246**	**287**	**332**	**381**	**433**	**490**	**550**	**613**	**678**

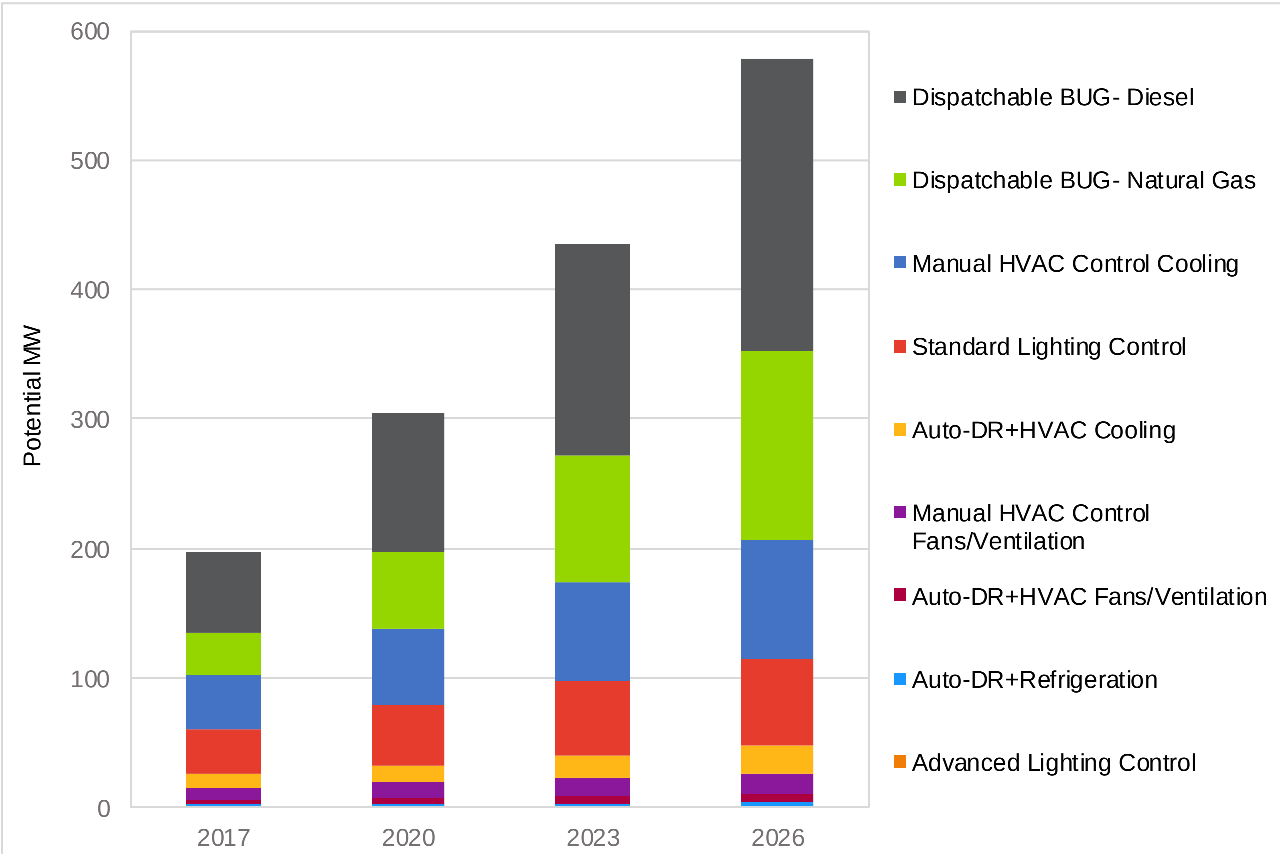
Source: Navigant

5.2.4.3 DLRP Achievable Potential

Figure 76 and

Table 94 display DLRP achievable potential projections by DR measures from 2017-2026. As discussed earlier, DLRP potential is projected to grow from approximately 196 MW in 2017 to 579 MW in 2026. The relative contributions across the DR measures for DLRP is similar to that for CSRP.

Figure 76. DLRP Programmatic Achievable Potential by Measure (MW)



Source: Navigant

Table 94. DLRP Programmatic Achievable Potential by Measure (MW)

Measure	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Dispatchable BUG- Diesel	62.4	75.6	90.3	106.3	123.8	142.6	162.5	183.3	204.7	226.5
Dispatchable BUG- Natural Gas	32.1	40.3	49.7	60.3	72	84.9	98.9	113.8	129.4	145.5
Manual HVAC Control Cooling	41.4	46.9	52.6	58.6	64.6	70.6	76.5	82.3	87.9	93.2
Standard Lighting Control	35	38.7	42.4	46.1	49.8	53.4	56.8	60.1	63.2	66.1
Auto-DR+HVAC Cooling	10.7	11.6	12.7	13.7	14.9	16.2	17.5	18.9	20.4	22
Manual HVAC Control Fans/Ventilation	8.9	9.7	10.5	11.3	12	12.7	13.4	14	14.6	15.2
Auto-DR+HVAC Fans/Ventilation	3.8	4.2	4.6	5	5.4	5.8	6.1	6.5	6.9	7.2
Auto-DR+Refrigeration	2.1	2.2	2.4	2.5	2.6	2.8	2.9	2.9	3	3.1
Advanced Lighting Control	0.01	0.02	0.03	0.05	0.07	0.09	0.12	0.15	0.19	0.23
Total	**197**	**229**	**265**	**304**	**345**	**389**	**435**	**482**	**530**	**579**

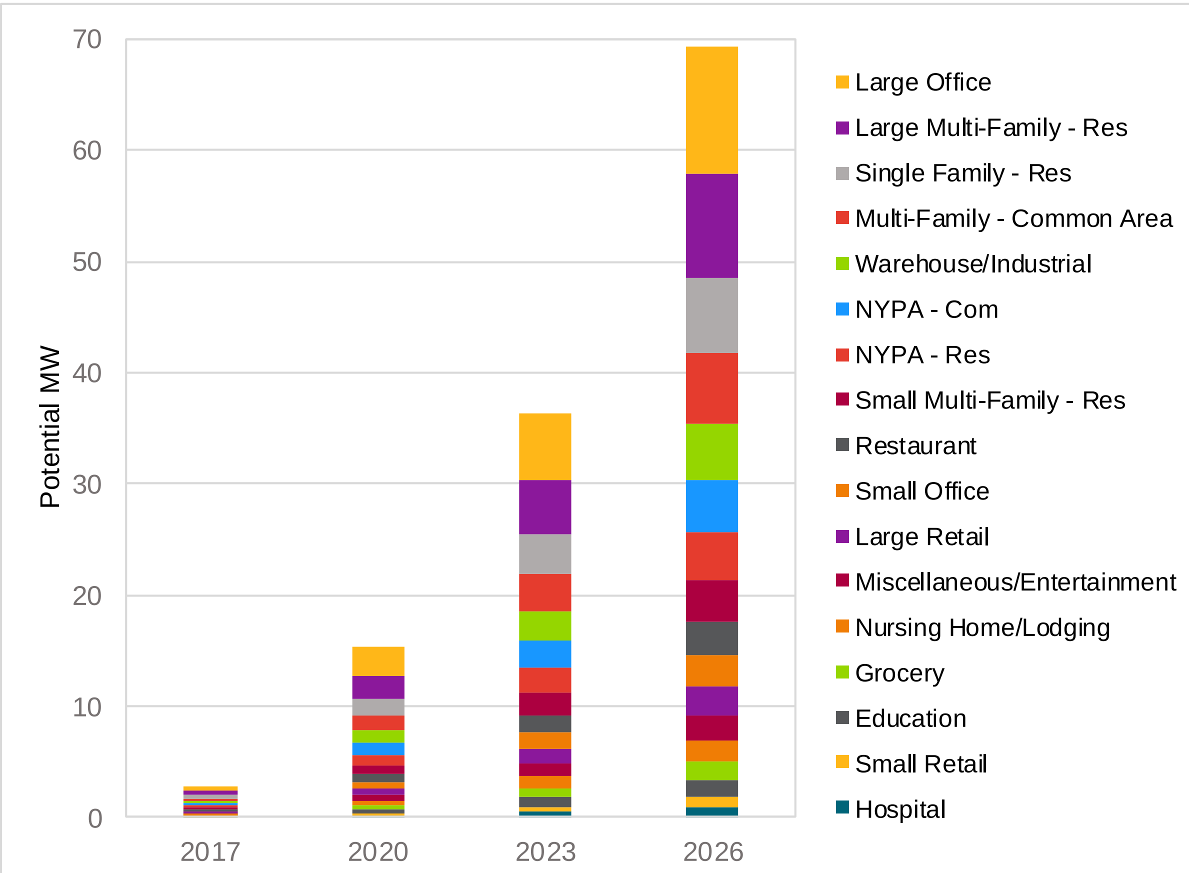
Source: Navigant

5.2.4.4 TVR Achievable Potential

Figure 77 and

Table 95 below show TVR achievable potential projections from 2017-2026. TVR potential is projected to grow from about 3 MW in 2017 to 70 MW in 2026. Residential sector accounts for approximately 30% share in the total TVR potential. Among residential customers, the largest contributors are large multi-family and single-family residential customers. Among the C&I segments, the top contributors are large offices, multi-family common area, NYPA-commercial, and warehouse/industrial. The other commercial segments individually have less than 5% share in the total potential.

Figure 77. TVR Programmatic Achievable Potential by Segment (MW)



Source: Navigant

Table 95. TVR Programmatic Achievable Potential by Segment (MW)

Customer Segment	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Large Office	0.5	1	1.7	2.5	3.5	4.7	6	7.6	9.4	11.4
Large Multi-Family - Res	0.4	0.8	1.4	2	2.8	3.8	4.8	6.1	7.6	9.2
Single Family - Res	0.3	0.6	1	1.5	2.1	2.8	3.6	4.6	5.6	6.9
Multi-Family - Common Area	0.3	0.6	0.9	1.4	1.9	2.6	3.3	4.2	5.2	6.3
Warehouse/Industrial	0.2	0.5	0.8	1.1	1.5	2.1	2.6	3.3	4.1	5
NYPA - Com	0.2	0.4	0.7	1.1	1.5	1.9	2.5	3.1	3.9	4.8
NYPA - Res	0.2	0.4	0.6	1	1.3	1.8	2.3	2.9	3.6	4.3
Small Multi-Family - Res	0.2	0.3	0.6	0.8	1.2	1.5	2	2.5	3.1	3.8
Restaurant	0.1	0.3	0.4	0.7	0.9	1.2	1.6	2	2.4	3
Small Office	0.1	0.3	0.4	0.6	0.9	1.2	1.5	1.9	2.3	2.8
Large Retail	0.1	0.2	0.4	0.6	0.8	1.1	1.4	1.7	2.1	2.6
Miscellaneous/Entertainment	0.1	0.2	0.3	0.5	0.7	0.9	1.1	1.4	1.8	2.2
Nursing Home/Lodging	0.1	0.2	0.3	0.4	0.6	0.8	1	1.3	1.6	1.9
Grocery	0.1	0.2	0.3	0.4	0.5	0.7	0.9	1.1	1.4	1.7
Education	0.1	0.1	0.2	0.3	0.4	0.6	0.8	1	1.2	1.5
Small Retail	0.0	0.1	0.2	0.2	0.3	0.4	0.5	0.7	0.9	1.0
Hospital	0	0.1	0.1	0.2	0.3	0.3	0.4	0.5	0.7	0.8
Total	**3**	**6**	**10**	**15**	**21**	**28**	**36**	**46**	**57**	**69**

Source: Navigant

5.2.5 DR Levelized Costs

Table 96 displays the levelized costs of DR measures over 2017-2026 and the associated 2026 programmatic achievable potential. The DR measures are sorted in the order of their decreasing contribution to the potential. This is useful for assessing the relative contributions versus costs of the different DR measures.

The two dispatchable BUG measures (diesel-based and natural gas-based) have highest DR potential at relatively low costs of approximately $50/kW-yr. The third highest potential contributor is DLC-thermostat with a levelized cost of around $75/kW-yr. Manual HVAC load control in commercial buildings at around $60/kW-yr. has significant contribution in potential, while Auto-DR HAVC control has 25% higher costs than manual HVAC control due to the additional costs associated with enabling the appropriate communications and controls for Auto-DR. The potential from Auto-DR enabled HVAC control is approximately a third of the potential from manual HVAC control since Auto-DR only applies to HVAC load with EMS, while manual HAVC load curtailment has much broader applicability. TVR without enabling technology at approximately $15/kW-yr. is the least cost DR measure with relatively low potential. When paired with enabling technologies such as thermostats and Auto-DR, the levelized cost of TVR increases to around $60/kW-yr. Lighting control measures are relatively more expensive at $104-131/kw-yr.

Table 96. DR Measures Levelized Costs and 2026 Programmatic Achievable Potential (MW)

DR Measure	Programmatic Achievable Potential (MW)	Levelized Cost $/kW-yr.
Dispatchable BUG- Diesel	240.2	52.8
Dispatchable BUG- Natural Gas	164.9	51.0
Direct Load Control-Thermostat	150.8	74.3
Manual HVAC	142.7	62.7
Standard Lighting Control	86.9	104.4
Auto-DR+HVAC	38.5	77.8
TVR (w/o enabling tech)	36.8	14.9
TVR (with enabling tech)	32.5	62.5
Auto-DR+Refrigeration	4.1	85.5
Advanced Lighting Control	0.3	131.1

Source: Navigant

5.2.6 Budget Estimates

Table 97 below presents the annual DR budget for programmatic achievable potential. The budget estimates include the enabling technology costs borne by the utility, the customer marketing and outreach related costs and the annual incentives to DR participants. The budget estimates are for all DR program types included in the analysis – DLC, CSRP, DLRP and TVR. As is evident from the results below, the annual DR budget is projected to grow steadily from around $36 million in 2017 to approximately $100 million in 2026 with steady growth in programmatic achievable potential during that period.

Table 97. Annual DR Budget for Programmatic Achievable Potential ($M)

Scenario	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Programmatic Achievable-DR Budget	$35.5	$42.7	$50.3	$58.0	$65.9	$73.7	$81.2	$88.2	$94.6	$100.3

Source: Navigant

6. CSG POTENTIAL FORECAST

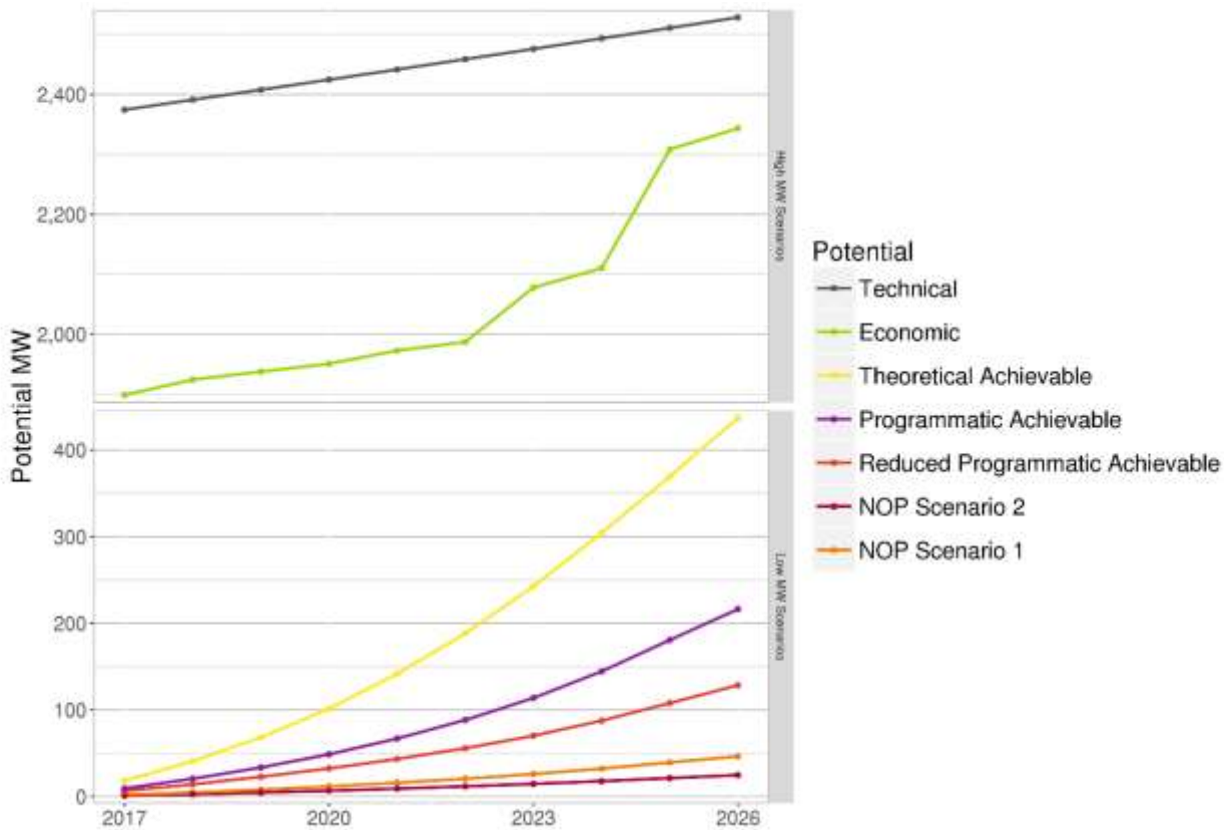
This section details the results for Navigant's analysis of CSG, including solar PV + storage, CHP, and CCHP. Table 98 and Figure 78 summarize these results. Within the technical potential of 2,528 MW in 2026, 826 MW comes from solar PV + storage, 1,507 MW from CHP, and 194 MW from CCHP. The utility-wide technical potential for solar PV is approximately 825 MW. The CHP and CCHP results fit within the estimated technical potential of about 12 GW (discussed in Section 8.1) for New York State. The economic potential of 2,343 MW is about 92% of the technical potential, and is reasonable given how much CSG costs have declined in recent years as well as their ability to be dispatched to reduce peak load. Achievable potential is detailed in the sections that follow.

Table 98. CSG Cumulative Potential Forecast by Scenario (MW, nameplate capacity)

Potential Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Technical	2,374	2,391	2,408	2,424	2,441	2,459	2,476	2,493	2,511	2,528
Economic	1,899	1,925	1,938	1,951	1,973	1,987	2,078	2,110	2,308	2,343
Theoretical Achievable	18	41	68	102	142	188	243	304	369	437
Programmatic Achievable	9	21	34	49	67	88	114	144	181	216
Reduced Programmatic Achievable	7	14	23	32	43	56	70	88	108	129
NOP Scenario 1	2	5	8	12	16	21	26	32	39	46
NOP Scenario 2	1	3	5	7	9	12	15	18	21	25

Source: Navigant

Figure 78. CSG Cumulative Potential Forecast by Scenario (MW, nameplate capacity)



Source: Navigant

6.1 Technical Potential Results

This section provides the technical savings potential for CSG calculated through IDSM at varying levels of aggregation. Results are shown by sector, customer segment, and measure.

6.1.1 Results by Sector

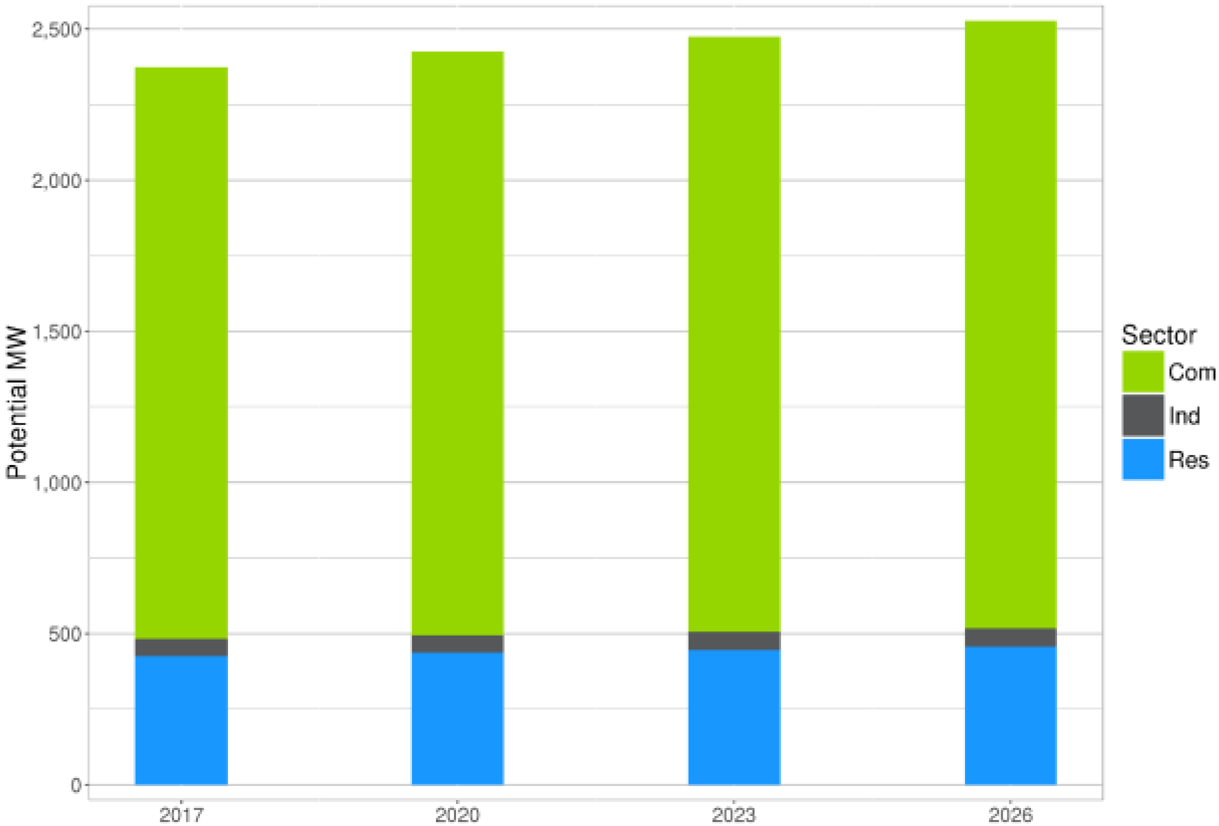
Table 99 and Figure 79 show the cumulative technical potential for commercial, industrial and residential respectively. Most of the technical potential is in the commercial sector, which is to be expected because CHP systems are not readily available for the residential sector; thus, the potential for the residential sector is comprised entirely of smaller sized solar PV + energy storage systems.

Table 99. CSG Cumulative Technical Potential by Sector (MW, Nameplate Capacity)

Sector	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Commercial	1,890	1,903	1,916	1,929	1,942	1,956	1,969	1,983	1,996	2,010
Industrial	58	58	58	59	59	60	60	61	61	62
Residential	427	430	433	436	440	443	446	450	453	457

Source: Navigant

Figure 79. CSG Cumulative Technical Potential by Sector (MW, nameplate capacity)



Source: Navigant

6.1.2 Results by Segment

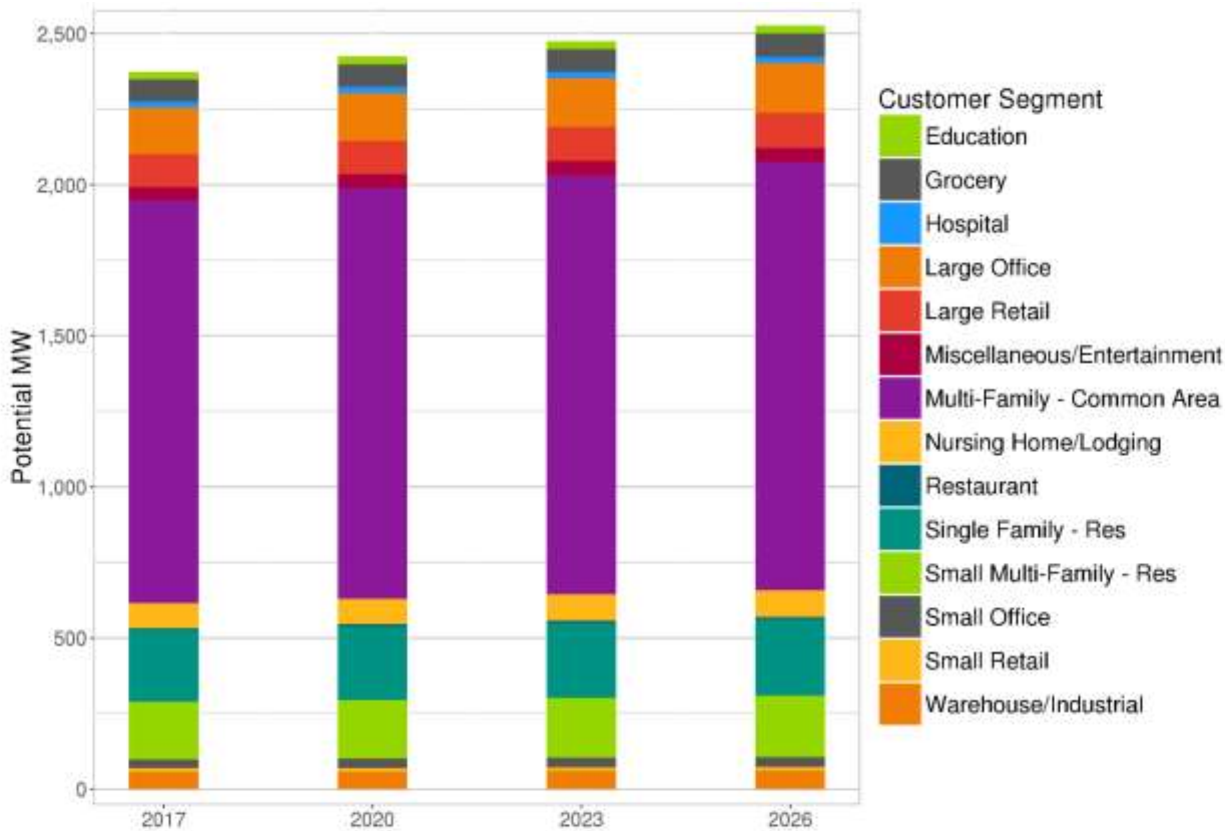
Table 100 and Figure 80 show the cumulative technical potential for by commercial, residential and industrial customer segments. Within the commercial sector, the biggest potentials are in multi-family common areas, large offices, and large retail. These segments have large loads and are well suited to CSG.

Table 100. CSG Cumulative Technical Potential by Segment (MW)

Customer Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Education	25.78	25.98	26.15	26.32	26.52	26.75	26.87	27.13	27.27	27.45
Grocery	72.68	73.19	73.70	74.18	74.75	75.23	75.81	76.29	76.86	77.38
Hospital	20.00	20.15	20.30	20.45	20.57	20.70	20.82	20.97	21.12	21.28
Large Office	154.59	155.57	156.58	157.60	158.67	159.72	160.77	161.85	162.91	163.97
Large Retail	108.19	108.93	109.67	110.41	111.21	111.92	112.70	113.50	114.28	115.05
Miscellaneous/Entertainment	45.16	45.45	45.79	46.09	46.45	46.82	47.13	47.47	47.82	48.16
Multi-Family - Common Area	1331.65	1340.78	1349.98	1359.24	1368.52	1377.92	1387.38	1396.91	1406.45	1416.11
Nursing Home/Lodging	83.17	83.70	84.27	84.87	85.41	85.98	86.55	87.15	87.72	88.32
Restaurant	7.27	7.32	7.38	7.43	7.48	7.54	7.59	7.65	7.70	7.76
Single Family - Res	236.50	238.30	240.12	241.96	243.81	245.67	247.55	249.45	251.36	253.29
Small Multi-Family - Res	190.13	191.57	193.02	194.47	195.94	197.42	198.92	200.42	201.94	203.47
Small Office	29.98	30.20	30.42	30.65	30.87	31.10	31.33	31.56	31.80	32.03
Small Retail	11.58	11.67	11.75	11.84	11.93	12.01	12.10	12.19	12.28	12.37
Warehouse/Industrial	57.64	58.08	58.49	58.94	59.32	59.74	60.19	60.62	61.11	61.54

Source: Navigant

Figure 80. CSG Cumulative Technical Potential by Segment (MW)



Source: Navigant

6.1.3 Results by Measure

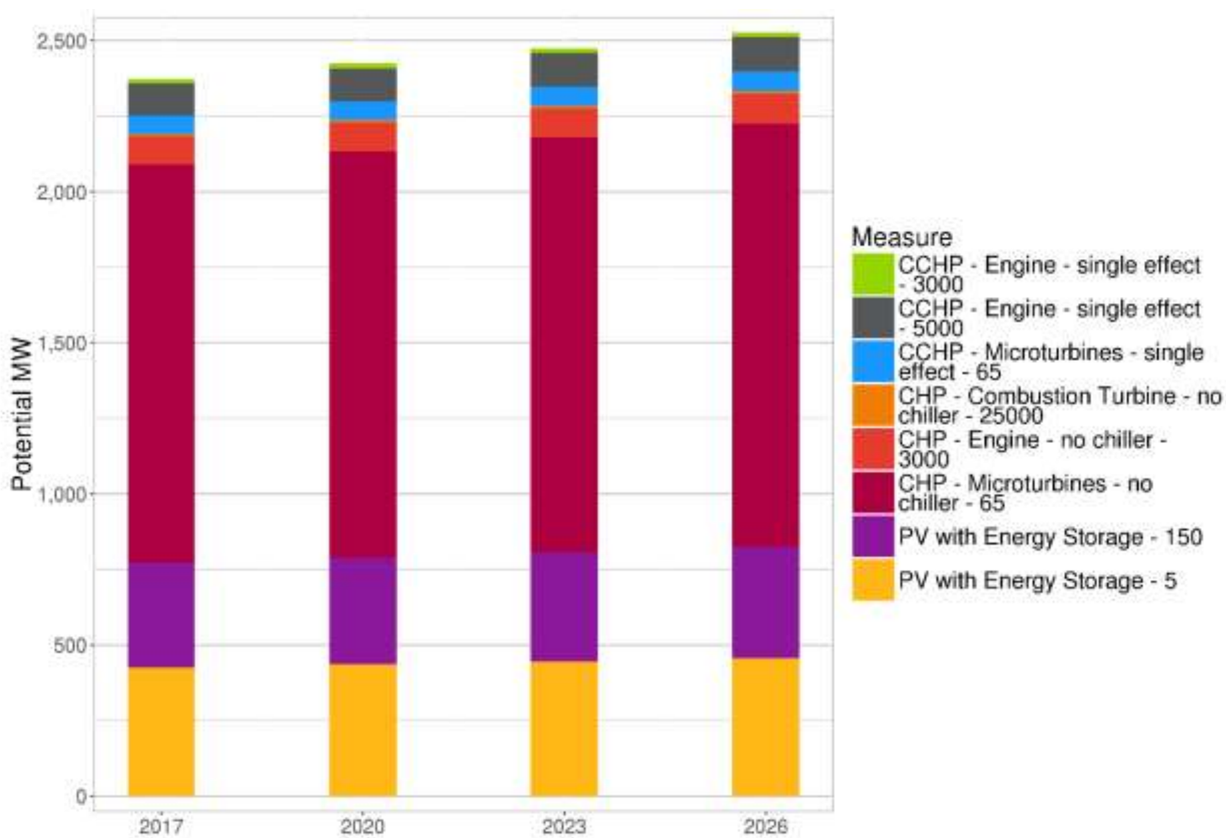
Examining the technical potential by measure, the 65 kW CHP with microturbines is the most popular. This is reasonable because the typical load sizes for many commercial segments is the 40 kW to 70 kW range. Note that the IDSM model allows a building to select the optimal CHP system size required, so the 65 kW is indicative of the average size installed. For prime movers selected, Navigant analysis is a mix of technologies, as is expected because different prime movers have advantages at different scales. For solar PV + energy storage, the potential is comprised of 5 kW and 150 kW systems. The 5 kW systems are for the residential segment and small businesses, with the 150 kW systems for medium and large commercial.

Table 101. CSG Cumulative Technical Potential by Measure (MW)

Measure	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
CCHP - Engine - single effect - 3000	16	16	16	16	16	16	16	17	17	17
CCHP - Engine - single effect - 5000	107	108	109	109	110	111	111	112	113	114
CCHP - Microturbines - single effect - 65	61	61	61	62	62	63	63	63	64	64
CHP - Combustion Turbine - no chiller - 25000	8	8	8	9	9	9	9	9	9	9
CHP - Engine - no chiller - 3000	93	94	94	95	96	96	97	98	98	99
CHP - Microturbines - no chiller - 65	1,317	1,326	1,335	1,344	1,353	1,362	1,371	1,381	1,390	1,400
PV with Energy Storage - 150	346	349	351	354	356	359	361	364	367	369
PV with Energy Storage - 5	427	430	433	436	440	443	446	450	453	457

Source: Navigant

Figure 81. CSG Cumulative Technical Potential by Measure MW)



Source: Navigant

6.2 Achievable Potential Results

Navigant next assessed the achievable potential for CSG. CECONY does not currently have any CSG programs, so these projections assume budgets are authorized and programs are created. The team did not run the alternative programmatic case because that is an energy efficiency specific scenario.

6.2.1 Results by Sector

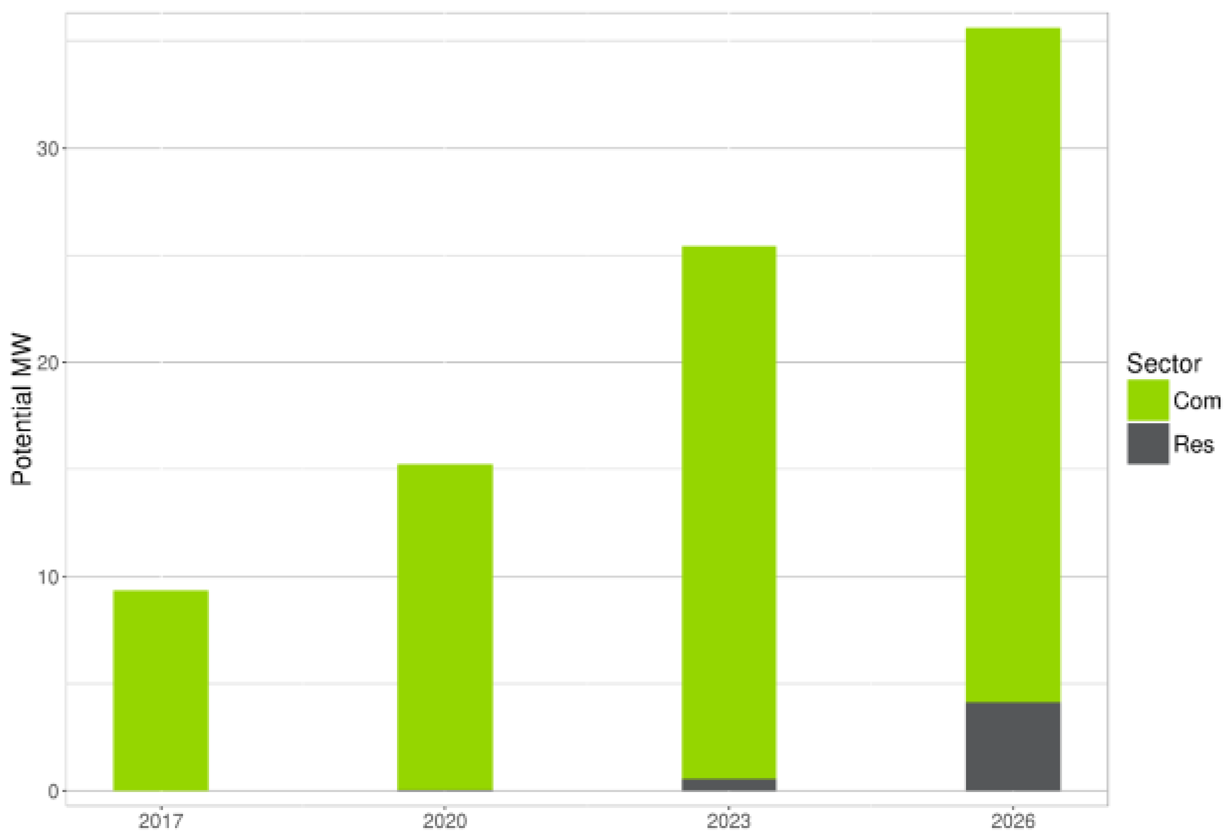
The achievable potential results by sector mirror the technical potential in that most of the opportunity is in the commercial sector, as shown in the figure below.

Table 102. CSG Incremental Annual Programmatic Achievable Potential by Sector (MW, Nameplate)

Sector	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Commercial	9	11	13	15	18	21	25	29	33	31
Residential	0	0	0	0	0	0	1	2	3	4

Source: Navigant

Figure 82. CSG Incremental Annual Programmatic Achievable Potential by Sector (MW, Nameplate)



Source: Navigant

6.2.2 Results by Segment

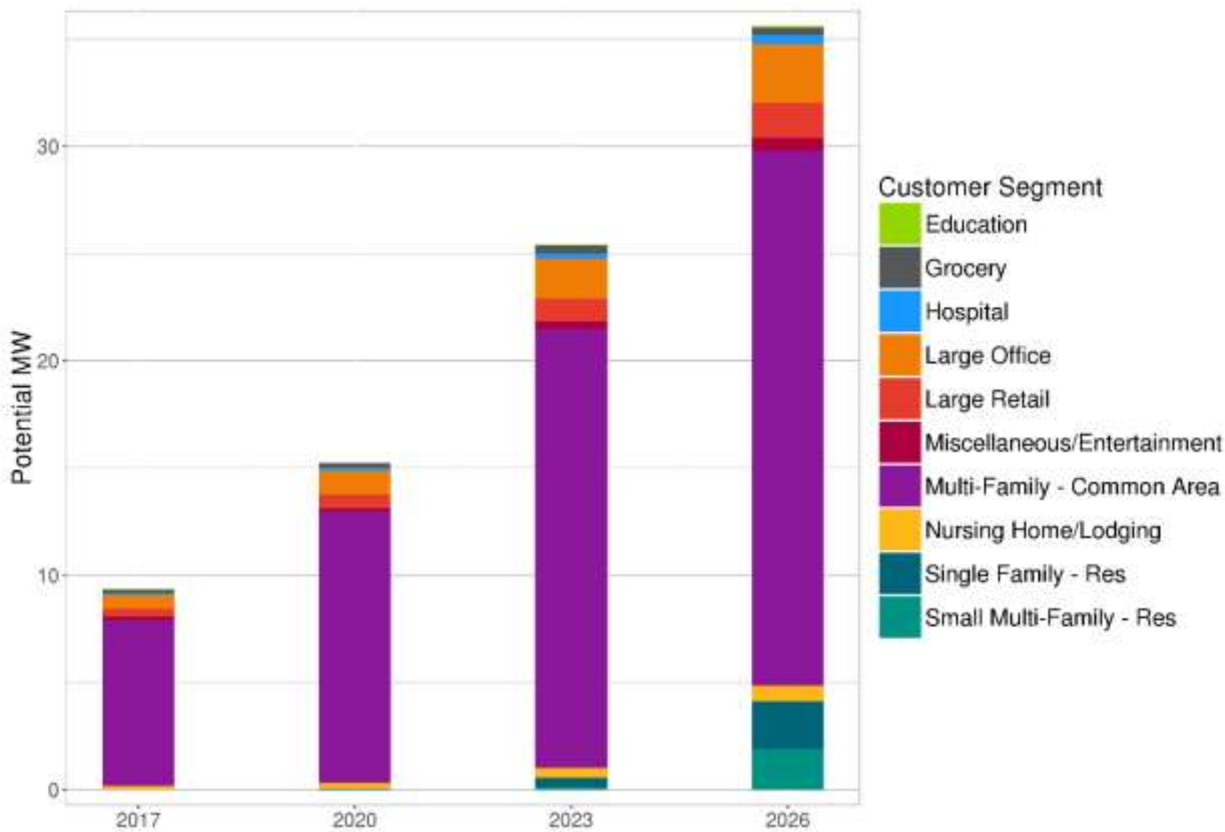
The largest segment is multi-family common areas deploying CHP. This is because this segment often has a high, stable thermal load, when tenant rent includes water and/or space heating. Furthermore, the economics of CHP systems are favorable. After multi-family common area, the other big segments have stable thermal loads and/or rate structures favorable for solar PV + storage.

Table 103. CSG Incremental Annual Programmatic Achievable Potential by Segment (MW, Nameplate)

Customer Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Education	0	0	0	0	0	0	0	0	0	0
Grocery	0	0	0	0	0	0	0	0	1	0
Hospital	0	0	0	0	0	0	0	0	0	0
Large Office	1	1	1	1	1	2	2	2	2	3
Large Retail	0	0	1	1	1	1	1	1	1	2
Miscellaneous/Entertainment	0	0	0	0	0	0	0	0	1	1
Multi-Family - Common Area	8	9	11	13	15	18	20	24	27	25
Nursing Home/Lodging	0	0	0	0	0	0	0	1	1	1
Single Family - Res	0	0	0	0	0	0	0	1	2	2
Small Multi-Family - Res	0	0	0	0	0	0	0	1	2	2

Source: Navigant

Figure 83. CSG Incremental Annual Programmatic Achievable Potential by Segment (MW, Nameplate)



Source: Navigant

6.2.3 Results by Measure

The measures deployed have a similar mix to the technical potential. 65 kW CHP units are similar in size to typical loads for multi-family common areas, so they are the most deployed. The 5 kW solar PV + storage is being deployed in single family residential homes.

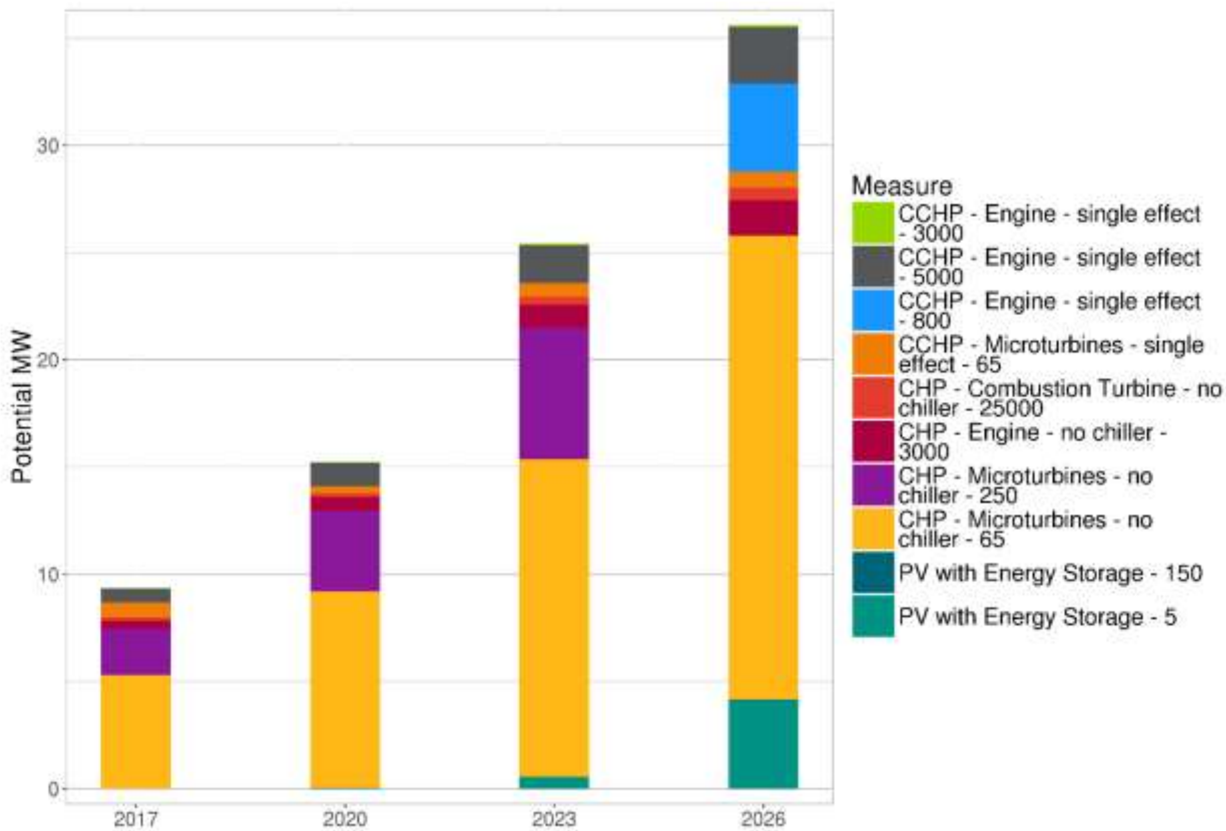
Table 104. CSG Incremental Annual Programmatic Achievable Potential by Measure (MW, nameplate)

Measure	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
CCHP - Engine - single effect - 3000	0	0	0	0	0	0	0	0	0	0
CCHP - Engine - single effect - 5000	1	1	1	1	1	2	2	2	2	3
CCHP - Engine - single effect - 800	0	0	0	0	0	0	0	0	0	4
CCHP - Microturbines - single effect - 65	1	1	1	0	0	1	1	1	1	1
CHP - Combustion Turbine - no chiller - 25000	0	0	0	0	0	0	0	0	1	1

CHP - Engine - no chiller - 3000	0	0	1	1	1	1	1	1	1	2
CHP - Microturbines - no chiller - 250	2	3	3	4	4	5	6	7	8	0
CHP - Microturbines - no chiller - 65	5	6	8	9	11	13	15	17	19	22
PV with Energy Storage - 150	0	0	0	0	0	0	0	0	0	0
PV with Energy Storage - 5	0	0	0	0	0	0	1	2	3	4

Source: Navigant

Figure 84. CSG Incremental Annual Programmatic Achievable Potential by Measure (MW, Nameplate)

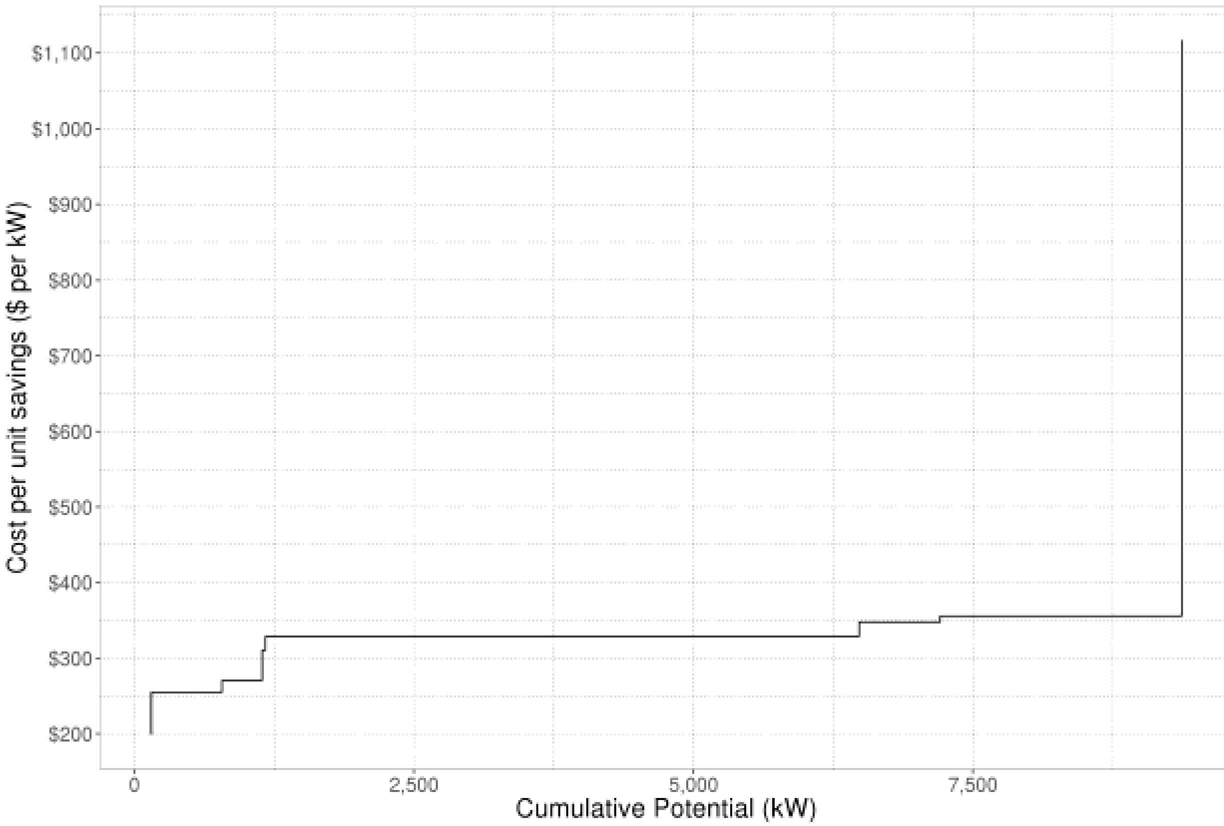


Source: Navigant

6.2.4 Supply Curves

The supply curve below shows a cutoff around $350/kW. This is reasonable and reflects the fact that CHP projects can be competitive with high usage and PV + storage prices are falling.

Figure 85. CSG Achievable Supply Curve



** Based on first-year (i.e., 2017) savings*
Source: Navigant

Table 105 identifies the measures that fall into four levelized cost categories: 0-200 $/kW, 200-300 $/kW, 300-400 $/kW, and greater than 400 $/kW. As can be seen, the majority of savings are available between $300/kW and $400/kW.

Table 105. Top Measures from the CSG Achievable Potential Supply Curve

Cost per unit savings	
0-200 $/kw	**300-400 $/kw**
CHP - Combustion Turbine - no chiller - 25000	CHP - Engine - no chiller - 3000
200-300 $/kw	CCHP - Engine - single effect - 3000
PV with Energy Storage - 150	CHP - Microturbines - no chiller - 65
CCHP - Engine - single effect - 5000	CCHP - Microturbines - single effect - 65
	CHP - Microturbines - no chiller - 250
	>400 $/kw
	CCHP - Engine - single effect - 800
	PV with Energy Storage - 5

6.2.5 Budget Estimates

The Navigant analysis used a targeted 10-year payback to incent customer participation for each of the achievable scenarios. The resulting incentive budgets are shown below.[82]

The large jumps from 2021 to 2022 are due to the federal Investment Tax Credit for solar PV, reverting from 30% to 10%. Navigant analysis assumes CECONY would raise the incentive level to compensate and maintain a 10-year payback period.

Table 106. CSG Achievable Potential Incentives Budget ($M)

Scenario	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Programmatic Achievable	$27	$30	$34	$38	$43	$48	$57	$69	$80	$75
Reduced Programmatic Achievable	$19	$21	$23	$24	$26	$28	$33	$40	$47	$45
Theoretical Achievable	$51	$60	$69	$81	$93	$103	$118	$134	$145	$145

Source: Navigant

6.3 NOP Results

In the NOP case—meaning no incentives are provided by CECONY beyond those offered by NYSERDA—Navigant projected CHP adoption in commercial buildings. This is reasonable because CECONY already has CHP installed in its service territory without having any targeted programs.

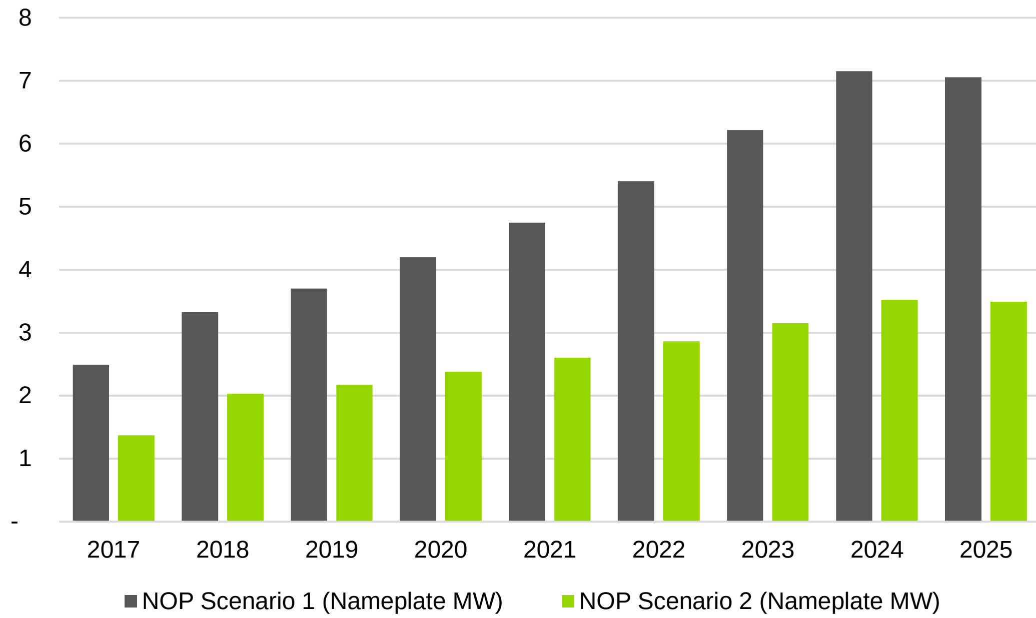
Table 107. CSG Incremental Annual NOP (MW, Nameplate)

Scenario	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
NOP Scenario 1	2.2	2.5	3.3	3.7	4.2	4.7	5.4	6.2	7.1	7.1
NOP Scenario 2	1.2	1.4	2.0	2.2	2.4	2.6	2.9	3.2	3.5	3.5

Source: Navigant

[82] This analysis did not consider administrative costs for CSG potential, due to CECONY's limited experience with these program types to inform administrative cost estimates. Thus, the budget estimates presented here are for incentives only.

Figure 86. CSG Incremental Annual NOP by Segment (MW, Nameplate)



Source: Navigant

7. STORAGE POTENTIAL FORECAST

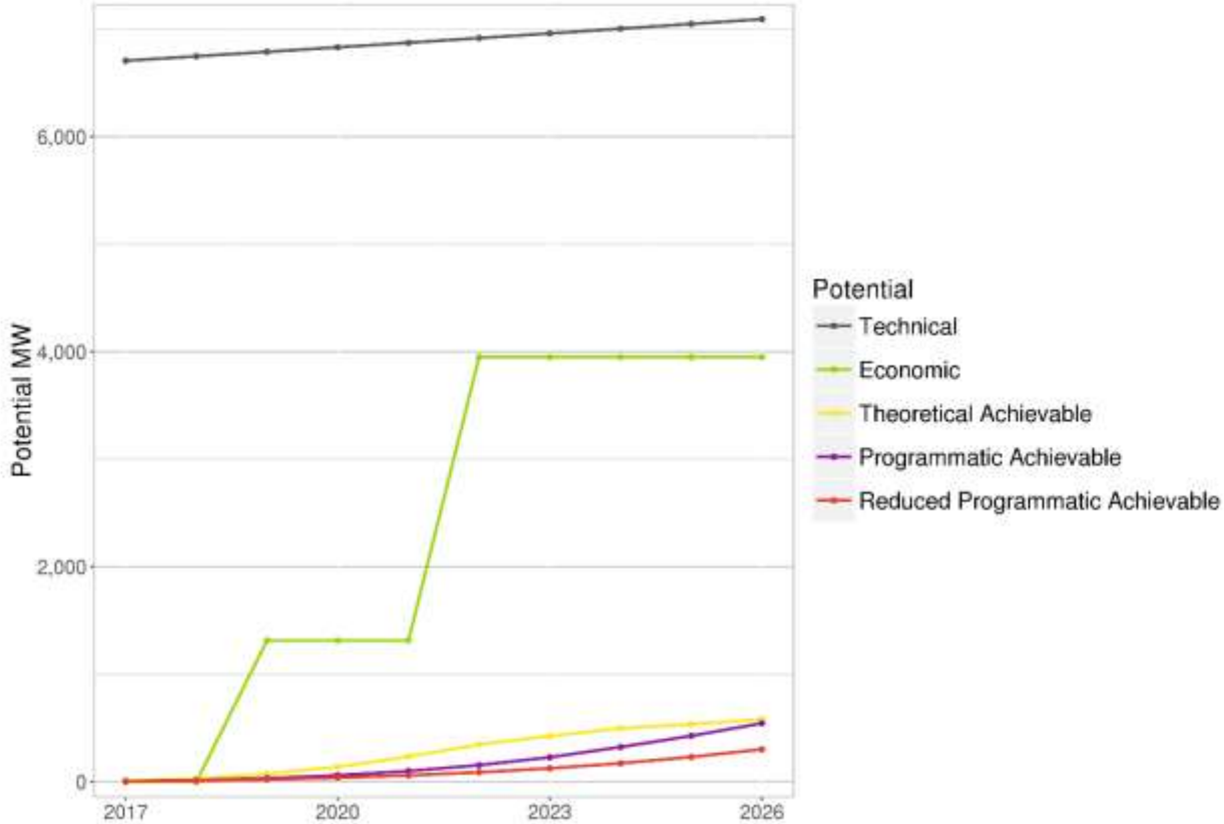
Table 108 and Figure 87 summarize the results of Navigant's potential study for energy storage potential. As discussed more in the following sections, the technical potential for storage capacity within CECONY's territory is significant, at more than half of CECONY's peak demand. The economic potential is roughly half of the technical potential by 2026 and shows two significant step increases, representing when certain technologies suddenly screen as economic under the SCT, due to declines in technology costs and changing avoided costs over time. Programmatic achievable potential is still less than 10% of the technical potential in 2026, which reflects that the estimated payback period for customers is projected to be high and limit customer adoption for most technologies over the lifetime of the study.

Table 108. Storage Cumulative Potential Forecast by Scenario (MW, Nameplate)

Potential Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Technical	6,706	6,747	6,789	6,831	6,873	6,917	6,960	7,004	7,048	7,093
Economic	0	0	1,314	1,314	1,314	3,950	3,950	3,950	3,950	3,950
Theoretical Achievable	12	30	73	139	234	348	425	497	535	582
Programmatic Achievable	6	14	33	61	100	155	229	324	427	545
Reduced Programmatic Achievable	4	9	22	38	60	88	125	172	231	302

Source: Navigant

Figure 87. Storage Cumulative Potential Forecast by Scenario (MW, Nameplate)



Source: Navigant

7.1 Technical Potential Results

The technical potential for storage is approximately 6.7 GW, as shown in Figure 88. The cumulative technical potential grows slowly, in step with new customer count and load growth.

This is a large number compared to CECONY's peak demand of between 13 GW and 14 GW. However, it was not unexpected as the main technical barrier for energy storage is having enough space to install the equipment. Navigant's primary data collection yielded that 77% of single family residential customers had space for storage, and between 20% and 50% (depending on segment) of commercial customers have space for storage.

7.1.1 Results by Sector

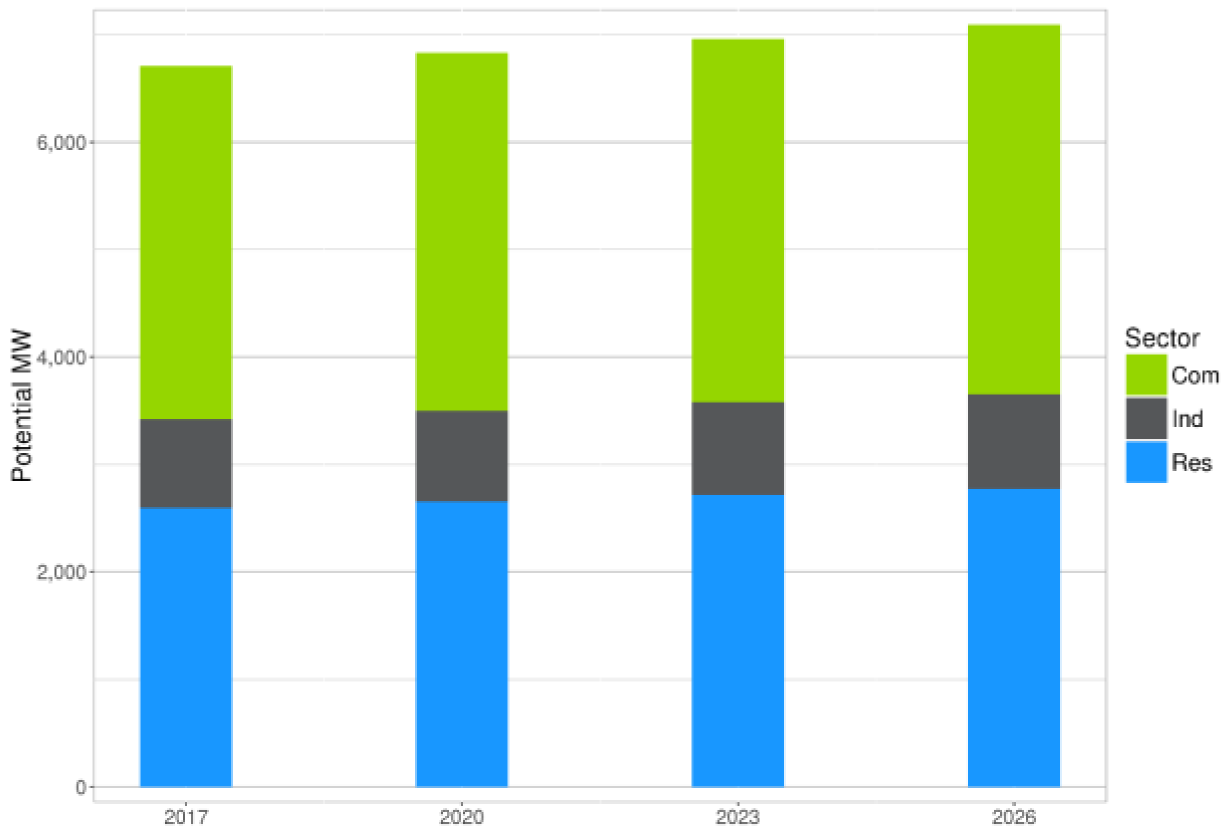
Together, the commercial and industrial sectors comprise roughly 60% of the overall technical potential for storage. As discussed more below, these two sectors include multi-family common area and warehouse/industrial, which have the highest technical potential aside from single-family residential homes.

Table 109. Storage Cumulative Technical Potential by Sector (MW, Nameplate)

Sector	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Commercial	3,283	3,299	3,316	3,333	3,350	3,367	3,385	3,403	3,420	3,438
Industrial	825	831	836	842	848	855	861	867	873	879
Residential	2,598	2,617	2,637	2,656	2,675	2,695	2,715	2,735	2,755	2,775

Source: Navigant

Figure 88. Storage Cumulative Technical Potential by Sector (MW, Nameplate)



Source: Navigant

7.1.2 Results by Segment

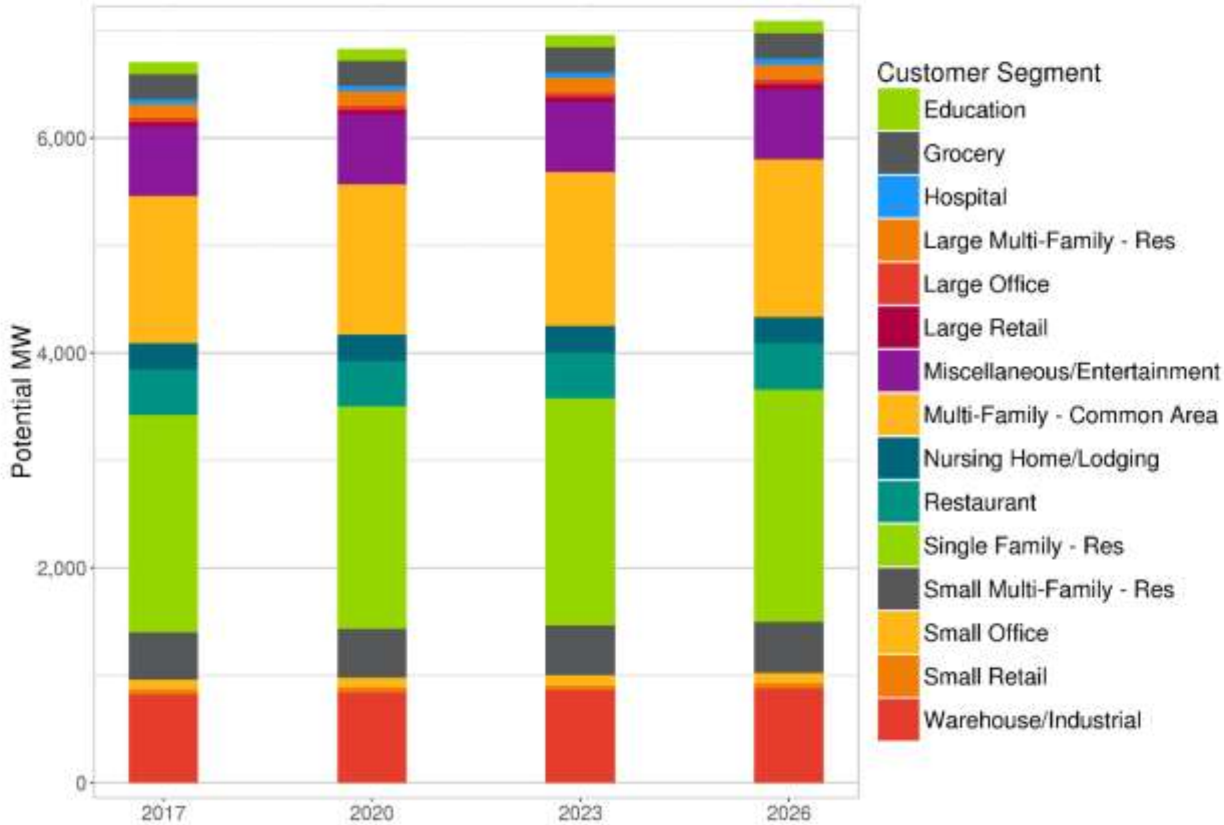
In looking at the technical potential by segment, the largest potential is in the residential single-family segment. This is reasonable as CECONY has over 600,000 single-family customers, and 77% of survey respondents stated they had space for a storage unit. On the commercial side, the common areas of multi-family units represent the largest potential. This is also reasonable because there were approximately 190,000 multi-family common area accounts, and 30% of survey respondents stated having space for storage.

Table 110. Storage Cumulative Technical Potential by Segment (MW, Nameplate)

Customer Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Education	111	112	113	114	114	115	116	117	118	118
Grocery	234	235	235	235	236	236	236	236	237	237
Hospital	46	47	47	48	49	50	51	52	53	54
Large Multi-Family - Res	131	132	133	134	135	136	136	137	138	139
Large Office	38	38	39	40	40	41	41	42	42	43
Large Retail	40	41	42	43	43	44	45	46	46	47
Miscellaneous/Entertainment	645	646	647	647	648	649	650	651	652	653
Multi-Family - Common Area	1,372	1,382	1,393	1,403	1,413	1,423	1,434	1,444	1,455	1,465
Nursing Home/Lodging	243	243	244	244	245	245	246	246	247	247
Restaurant	419	420	421	422	423	425	427	428	430	431
Single Family - Res	2,024	2,038	2,053	2,069	2,084	2,099	2,115	2,130	2,146	2,162
Small Multi-Family - Res	444	447	450	454	457	460	464	467	471	474
Small Office	90	90	91	92	92	93	93	94	95	95
Small Retail	44	45	45	45	46	46	46	46	47	47
Warehouse/Industrial	825	831	836	842	848	855	861	867	873	879

Source: Navigant

Figure 89. Storage Incremental Annual Technical Potential by Segment (MW, Nameplate)



Source: Navigant

7.1.3 Results by Measure

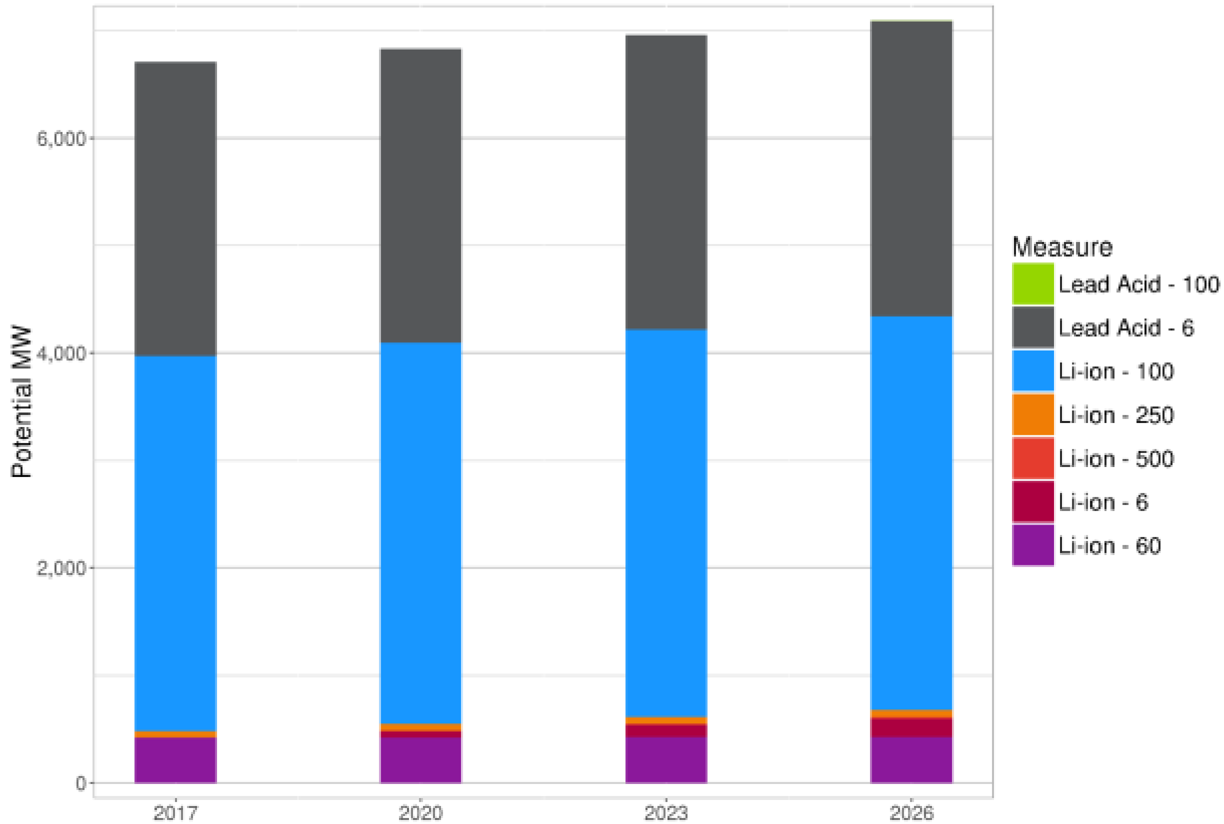
Navigant's analysis focused on Li-Ion and Lead Acid chemistries. The technical potential is spread across a range of sizes from 6 kW to 250 kW. This is consistent with current customer sited installations in the US.

Table 111. Storage Incremental Annual Technical Potential by Measure (MW, Nameplate)

Measure	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Lead Acid – 100	0	0	0	0	0	1	3	4	6	7
Lead Acid – 6	2,732	2,734	2,735	2,736	2,738	2,739	2,741	2,742	2,743	2,745
Li-ion – 100	3,495	3,513	3,531	3,550	3,568	3,587	3,606	3,625	3,644	3,664
Li-ion – 250	60	60	61	61	62	62	62	63	63	63
Li-ion – 500	0	2	4	6	7	9	11	13	15	17
Li-ion – 6	0	19	38	57	76	96	115	135	155	175
Li-ion – 60	419	420	421	422	423	423	423	423	423	423

Source: Navigant

Figure 90. Storage Incremental Annual Technical Potential by Measure (MW, Nameplate)



Source: Navigant

7.2 Achievable Potential Results

The achievable potential for storage was also assessed. CECONY does not currently have any dedicated storage programs, so these projections assume budgets are authorized, programs are created, and they are implemented.

7.2.1 Results by Sector

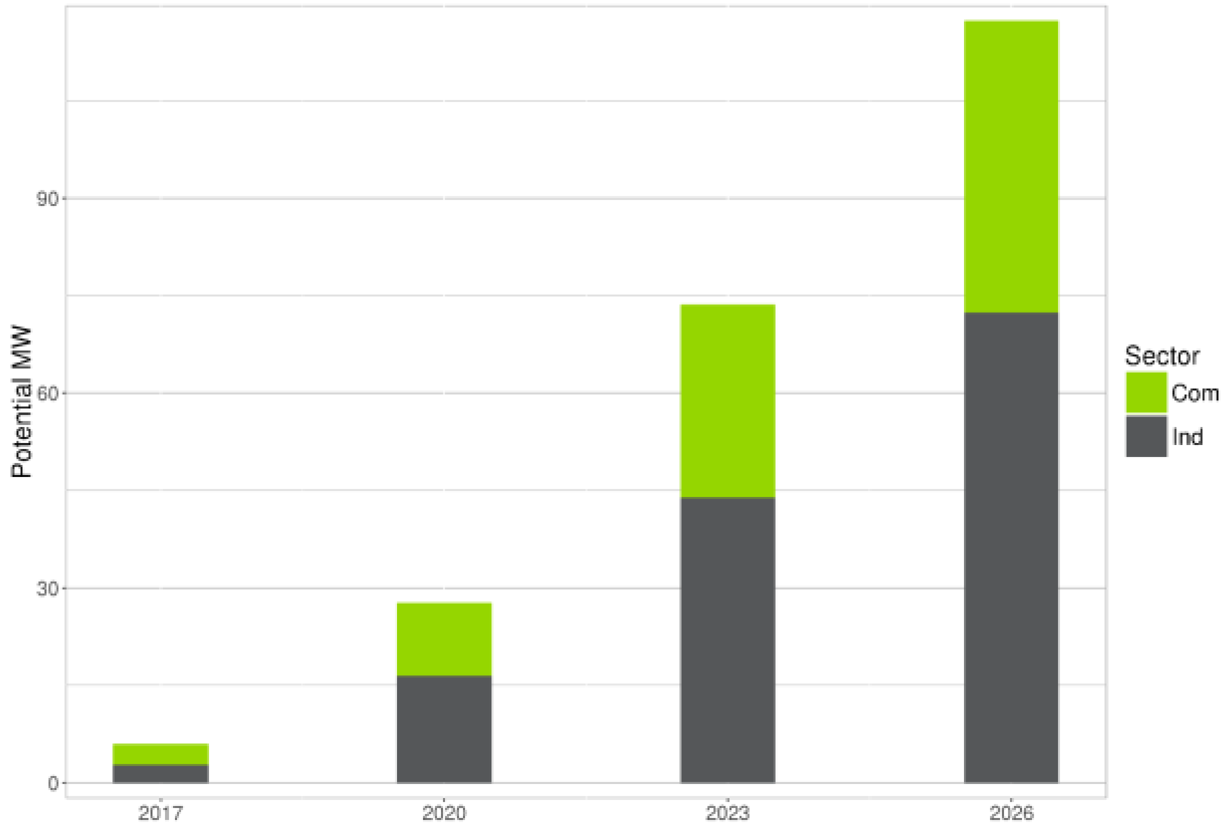
The table and figure below show the results by sector. Residential customers did not show any achievable potential, but this is expected because our analysis focused on economically driven installations. Residential customers do not have demand charges to avoid and do not have TOU rates. Most of the potential is in the industrial sector, which is expected because of the prevalence of demand charges.

Table 112. Storage Incremental Annual Programmatic Potential by Sector (MW, Nameplate)

Sector	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Commercial	3	3	8	11	16	22	30	38	41	45
Industrial	3	4	11	16	23	33	44	57	63	72

Source: Navigant

Figure 91. Storage Incremental Annual Programmatic Potential by Sector (MW, Nameplate)



Source: Navigant

7.2.2 Results by Segment

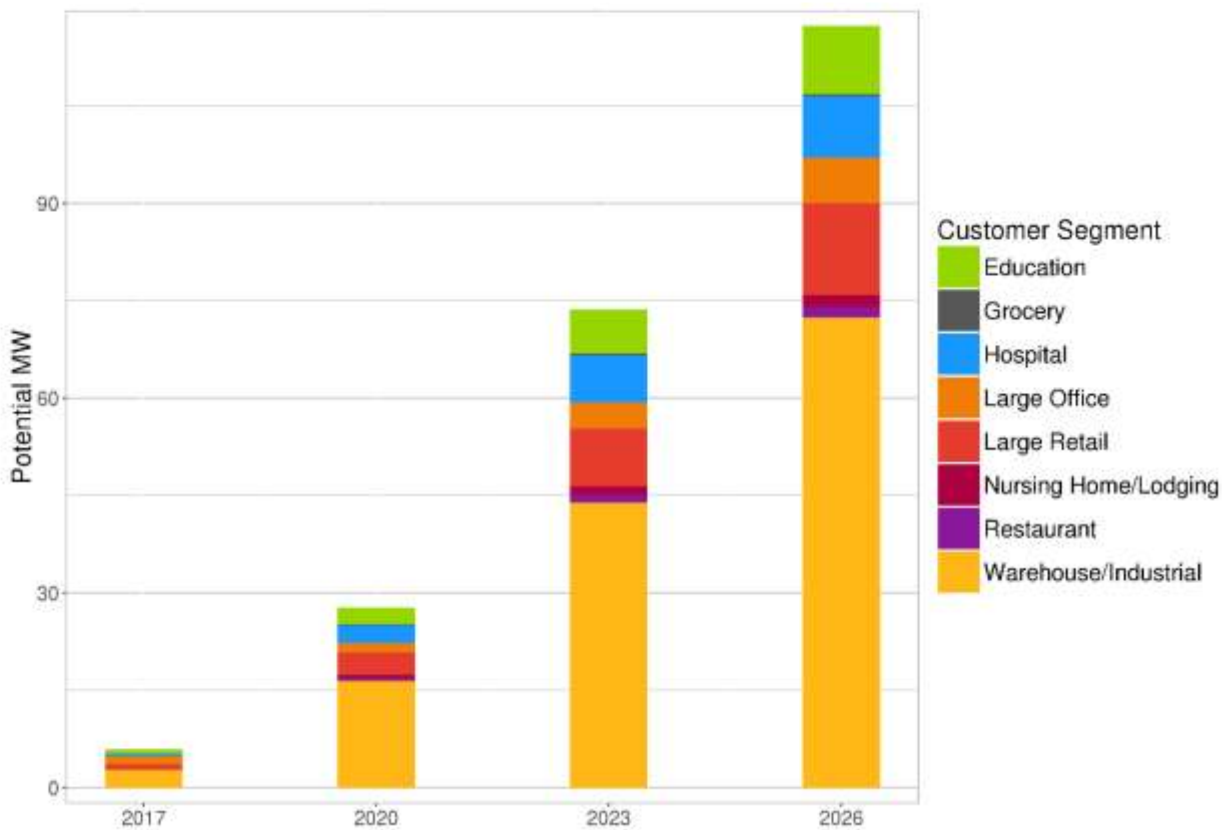
Figure 92 and Figure 93 show results by customer segment. The largest segment was warehouses/industrial. This segment's load shape and rate structure that includes demand charges make storage economically attractive. In both cases, adoption ramps up slowly. While many commercial customers may be aware of the technology, Navigant found that many customers are not willing to adopt it until they have seen successful case studies in applications similar to theirs. As adoption takes off, the word-of-mouth influence becomes stronger and adoption rises to about 200 MW/year.

Table 113. Storage Annual Incremental Programmatic Achievable by Segment (MW, Nameplate)

Customer Type	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Education	1	1	2	3	4	5	7	8	9	11
Grocery	0	0	0	0	0	0	0	0	0	0
Hospital	0	1	2	3	4	5	7	10	8	9
Large Office	1	1	1	1	2	3	4	5	6	7
Large Retail	1	1	2	3	5	7	9	11	13	14
Nursing Home/Lodging	0	0	0	0	1	1	1	2	2	2
Restaurant	0	0	0	0	1	1	1	2	2	2
Warehouse/Industrial	3	4	11	16	23	33	44	57	63	72

Source: Navigant

Figure 92. Storage Annual Incremental Programmatic Achievable by Segment (MW, Nameplate)



Source: Navigant

7.2.3 Results by Measure

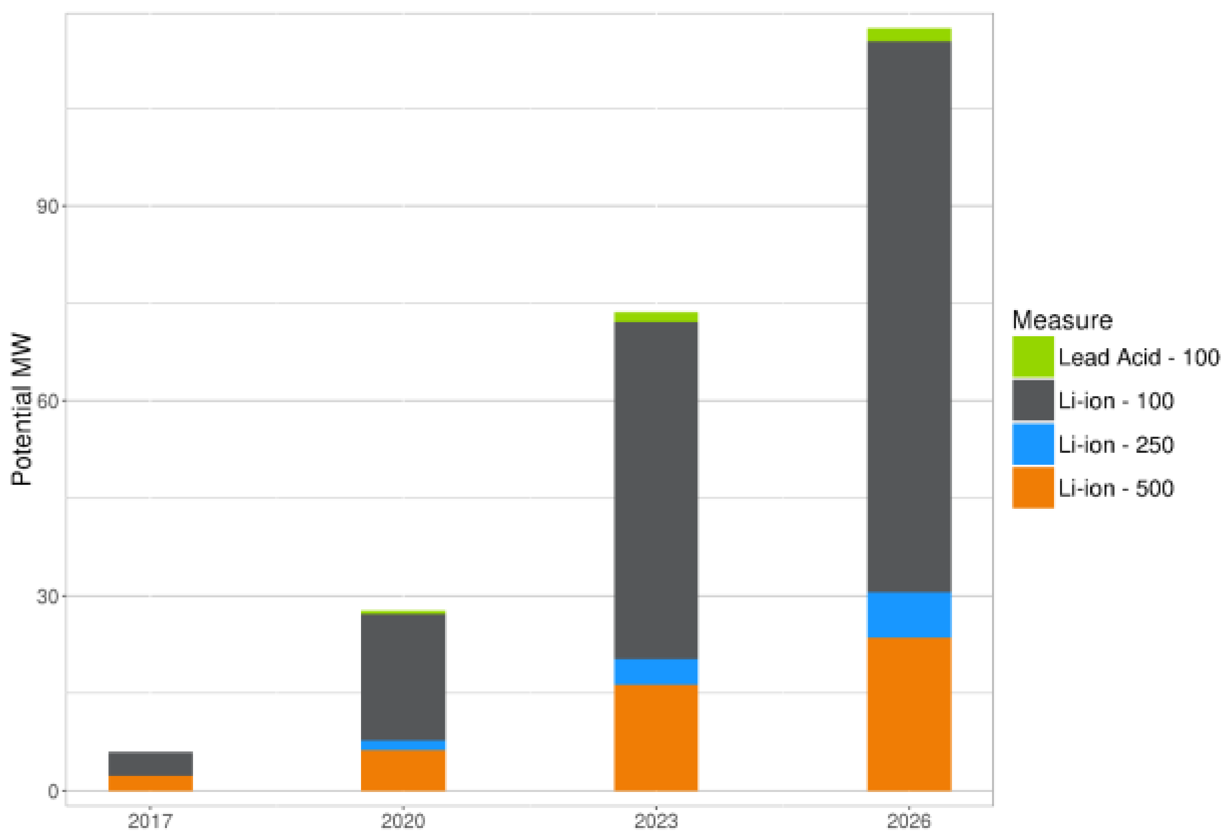
Figure 93 displays results by type of technology selected; with Li-ion and lead-acid batteries shown as being deployed. This fits what is happening in the market now, where Li-ion is the leading technology globally. In addition, this study focused on customer-sited applications for energy cost management, which typically requires a 2- to 4-hour battery duration. Whereas, many of the flow battery technologies that Navigant analyzed (see Section 2.8.1) are optimized for longer durations.

Table 114. Storage Annual Incremental Programmatic Achievable Potential by Measure (MW, Nameplate)

Measure	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Lead Acid - 100	0	0	0	1	1	1	1	2	3	2
Li-ion - 100	4	5	14	20	28	39	52	67	74	85
Li-ion - 250	0	1	1	1	2	3	4	5	6	7
Li-ion - 500	2	2	4	6	9	12	16	21	21	24

Source: Navigant

Figure 93. Storage Annual Incremental Programmatic Achievable Potential by Measure (MW, Nameplate)

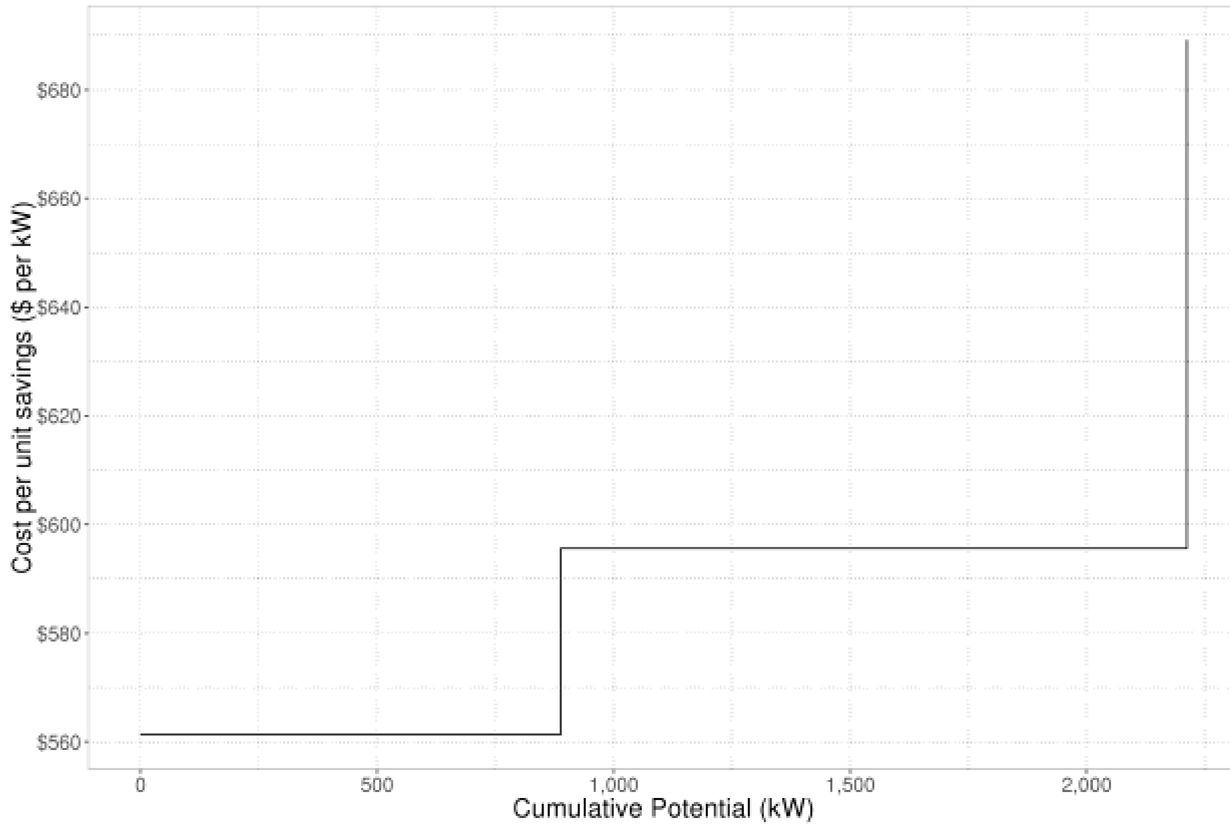


Source: Navigant

7.2.4 Supply Curves

Figure 94 shows the programmatic supply curve for storage. Some portion of the potential is very cost effective. This potential is at customer sites with high peak loads and demand charges. After this, the supply curve goes up to $600/kW and is representative of customers with lower peaks.

Figure 94. Storage Programmatic Supply Curve ($/kW)



** Based on first-year (i.e., 2017) savings*
Source: Navigant

Table 115 identifies the measures that fall into the levelized cost categories of 500-600 $/kW and 600-700 $/kW.

Table 115. Storage Programmatic Supply Curve ($/kW)

Cost per unit savings	
500-600 $/kW	**600-700 $/kW**
Li-ion - 250 : BTM & Utility Control	Li-ion - 100 : BTM & Utility Control
Li-ion - 500 : BTM & Utility Control	Lead Acid - 100 : BTM & Utility Control

7.2.5 Budget Estimates

While energy storage costs are falling quickly, costs are still high enough that CECONY would need to incent customer adoption. As shown in Table 116 below, this could result in an incentives budget of $100M+ per year.[83]

[83] This analysis did not consider administrative costs for storage potential, due to CECONY's limited experience with these program types to inform administrative cost estimates. Thus, the budget estimates presented here are for incentives only.

The Theoretical Achievable results have a different trend than the other two. In looking at Figure 87, the Theoretical Achievable deployment ramps up faster and then levels off after 2022. This is because more of the cost effective storage is deployed in the earlier years. After 2022, not as many cost effective opportunities are available.

Table 116. Storage Achievable Potential Incentives Budget ($M)

Scenario	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Programmatic Achievable	$15	$17	$38	$49	$62	$77	$92	$106	$104	$105
Reduced Programmatic Achievable	$11	$11	$24	$29	$34	$40	$46	$53	$59	$64
Theoretical Achievable	$31	$38	$85	$115	$148	$161	$97	$78	$41	$40

Source: Navigant

8. CONCLUSIONS

This section discusses the overall conclusions from the 2017 DER potential study, beginning with a benchmarking comparison of the potential estimated for CECONY's territory to other jurisdictions across the country, followed by recommendations and best practices for future portfolio development to help realize the DER potential estimated here.

8.1 Benchmarking the Results

After computing the results for each study area, Navigant conducted a thorough benchmarking analysis to contextualize them. The benchmarking analysis included a literature review of recent studies and the extraction of similar best available quantitative data for comparison. This section details how the information from other studies compares to Navigant's conclusions. Table 117 details the sources used to compare each resource.

Table 117. Studies Reviewed for Benchmarking

Resource	Studies Reviewed
Electric Energy Efficiency	• Navigant DSM analysis conducted for utilities around the United States
	• Energy Efficiency Potential Study for Pennsylvania, Statewide Evaluation Team, 2015
	• Preliminary Assessment of Potential 2016-2018, MA Energy Efficiency Advisory Council, 2015
	• Vermont Energy Efficiency Potential Study Update, GDS Associates, 2014
	• Energy Efficiency Potential Study for Consolidated Edison Company of New York, Inc., Global Energy Partners, 2010
Gas Energy Efficiency	• Navigant DSM analysis conducted for utilities around the United States
	• Preliminary Assessment of Potential 2016-2018, MA Energy Efficiency Advisory Council, 2015
	• Potential for Natural Gas Fuel Efficiency Savings in Vermont, Optimal Energy, 2015
	• Energy Efficiency Potential Study for Consolidated Edison Company of New York, Inc., Global Energy Partners, 2010
DR	• Assessment of Demand Response and Advanced Metering, Federal Energy Regulatory Commission (FERC), 2016
	• Act 129 Statewide Evaluator DR Potential for Pennsylvania, Statewide Evaluation Team, 2015
	• DR Market Potential in Xcel Energy's Northern States Service Territory, The Brattle Group, 2014
	• Electric Energy Efficiency Potential for Vermont, GDS Associates & The Cadmus Group, 2011

Resource	Studies Reviewed
	• AmerenUE DSM Market Potential Study, Global Energy Partners, 2010
	• CECONY Callable Load Study, Summit Blue Consulting, 2008
Customer-Sited Generation	• New York Solar Map, City University of New York (CUNY), 2017
	• US DOE CHP Installation Database, US DOE, 2016
	• CHP Technical Potential in the United States, US DOE, 2016 • Navigant benchmarked solar PV + storage against storage targets due to the lack of publicly available solar PV and storage potential studies.
Storage Technology	• No public studies of energy storage potential have been conducted, so Navigant benchmarked achievable potential against stated goals and targets from around the United States.

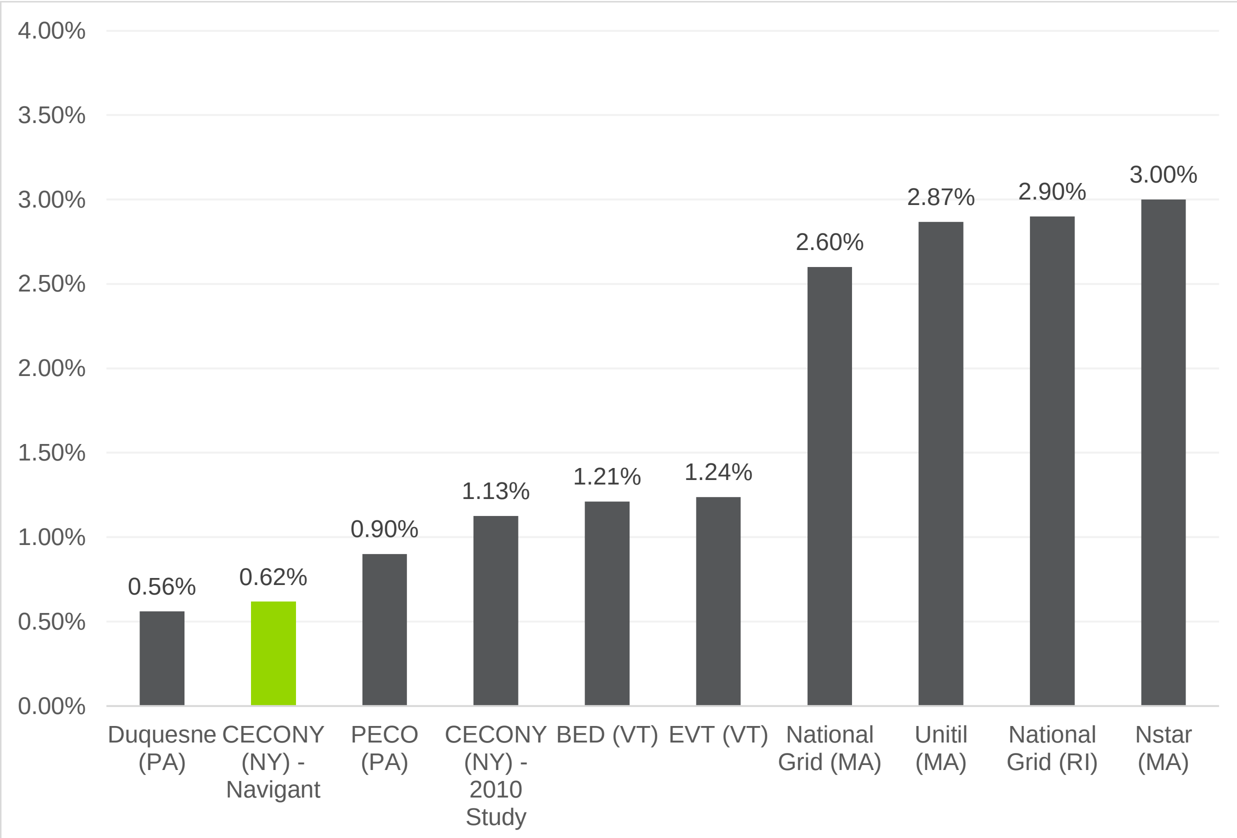
Source: Navigant

It is important to note that potential studies include thousands of data points and assumptions, including utility forecasting, measure parameters, existing saturation levels, avoided costs, program assumptions, measure costs, and other inputs. For this reason, data points and sources may differ from study to study, resulting in different potential savings. Additionally, studies often have various goals, which may also account for differences in study conclusions.

8.1.1 Electric Energy Efficiency Benchmarking

To benchmark the electric energy efficiency results, Navigant examined data at the utility level, specifically larger, investor-owned utilities (IOUs) in urban areas similar to CECONY. Given that energy efficiency savings tend to depend on rates, climate, legislation, and a variety of other factors, Navigant aimed to compare peer utilities in the Northeastern and Mid-Atlantic region. As mentioned, study goals often vary and model different scenarios; therefore, Navigant focused on benchmarking achievable potential for electric energy efficiency due to data availability. Figure 95 shows the average achievable potential savings per year for various IOUs surrounding CECONY, as well as this study's results.

Figure 95. Average Annual Electric Energy Efficiency Achievable Potential Savings by Utility (% of Sales)[84]



Source: Navigant

As shown in Figure 95, potential savings in this region vary from roughly 0.50% to 3.00% of sales. Compared to the rest of the country, the Northeast and Mid-Atlantic region tends to have higher savings than other regions in the United States, as evidenced by these states' high ranking on the American Council for an Energy-Efficient Economy (ACEEE) State Energy Efficiency Scorecard.[85] Additionally, Massachusetts and Rhode Island are considered leaders in this area given they consistently achieve the most annual incremental savings in the nation according to savings data from ACEEE.[86] Higher-than-average savings in this region may stem from high electricity costs, robust energy efficiency legislation, more spending on energy efficiency measures, and more well-established programs, among other factors.

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[84] Many potential studies calculate achievable potential savings as an aggregate total at the end of a forecast period. Since these periods differ from study to study, Navigant estimated the annual average savings per year for illustrative purposes. However, one should note that annual savings tend to vary depending on ramp rates, incentives, and factors in that specific year. 2026 sales used to calculate savings as a percent of sales for CECONY. Note that the CECONY (NY) non-Navigant study refers to an older potential study: Global Energy Partners, "Energy Efficiency Potential Study for Consolidated Edison Company of New York, Inc. Volume 1: Executive Summary", June 2010, http://be-exchange.org/media/07_ConEd_Efficiency_Potential_Study.pdf.

[85] Massachusetts, Vermont, Rhode Island, New York, Connecticut, Maryland, Washington, DC, and Maine all rank within the top 15 on this scorecard; ACEE, "State Scorecard Rank," 2016, http://database.aceee.org/state-scorecard-rank.

[86] ACEEE, "2016 Spending Savings Tables", http://database.aceee.org/sites/default/files/docs/spending-savings-tables.pdf

Meanwhile, CECONY's achievable potential falls near the bottom of the group. This occurrence is partially due to the higher-than-average savings among neighbors in Massachusetts, Vermont, and Rhode Island. The differences in potential savings may be attributed to allocated funding for energy efficiency. For example, according to ACEEE, Massachusetts and Rhode Island spent over 6% of their statewide utility revenues on electric energy efficiency, as compared to New York which spent roughly 1.5%.[87] Differences in local and state legislation and DER goals may affect spending rates and in turn, affect savings. As support for this, CECONY would achieve 1.09% average savings per year under the theoretical achievable scenario within this study, as compared to the 0.62% average savings per year in the programmatic achievable scenario—with the primary difference being that the theoretical achievable scenario has more than double the budget of the programmatic achievable scenario in later years.

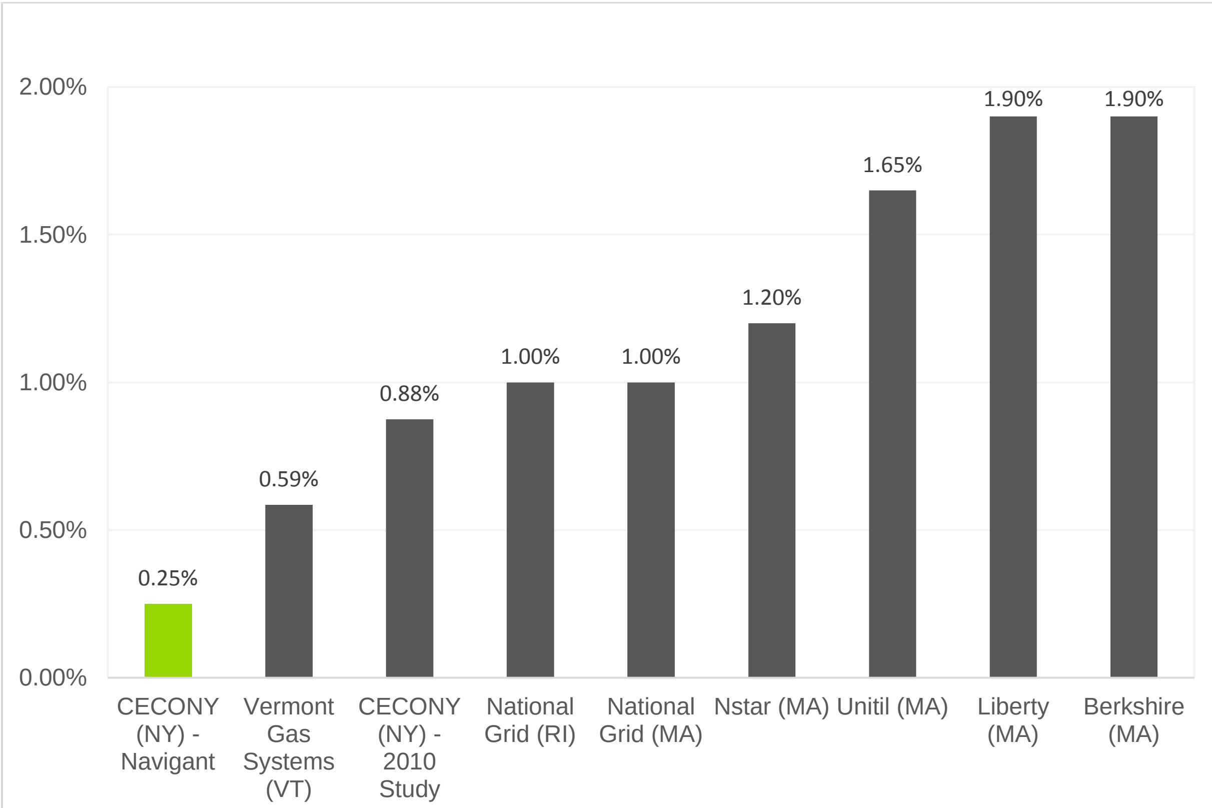
8.1.2 Gas Energy Efficiency Benchmarking

Similar to the electric energy efficiency benchmarking, Navigant surveyed publicly available data on achievable potential savings at the utility level, specifically for IOUs in the region, given that gas energy efficiency savings are dependent on similar factors to electric savings. Figure 96 illustrates the results of the data collection and comparison effort.[88]

[87] Ibid.

[88] Navigant followed the same approach for estimating average annual achievable potential for gas energy efficiency benchmarking as the electric energy efficiency benchmarking. See footnote 41 for more details. Likewise, the CECONY (NY) non-Navigant study refers to the same study by the Global Energy Partners referenced above. 2026 sales used to calculate savings as a percent of sales for CECONY.

Figure 96. Average Annual Gas Energy Efficiency Achievable Potential Savings by Utility (% of Sales)



Source: Navigant

Figure 96 illustrates that annual achievable potential savings for gas energy efficiency ranges from 0.25% to 1.90% of sales for this region, with CECONY at the low end. Like electric energy efficiency, gas energy efficiency savings tend to be higher in the Northeast and Mid-Atlantic regions than in the rest of the country, as evidenced by the aforementioned ACEEE rankings that factor in gas energy efficiency programs and efforts. Massachusetts, Vermont, and Rhode Island are recognized as leaders in both gas and electric energy efficiency, again proven by their leading savings achievements.[89] The differences in potential savings may again be attributed to allocated funding for energy efficiency. As support for this, CECONY would achieve 0.64% average savings per year under the theoretical – high achievable scenario within this study, as compared to the 0.25% average savings per year in the programmatic achievable scenario—with the primary difference being that the theoretical – high achievable scenario has a budget many times higher than the programmatic achievable scenario.

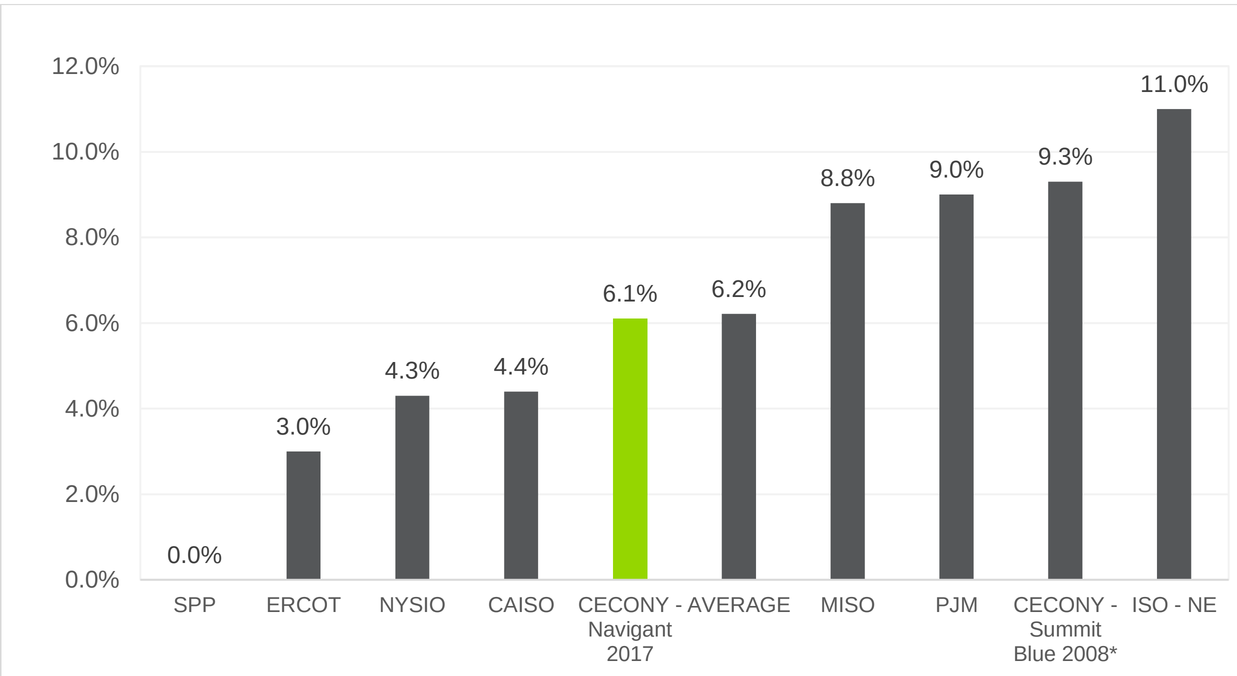
8.1.3 DR Benchmarking

DR potential studies at the utility level are less prevalent compared to energy efficiency studies. Additionally, the studies often do not include incremental potential but rather show potential savings as a percent of peak demand in a given forecast year, which may vary across studies. Reporting units may also vary based on study goals. For these reasons, Navigant benchmarked CECONY's achievable

[89] ACEEE, "2016 Spending Savings Tables".

potential against the Federal Energy Regulatory Commission's (FERC) most recent annual DR potential figures by ISO/regional transmission organization (RTO). The goal of this benchmark is to understand how CECONY's specific territory compares to its own region as well as other areas across the country under current market conditions, as shown in Figure 97. Note that the ISO and RTO data comes from FERC's most recent forecast from 2016 and represents potential in 2015, as compared to Navigant's estimates of CECONY 2017 potential. Navigant used these FERC figures because they represent the best available data at the time of comparison. Navigant also included the results from the 2008 Callable Load Study conducted on behalf of CECONY as an additional point of reference.[90]

Figure 97. 2015 ISO/RTO vs. 2017 CECONY DR Achievable Potential (% of Peak Demand for Respective Year)



*The CECONY Summit Blue 2008 Study represents the potential estimated for 2017 within the study.
Source: Navigant

Figure 97 shows that CECONY's 2026 DR potential falls in the middle of all the ISOs and RTOs and slightly above its own ISO. The differences among ISOs and RTOs may be attributed to different program spending rates and resource focuses. For instance, the Consortium for Energy Efficiency data shows that ISO-NE utilities increased spending in recent years.[91] Additionally, FERC noted that the Southern Power Pool (SPP) did not have a category for DR resources in its recent reporting and therefore appears to be focusing on growing other resources.[92]

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[90] Summit Blue, Con Edison Callable Load Study, May 15, 2008, https://legacyold.coned.com/documents/Con%20Edison%20Callable%20Load%20Study_Final%20Report_5-15-08.pdf.

[91] Consortium for Energy Efficiency (CEE), "Efficiency Program Industry by State and Region Appendices, 2015", 2016, https://library.cee1.org/content/efficiency-program-industry-state-and-region-appendices-2015/

[92] FERC, "Assessment of Demand Response and Advanced Metering", 2016.

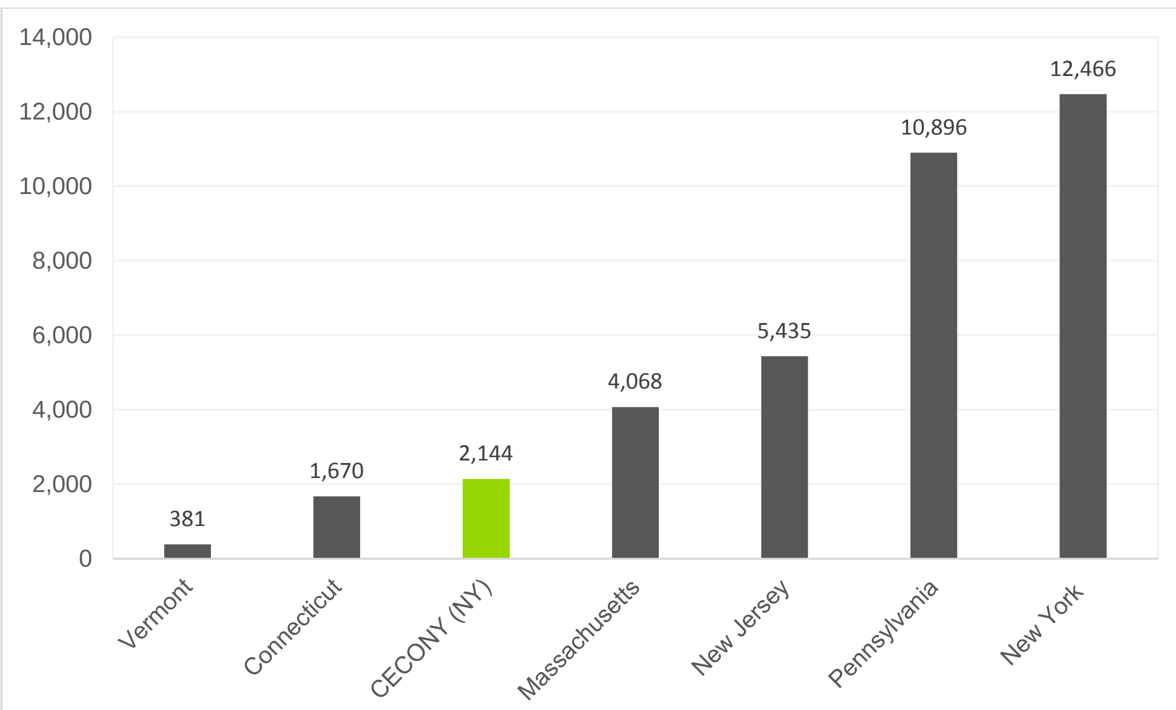
As compared to NYISO's 2015 potential, CECONY has slightly higher potential, showing the potential to grow its savings from DR savings in the coming years. CECONY has slightly lower potential, however than the 2008 Callable Load Study from Summit Blue. These changes may be attributed to changes in regulations and program funding. This is supported by the fact that the FERC results were reported in 2016 and show a significantly lower potential. CECONY may look to its peers in the ISO-NE for practices on expanding its DR programs further in the future.

Navigant chose to compare this study's results to the FERC data rather than individual utilities due to data availability. The publicly available data found by Navigant for individual utilities did not reflect industry standards, according to Navigant expertise.

8.1.4 CHP Benchmarking

Utility-specific potential studies for CHP are not readily available. Instead, Navigant compiled the technical potential estimates of states surrounding New York from the DOE.[93] Figure 98 shows these results graphically.

Figure 98. Comparison of CHP Technical Potential (MW)



Source: Navigant

Including CECONY's currently installed CHP brings the technical potential to 2,144 MW. This figure is smaller than New York, which makes sense given that CECONY's territory resides within the state. Additionally, the figure is larger than Connecticut and Vermont, two areas with less industry than New

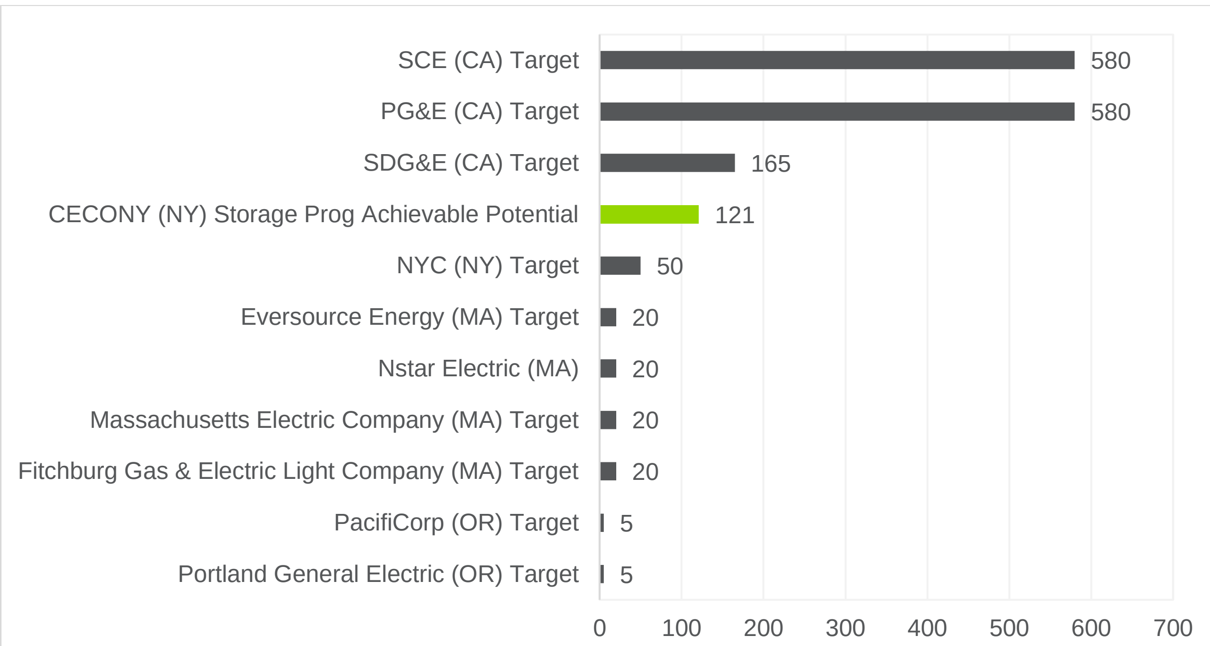
[93] US Department of Energy (DOE), "Combined Heat and Power Technical Potential in the United States," March 2016; DOE, "CHP Installation Database," December 31, 2016, https://doe.icfwebservices.com/chpdb/.

York City and CECONY's territory. Once more the technical potential numbers for CECONY make sense given this fact, because CHP potential depends on commercial and industrial space.

8.1.5 Storage and PV + Storage Benchmarking

Utility and statewide potential studies on energy storage are less prevalent than other resources, since storage as a resource is still in its nascent stages. However, some states and cities have begun analyze the capacity for energy storage more closely in recent years because of policy or regulatory mandates and have instituted targets for its integration. These states include New York, California, Oregon, and most recently Massachusetts. Thus, given these factors, Navigant benchmarked CECONY's potential for energy storage against recent regulatory targets throughout the country.[94] Figure 99. Comparison of Energy Storage Targets and CECONY Achievable Potential indicates CECONY's potential compared to these targets. Navigant included the storage and solar PV + storage results.

Figure 99. Comparison of Energy Storage Targets and CECONY Achievable Potential



Source: Navigant

Figure 99. Comparison of Energy Storage Targets and CECONY Achievable Potential illustrates how energy storage targets vary across the country. Many of these targets stem from legislation spanning only

[94] California Energy Storage Targets: Green Tech Media (GTM), "California Passes Huge Energy Grid Storage Mandate," October 17, 2013, https://www.greentechmedia.com/articles/read/california-passes-huge-grid-energy-storage-mandate; New York City Target: New York City, "Climate Week: Solar Power In NYC Nearly Quadrupled Since Mayor de Blasio Took Office and Administration Expands Target," September 23, 2016; Massachusetts Energy Storage Targets: GTM, "The Long-Awaited Massachusetts Energy Storage Target Has Arrived," June 30, 2017. Upper end MW equivalent calculated from target and distributed evenly amongst IOUs overseen by the MA Department of Public Utilities (DPU). Oregon Energy Storage Target: UtilityDive, "Oregon PUC Release Guidelines for Energy Storage Mandate," January 6, 2017, http://www.utilitydive.com/news/oregon-puc-release-guidelines-for-energy-storage-mandate/433462/. Upper-end MW equivalent calculated from target.

the past few years (2013 onward), indicating that the targets merely represent a starting point for utilities. For example, Oregon mandated that PacifiCorp and Portland General Electric have a minimum of 10 MWh each (translated to roughly 5 MW on the upper end, as shown above), which suggests utilities have more potential for storage than the mandated amount. This fact can also be illustrated by CECONY's incremental annual achievable potential in 2026 of 117 MW for storage and an additional 4 MW for PV and storage combined as compared to New York City's target of 50 MW (100 MWh). This means that programs for this resource have a significant potential for growth in the coming years, especially given advances in technology.

8.2 Best Practices and Recommendations

CECONY offers a diverse set of DER programs to its customers. In the following section, Navigant highlights specific opportunities to further maximize utility market impact. For example, the incentives associated with the programs may need to vary to optimize the tradeoff between participation and budget. Additionally, other non-monetary levers exist that help push program participation and energy savings activities. These include benchmarking, social influence (behavior based tactics), and marketing and outreach.

8.2.1 Portfolio Recommendations

Certain tactics that drive adoption of DER are cross-cutting across programs. Some of the suggestions in this section may already be available to CECONY customers, implying that CECONY should continue to pursue these programs, as appropriate. The list below shows cross-cutting portfolio recommendations, based on Navigant's expertise.

- **High Incentives:** Offering incentives help increase measure adoption. Utilities often use incentives to influence the market. As incentives go up, the measure payback period decreases, increasing market share adoption as indicated by the payback acceptance curve.
- **Innovative Marketing Strategies:** Using high value analytics by looking at segmentation, current and past participation and non-participation, and total customers to pinpoint which customers are underserved and why. Using this data with firmographic or demographic information can inform what the current strengths and gaps are in a portfolio from a customer participation and segmentation standpoint. Geotargeting can be used to identify specific customer groups, send tailored messages, and generally raise energy efficiency awareness.
- **Blitz Campaigns:**[95] Blitz campaigns use various mass media outlets, specifically the Internet, to deliver information about a product or business quickly to a local audience. These efforts often target a geography, specific market segment, or specific technology, and have proven to capture savings quickly. Blitz campaigns sometimes combine direct install or high incentives and multi-pronged marketing.
- **Financing:**[96] Upfront cost is a major barrier to implementing energy efficiency measures for businesses and home owners, and an important goal of efficiency programs is to minimize these

[95] Department of Energy, "Energy Island: A Guide to Creating Your Island Energy Challenge," http://repowerkitsap.org/documents/DOE%20Handbook_FINAL.pdf

[96] American Council for an Energy Efficient Economy, "Energy Efficiency Financing," http://aceee.org/topics/energy-efficiency-financing.

upfront project costs so owners are encouraged to invest in energy efficiency improvements and significant retrofits. Some financing mechanisms include: utility-based on-bill financing, third-party financing, Property Assessed Clean Energy, and micro-financing revolving funds.

- **Multiple-Measure Bonus:**[97] Multi-measure bonus programs promote the installation of multiple energy upgrades simultaneously, a strategy incorporated by some utilities as a motivation to create deeper customer energy retrofits by providing additional monetary incentive when multiple measures are installed together.
- **Pay for Performance:**[98] Generally means an approach in which an incentive is not provided upfront and instead payments are awarded for energy savings on an ongoing basis. This program feature has revolutionized from the days of standard offer programs with payment after a year of measure and verification. Today the penetration of advanced metering infrastructure shows promise for capturing full and whole building savings at real-time.
- **Third-Party Programs:** Many utilities are passing the savings and budget risks on to third-party implementers for customer core programs and niche service offerings. Passing the risk and responsibility onto third-party vendors can result in innovative market deliveries often leading to high value, cost-effective programs.

The following sections provide suggestions for program concepts that could be implemented in the future. Recommendations vary by resource depending on best practices.

8.2.2 *Energy Efficiency*

8.2.2.1 Program Design

Given the maturity of energy efficiency programs, utilities should begin by assessing successful program approaches and adapting these approaches to local conditions. The approach should help build a foundation for the future, including market improvements and changes. Keys to a successful program approach include conducting a thorough market assessment, soliciting stakeholder feedback, offering a wide variety of programs, testing cost-effectiveness against long-term planning, and allowing for the incorporation of new technologies along the way. Additionally, utilities should plan to leverage the breadth of existing external expertise and funding.[99]

8.2.2.2 Customer Adoption

Customer adoption strategies for energy efficiency programs involve investing in educating customers, determining the proper incentives, and keeping the enrollment process simple. Messaging, providing incentives, and process structure should all account for nuances in individual customer segmentation. This means utilities must understand their target markets and align adoption strategies to these markets.

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[97] Detroit Edison Energy, "Multi-measure Incentive Bonus," https://www.newlook.dteenergy.com/wps/wcm/connect/dte-web/home/save-energy/business/programs+and+offers/multi-measure+incentive+bonus

[98] Natural Resources Defense Council, "Putting Your Money Where Your Meter Is: A Study of Pay-for-Performance Energy Efficiency Programs in the United States," https://www.nrdc.org/sites/default/files/pay-for-performance-efficiency-report.pdf

[99] EPA, "Chapter 6: Energy Efficiency Program Best Practices," 2015, https://www.epa.gov/sites/production/files/2015-08/documents/napee_chap6.pdf.

For example, many studies emphasize the need to inform customers about benefits as well as appealing to them emotionally can help drive adoption.[100]

8.2.2.3 Implementation

The implementation process for energy efficiency programs should begin with a pilot program to test new concepts. As utilities adopt more measures over time, they should plan new pilots to help ensure proper program administration. Utilities should also create a firm budget, plan, and evaluation processes from the beginning. Doing so will help utilities measure performance against changes from year-over-year and help drive continuous improvement processes for energy efficiency.

8.2.3 DR

8.2.3.1 Program Design

The DR program design process should take into account DR portfolio considerations, results of recent DR potential studies, input from stakeholders, and program experience. Following the review of those inputs, utilities should assess the available market, customer eligibility, and risk factors to set specific programmatic goals (e.g., targeted number of customers for each program and component). Based on these goals, the utility should develop specific communication and incentive strategies for each target market, balancing compliance and cost-effectiveness. These plans will help inform the detailed program implementation timeline.

8.2.3.2 Customer Adoption

To enhance program outreach, utilities should employ distinct marketing approaches for each DR program and customer type. For instance, C&I customers may require direct contact, whereas residential customers can be reached through bill inserts or print media. Messaging is key to customer adoption, since most customers do not distinguish DR from other efficiency programs. For this reason, utility staff should have enough technical knowledge to answer questions for customers and put any fears at ease. It may also help if a utility can provide customers with real-time energy information to further promote the value of DR. In addition to messaging, utilities must create an incentive approach. Examples of incentive structures for DR programs include one-time payments, capacity payments, and energy payments.

8.2.3.3 Implementation

Program implementation should begin with a pilot program to test the functionality of DR components. The pilot can also help evaluate the program design's performance and assist in making adjustments to further optimize the program. The rest of the programs should be implemented in phases over several years with some legacy programs phasing out over time. Throughout the process, the utility should continue to communicate with customers as well as any vendors or program partners. Given the rate of new technologies emerging to further DR, utilities should revisit their program design and implementation plans regularly to account for industry changes.

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[100] McKinsey & Company, "Using a Consumer-Segmentation Approach to Make Energy-Efficiency Gains in the Residential Market," November 2013.

8.2.4 CHP

8.2.4.1 Program Design

Utilities aiming to incorporate CHP programs into their portfolios have a variety of options to align with unique preferences and constraints. Since C&I customers with a steady baseload electricity usage and thermal demand benefit the most from CHP systems, utilities should implement minimum system eligibility requirements to fully optimize CHP technologies. Table 118 summarizes a few CHP technologies, technology advantages, and available sizes to illustrate system constraints.[101]

Table 118. CHP System Advantages & Sizes

CHP Technology	Advantages	Available Sizes
Steam Turbine	High efficiency; ability to meet more than one site heat grade requirement; power-to-heat ratio can be varied	50 kW – several hundred MWs
Gas Turbine	High reliability; low emissions; no cooling required	500 kW – 300 MW
Microturbine	Small number of parts; compact size; low emissions	30 kW – 250 kW
Fuel Cells	Low emissions; low noise; modular design	5 kW – 2MW

Source: Navigant

In designing CHP programs, utilities should consider technology application, available funding, and anticipated capacity needs. After determining the minimum facility requirements for customers, entities must determine an appropriate incentive structure to entice customers.

8.2.4.2 Customer Adoption

As mentioned above, CHP systems work best when matching both the minimum electric and thermal loads of facilities. To attract the ideal customers, utilities should offer incentives to facilitate the financing of CHP systems. Potential options for incentive payment structures include capacity, energy generation, project cost, tiered capacity, tiered capacity with performance measurements, and hybrid capacity with performance measurements structures. As the technologies become increasingly prevalent, additional incentive structures have and will continue to emerge.

8.2.4.3 Implementation

Due to various considerations necessary for implementing a CHP program, utilities should conduct a thorough market analysis of available short- and long-term opportunities in their specific service area territory. Utilities should then target marketing and outreach efforts based on the market analysis. The latter effort is especially important given that the DOE cited awareness of available incentives, technical

[101] US Environmental Protection Agency (EPA), Combined Heat and Power Partnership, "Catalog of CHP Technologies," March 2015, https://www.epa.gov/sites/production/files/2015-07/documents/catalog_of_chp_technologies_section_1._introduction.pdf

knowledge, and resource availability as barriers to CHP implementation.[102] For this reason, utilities should focus on ensuring the proper financial structures and in-house technical knowledge for successful CHP program implementation.

8.2.5 Residential Energy Storage and Solar PV + Storage

This section focuses on residential storage and residential solar PV + storage best practices. This is because a) most of the achievable potential Navigant forecast for solar PV + storage goes into the residential sector, and b) of the few utility energy storage programs established, most of their focus is residential systems. Most of the commercial energy storage being installed in the United States is via third-party shared savings agreements and is driven by the installer/vendor, not utility involvement.

8.2.5.1 Program Design

Key to any early stage residential storage initiative is establishing a program that is well-defined and highly flexible. These programs should be developed as if they were full commercial offerings, rather than solely pilot projects, with defined revenue streams and payback/performance targets. As the technology and business model are new to most utilities, it is important to allow for the program to evolve over time based on customer feedback and any technical issues that may arise. Program directors should plan to identify and implement lessons learned as they gain a greater understanding of the impacts and benefits.

8.2.5.2 Customer Adoption

It is important to ensure that presenting the program to customers is kept simple, as most customers are likely to be unfamiliar with energy storage technologies and their value. Programs should be designed to target existing concerns or desires of customers. For example, many residential customers place a premium on the ability to have backup power. Some early residential storage programs have marketed their offering mainly as a backup power solution to customers. However, the systems will be used primarily as a tool for the utility to reduce peak demand and congestion in certain parts of the grid.

8.2.5.3 Implementation

When implementing and operating a residential storage network, the focus should remain on having a program that is both well-designed and flexible. By defining the necessary operating parameters and specifications, utilities can select the best vendors and products to meet their requirements upfront, limiting the need to add or change suppliers. A key aspect of this is determining the operating specifications for systems upfront, while also planning for them to change over time. For example, identifying what percentage of battery capacity must always be held in reserve in case of an outage to ensure customers have backup power.[103] Additionally, the optimal charging and discharging patterns to align with grid needs in each area is an important consideration. These parameters should be determined

[102] DOE, "Barriers to Industrial Energy Efficiency," June 2015, https://energy.gov/sites/prod/files/2015/06/f23/EXEC-2014-005846_6%20Report_signed_v2.pdf.

[103] Wired, "What Size Battery Would You Need to Power Your House?" 2015, https://www.wired.com/2015/02/size-battery-need-power-house/.

upfront; however, they are likely to change over time and program operators should have a plan in place to make the necessary adjustments.

The residential energy storage industry is evolving rapidly as new products and business models are developed around the world. New potential revenue streams for these systems, such as frequency regulation, may begin to emerge over the coming years. Ensuring that change and evolution are part of any program upfront will enable utilities to realize the maximum benefits of this technology while reducing the risk of stranding assets.

APPENDIX A. OVERVIEW OF IDSM MODEL

In 2014, E3 created the IDSM Potential Model—a dynamic, geographically specific, and technology integrated analysis tool to assess the market potential and economics of energy efficiency and demand management for cost-effective deferral or avoidance of capital expenditures required to meet growing customer demand.

The IDSM model provides actionable demand-side measures to varied CECONY work groups such as engineering, system operations, transmission planning, resource planning, marketing, and others. This project provides an innovative approach to analyzing not only energy efficiency and DR but includes evaluation of CSG and energy storage. The model was designed to evaluate individual electric networks or groups of networks within the CECONY service territory. The model can be operated to evaluate each network or group of networks to solve for the market potential and economics of energy efficiency, DR, CSG, or energy storage measures in relation to a capital expenditure plan, or it can integrate the four demand management options to develop an integrated set of measures to compare to a traditional infrastructure investment. This feature allows CECONY to develop a tailored approach that best fits each network's customer characteristics, whether the network is primarily residential, commercial, or a mixture. The model is also capable of evaluating whole boroughs and the entire service territory from the bottom-up once all the individual networks are built into the model.

See the report from 2014 in attachment "CECONY - IDSM Final Report Final.docx" with more information on the model.

A.1 Updates to the 2014 Model

Navigant made the following updates to the IDSM inputs relative to the 2014 effort:

- Network load data incorporated for 83 networks in CECONY's service territory
- Updated end-use load shape data
- Global data based on the BCA Handbook:[104]
    - LBMPs by NYISO zone
    - AGCCs by NYISO zone from ICAP Model
    - T&D Marginal Costs
    - Societal Cost of Carbon
    - Carbon Adder to LBMP
    - Discount Rates
    - Loss Factors
- Customer and square footage data
- Updated growth rates

[104] NYSEG and RG&E, "Benefit Cost Analysis Handbook Version 1.1", 2016.

Navigant and E3 made the following updates to the IDSM model functionality:

- Expanded the model to have two model modes: Integrator (original) and Potential Mode
- Potential Mode allows the user to calculate technical, economic, multiple types of achievable potential, and NOP separately for energy efficiency, DR, STR, and CSG
- Incorporation of BCA Handbook
  - Benefit and cost streams
  - Ability to specify avoided costs (energy, demand, and ancillary services) at the NYISO zone level.
- Manual specification of PCAF to allow for user to test conditions where PCAFs are many hours in a row
- Expanded dimensionality of the adoption parameters
- Expanded dimensionality of target payback levels for incentives
- Ability to calculate results based on existing conditions and TRM baselines
- Ability to roll up DR results by program for calibration purposes
- Expanded ability to use three separate escalation factors for load, customer count, and square footage
- Tariff escalation rates based on year

Navigant and E3 made the following updates to the key outputs available in the IDSM model:

- DER potential by borough (i.e., transmission region)
- Detailed BCA results by benefit-cost stream
- Peak day load shape output by incorporating network capacity, delta between before and after measures are incorporated, incorporate time and amount of technology impacts
- Levelized cost outputs

APPENDIX B. SURVEY INSTRUMENTS

B.1 Residential Online Survey Instrument

See attachment "Con Edison Online Residential Ad Hoc Revised 8 11.docx" for the residential online survey instrument.

B.2 Residential Onsite Survey Instrument

See attachment "Navigant - ConEd Residential Field Forms_091916.docx" for the residential online survey instrument.

B.3 Commercial Phone Survey Instrument

See attachment "E16151 Navigant - ConEd Commercial Survey v3 1.docx" for the residential online survey instrument.

B.4 Commercial Onsite Survey Instrument

See attachment "Navigant - ConEd Commercial Field Forms_092116.docx" for the residential online survey instrument.

APPENDIX C. RESULTS

C.1 Residential Survey Results

See the “Res Survey Results” tab of attachment “CECONY_DER Potential Study_Survey Results_RES and COM_2017-05-01_FINAL.xlsx” for the detailed residential survey results.

C.2 Commercial Survey Results

See the “Commercial Survey Results” tab of attachment “CECONY_DER Potential Study_Survey Results_RES and COM_2017-05-01_FINAL.xlsx” for the detailed residential survey results.

APPENDIX D. DATA INPUTS AND OUTPUTS

The following table summarizes the updates made to the global inputs.

Key Inputs

Category	Parameter	Units	Dimensionality	New Source
Model Run Inputs	Network Load	MW	8760, Network	CECONY
Model Run Inputs	Annual Peak Load Reduction Target	MW	Year	Not used, model deployed based on budget, not load reduction target
Model Run Inputs	Total Peak Load Reduction Target	MW	None	Based on Annual Peak Load Reduction Target
Model Run Inputs	Network PCAF Hours	Hours	None	Assume 100 hours
Model Run Inputs	Annual Budget	$	Year	CECONY
Model Run Inputs	Annual Admin Budget	$	Year	CECONY
Model Run Inputs	Total Budget	$	None	Not used
Model Run Inputs	Total Admin Budget	$	None	Not used
Avoided Cost Inputs	System Energy Loss Factor	% of kWh	Customer Service Voltage	DSIP Filing; CECONY's 2007 Electric System Losses study
Avoided Cost Inputs	System Capacity Loss Factor	% of kW	Customer Service Voltage	DSIP Filing; CECONY's 2007 Electric System Losses study[105]
Avoided Cost Inputs	Social Cost Flat Adder	$/kWh	Year	Net Marginal Cost of CO_2 from DPS
Avoided Cost Inputs	Market Generation Energy Prices	$/MWh	Month, Year, NYISO Zone	NYISO CARIS II LBMP 2016-2035
Avoided Cost Inputs	T&D Marginal Costs	$/kW per year	Borough, T&D Component, Year	"Marginal Costs of T and D (NERA Study).docx"
Avoided Cost Inputs	Generation Capacity Marginal Costs	$/kW per year	Year	Staff ICAP Model
Avoided Cost Inputs	Market Ancillary Service Prices	% of $/MWh	Year	2 year historical average of NYISO prices; not used in model
Customer Inputs	Tariff Definitions	varies	8760, Tariff Cost Component, Tariff List	CECONY Tariffs 2016
Customer Inputs	Tariff Escalation Rate	%/year	None	Same as 2014
Financial Inputs	Societal Discount Rate	%	N/A	Assumed 2%
Financial Inputs	Utility WACC	%	N/A	DSIP Filing; CECONY Electric Case 13-E-0300

[105] The results presented within this study are based on a model run that uses a higher loss factor than shown in the DSIP filing to represent slightly higher benefits during peak times. However, all results presented in this report are at the meter-level and may be converted to the wholesale level using the DSIP filing loss factor values.

Category	Parameter	Units	Dimensionality	New Source
Financial Inputs	Customer Discount Rate	%	Customer Segment	Assumed 8%
T&D Investment Plan Inputs	T&D Investment Plan (specific projects)	MW, Years, $	Database	This is not necessary for the potential study portion of the project
T&D Investment Plan Inputs	Capital Recovery Factor	%	None	Assumed 10%
T&D Investment Plan Inputs	TD Investment Inflation Rate	%	None	Assume same as inflation rate (2%)
Load Shapes	Load Shape	kW/hour	8760, Customer Segment, End-Use, Weather Year	Updated by Navigant in 2016
System Inputs	Historical System Loads	MW	8760, Historical Data Year	Sum of Network load shapes
Network Inputs	SQFT by Network	Square Feet	Network, Customer Segment	Accounts and BL Databases from CECONY
Network Inputs	Network Consumption, Demand, Customers	MWh, MW, customer	Network, Customer Segment	Accounts and BL Databases from CECONY
Adoption Parameters	q - "coefficient of imitation"	Dimensionless	Customer Segment, Measure	Navigant 2017; based on various sources
Adoption Parameters	p - "coefficient of innovation"	Dimensionless	Customer Segment, Measure	Navigant 2017; based on various sources
Payback Inputs	Payback Coefficient	Dimensionless	DER Technology	Navigant 2017; based on various sources
DER Incentive Inputs	DER Global Measure Incentives	Varies	DER Technology	N/A
DER Incentive Inputs	DER Measure Incentives	Varies	DER Technology	Automatically set
DER Incentive Inputs	DER Measure Third-Party Incentives	Varies	DER Technology	N/A; if used, would come from DSIRE or NYSERDA
DER Incentive Inputs	DER Measure Utility Incremental Cost	Varies	DER Technology	N/A

Key Outputs

Category	Parameter	Units	Dimensionality
Potential	Annual Potential	kWh (energy efficiency), nameplate kW (CSG, STR, DR), weighted average network kW (energy efficiency, CSG, STR, DR)	Year, DER Category, Measure, Customer Segment, Baseline Method, Potential Type, Borough
BCA	Benefit-Cost Analysis Results	NPV $	Year, DER Category, Measure, Customer Segment, Benefit-Cost Stream
Supply Curve	Supply Curve	$/kWh and Cumulative MW (or Cumulative MWh)	Year, DER Category, Measure, Customer Segment

APPENDIX E. LOAD PROFILES

See attachment “ConEdison 2013 Loadshapes Library and Tool - Final.xlsb” for the detailed load profiles used in the study.

APPENDIX F. ELECTRIC ENERGY EFFICIENCY TECHNOLOGY CHARACTERIZATION AND RESULTS

F.1 Measure List and Measure Characteristics Data File

See attachment “EE.csv” for the detailed electric energy efficiency measure list and measure characteristics data.

F.2 Detailed Results

See attachment “IDSM EE Output_2017-09-25.xlsx” for the detailed electric energy efficiency results for all scenarios.

APPENDIX G. GAS ENERGY EFFICIENCY TECHNOLOGY CHARACTERIZATION AND RESULTS

G.1 Measure List and Measure Characteristics Data File

See attachment "CECONY Core Gas EE Measure 2017-10-04.xlsx" for the detailed gas energy efficiency measure list and measure characteristics data.

G.2 Detailed Results

See attachment "ConEd DSMSim Gas EE Output 2017-09-26.xlsx" for the gas electric energy efficiency results for all scenarios.

APPENDIX H. DR TECHNOLOGY CHARACTERIZATION AND RESULTS

H.1 Measure List and Measure Characteristics Data File

See attachment “DR.csv” for the detailed DR measure list and measure characteristics data.

H.2 Detailed Results

See attachment “IDSM DR Output_2017-10-08.xlsx” for the DR results for all scenarios.

APPENDIX I. CSG TECHNOLOGY CHARACTERIZATION AND RESULTS

I.1 Measure List and Measure Characteristics Data File

See attachment "CSG.csv" for the detailed CSG measure list and measure characteristics data.

I.2 Detailed Results

See attachment "IDSM CSG Output_2017-10-02.xlsx" for the CSG results for all scenarios.

APPENDIX J. STORAGE TECHNOLOGY CHARACTERIZATION AND RESULTS

J.1 Measure List and Measure Characteristics Data File

See attachment “STR.csv” for the detailed storage measure list and measure characteristics data.

J.2 Detailed Results

See attachment “IDSM STR Output_2017-10-12.xlsx” for the storage results for all scenarios.

APPENDIX K. NATURAL GAS SUPPLEMENTAL REPORT

Attachment "CECONY_2017_DER Potential_Gas EE DR Supplemental_Final_11-22-17.docx" contains the supplemental report that Navigant prepared for CECONY to further assess the potential for natural gas energy efficiency and DR. The work presented in this supplemental report includes the following three tasks for natural gas energy efficiency and one task for natural gas DR potential analysis:

1. Adding five new energy efficiency measures, not included in the core DER potential analysis
2. Reporting energy efficiency potential savings for peak day impacts, which requires defining the gas peak period
3. Reporting energy efficiency potential savings by gate station
4. Conducting a gas DR potential analysis

All methodologies and approach to this supplemental natural gas potential analysis are based on the core DER potential study.

Navigant conducted this work following the completion of the core DER potential study as a separate add-on effort; thus, the results from this add-on work have not been integrated into the core DER potential study. The natural gas report is provided here for reference.

APPENDIX L. CODES AND STANDARDS SUPPLEMENTAL REPORT

Attachment “CECONY_2017_EE Potential_Codes Standards Supplemental_Final_11-17-17.docx” contains the supplemental report that Navigant prepared for CECONY to assess the impacts of changes to codes and standards on the energy efficiency electric and gas potential savings estimated in the core DER potential study. The C&S project tasks included:

1. Review updates to the codes and standards
2. Apply updates to affected measures and potential changes to measure adoption
3. Model updates to the energy efficiency potential savings
4. Identify potential programmatic impacts

All methodologies and approach to this supplemental natural gas potential analysis are based on the core DER potential study. Navigant presents the results for only the programmatic, code baseline scenario from the core DER potential study and provides quantitative descriptions of the effects of these codes and standards changes.

Navigant conducted this work following the completion of the core DER potential study as a separate add-on effort; thus, the results from this add-on work have not been integrated into the core DER potential study. The codes and standards report is provided here for reference.