Estimating the Impact of Carbon Legislation for NYC Buildings on Electricity Costs

Prepared for the New York Energy Consumers Council by London Economics International LLC

October 26, 2018

London Economics International ("LEI") was engaged by the New York Energy Consumers Council ("NYECC") to perform an analysis of potential impacts on electricity costs from proposed carbon legislation (Bill No. 1745) in New York City ("NYC"), which would impose limits on the use of fossil fuel and total energy usage for buildings in NYC. This document estimates the impact on NYC capacity and transmission & distribution system costs due to increased peak electric demand following the electrification of buildings in order to comply with the proposed limits on fossil fuel usage. Using a Base Case set of assumptions, LEI estimated that the NYC peak load by 2035 could be approximately 3,148 MW higher than currently forecast. This additional peak load could lead to an increase of $1.5 billion in capacity costs for that year, in addition to $1.4 billion annually in additional costs associated with expanding ConEd's electric transmission and distribution network in NYC.

Table of contents

Table of figures

List of acronyms

AFUE	Annual Fuel Utilization Efficiency
BPTF	Bulk Power Transmission Facilities
BTM	Behind-the-Meter
BTU	British Thermal Units
CARIS	Congestion Assessment and Resource Integration Study
CES	Clean Energy Standard
CONE	Cost of New Entry
ConEd	Consolidated Edison Company of New York
COP	Coefficient of Performance
CRP	Comprehensive Reliability Plan
CSPP	Comprehensive System Planning Process
DCR	Demand Curve Reset
DER	Distributed Energy Resource
DMNC	Dependable Maximum Net Capability
DOE	Department of Energy
DSIP	Distribution System Implementation Plan
DSM	Demand Side Management
ECM	Energy Conservation Measures
EF	Energy Factors
EFORd	Estimated Forced Outage Rate on demand
EIA	Energy Information Administration
EREE	Office of Energy Efficiency and Renewable Energy
EUI	Energy Use Intensity
FERC	Federal Energy Regulatory Commission
GHG	Greenhouse Gas
HVDC	High Voltage Direct Current
ICAP	Installed Capacity
ILRP	Integrated Long Range Plan
IRM	Installed Reserve Margin
LCR	Locational Capacity Requirements
LEI	London Economics International, LLC
LL84	Local Law 84
LL87	Local Law 87
LOLE	Loss of Load Expectation
LSE	Load Serving Entities
LTPP	Local Transmission System Planning Process

MMBtu	Million British Thermal Units
NERC	North American Electric Reliability Corporation
NPCC	Northeast Power Coordinating Council
NREL	National Renewable Energy Laboratory
NWS	Non-Wires Solutions
NY PSC	New York Public Service Commission
NYC	New York City
NYCA	New York Control Area
NYECC	New York Energy Consumers Council
NYISO	New York Independent System Operator
NYSERDA	New York State Energy Research and Development Authority
NYSRC	New York State Reliability Council
OpenEI	Open Energy Information
PPTPP	Public Policy Transmission Planning Process
RECS	Residential Energy Consumption Survey
REV	Reforming the Energy Vision
RNA	Reliability Needs Assessment
RPP	Reliability Planning Process
T&D	Transmission and Distribution
TMY	Typical Meteorological Year
TO	Transmission Owner
UCAP	Unforced Capacity
ZEC	Zero-Emission Credits

1 Executive Summary

London Economics International ("LEI") was engaged by the New York Energy Consumers Council ("NYECC") to perform an analysis of potential impacts on electricity costs from proposed carbon legislation (Bill No. 1745) in New York City ("NYC"), which would impose limits on the use of fossil fuel and total energy usage for buildings in NYC.

For those buildings in NYC whose usage of fossil fuel is currently over the proposed limit, there are a few options. Notably, building owners can offset a portion of their fossil fuel usage through purchases of renewable energy, or invest in energy efficiency measures in order to reduce their overall usage of energy, including fossil fuel. Another measure that can be undertaken to reduce the reliance on fossil fuel is to convert some or all of the building systems to electricity. However, building electrification will cause an increase in electric demand will in turn will result in additional costs for all electricity consumers in NYC due to the need for additional generation resources to meet the additional demand, and a need for additional transmission/distribution infrastructure within ConEd's service territory in NYC.

1.1 Building electrification impact on electric demand

The first step in the process to estimate a range of costs due to building electrification is to estimate the impacts on NYC's peak electric demand, resulting from the conversion of building systems from fossil fuels to electricity in order to comply with the proposed limits.

LEI established a baseline fossil fuel consumption for buildings in NYC affected by the proposed legislation based on publicly available information. LEI then estimated the additional electric load that could result from building electrification, including several parameters and conversion factors in this calculation:

- the proposed fossil fuel usage limits on buildings based on their primary and other usages;
- potential reductions in energy usage from energy efficiency projects; and
- the relative efficiency of fossil fuel versus electric systems, mainly for space and water heating.

Finally, using seasonal and hourly consumption patterns, LEI estimated a range of additional peak demand quantities by analyzing a Base Case electrification scenario and several sensitivity sets of assumptions, varying the assumptions used for each of the parameters listed above.

For all scenarios, LEI assumed that building owners would invest in energy efficiency measures before contemplating conversion of heating systems to electricity since the existing LL87, which requires an audit and retro commissioning every 10 years, will help building owners identify cost effective energy efficiency retrofits to improve the energy performance of their buildings gradually over time between now and 2035.

In the Base Case, LEI assumed that buildings are able to meet 50% of the average energy efficiency gains that have been identified in past energy audit recommendations; LEI then assumed that those buildings which are still over the proposed fossil fuel usage limits will convert their systems to electric usage. LEI's sensitivity cases 1 through 3 assume varying levels of energy efficiency gains. Finally, Case 4 is similar to the Base Case but with the assumption that the technological advancements assumed in the Base Case for electric space and water heating efficiency rates are not achieved,[1] leading to 50% lower efficiency rates than in the Base Case. Figure 1 summarizes LEI's modeling scenarios.

Figure 1. Summary of modeling scenarios

Modeling scenarios		
Base Case		Buildings are able to meet 50% of the average energy efficiency gains from energy audit recommendations; buildings electrify if they are over the limit
Case 1	20% of energy efficiency targets	Buildings are able to meet 20% of the average energy efficiency gains from energy audit recommendations; buildings electrify if they are over the limit
Case 2	100% of energy efficiency targets	Buildings are able to meet 100% of the average energy efficiency gains from energy audit recommendations; buildings electrify if they are over the limit
Case 3	150% of energy efficiency targets	Buildings are able to meet 150% of the average energy efficiency gains from energy audit recommendations; buildings electrify if they are over the limit
Case 4	Lower electric heating efficiency	Same assumptions as Base Case, but efficiency rates for electric space heating (COP) and water heating (EF) are 50% lower than in Base Case

As illustrated in Figure 2, total additional NYC winter peak load resulting from building electrification is approximately 7,210 MW in LEI's Base Case, and ranges from 4,826 MW to 14,420 MW in the various sensitivity scenarios.[2]

Figure 2. Total incremental winter peak load in NYC from building electrification (MW)

MW	Incremental winter peak load		
	Residential	Commercial	Total
Base Case	3,695	3,515	7,210
Case 1	4,026	3,768	7,794
Case 2	2,747	3,123	5,870
Case 3	2,159	2,667	4,826
Case 4	7,391	7,029	14,420

For comparison purposes, the winter peak load in NYC for 2017 was 7,822 MW while the summer peak load was 10,241 MW. The 2035 forecast values are 7,396 MW and 11,458 MW for the winter

---

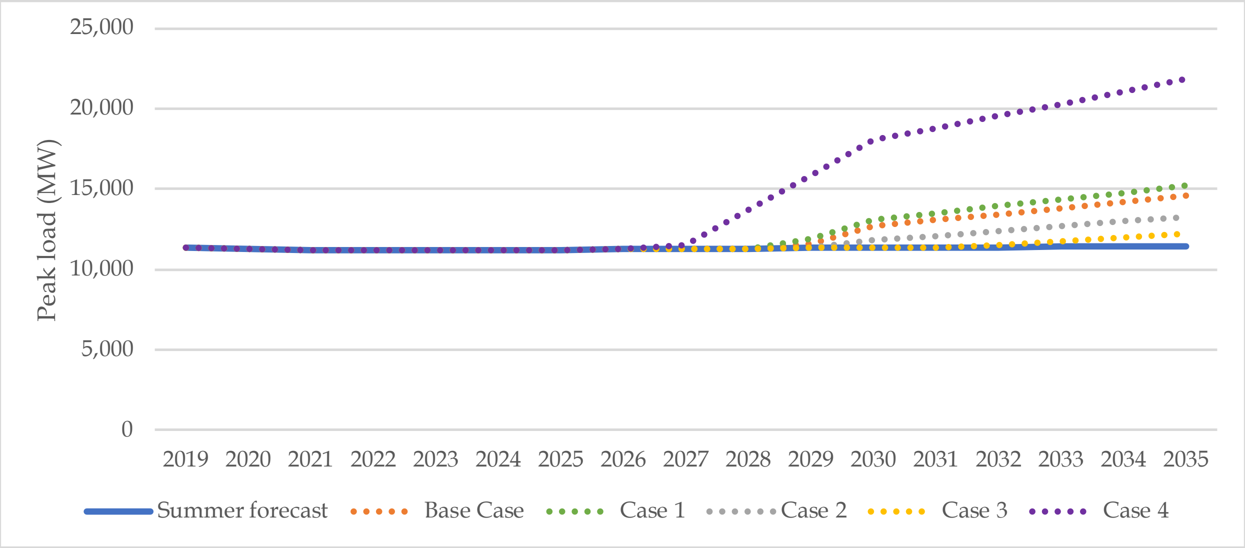
[1] It is LEI's understanding that large heat pump technology is not currently commercially available for use in large commercial or institutional buildings. Should the expected technological developments be delayed and efficiency values lower than those assumed in LEI's Base Case, the impact of building electrification on NYC load could be higher.

[2] The incremental peak load values are based on LEI's analysis of impact from electrification of existing buildings, and do not take into account new buildings, electric vehicles, or other factors which can impact electric demand.

and summer NYC peak loads.[3] As such, by 2035, NYC would become a winter-peaking region since the additional winter load on top of the forecast winter peak load (7,210 MW + 7,396 MW = 14,606 MW in the Base Case) would then surpass the summer peak load (11,458 MW).

In Figure 3 below, the solid blue line represents the current NYC (summer peaking) peak load forecast, absent any additional building electrification as a result of Intro 1745, which we can consider a "baseline". Under the various building electrification scenarios, the annual peak load starts diverging from the baseline from 2027-2029, increasing until 2035.

Figure 3. NYC annual peak load following building electrification



Source: NYISO 2018 Load and Capacity Data report; LEI

Furthermore, LEI's analysis shows that additional electric load in NYC resulting from building electrification could range from 4.2 TWh to approximately 13.4 TWh annually by the time the proposed limits are enforced (2030 to 2035). Considering New York State's Clean Energy Standard mandating that 50% of the state's load be served by renewable energy by 2030, this would result in an additional 2.1 TWh to 6.7 TWh of renewable energy required. If however the increased load from building electrification is realized faster than the additional renewable energy can come online, this could result in a temporary uptick in carbon emissions in NYC.

1.2 Building electrification impact on capacity and transmission costs for NYC consumers

In order to meet the increased peak demand in NYC, new resources would need to come online such as generation resources, interruptible load, or transmission infrastructure. When foreseeing such a need, NYISO's goal is to stimulate market response through appropriate capacity market price signals to ensure sufficient resources are available to meet peak load. As such, NYC

---

[3] NYISO. "2018 Load and Capacity Data". April 2018

consumers would not need to directly fund the construction of new generation capacity, or alternatives such as external controllable lines. Rather, the market construct dictates that Load Serving Entities ("LSE") must procure an amount of capacity product from the capacity market (through auctions or bilateral contracts) consistent with their share of the installed capacity requirement, then distribute costs among consumers through electric rates. If Intro 1745 were to be adopted as proposed, the increasing NYC peak load in the late 2020s would translate into a larger quantity of capacity resources clearing the auctions, at a price sufficient to incentivize construction of new in-city resources. This would thus result in a higher overall cost for capacity resources for NYC consumers.

In order to estimate additional capacity costs, LEI prepared an outlook of capacity market drivers until 2035 under the baseline conditions, as well as for the various building electrification scenarios.[4] Figure 4 illustrates the total capacity costs, and resulting average capacity price, for NYC consumers for 2030 and 2035.[5] The figure also illustrates the overall cost of capacity, and prices, for NYC consumers under the various scenarios related to building electrification.

Figure 4. NYC consumers capacity costs under various scenarios

		Baseline	Building electrification scenarios				
			Base Case	Case 1	Case 2	Case 3	Case 4
2030	Total capacity cost [$ billion]	$1.39	$2.33	$2.43	$2.13	$1.39	$3.57
	Peak load [MW]	11,346	12,666	13,084	11,800	11,346	18,028
	Capacity price [$/kW-yr]	$122.4	$183.9	$185.4	$180.5	$122.4	$198.2
	Increase from baseline		*50.2%*	*51.5%*	*47.5%*	*0.0%*	*61.9%*
2035	Total capacity cost [$ billion]	$1.62	$3.12	$3.27	$2.78	$2.51	$4.99
	Peak load [MW]	11,458	14,606	15,190	13,266	12,222	21,816
	Capacity price [$/kW-yr]	$141.4	$213.7	$215.4	$209.4	$205.4	$228.9
	Increase from baseline		*51.1%*	*52.3%*	*48.1%*	*45.2%*	*61.9%*

Under baseline conditions, i.e. without additional load from building electrification as a result of Intro 1745, the total cost of purchasing capacity for NYC consumers would be $1.39 billion in 2030, and $1.62 billion in 2035 (nominal dollars). Assuming that Intro 1745 is adopted as proposed, the annual capacity costs for NYC consumers would increase to $2.33 bllion, resulting in an average capacity price increase of 50% in 2030 for the Base Case scenario, and range from no change to as high as $3.57 billion (62% price increase) in the various sensitivity analyses. The relatively small difference in price increase between the sensitivity scenarios is due to the fact that

---

[4] See Section 5.2 and appendix B for more details on LEI's methodology and assumptions.

[5] Total capacity costs and average capacity price include the sum of costs for NYC consumers to purchase in-city capacity to meet the NYC Locational Capacity Requirement ("LCR"), together with additional capacity purchased in the G-J locality to meet the G-J LCR and additional capacity purchased in the NYCA zone to meet the overall statewide installed capacity requirement.

the NYC capacity price reaches the net Cost of New Entry ("net CONE") level,[6] incentivizing the construction of new resources to maintain the resource adequacy reliability standard. There would also be a capacity price increase for New York State consumers outside of NYC, as discussed in the body of this report.

To accommodate a large increase in end-use electric demand, the Transmission and Distribution ("T&D") network in the City would also need to be upgraded and expanded to meet reliability needs. LEI reviewed past ConEd infrastructure development plans to estimate increased T&D costs due to building electrification.

As depicted in Figure 5, LEI estimated incremental T&D investment costs of $11.11 billion in the Base Case, and ranging from $2.70 billion in Case 3 to as much as $36.55 billion in Case 4. ConEd would spread out the investment over a period of years prior to 2035, so that the T&D system is ready by the time the full additional load from building electrification is realized. Using a generic annualization factor to convert the investment cost into annual revenue requirement for ConEd, LEI estimated that annual costs for NYC consumers from 2035 onward could represent $1.44 billion in the Base Case, and range from $0.35 billion in Case 3 to $4.75 billion in Case 4.

Figure 5. Estimated NYC transmission and distribution costs due to building electrification

	Incremental Peak Load (MW)	Total T&D costs ($ billion)	Annual T&D costs ($ billion)
Base Case	3,148	$11.11	$1.44
Case 1	3,732	$13.17	$1.71
Case 2	1,808	$6.38	$0.83
Case 3	764	$2.70	$0.35
Case 4	10,358	$36.55	$4.75

Note: LEI annualized the T&D investment costs using a generic 13% factor, which is meant to cover financing costs as well as O&M costs for the transmission investment

Should Intro 1745 be adopted as proposed, T&D upgrade costs in NYC will be necessary to accommodate an increase in peak load caused by building electrification. While the above calculation of potential T&D costs is a very high-level approximation, it is apparent these costs are significant and could potentially be higher than the cost related to additional generation infrastructure.

---

[6] Net CONE represents the annualized cost of constructing and operating a generic peaking plant, minus expected annual energy and ancillary service revenues.

2 Summary of proposed legislation

On October 31, 2017, New York City council introduced legislation known as Intro 1745, which would impose limits on the use of fossil fuel and energy for buildings in NYC.[7] The legislation would affect "covered buildings", which is a definition that has been used for other green building legislation. It includes buildings which exceed 25,000 gross square feet, two or more buildings on the same tax lot or shared condominium ownership which exceed 100,000 gross square feet, and city buildings.[8] The legislation, if adopted as proposed, would come into effect January 1, 2030 for buildings which do not have any rent-regulated units, and January 1, 2035 for those that do.

Figure 6. Proposed fossil fuel use limits (all values per square feet)

Occupancy Group	kBTU/yr
A: Assembly (eg restaurants, stadiums, houses of worship)	60
B: Business (eg offices, banks, professional services)	35
E: Educational (eg schools, libraries)	45
F: Factory and Industrial or B: non-production laboratory	80
B: Civic administrative facility for emergency response services, I-1: Supervised residential (eg halfway houses) or I-4: Custodial care facilities (eg day nurseries)	50
H: High Hazard (eg sales and storage of flammable liquids), I-2: 24 hour medical related buildings (eg hospitals or nursing homes) or I-3: Correctional centers	100
M: Mercantile (eg retail stores and markets)	45
R: Residential that does not contain any rent-regulated units or affordable units	50
R: Residential that contains one or more affordable units and no rent-regulated units	55
R: Residential that contains one or more rent-regulated units	To be established
R: Residential that (i) contains no rent-regulated units and (ii) is receiving steam produced within a separate building or producing steam for use in two or more buildings that are in existence as of January 1, 2018	70

Source: City of New York. USE AND OCCUPANCY CLASSIFICATION. <https://www1.nyc.gov/assets/buildings/apps/pdf_viewer/viewer.html?file=2014CC_BC_Chapter_3_Use_and_Occupancy_Classification.pdf&section=conscode_2014>

In terms of fossil fuel use, the legislation places usage limits (in terms of thousands of British Thermal Units ("Btu"), or kBtu per year) on buildings, which vary depending on the occupancy

---

[7] The New York City Council. *Int 1745-2017.* <http://legistar.council.nyc.gov/LegislationDetail.aspx?ID=3199728&GUID=C3B86314-67AF-4037-B8CD-2CA4C10E631D&Options=ID%7CText%7C&Search=1745>

[8] New York City Administrative Code. *§ 28-308.1 Definitions.* <http://library.amlegal.com/nxt/gateway.dll/New%20York/admin/title28newyorkcityconstructioncodes/chapter3maintenanceofbuildings?f=templates$fn=default.htm$3.0>

group of the building, as per New York City building code. Buildings with multiple occupancy groups develop a weighted average limit, based on the conditioned floor area usage.[9] As shown in Figure 6, residential buildings (no rent regulated and one or more affordable units) would be limited to 55 kBtu/yr (50 kBtu/yr if no rent regulated or affordable units), businesses would be limited to 35 kBtu/yr, while factories would be limited to 80 kBtu/yr. Buildings with rent-regulated residential units will have targets set by January 1, 2021.

In addition to reducing fossil fuel use, buildings will be able to offset their usage up to 9% by generating energy from renewable sources ("green energy"), purchasing green energy from offsite, or investing in green energy systems. Also, if the building is in compliance with New York City lighting standards, buildings will be able to offset fossil fuel use by 1%.

The legislation also details whole building energy targets and directs targets and penalties to be developed by January 1, 2021. If no such limit is developed, the limit would become the Energy Star rating of the sixtieth percentile of a similar building in 2016. However, the fossil fuel use limit section of the legislation is expected to have the greatest impact on electrification of buildings and therefore LEI will focus its modeling efforts on those proposed limits on fossil fuel use.[10]

---

[9] Conditioned floor area defined in the NYC Energy Conservation Code as the horizontal projection of the floors of the area within a building which is directly or indirectly heated or cooled using fossil fuel or electricity. < https://www1.nyc.gov/assets/buildings/apps/pdf_viewer/viewer.html?file=2016ECC_CHR2.pdf&section=energy_code_2016>

[10] LEI understands that a new version of the legislation is being discussed (the REBNY-NRDC-Urban Green joint proposal), however LEI's analysis focused on the language of Intro 1745 as proposed.

3 Estimate of building electrification impact on NYC electric demand

For those buildings in NYC whose usage of fossil fuel to power their systems is currently over the proposed limit, there are a few options. As mentioned in the summary of the proposed legislation (Section 2), building owners can offset up to 10% of their fossil fuel usage through generation or purchase of green energy, and being in compliance with the City's lighting standards. In addition, building owners can invest in energy efficiency measures in order to reduce their overall usage of energy, including fossil fuel. Finally, a final measure that can be undertaken to reduce the reliance on fossil fuels is to convert some or all of the building systems to electricity.

Since New York State adopted the Clean Energy Standard in 2017, mandating that 50% of the State's load be served by renewable resources by 2030, it is reasonable to assume that building electrification will result in a decrease in greenhouse gas emissions, as stated in the proposed legislation. However, system conversion will result in additional costs for building owners, and a sharp increase in electric demand will also result in additional costs for all NYC electricity consumers due to the need for additional generation resources, and T&D system reinforcements.[11]

The first step of the process to calculate this range of costs is to estimate a range of possible impacts on NYC's peak electric demand, resulting from the conversion of building systems from fossil fuel to electricity in order to comply with the proposed limits. The methodology and results from this first step are the focus of this section. LEI's methodology to calculate the impact of building electrification on peak load includes three major steps, as illustrated in Figure 7.

Figure 7. Methodology to estimate peak load impacts from building electrification

1. Baseline fossil fuel consumption

- Calculate the baseline fossil fuel consumption for all buildings in NYC subject to the proposed legislation

2. Additional electric load

- Calculate the expected aditional annual electric energy demand resulting from building electrification given current fossil fuel usage, proposed limits, and energy efficiency measures

3. Impact on NYC peak load

- Using seasonal and hourly consumption patterns, estimate the impact on NYC peak load from the additional electric demand

---

[11] LEI did not study the cost, or perform any cost-benefit analysis, of converting the building systems to electricity for building owners as that task falls outside its mandate.

3.1 Baseline fossil fuel consumption

To determine the baseline fossil fuel consumption for NYC buildings, LEI used the City's Energy and Water Data Disclosure for calendar year 2016.[12] The data contains comprehensive information on the consumption of fuel oil #1, fuel oil #2, fuel oil #4, fuel oil #5 and #6 (grouped), diesel, district steam, natural gas, and electricity use for buildings that are greater than or equal to 50,000 square feet.[13,14] When analyzing the data, LEI used a data cleaning methodology to remove data that had source Energy Use Intensities ("EUI") above two standard deviations. The data cleaning methodology is explained in the appendix A (Section 7.1).

Energy use data for buildings between 25,000 and 50,000 square feet is not yet available through the City's LL84 efforts. As a result, LEI extrapolated the energy consumption of these buildings by determining their total square feet, then applying the average site EUI by fuel type obtained through from the dataset described above. The methodology to determine the contribution of mid-sized buildings is further explained in Appendix A (Section 7.2).

The total annual fossil fuel use for buildings subject to the proposed legislation in NYC is approximately 137,883,849 million Btu ("MMBtu"), primarily driven by natural gas (110.6 million MMBtu) use as shown in Figure 8. Fuel oil #2 and #4 follow suit with 14.2 million MMBtu and 11.0 million MMBtu respectively. Current use of fuel oil #5 and #6 totals 2.0 million MMBtu and a small portion of buildings continue to use fuel oil #1 and diesel, together totaling less than 0.1 million MMBtu per year.

For comparison purposes, other sources of energy for NYC buildings subject to the proposed legislation include district steam (20.5 million MMBtu) and electricity (95.7 MMBtu) annually.

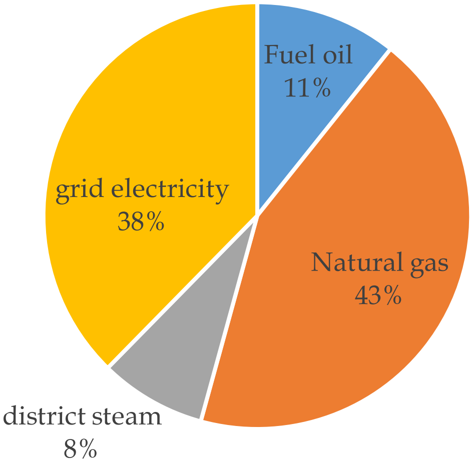
---

[12] The NYC Benchmarking Law (Local Law 84) requires owners of large buildings (greater than 50,000 sq. ft.) to measure annual energy and water consumption and submit the data to the City using the U.S. EPA's online tool. Available here: <http://www.nyc.gov/html/gbee/html/plan/ll84_scores.shtml>

[13] The data for certain buildings below 50,000 sf is also included, although in 2017 data reporting for those buildings was not mandatory.

[14] The Energy and Water Data Disclosure is the most comprehensive information available but the data is only inclusive of buildings complying with the benchmarking law. NYC reported that compliance with LL84 has continued to improve and in 2015, 90% of buildings required to benchmark submitted data. LEI is cognizant that this dataset is not a complete representation of NYC buildings and data for up to 10% of buildings may be absent in the 2017 Energy and Water Data Disclosure.

Figure 8. Current energy consumption by NYC buildings as of 2016



Source: NYC 2017 Energy and Water Data Disclosure (Data for Calendar Year 2016), edited and supplemented as described in Appendix A

The current fossil fuel usage of 137.8 million MMBtu for buildings affected by the proposed legislation has an average fossil fuel EUI of approximately 55.3 kBtu per square feet. This value can be compared against the proposed limits on fossil fuel usage, ranging from 35 to 70 kBtu/per square feet for the most common types of buildings (residential and business), to give an idea of the magnitude of the reduction contemplated.

3.2 Additional electric load

Having established the baseline fossil fuel consumption for buildings in NYC, LEI then estimated the additional electric load that could result from building electrification.[15] For this analysis, LEI assumes full compliance of buildings with limits set forth in the proposed Intro 1745.

LEI included several parameters and conversion factors in this calculation, including:

- the proposed fossil fuel usage limits on buildings depending on their primary and other usages;
- potential reductions in energy usage from energy efficiency projects; and
- the relative efficiency of fossil fuel versus electricity, mainly for space and water heating.

---

[15] LEI analyzed the impact from electrification of existing buildings, and as such did not take into account new buildings, electric vehicles, or other factors which can impact electric demand.

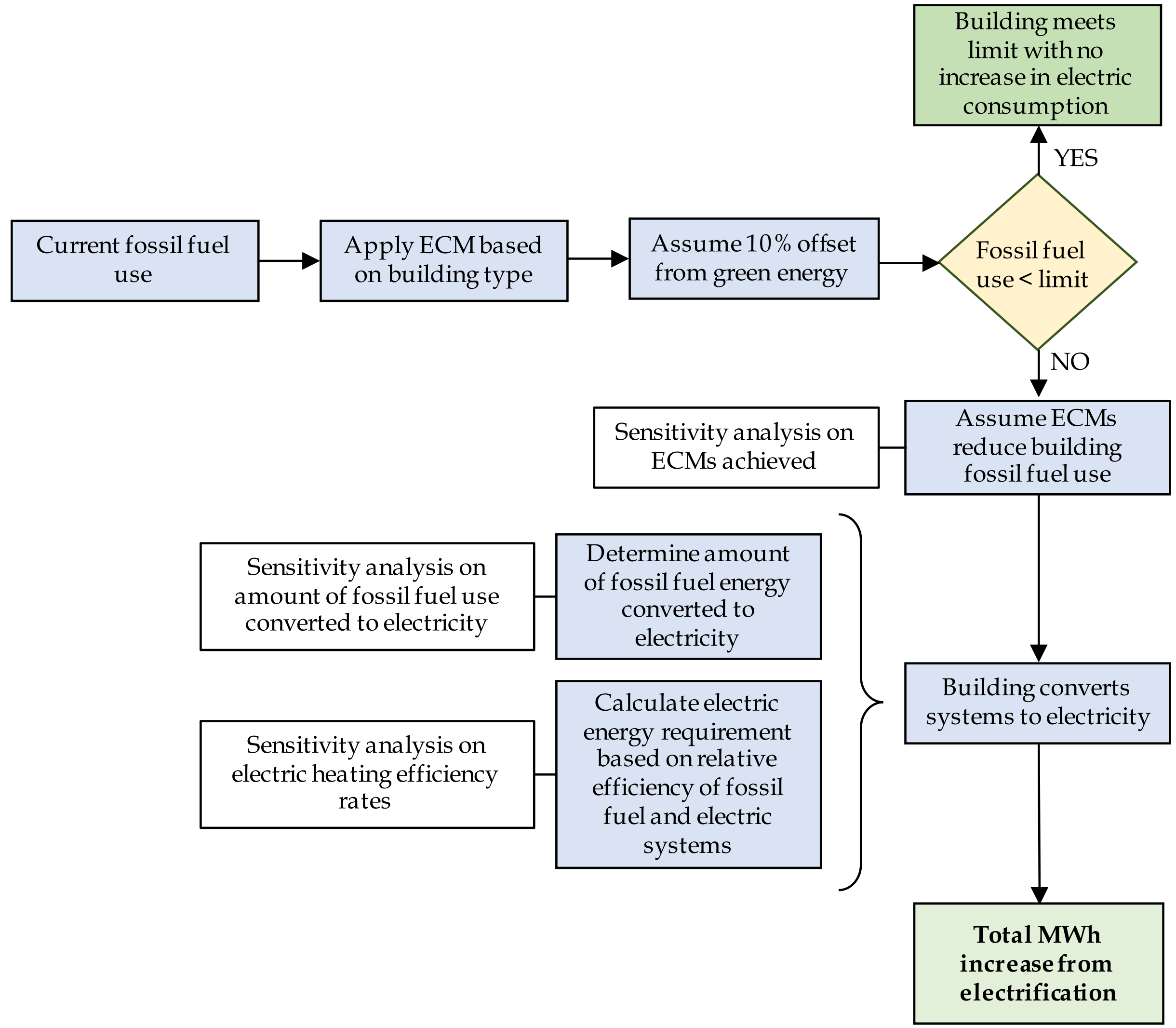
3.2.1 Methodology

To explore the potential increase in electric energy use due to building electrification, LEI used the baseline fossil fuel consumption from the NYC data disclosure then applied various metrics to lower the fossil fuel use to meet the proposed legislation limits. LEI applied the methodology described below to each building for which there is data, so all calculations are at the building level and the results are then aggregated.

The proposed legislation offers the option to offset up to 10% of fossil fuel consumption through purchases of green energy. However, fundamentally, the potential reductions in fossil fuel consumption by buildings come from two sources:

1. through energy efficiency measures or otherwise known as energy conservation measures ("ECM"); and
2. through the conversion of fossil fuel-burning systems into electric systems.

Figure 9. Methodology to estimate increased electrical demand



LEI assumed that if building owners can meet the proposed limits on fossil fuel use through green energy purchase offsets and ECMs, then they would opt for that option rather than converting systems to electricity. Indeed, the requirements under the existing LL87, which requires an audit and retro commissioning every 10 years, will help building owners identify cost effective energy efficiency retrofits to improve the energy performance of their buildings gradually over time between now and 2035. [16]

For buildings that cannot comply through the green energy offsets and ECMs, LEI assumed that building owners would still first opt for ECMs as they are generally a more cost-effective solution to reduce energy use versus conversion. Any remaining fossil fuel usage above the proposed limits once ECMs are in place would then lead to a conversion of systems to electricity, as illustrated in Figure 9 above.

Possible energy usage reductions that can be achieved through ECMs for various types of buildings are shown in Figure 10 and Figure 11 below, which were derived by the NYC Technical Working Group based on Local Law 87 energy audit recommendations.[17] Modeled ECM scenarios are described in Section 3.2.2. Note the average reductions shown typically include only the most cost-effective ECM measures with paybacks of less than 10 years, meaning that not all efficiency opportunities are included.

Figure 10. Energy usage reductions from ECMs for residential and commercial building types

Building type	Built year	Reductions through ECM
Multifamily	post-1980	10%
Multifamily	1945 to 1980	14%
Multifamily	pre-1945	15%
Commercial	post-1980	15%
Commercial	1945 to 1980	14%
Commercial	pre-1945	10%

---

[16] Note that any financial support from the government for ECMs would ultimately be funded indirectly by New York consumers and businesses through ratepayer surcharges or tax increases, though it is likely that policymakers would try to minimize total incremental costs to the extent possible.

[17] The City of New York. *One City Built to Last Technical Working Group Report*. 2015. Available here: < http://www.nyc.gov/html/gbee/html/one-city/technical-working-group.shtml>

Figure 11. Energy usage reductions from ECMs for industrial and institutional building types

Building type	Building use	Reductions through ECM
Industrial	warehouse/factory	15%
Industrial	transport/garage/utilities	25%
Institutional	General	16%
Institutional	Hospitals & Health	9%
Institutional	K-12	13%
Institutional	Religious	16%
Institutional	University	5%

Source: NYC TWG report

Once the ECMs are applied to the baseline fossil fuel usage, the reduced usage is compared to the maximum fossil fuel limit. The maximum fossil fuel limit is calculated by multiplying the buildings' total square footage by the limit outlined in the proposed legislation as shown in Figure 12. If a building has more than one type of use (i.e. contains multiple occupancy groups), a weighted average of the proposed limit is calculated.[18]

Figure 12. Simplified legislation limits for modeling purposes

Occupancy group	Proposed limit (kBtu/sq. ft./year)
Assembly	60
Business	35
Educational	45
Factory	80
Civic	50
High Hazard	100
Mercantile	45
Residential	55
Other	50

Source: Intro 1745

If a building's fossil fuel usage is lower than the limit through ECMs only, the building theoretically does not need to electrify its fossil fuel systems. However, if the fossil fuel usage is higher than the maximum limit, the building must find alternatives to further reduce its fossil fuel use. Thus, the next process in the model looks at converting the buildings' fossil fuel-use systems to electric systems.

If a building's fossil fuel usage is greater than the proposed limit through ECMs only, the building must electrify its entire fossil fuel systems. LEI assumed partial conversion of fossil fuel systems

---

[18] It is LEI's understanding from the proposed legislation language that this is how the limits would be calculated for buildings with multiple occupancy groups.

is not possible and building owners would opt to convert its entire system if needed. The total reduction in fossil fuel use in this step represents the conversion of fossil fuel to electric systems.

To translate fossil fuel consumption to electricity demand, the relative efficiencies of fossil fuel systems versus electric space heating and water heating were used. For fossil fuels, LEI relied on annual fuel utilization efficiency ("AFUE") values as calculated by the U.S. Department of Energy National Renewable Energy Laboratory ("NREL"); this value essentially represents the ability to convert fuel energy into heating energy.[19] According to the NREL report, fuel oil and diesel have an approximate AFUE of 70% while natural gas has an AFUE of 80%. By applying the AFUE against the total fossil fuel reduction, LEI estimated the actual heat required from fossil fuel (in kBtu).

Similarly, LEI used the NREL report to get electric energy coefficients of performance ("COP") for space heating and energy factors ("EF") for water heating, as shown in Figure 13. The COP and EF are measures of electric heating efficiency, and are directly comparable to the fossil fuel AFUE values. These efficiency numbers show that electric heating (space or water) is generally more efficient than heating with fossil fuel, as an electric heat pump can leverage the thermal content of outside air even in the winter time.

Figure 13. Electrical heating system efficiency ratings in 2030, moderate advancement

Building type	Space heating (COP)	Water heating (EF)
Residential	2.75	3.5
Commercial	2.5	3.25
Industrial	2.5	3
Institutional	2.5	3
Other	2.5	3

Source: NREL

LEI's use of the NREL values is conservative, since these COP and EF values are the result of technological developments expected to occur in the next ten years; it is LEI's understanding that large heat pump technology is not currently commercially available for use in large commercial or institutional buildings. Should the expected technological developments be delayed and COP/EF values lower than those shown in Figure 13, the impact of building electrification on NYC load could be higher (this possibility is studied as a sensitivity analysis, as discussed in the next section).

Current fossil fuel use in buildings is primarily used for space heating and water heating. To determine the breakdown between fossil fuel use, LEI analyzed annual fossil fuel consumption for various building types. The breakdown of fossil fuel use for space heating and water heating is shown in Figure 14. Generally speaking, residential buildings use slightly more energy for

---

[19] NREL. "Electrification & Decarbonization: Exploring U.S. Energy Use and Greenhouse Gas Emissions in Scenarios with Widespread Electrification and Power Sector Decarbonization". July 2017.

space heating (as opposed to water heating), while other building types use the majority of energy for space heating.

Figure 14. Ratio of fossil fuel use for space and water heating

Building type	Fossil fuel use for space heating	Fossil fuel use for water heating
Residential	53%	47%
Commercial	72%	22%
Industrial	100%	0%
Institutional	84%	7%
Other	77%	19%

Source: OpenEI data analysis

3.2.2 Modeling scenarios

LEI calculated a range of possible building electrification scenarios, and the consequential impact on the NYC electric demand. LEI's Base Case set of assumptions represents the most realistic outcome, while the sensitivities show results with varying success of energy efficiency improvements, and a case that assumes lower efficiency for space and water heating. The assumptions related to each of these cases are illustrated in Figure 15.

Figure 15. Summary of modeling scenarios

Modeling scenarios		
	Base Case	Buildings are able to meet 50% of the average energy efficiency gains from energy audit recommendations; buildings electrify if they are over the limit
Case 1	20% of energy efficiency targets	Buildings are able to meet 20% of the average energy efficiency gains from energy audit recommendations; buildings electrify if they are over the limit
Case 2	100% of energy efficiency targets	Buildings are able to meet 100% of the average energy efficiency gains from energy audit recommendations; buildings electrify if they are over the limit
Case 3	150% of energy efficiency targets	Buildings are able to meet 150% of the average energy efficiency gains from energy audit recommendations; buildings electrify if they are over the limit
Case 4	Lower electric heating efficiency	Same assumptions as Base Case, but efficiency rates for electric space heating (COP) and water heating (EF) are 50% lower than in Base Case

For the Base Case scenario, LEI assumed that on average, building owners will first invest in energy efficiency measures, yielding a reduction in energy usage for their buildings equivalent to 50% of the average energy reduction illustrated in Figure 10 and Figure 11. LEI assumed that building owners whose property is still above the proposed fossil fuel usage limit would reduce their reliance on fossil fuels through electrification of their fossil fuel systems.

For Case 1, LEI assumed that building owners would on average implement energy efficiency measures that are equivalent to 20% of the average energy efficiency measures recommended in the LL87 energy audits. This represents the minimum energy efficiency measures building owners would make which could be caused by a lack of financial support from government institutions to invest in energy efficiency, or the inability of building owners to fully realize the theoretical gains.

For Case 2, LEI assumed that building owners would implement energy efficiency measures that are equivalent to 100% of the average energy efficiency measures recommended in the LL87 energy audits.

For Case 3, LEI assumed that building owners would implement energy efficiency measures that are equivalent to 150% of the average energy efficiency measures recommended in the LL87 energy audits. This represents a greater role of energy efficiency in reducing building energy use through enhanced financial support from the government.

In Case 4, LEI assumed that efficiency of the electric space and water heating systems is only 50% of the COP and EF values illustrated in Figure 13. This scenario assumes that the technological advancements forecast in the NREL report are not realized. The other assumptions are similar to the Base Case.

3.2.3 Results

In LEI's analysis, building electrification in the Base Case and all sensitivity cases ranges from around 22% to 38% in terms of total building square footage included in LEI's analysis.[20] In Case 3, the lowest number of buildings (approximately 3,994 buildings out of 14,489) electrified as a result of 150% of average energy efficiency gains. The highest level of building electrification occurred in Case 1 with 6,622 buildings electrifying, due to the smaller impact from assuming that buildings achieve 20% of average energy efficiency gains. Figure 16 summarizes the electrification of NYC buildings in all scenarios.

Figure 16. Building electrification results for LEI's Base Case and sensitivity cases

	No. of buildings that electrify	Percent of buildings that electrify	Total SF of buildings that electrify	Percent of SF of buildings that electrify
Base Case	6,103	42%	1,043,259,460	36%
Case 1	6,622	46%	1,108,653,405	38%
Case 2	5,125	35%	798,524,999	27%
Case 3	3,994	28%	646,963,759	22%
Case 4	6,103	42%	1,043,259,460	36%

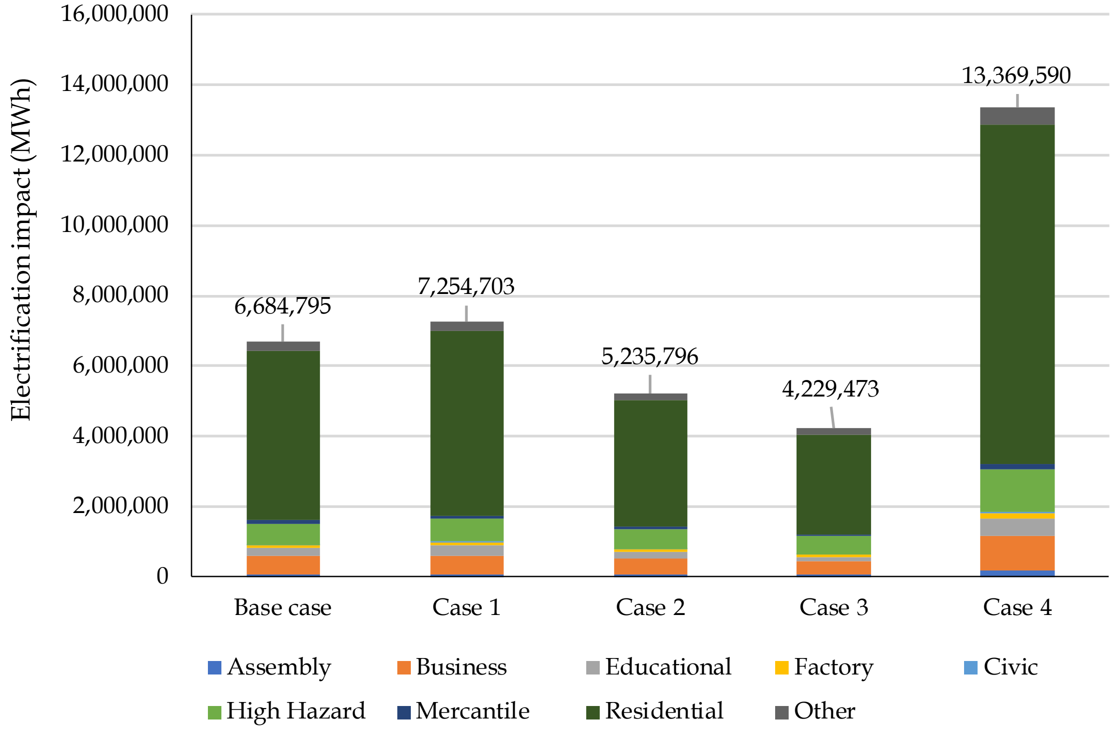
For the Base Case and all sensitivity cases, LEI's analysis shows that additional electric load in NYC resulting from building electrification could range from 4.2 TWh to approximately 13.4 TWh by the time the proposed limits are enforced (2030 to 2035), as illustrated in Figure 17. For comparison purposes, the actual energy demand in NYC for 2017 was 52.3 TWh and the forecast

---

[20] Buildings 50,000 sf and more that complied with LL84 reporting requirements, plus estimate of buildings 25,000 to 50,000 sf.

for 2035 is 51.8 TWh.[21] Therefore the increase in demand could range from 8.1% to 25.9% of the forecast 2035 annual electric demand.

Figure 17. Additional annual electric demand from building electrification in NYC



3.3 Impact on NYC peak load

The incremental load resulting from the electrification of applicable NYC buildings is distributed across different times of day and seasons affecting the variability and shape of the prevailing load distribution. In this analysis, LEI assumed that the incremental electric load due to switching from fossil fuel to electricity for end-use services including water heating, space heating, and interior equipment use, will have a shape identical to the typical load shape of natural gas consumption for each building category. Indeed, LEI assumed that the natural gas consumption is representative of the consumption pattern for other fossil fuels since the end use is the same. Furthermore, since this study looks at converting fossil fuel usage into electricity usage, it is logical to rely on the current load shape for fossil fuel consumption as a proxy for the additional electricity load shape.

Accordingly, LEI determined the aggregate load shape for the incremental electric load by analyzing hourly gas consumption patterns of different building types in NYC and applying

---

[21] NYISO. “2018 Load and Capacity Data”. April 2018

these patterns to the incremental electric energy required by the buildings affected by the proposed legislation.

In order to analyze the aggregate impacts on load distribution, LEI disaggregated the occupancy groups of buildings applicable to the legislation into two broad categories, namely, residential and commercial. Buildings whose primary property use type is residential such as multifamily housing and hotels are grouped under the residential category. All other nonresidential buildings are placed in the commercial category. Figure 18 below summarizes the occupancy groups of all buildings covered under the legislation and their corresponding categories.

Figure 18. Modeled residential and commercial categories and end-use services

	Residential	Commercial
Occupancy group	Residential	Business Educational Mercantile Civic Assembly High hazard Facory Other
End uses analyzed	Water heating Space heating Interior equipment use	

Using these categories, LEI determined the magnitude and shapes of the incremental electricity load by using datasets sourced from Open Energy Information ("OpenEI"), an open source online energy database run by the U.S. Department of Energy. Collected by the Office of Energy Efficiency and Renewable Energy ("EREE"), the datasets contain hourly load profile data for gas and electricity demand of residential buildings and 16 commercial building types in three Typical Meteorological Years ("TMY") locations in New York including Central Park, J.F. Kennedy International Airport, and LaGuardia Airport.[22] Given the significant similarity of gas load shapes for buildings across the three locations, this report uses the data collected for residential and commercial buildings in the Central Park TMY location.

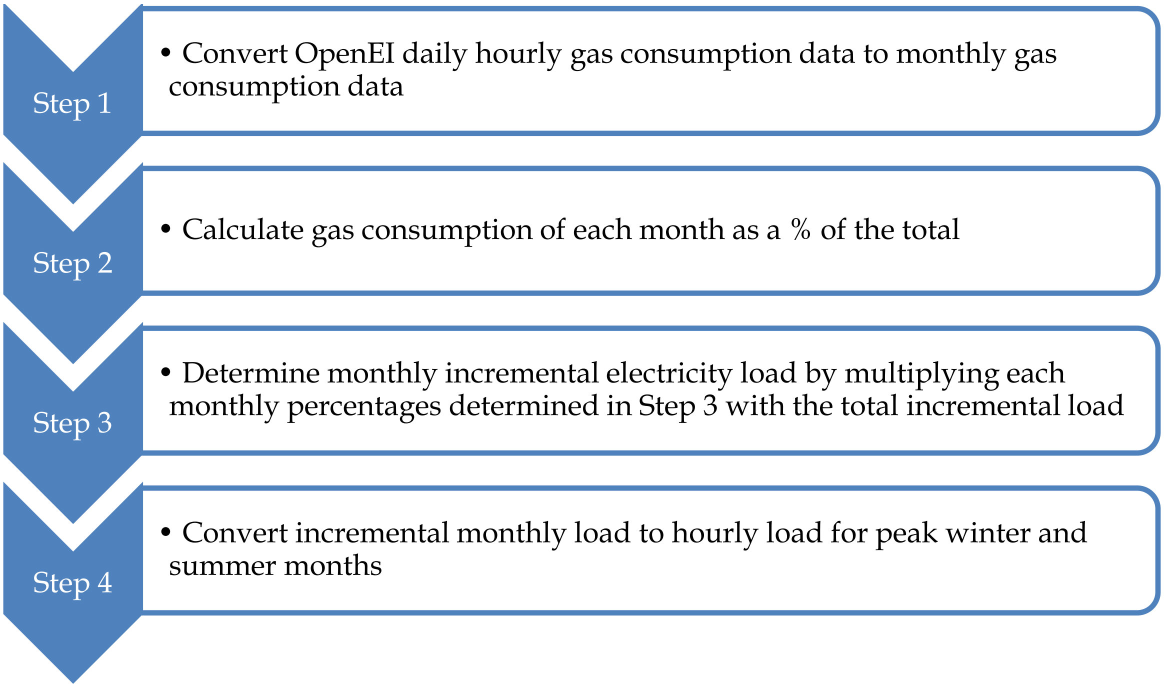
Figure 19 below illustrates the series of steps followed to estimate a load shape for the incremental electricity due to the electrification of NYC buildings affected by the proposed limits on fossil fuel

---

[22] The TMY3 data sets are derived from the 1991-2005 National Solar Radiation Data Base (NSRDB) update. For more information, please refer to the TMY3 User's Manual <https://www.nrel.gov/docs/fy08osti/43156.pdf>

usage. Since heating requirement is not uniform on seasonal and hourly bases, the peak energy usage is much higher than the average energy usage. LEI applied these steps to each occupancy group under both categories of residential and commercial buildings.

Figure 19. Steps to determine the hourly load shape of incremental electricity



Step 1
- Convert OpenEI daily hourly gas consumption data to monthly gas consumption data

Step 2
- Calculate gas consumption of each month as a % of the total

Step 3
- Determine monthly incremental electricity load by multiplying each monthly percentages determined in Step 3 with the total incremental load

Step 4
- Convert incremental monthly load to hourly load for peak winter and summer months

3.3.1 Residential buildings

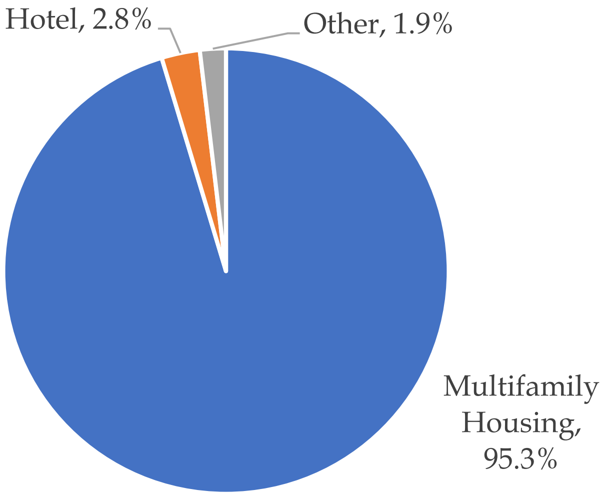
The residential occupancy group represents approximately 66% of all buildings affected by the proposed legislation. Within the residential category, "Multifamily Housing" represents the largest share of residential buildings, accounting for 95.3% of all buildings in the category. Figure 20 below shows the building types covered under the residential occupancy group and their corresponding proportions. It is important to remember that the proposed legislation applies only to large buildings, so that single family houses and smaller residential buildings are not represented in the dataset.

The incremental load analysis for buildings in the residential category uses OpenEI's base load benchmark data for residential buildings in the Central Park TMY location. The datasets are based on the Building American House Simulation Protocols and statistical references of Residential Energy Consumption Survey ("RECS") developed by the DOE and EIA, respectively.[23]

---

[23] https://openei.org/doe-opendata/dataset/commercial-and-residential-hourly-load-profiles-for-all-tmy3-locations-in-the-united-states

Figure 20. Building types under the residential occupancy group

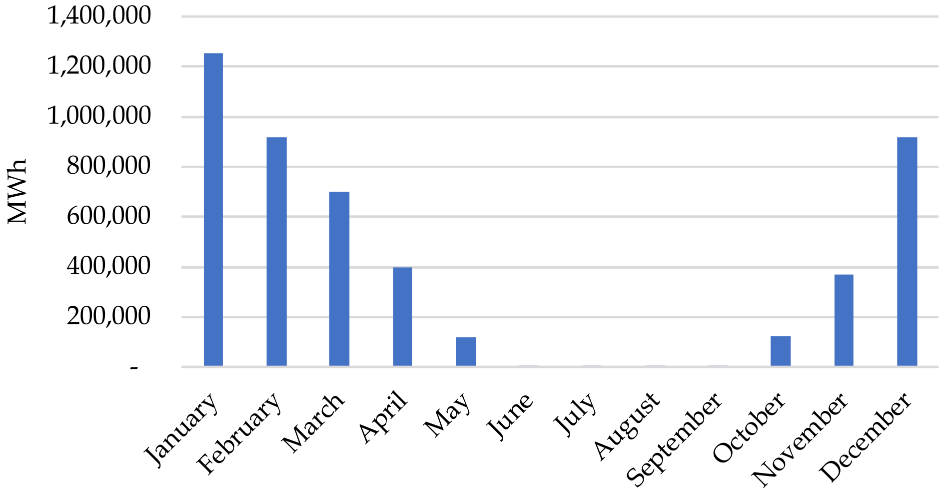


Note: The other category represents buildings whose largest property use type includes: "residence hall/dormitory", "other – lodging/residential", and "residential care facility"

3.3.1.1 Base Case analysis and results

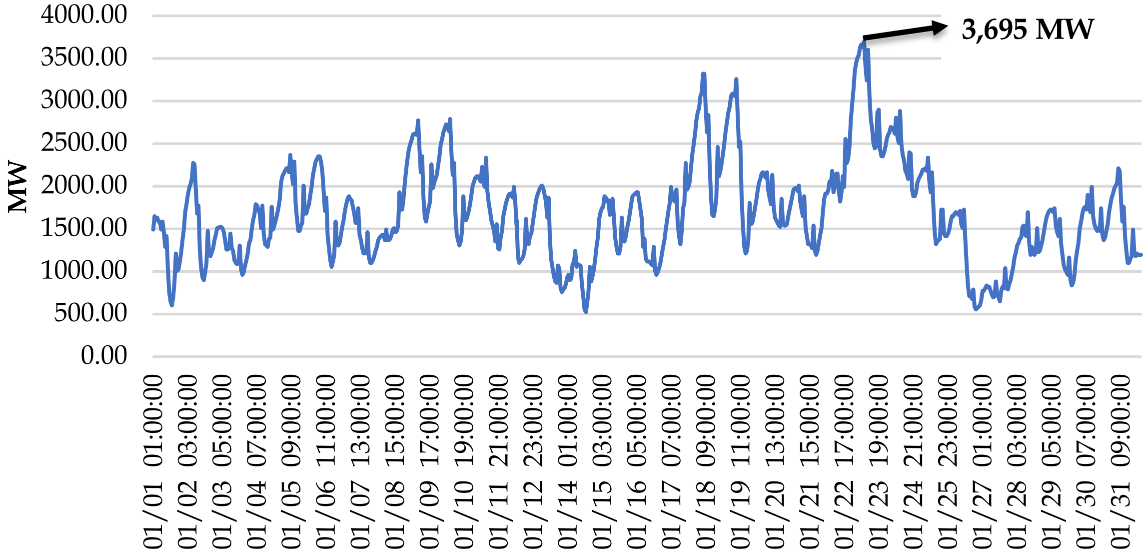
In the Base Case, the total incremental load for residential buildings is 4.8 TWh. LEI determined the monthly and corresponding hourly incremental electric load by applying the methodology noted in Figure 19. Figure 21 below shows a summary of the monthly incremental load from residential buildings. The months of December, January, and February account for approximately 64% (3.0 TWh) of the total increase in annual electrical demand with the month of January representing the highest increase at 26% of the total (1.2 TWh). On the other hand, the months of June, July, August, and September had the lowest values of incremental load representing just 0.3% (17 GWh) of the total incremental annual electrical demand.

Figure 21. Monthly incremental load for residential buildings



Based on the above results, LEI determined that the peak load occurs in the month of January and subsequently identified the highest hourly peak achieved in January based on the hourly TMY data. As noted in Figure 22 below, the incremental peak load due to the electrification of the residential category of buildings is 3,695 MW.

Figure 22. January hourly load profile for residential buildings (Base Case)

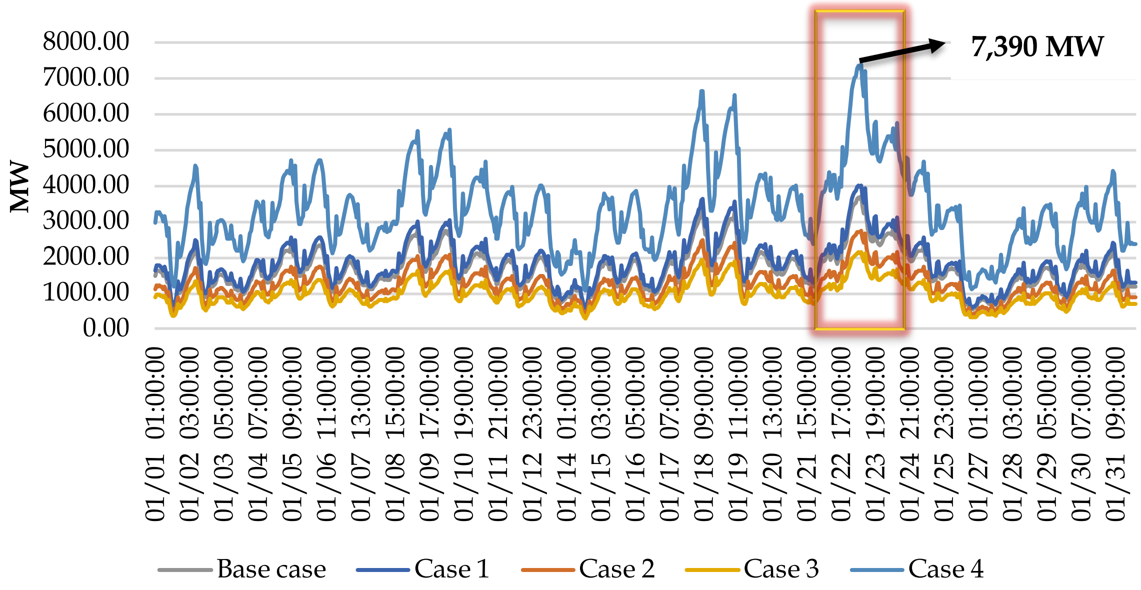


3.3.1.2 Sensitivity analysis

As mentioned in Section 3.2.2, LEI analyzed four sensitivities, in addition to the Base Case, to assess the impacts of factors including fossil fuel to electricity conversion rates, energy efficiency targets, and electric heating efficiencies on the total incremental load and corresponding monthly and hourly load profiles for residential buildings.

Similar to the Base Case, LEI determined the monthly and corresponding hourly incremental electricity loads by applying the methodology noted in Figure 19. With the understanding that the peak load occurs in the month of January, Figure 23 below illustrates the hourly load shapes for the Base Case and all four sensitivities. As noted in the highlighted area, the peak load occurs in the later part of January for all scenarios and Case 4 represents the highest incremental peak load of 7,390 MW compared to the Base Case incremental peak load of 3,695 MW.

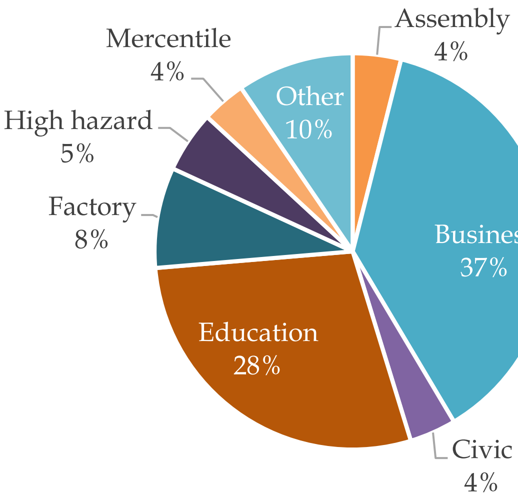
Figure 23. January hourly load profile for residential buildings (All sensitivities)



3.3.2 Commercial buildings

The commercial category represents eight occupancy groups accounting for the remaining 34% of NYC buildings affected by the proposed legislation. Within this category, the "Business" occupancy group represents the largest share of buildings representing 37.5% of all buildings in the category followed by "Education" representing 28.4%. Figure 24 below shows the different building types covered under the commercial category and their corresponding proportions.

Figure 24. Building types under the commercial occupancy group



Note: The other category represents buildings whose largest property use type includes: "Energy/Power Station", "Other", "Other - Public Services", "Other – Services", "Other - Technology/Science", "Other – Utility", "Parking", "Police Station", "Self-Storage Facility", and "Wastewater Treatment Plant"

Similar to the analysis conducted for the residential category, the incremental load analysis for occupancy groups in the commercial category uses OpenEI hourly gas consumption data specifically for five buildings types in the Central Park TMY location including: "Office", "School", "Retail", "Hospital", and "Warehouse". The OpenEI datasets are based on the DOE commercial reference building models.[24] below shows LEI's groupings of the eight occupancy groups in the commercial category and the corresponding OpenEI data used to analyze their incremental load shapes.

3.3.2.1 Base Case analysis and results

In the Base Case, the total incremental electric load for all commercial building types is 1.8 TWh. LEI determined the monthly and corresponding hourly incremental electric load using OpenEI datasets for the building categories shown in Figure 25 and applying the methodology noted in Figure 19.

Figure 25. Commercial occupancy groups and corresponding OpenEI categories

OpenEI category	Occupancy group	% Share of commercial buildings
Office	Business Civic Assembly Factory Other	59.2%
School	Education	28.4%
Hospital	High hazard	5.0%
Retail	Mercantile	3.6%
Warehouse	Other*	3.6%

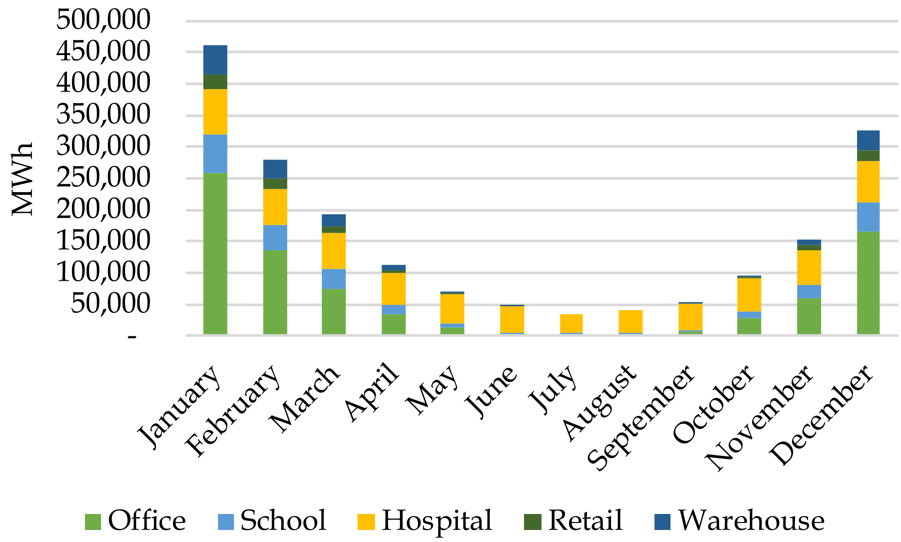
Note: 1) The "Other*" occupancy group under the "Office" OpenEI category includes "Police Station", "Other", "Other - Public Services", "Other - Services", "Other - Technology/Science", and "Other – Utility" 2) The "Other*" occupancy group under the "Warehouse" OpenEI category includes "Energy/Power Station", "Parking", "Self-Storage facility", and "Wastewater Treatment Plant".

Figure 26 below illustrates the monthly incremental load for all occupancy groups under the five OpenEI categories. The month of January accounts for the largest share representing approximately 25% of the total incremental annual electricity demand (0.4 TWh).

---

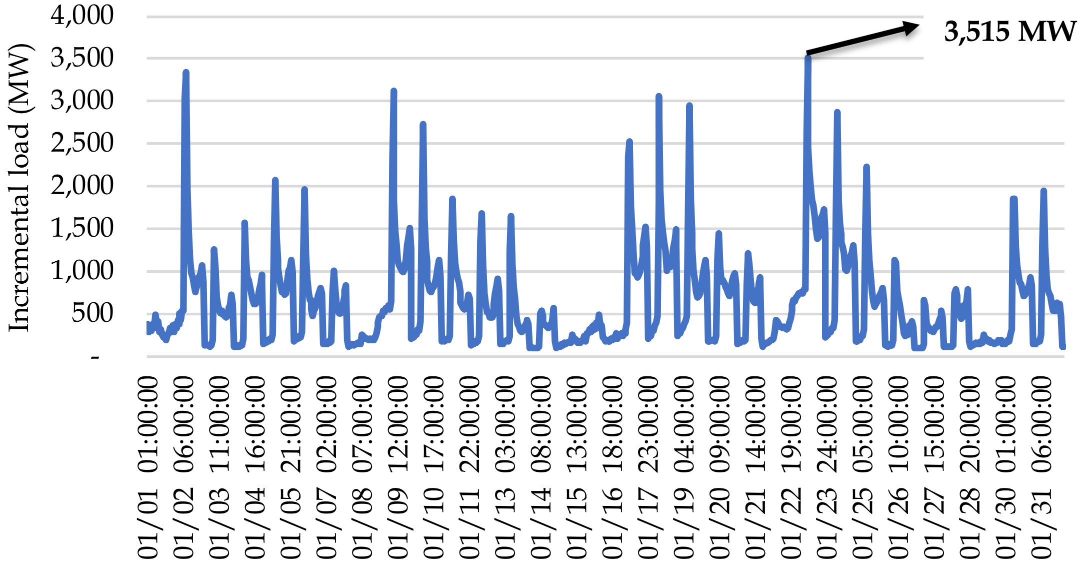
[24] Ibid

Figure 26. Monthly incremental load for commercial categories



Based on the above results, LEI determined that the peak load also occurs in the month of January for the commercial category of buildings and subsequently identified the highest hourly peak achieved in January based on the hourly TMY data. As noted in Figure 27 below, the incremental peak load due to the electrification of the commercial category of buildings is 3,515 MW.

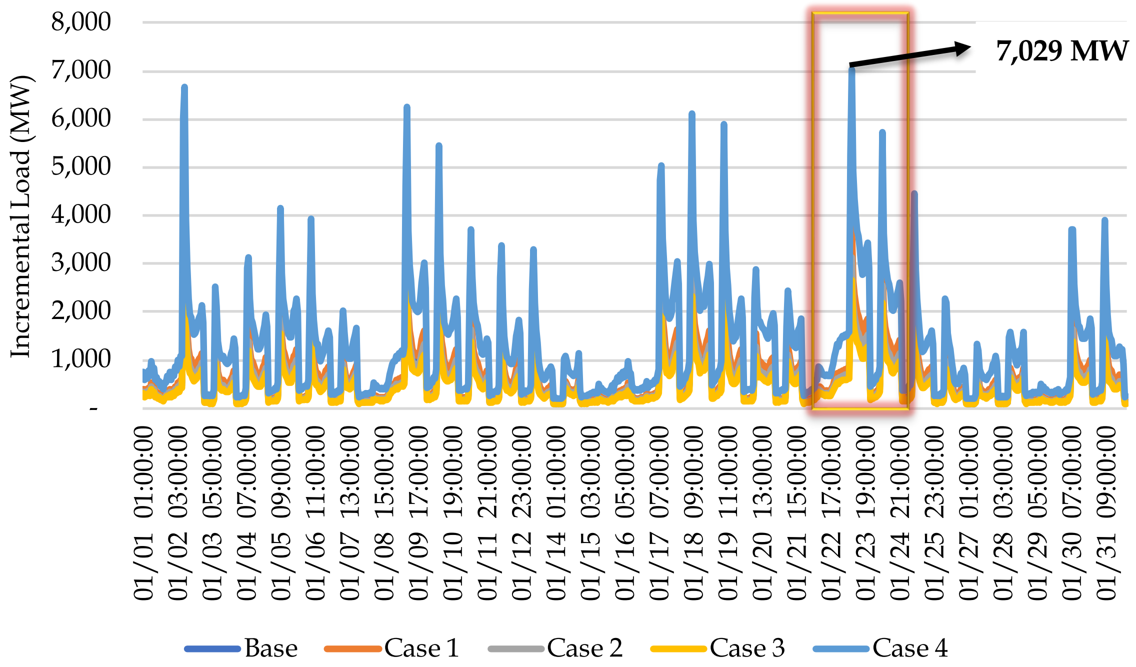
Figure 27. January hourly load profile for all commercial buildings (Base Case)



3.3.2.2 Sensitivity analysis

Similar to the Base Case, LEI determined the monthly and corresponding hourly incremental electricity loads by applying the methodology noted in Figure 19. With the understanding that the peak load occurs in the month of January, Figure 28 below illustrates the hourly load shapes for the Base Case and all four sensitivities. As noted in the highlighted area, the peak load occurs in the later part of January for all scenarios and Case 4 represents the highest incremental peak load of 7,029 MW compared to the Base Case incremental peak load of 3,515 MW.

Figure 28. January hourly load profile for all commercial buildings (all sensitivities)



3.3.3 Consolidated results

During peak (i.e. coldest) winter season days, natural gas usage (which is used to represent the shape of the incremental electricity demand) in both residential and commercial buildings typically peaks in the morning around 8am. Accordingly, given the coincidental peaks of both building types, LEI determined the overall incremental electric peak load in NYC from building electrification by adding the incremental peak load from residential buildings and the incremental peak load from commercial buildings.

Figure 29. Incremental winter peak load in NYC from building electrification (MW)

MW	Incremental winter peak load		
	Residential	Commercial	Total
Base Case	3,695	3,515	7,210
Case 1	4,026	3,768	7,794
Case 2	2,747	3,123	5,870
Case 3	2,159	2,667	4,826
Case 4	7,391	7,029	14,420

In the Base Case, the incremental total peak load for NYC represent as much as 7,210 MW for a peak January day. Since electric resource adequacy must plan for peak conditions, the incremental load of 7,210 MW represents the additional peak load resulting from building electrification that would be added to the existing NYC winter peak load. In the sensitivity cases, the NYC winter peak load could increase from 7,794 MW to as much as 14,420 MW due to building electrification.

For comparison purposes, the winter peak load in NYC for 2016 was 7,822 MW while the summer peak load was 10,241 MW. The 2035 forecast are 7,396 MW and 11,458 MW for the winter and summer NYC peak loads respectively.[25] Under the current conditions, NYC, like the rest of the New York Control Area, is a summer-peaking region because of the air conditioning load. However, if heating load currently being met through fossil fuel sources is converted to electricity, then NYC would become a winter-peaking locality since the additional winter load, added to the forecast winter peak load (7,396 MW + 7,210 MW = 14,606 MW in the Base Case), would then surpass the summer peak load (11,458 MW).

---

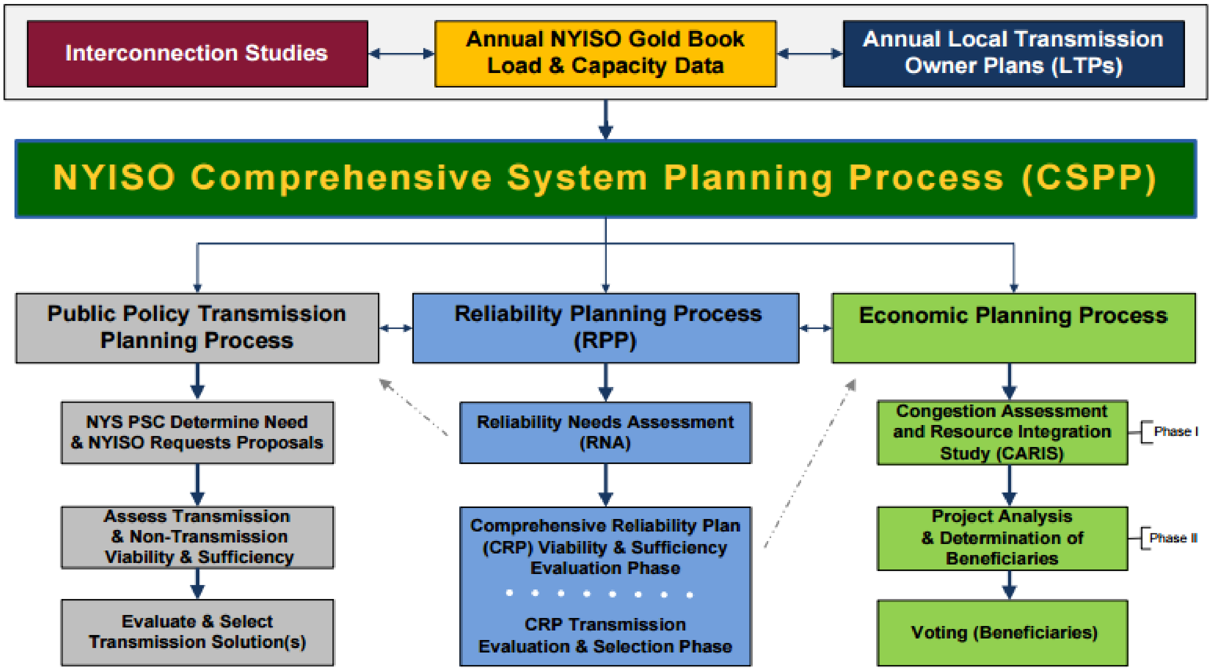
[25] NYISO. "2018 Load and Capacity Data". April 2018

4 NYISO’s Comprehensive System Planning Process

The proposed Bill No. 1745 will cause the electrification of many New York City buildings, which LEI forecasts will result in a significant increase in electricity demand. This additional demand is likely to require additional infrastructure, which is typically addressed through the NYISO’s planning process. This section presents an overview of the NYISO’s overall Comprehensive System Planning Process (“CSPP”), which governs this planning process. The CSPP takes into account both reliability needs and economic considerations. The process is comprised of the following components and is summarized in Figure 30 below:

1. Local Transmission System Planning Process (“LTPP”)
2. Reliability Planning Process (“RPP”);
3. Congestion Assessment and Resource Integration Study (“CARIS”); and
4. Public Policy Transmission Planning Process (“PPTPP”).

Figure 30. NYISO Comprehensive System Planning Process



Source: NYISO

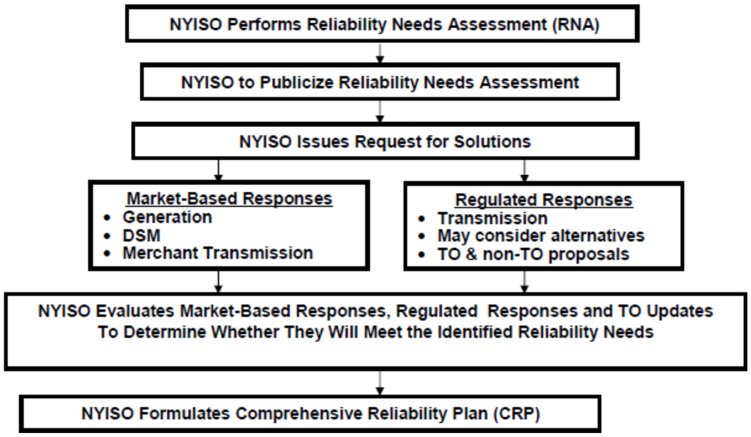
4.1 Local Transmission System Planning Process

The LTPP is a step that provides input to the CSPP. As part of the LTPP, each Transmission Owner (“TO”) performs transmission security studies for their Bulk Power Transmission Facilities (“BPTF”) in their transmission areas according to all applicable criteria. These criteria are defined by the North American Electric Reliability Corporation (“NERC”), the Northeast Power Coordinating Council (“NPCC”), and the New York State Reliability Council (“NYSRC”). As part of the LTPP, each TO posts its criteria and assumptions for review and comment by stakeholders. NYC's responsible TO is Consolidated Edison Company of New York ("ConEd"). It is expected that the increased demand forecast from electrification of New York City buildings would significantly impact ConEd's LTPP, which would then feed into the rest of the CSPP.

4.2 Reliability Planning Process

The RPP is anchored in the market-based philosophy of the NYISO and its Market Participants, which posits that market solutions should be the preferred choice to meet any reliability need identified during the planning process. During the RPP, the NYISO conducts the Reliability Needs Assessment ("RNA") to identify any potential reliability issue over the next ten years, and the Comprehensive Reliability Plan ("CRP") to identify solutions if needed. Figure 31 summarizes the RPP process.

Figure 31. NYISO Reliability Planning Process



Source: NYISO

The RNA is performed every two years and evaluates the adequacy and security of the BPTFs over a ten-year study period. For adequacy and security studies, NYISO develops a base case forecast for peak demand and energy, typically based off the latest Load and Capacity Data report (aka Gold Book). In identifying resource adequacy needs, the NYISO identifies the amount of resources in megawatts (MW, known as "compensatory MW") and the locations in which they are needed, if applicable. The RNA does not identify specific solutions to meet the needs.

Adequacy and Security

There are two different aspects to analyzing the Bulk Power Transmission Facilities ("BPTF") reliability in the RNA: adequacy and security. Adequacy is a planning and probabilistic concept. A system is adequate if the probability of having sufficient transmission and generation to meet expected demand is equal to or less than the system's standard, which is expressed as a loss of load expectation ("LOLE"). The New York State bulk power system is planned to meet an LOLE that, at any given point in time, is less than or equal to an involuntary load disconnection that is not more frequent than once in every 10 years, or 0.1 days per year. This requirement forms the basis of New York's IRM resource adequacy requirement.

Security is an operating and deterministic concept. This means that possible events are identified as having significant adverse reliability consequences. The system is planned and operated so that the system can continue to serve load even if these events occur. Security requirements are sometimes referred to as N-1 or N-1-1. N is the number of system components. An N-1 requirement means that the system can withstand single disturbance events (e.g., generator, bus section, transmission circuit, breaker failure, double-circuit tower) without violating thermal, voltage and stability limits or before resulting in unplanned loss of service to consumers. An N-1-1 requirement means that the Reliability Criteria apply after any critical element such as a generator, a transmission circuit, a transformer, series or shunt compensating device, or a high voltage direct current (HVDC) pole has already been lost.

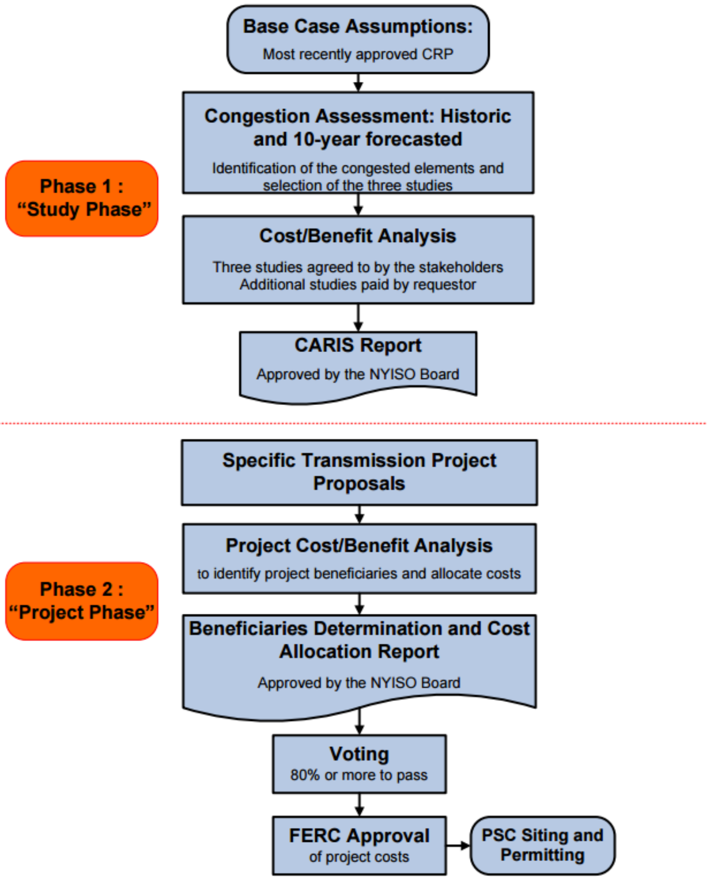
Following approval of the RNA by its Board of Directors, if necessary, the NYISO issues a request for market-based and regulated solutions to the identified Reliability Needs. This process lasts for two to three months and is open to all types of resources, including generation, demand response and transmission. Note that the Responsible TO, typically the TO in whose service territory there is an identified reliability need, is obliged to submit a regulated solution. Private developers are also allowed to propose "Alternative Regulated Solutions". Each proposed solution is assessed in terms of their viability and sufficiency, in terms of their ability to satisfy the needs identified in the RNA.

The request for solutions process leads to the development of the CRP, which provides documentation of the solutions. Note the CRP does not actually select from the proposed market-based solutions, but only states whether they are sufficient and timely to meet the identified needs. In the event that market-based solutions do not materialize, NYISO will indicate in the CRP the need to trigger a regulated solution which would be eligible for cost allocation and recovery under the NYISO's tariff. In addition, the NYISO and its Independent Market Advisor investigate whether market rules changes are necessary to address a possible failure in one of the NYISO's competitive markets.

LEI believes that Bill No. 1745 in New York City would have a significant impact on the RPP process. For instance, a higher forecast peak load in NYC due to anticipated building electrification may to lead to resource adequacy needs identified by the RNA in Zone J, which will lead to a request for and subsequent development of a significant number of market-based or regulated solutions. Note that NYISO's base case RNA forecast only assumes programs, legislations and regulations which have been already been adopted; however NYISO also works with stakeholders to develop additional reliability scenarios.[26] For example in the 2018 RNA, NYISO considered high load and removal of capacity scenarios.[27]

4.3 Economic Planning Process

Figure 32. NYISO Congestion Assessment and Resource Integration Study



Source: NYISO

The Congestion Assessment and Resource Integration Study ("CARIS") is the primary component of the Economic Planning Process. The CARIS is performed every two years, alternating with the RNA. The study analyzes congestion in the New York bulk power system and projects economic benefits associated with relieving that congestion, utilizing the finalized viability and sufficiency assessment from the CRP. Key objectives are to:

---

[26] Pursuant to Section 31.2.2.5 of Attachment Y to the NYISO Open Access Transmission Tariff.

[27] NYISO. 2018 RNA Report. <https://home.nyiso.com/wp-content/uploads/2016/10/2018-Reliability-Needs-Assessment.pdf>

1. project congestion on the New York State BPTFs over the ten-year CSPP planning horizon;
2. identify, through the development of appropriate scenarios, factors that might affect congestion;
3. provide information to Market Participants, stakeholders and other interested parties on solutions to reduce congestion and to create production cost savings which are measured in accordance with the Tariff requirements;
4. provide an opportunity for developers to propose solutions that may reduce the congestion; and
5. provide a process for the evaluation and approval of regulated economic transmission projects for regulated cost recovery under the NYISO Tariff.

The CARIS process has two phases as seen in Figure 32. The purpose of Phase 1 is to provide information regarding projects that address congestion costs to developers and the marketplace. The NYISO performs a forward-looking assessment to determine the three most congested elements or groupings, which become the subject of more detailed cost benefit analysis in the CARIS studies. Note that this analysis refers to generic solutions and therefore do not represent specific projects. CARIS study assumptions are typically based on those utilized in the Reliability Planning Process from the previous year; scenario analysis such as high load, or impact of carbon pricing is also undertaken. The Phase 2 process is for developers to seek regulated cost recovery for specific projects.

Although the estimated impact of Bill No. 1745 to New York City load is likely to increase congestion into Zone J, LEI believes that the size of the increased load from building electrification will have to be addressed through the reliability planning process summarized in Section 4.1, as opposed to an economic planning process such as CARIS.

4.4 Public Policy Transmission Planning Process

Under the Public Policy Transmission Planning Process ("PPTPP"), the NYISO solicits proposal solutions for transmission needs driven by Public Policy Requirements, as identified by the New York Public Service Commission ("NY PSC"). The NYISO then evaluates the viability and sufficiency of the proposed solutions to satisfy the identified Public Policy Transmission Need. The NYPSC holds considerable influence over this process, as it defines evaluation criteria and reviews the assessment of the NYISO. The Public Policy planning process could be an alternative to the RPP, should the NY PSC feel that it could better control the additional infrastructure built to address the rising load in NYC by identifying a need for specific types of transmission projects.

Recent public policy transmission proceedings have been undertaken by the NY PSC when it felt that the CARIS process did not sufficiently consider all the benefit categories of transmission infrastructure in the state.

<u>Recent NY PSC Public Policy Projects</u>

Western NY Transmission: In July 2015, the NY PSC adopted a public policy requirement related to the potential need for additional transmission capability in western New York. The NY PSC identified significant environmental, economic, and reliability benefits that could be achieved by relieving the transmission congestion identified in the western New York region. As a result, on November 1, 2015, the NYISO issued a solicitation for projects designed to address the need identified by the NY PSC. In October 2017, NYISO selected a project from NextEra Energy Transmission New York as being both the more efficient and cost-effective project based on its overall performance.

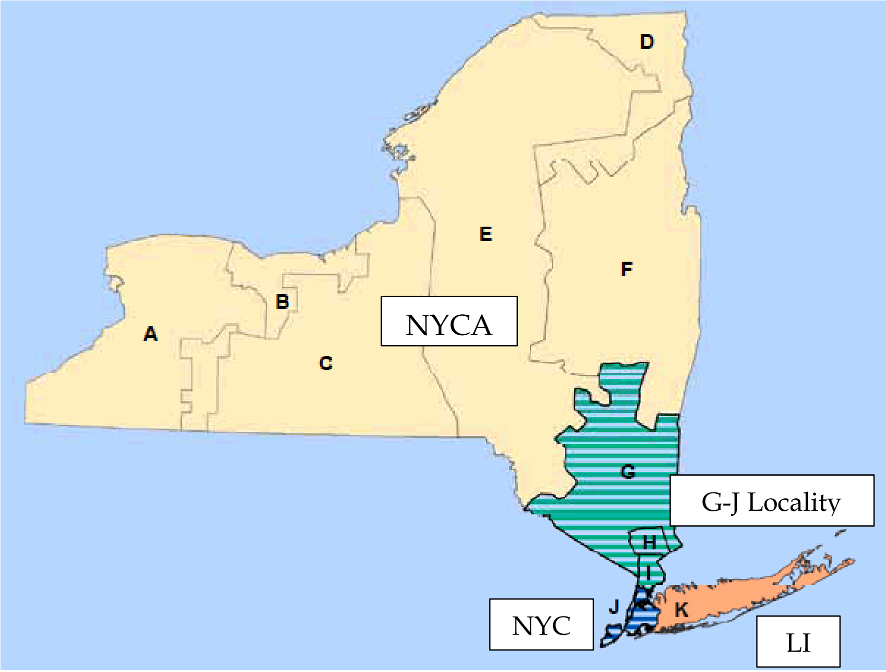
AC Upgrades: In its December 17, 2015 Order Finding Transmission Needs Driven by Public Policy Requirements, the NY PSC identified a very precise set of upgrades to the NYCA bulk power system that, in its view, would be necessary pursuant to the state's policy goals. On February 29, 2016, NYISO issued a solicitation for projects to fulfill the public policy need identified by the NY PSC's Order. NYISO has completed a preliminary evaluation of 13 viable and sufficient projects and submitted a draft report to the NYISO board in July 2018.

4.5 NYISO Capacity Market

As discussed in the previous section, new resources such as generation resources, interruptible load, storage resources, or transmission infrastructure would need to come online in order to meet the increased peak demand in NYC. When foreseeing such a need, the NYISO believes that market-based solutions should be the preferred choice to meet reliability needs. Market-based resources in the NYISO power markets can make revenue through energy markets, ancillary services (regulation and operating reserve), as well as the capacity market. Generation, demand response, and certain types of transmission are paid for capacity. It was introduced by the NYISO in 1999 to fill a perceived gap in the 'reliable' operations of the wholesale electricity market. Through the capacity market, the NYISO ensures resource adequacy by providing a market signal to incentivize investment in market-based solutions.

The capacity market is locational, including the New York City, Long Island, G-J Locality, and NYCA zones as shown in Figure 33. Due to this locational nature, the capacity market facilitates investment in the localities in which it is needed. Localities are nested within one another (NYC is within the G-J locality) and within NYCA (both G-J and Long Island are in NYCA).

Figure 33. NYISO capacity zones



Source: NYISO

In order to maintain resource adequacy, LSEs are required to procure sufficient capacity such that they meet a reserve margin above their projected peak demand, known as the Installed Reserve Margin ("IRM"). IRM is established annually by the New York State Reliability Council, according to the reliability criteria of a Loss of Load Expectation of no greater than 0.1 days per year.[28] In 2018, the IRM was set at 18.2%. LSE's may also have Locational Capacity Requirements ("LCR") if they are located in New York City, Long Island, or G-J Locality. These are designed to ensure that LSE's do not rely too much on imports to meet their resource adequacy requirements. As such, LSEs within localities need not only procure sufficient capacity to meet their LCR from within their own locality, but also sufficient NYCA capacity to meet the overall statewide IRM.

Figure 34. Capacity market locality parameters (2018-2019)

Capacity Region	Requirement (%)	Demand Curve Length (%)
NYCA	118.2%	112%
G-J Locality	94.5%	115%
NYC	80.5%	118%
LI	103.5%	118%

---

[28] http://www.nysrc.org/pdf/Reports/2018%20IRM%20Study%20Report%20Final%2012-8-17[2098].pdf

The NYISO conducts three types of centralized capacity auctions: a strip or capability period auction,[29] in which UCAP may be sold or purchased for six-month periods, a forward monthly auction, and a monthly spot auction. In addition to the auction process, capacity may also be traded bilaterally.

While the strip and monthly auctions clear at the intersection of supply offers and demand bids, the spot auction uses an administratively-set downward sloping demand curve to determine the capacity auction results.[30] The sloped demand curves value additional capacity above NYCA and locational minimum installed capacity requirements, and provide signals for capacity investments. Indeed, the demand curves are designed to make a new plant economic when it is needed – specifically, at 100% of the installed capacity requirement, the clearing price equals the reference point which is set so that over a capability year, a new generic peaking unit can earn its annualized net CONE.[31] NYISO's tariff requires an independent review of the demand curve parameters every four years,[32] in a process known as the Demand Curve Reset ("DCR"). The demand curves are based on levelized costs of peaking plants in the different capacity regions. In January 2017, FERC accepted the annual update methodology and inputs for capability years 2018/19 through 2020/21.[33]

Several demand curve parameters will evolve throughout the forecast horizon, notably the reference price and installed capacity requirement.

The reference price is a function primarily of the gross CONE in each locality, which generally speaking increases with inflation over time, and the energy and ancillary services revenues for the generic plants, which change as a function of energy market conditions.

The installed capacity requirement (or locational capacity requirement for the localities) is a function of the peak load, average forced outage rate, together with transmission constraints that can prevent outside supply from reaching the import-constrained localities (thus driving the need to procure a certain amount of capacity located within the locality)

---

[29] NYISO capability periods include summer (May through October) and winter (November through April)

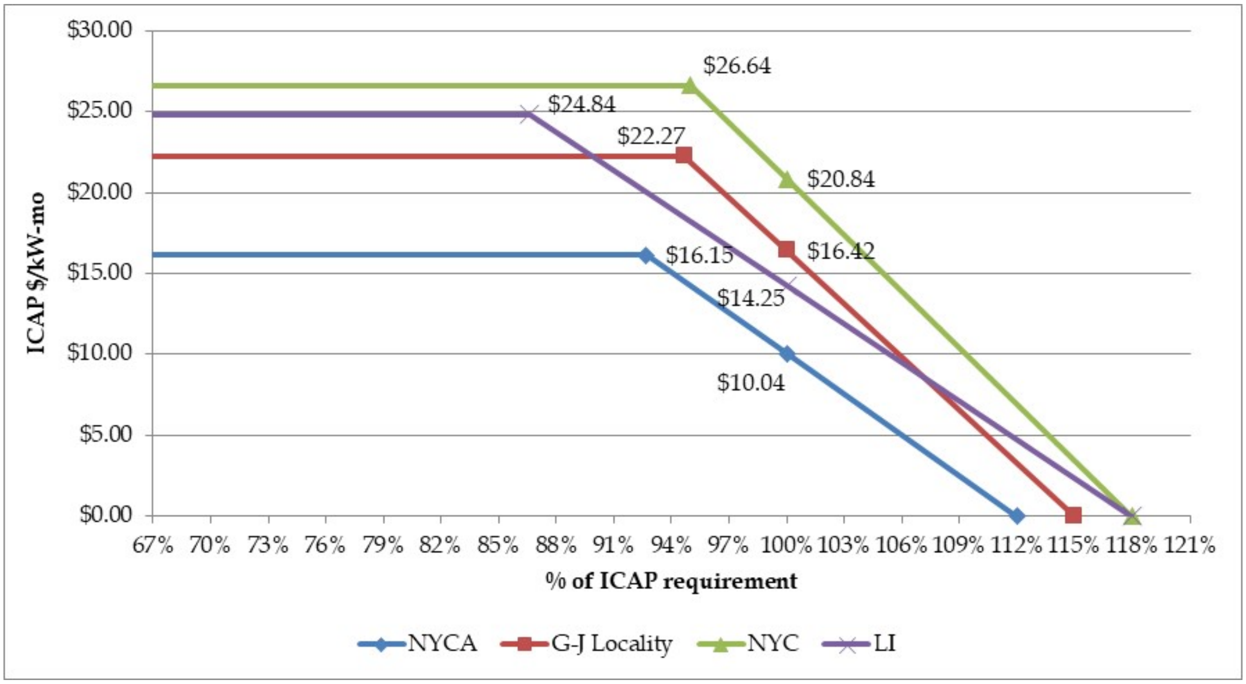
[30] See Section 5.15.2 of the NYISO Installed Capacity Manual, pg 5-15.

[31] Net CONE represents the annualized cost of constructing and operating a plant, minus expected annual energy and ancillary service revenues.

[32] Demand curves are adjusted every year based on average prices in the energy and ancillary services markets in previous years, but the cost component for the generic generation resources are recalculated every four years.

[33] FERC. Order Accepting Tariff Filing Subject to Condition. Docket ER17-386-000. January 17, 2017.

Figure 35. 2018-2019 ICAP spot auction demand curves



Source: NYISO, ICAP/UCAP Translation of Demand Curve – Summer 2018 Capability Period.

Suppliers sell unforced capacity ("UCAP"), which considers capacity resources' maximum capability in addition to historical operating performance to determine how much the supplier is qualified to offer. Any resource that is able to meet the minimum Dependable Maximum Net Capability ("DMNC") of 1 MW and maintenance schedule reporting requirements may qualify as an ICAP resource, though some individual resource types (such as external resources or Special Case Resources, which is NYISO's official name for capacity-qualified demand response) may have to meet additional requirements.[34] Participation in the capacity market, however, is optional for all suppliers. A supplier can choose to not participate at all, sell their capacity elsewhere, or sell their capacity in the bilateral market in NY.

As mentioned in Section 4.2, the NYISO's preference is always to have market-based solutions come online to satisfy the system's reliability requirements. Price signals from the capacity market are thus designed to encourage new resources to come online to ensure adequacy of resources in the state. The proposed Bill No. 1745 is expected to cause a significant increase in peak electricity demand due to the electrification of buildings in NYC. This will increase the ICAP requirement and the demand for capacity, therefore increasing capacity prices and the total costs of the wholesale capacity market – not only for NYC consumers, but for other consumers in New York State as well. Higher capacity prices provide the economic incentive for new market-based resources to come online, particularly in the New York City locality.

---

[34] NYISO Installed Capacity Manual, p. 4-1.

5 Building electrification impact on capacity and transmission costs for NYC consumers

Building electrification in NYC as a result of Intro 1745, if adopted as proposed, can result in increased costs for electricity consumers.

One reason for such an increase is the need for additional generation infrastructure (or equivalent means of meeting resource adequacy requirements, such as interruptible load, storage resources, or transmission infrastructure) to meet increased peak electric demand in NYC, which will result in higher capacity market prices so as to incentivize the construction of these new resources. Secondly, the increased electricity demand during winter months as a result of the heating load will increase the price in NYISO's energy market for this period, although the effect could be offset by the reduction in natural gas usage, and therefore lower price of natural gas, which directly affects the city's gas-fired generation resources' short-run marginal costs.[35]

Finally, to accommodate a large increase in end-use electric demand, the transmission and distribution network in the City would also need to be upgraded and expanded to meet reliability. LEI extrapolated from a previous report on ConEd's infrastructure costs to estimate increased costs due to building electrification.

5.1 NYC peak load calculation

NYC and the state of New York are currently summer-peaking regions, with winter load approximately 35%, or 4,000 MW, lower than summer load. However, the additional load from building electrification during the winter, mostly driven by heating requirements (space and water heating), would eventually turn NYC into a winter-peaking region.

The legislation, if adopted as proposed, would come into effect January 1, 2030 for buildings which do not have any rent-regulated units, and January 1, 2035 for those that do. The term rent-regulated encompasses both buildings that include rent-controlled as well as rent-stabilized apartments. While just about one percent of the total housing stock in New York City is rent-controlled, roughly 50 percent of the City's units are stabilized.[36]

This means that the additional load from electrification of commercial buildings would gradually increase NYC's peak load in the years leading to 2030,[37] while approximately half the additional residential load would appear in the years leading to 2030 and the other half in years leading to

---

[35] LEI did not analyze the impact of building electrification on NYISO energy market prices, as a full production cost modeling simulation was beyond the scope of this project.

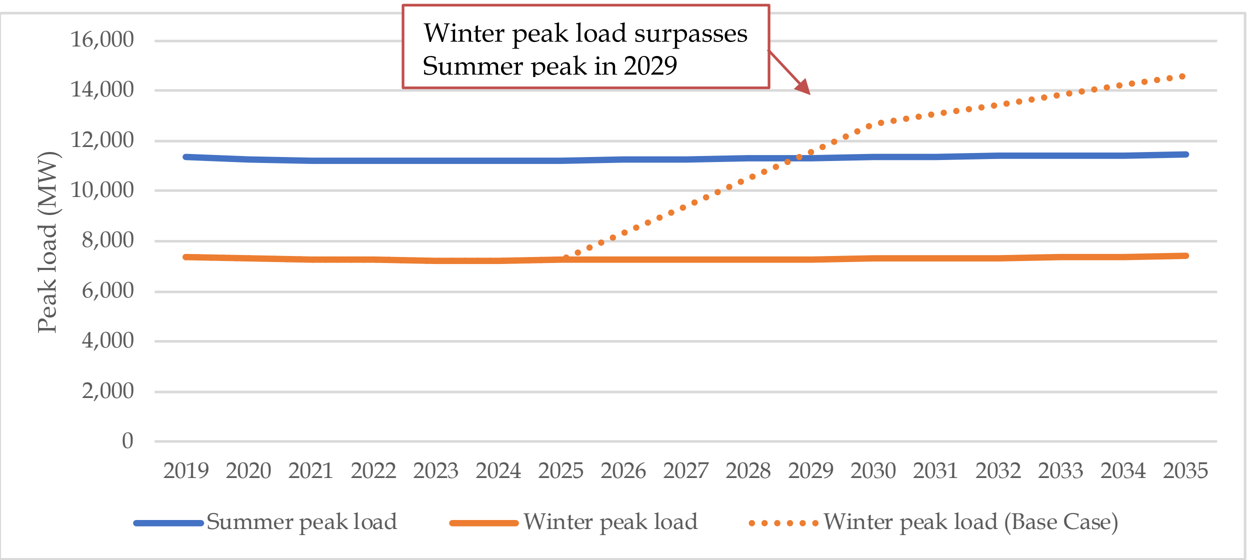
[36] "New York apartment guide: rent control vs. rent stabilization". August 28, 2017. Web. <https://ny.curbed.com/2017/8/28/16214506/nyc-apartments-housing-rent-control>

[37] LEI assumed that commercial buildings would electrify gradually over a period of five years leading to 2030

2035. LEI assumed a gradual increase in load over five years preceding effective dates for the fossil fuel usage limits.

Figure 36 illustrates the gradual increase in winter peak load for NYC based on the Base Case building electrification scenario, with respect to current summer and winter NYC peak load forecast absent building electrification as a result of Intro 1745. Using the current forecast peak load for the city, the additional load from electrification of commercial and a portion of residential buildings results in winter peak load slightly surpassing summer peak load in 2029, while the additional load from electrification of rent-regulated residential buildings increases NYC's winter peak load further until 2035. In this scenario, NYC's 2035 winter peak load is approximately twice the forecast winter peak load absent building electrification, and 30% or 3,150 MW higher than the summer peak load.

Figure 36. NYC summer and winter peak load with effect from Base Case building electrification



Source: NYISO 2018 Load and Capacity Data report; LEI

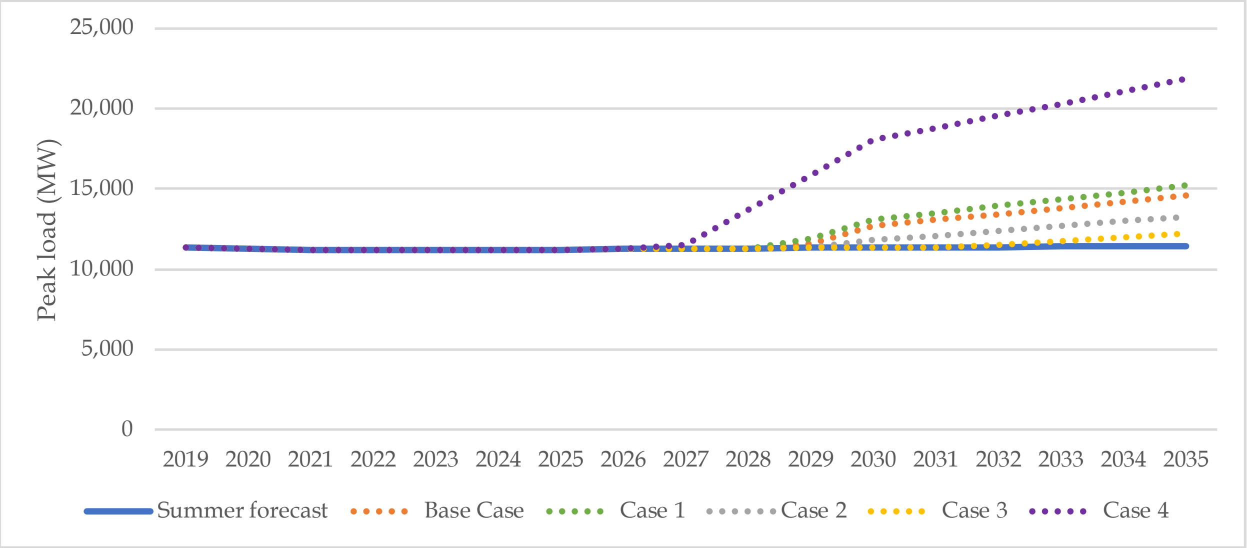
For purposes of NYISO's capacity market, the amount of installed capacity that must be procured is based on each region's forecast peak load during each twelve-month capability period.[38] As such, based on the current forecast of summer and winter peak load in NYC together with added impact from building electrification for the Base Case and all sensitivity cases, Figure 37 illustrates the resulting NYC peak load outlook for installed capacity procurement purposes.

The solid blue line represents the current NYC peak load forecast, based on summer peak load, absent any additional building electrification as a result of Intro 1745, which we can consider a "baseline". Under the various building electrification scenarios, the annual peak load starts diverging from the baseline in the 2027-2029, increasing until 2035.

---

[38] NYISO capability periods range from May through March of each year

Figure 37. NYC annual peak load following building electrification



Source: NYISO 2018 Load and Capacity Data report; LEI

5.2 NYISO market response to increasing peak load

In order to estimate costs, LEI replicated the processes embedded in the NYISO capacity market to determine the impact of increased NYC peak demand following building electrification, given the forecast of supply resources and demand curve parameters. As such, LEI prepared an outlook of capacity market drivers until 2035 under the baseline conditions, as well as for the various building electrification scenarios. See Appendix B for details of LEI's capacity market modeling assumptions and methodology.

NYISO's locational capacity market mandates that a certain proportion of NYC's installed capacity requirement (peak load plus reserve margin) be met by through resources electrically located in-city.[39] The remainder of capacity can be procured from resources located in the G-J capacity locality and elsewhere in the state, taking advantage of available transmission capacity from other parts of the state and adjoining areas.

As the peak load and installed capacity requirement increase in NYC, the design of the sloped demand curves causes the offer curve (offers from generators, controllable lines, and interruptible load) to intersect with the demand curve at a higher point, resulting in higher prices for capacity. Eventually as load continues to increase, the price for capacity reaches a level sufficient to incentivize the construction of new supply resources; at that point, the average annual capacity price in New York City would be equivalent to the net CONE of a generic peaking plant.

---

[39] Currently, NYISO's LCR is 80.5% of the city's peak load

Once the equilibrium (i.e. installed capacity equal to the locational capacity requirement) is reached, the price for capacity in NYC would not necessarily increase significantly even as load keeps increasing, since it is already at a level sufficient to incentivize new generation resources.[40] However, the amount of capacity procured through the auctions will increase concurrently with the increase in installed capacity requirement, so that the overall cost of procuring capacity increases as load increases.

LEI's approach of using the same net CONE in the baseline and all building electrification scenarios is conservative, as the large quantity of peak load increase due to building electrification, and additional generation resources required within an extremely limited NYC footprint, would likely create the need to bring in resources located outside NYC but electrically connected to the NYC grid. These resources would presumably be more expensive than the current cost for a generic resource (in constant dollars), leading to an increase in net CONE with respect to the level assumed in LEI's analysis.

Figure 38 illustrates the overall capacity costs, and resulting average capacity prices, for NYC consumers for 2030 and 2035, given the baseline supply/demand parameters and capacity price forecast as detailed in Appendix B. The figure also illustrates the overall cost of capacity, and capacity prices, for NYC consumers under the various scenarios related to building electrification. Total capacity costs, and average prices, include the sum of costs for NYC customers to purchase in-city capacity to meet the NYC LCR, together with additional capacity purchased in the G-J locality to meet the G-J LCR and additional capacity purchased in the NYCA zone to meet the overall statewide installed capacity requirement.

Figure 38. NYC capacity costs under various scenarios

		Baseline	Building electrification scenarios				
			Base Case	Case 1	Case 2	Case 3	Case 4
2030	Total capacity cost [$ billion]	$1.39	$2.33	$2.43	$2.13	$1.39	$3.57
	Peak load [MW]	11,346	12,666	13,084	11,800	11,346	18,028
	Capacity price [$/kW-yr]	$122.4	$183.9	$185.4	$180.5	$122.4	$198.2
	Increase from baseline		*50.2%*	*51.5%*	*47.5%*	*0.0%*	*61.9%*
2035	Total capacity cost [$ billion]	$1.62	$3.12	$3.27	$2.78	$2.51	$4.99
	Peak load [MW]	11,458	14,606	15,190	13,266	12,222	21,816
	Capacity price [$/kW-yr]	$141.4	$213.7	$215.4	$209.4	$205.4	$228.9
	Increase from baseline		*51.1%*	*52.3%*	*48.1%*	*45.2%*	*61.9%*

Under baseline conditions, i.e. without additional load from building electrification as a result of Intro 1745, the total cost of purchasing capacity in NYC would be $1.39 billion in 2030, and $1.62 billion in 2035 (nominal dollars). Assuming that Intro 1745 is adopted as-is, the annual capacity costs for NYC consumers would increase to $2.33 billion, resulting in a price increase of 50% in

---

[40] The price might still increase modestly as NYC load must still purchase a portion of its capacity in the G-J locality and NYCA region, where an increase in load can still cause an increase in price for these zones.

2030 for the Base Case scenario, and range from no change to as high as $3.57 billion (62% price increase) in the various sensitivity analyses. The relatively small difference in rate increase between the sensitivity scenarios is due to the fact that the NYC capacity price reaches the net CONE level, incentivizing the construction of new resources to maintain the resource adequacy reliability standard.

Similarly in 2035, once all buildings above 25,000 square feet are subject to the fossil fuel use limitations, the additional load would result in a total capacity cost for NYC customers of $3.12 billion (price increase of 51%) for the Base Case scenario, and range from $2.51 billion (45% price increase) to $4.99 billion (62% price increase) in the various sensitivity analyses.

As mentioned previously, LEI used a conservative assumption that the net CONE for new capacity resource would be similar in the building electrification scenarios as it is in the baseline forecast. However, an increase in the net CONE due to the large amount of new capacity required would directly translate into an additional increase in capacity prices. For instance, if the large amount of required new resources in the building electrification scenarios results in a net CONE value which is 10% higher than in the baseline, this would result in a larger price increase – for instance, for the Base Case scenario in 2035, the capacity price increase would change from 51% to 64% with a 10% higher net CONE.

The impact of increased load due to building electrification on capacity prices, with respect to baseline capacity prices, will not persist indefinitely. Indeed, in the baseline scenario, the equilibrium between installed capacity and locational capacity requirement in NYC would be reached around 2041, at which point the baseline capacity price would be equal to the net CONE and capacity rates in the baseline forecast be roughly equivalent to rates in the building electrification scenarios. Any increase in the net CONE caused by building electrification, however, would result in persistently higher prices in the building electrification scenarios with respect to baseline rates.

In all cases, the total cost for capacity in NYC (in dollar amount) persistently remains much higher in the building electrification scenarios than in the baseline forecast, due to the higher installed capacity requirement.

5.3 Potential transmission and distribution expansion costs in NYC

To estimate the impact of building electrification on transmission and distribution costs in NYC, LEI used findings from ConEd's 20-year Integrated Long Range Plan ("ILRP") from 2011 to 2031.[41] The ILRP studies potential infrastructure needs and costs over the 20-year planning horizon as a result of customer demand trends for electricity.

In the study, ConEd had forecast a peak demand of 13,100 MW in 2011 and a peak demand of 16,425 MW in 2031. This represents an increase of 3,325 MW or approximately 25% additional

---

[41] ConEd's most recent 20-yr comprehensive planning report is from April 2012, through the Integrated Long-Range Plan. ConEd also produces annual 10-year Long-Range Transmission Plans but these reports do not include indicative infrastructure costs. As a result, LEI used the results from the Integrated Long-Range Plan.

demand. ConEd estimated that this increase in demand would require 6 new substations at the transmission or sub-transmission level to accommodate 6 new distribution networks in their service area. In addition to the substations, ConEd would need to implement associated equipment and cable transfers and expansions in local areas of the distribution system.[42]

Impact of DERs

With the State's REV initiative and aggressive clean energy goals, the integration of DERs and non-wires solutions ("NWS") will continue to expand. In ConEd's Distributed System Implementation Plan ("DSIP"), ConEd states that they expect solar installations to reach 600 MW and CHP installations to reach 260 MW by the end of 2023. In addition, ConEd expects a large growth in energy storage technologies and up to 800 MW in peak demand savings from Demand-Side Management ("DSM") programs. This translates to over 1,700 MW in load offset from DERs by 2023.[1]

It is inevitable that DERs will continue to offset the City's load as the grid becomes modernized. As a result, DERs will help mitigate some of the transmission and distribution costs that will be required as a result of building electrification.

ConEd estimated that the total infrastructure cost over the 20-year planning horizon would be approximately $23.8 billion (in 2011 dollars) or $26.7 billion in 2018 dollars.[43] Of this, approximately 44% would be proportioned towards system expansion, 31% towards reliability, 16% towards T&D replacement, and 9% for other costs.[44]

Therefore, system expansion costs equate to $10.5 billion to service the additional 25% or 3,325 MW in increased peak demand. Based on this estimate, LEI calculated an indicative approximation that a 1 MW peak demand increase translates to $3.5 million in T&D costs. LEI then applied this value to the incremental NYC peak load from each sensitivity case, to determine the estimated T&D costs as a result of building electrification by 2035. Results are shown in Figure 39.

---

[42] ConEd's Integrated Long Range Plan is based off of ConEd's Electric Long Range Plan which was released 4 months prior. Source: Consolidated Edison. "Electric Long-Range Plan". December 2011.

[43] LEI used an inflation rate of 12.03% to convert 2011$ to 2018$. Source: < https://www.officialdata.org/2011-dollars-in-2018?amount=100>

[44] ConEd was estimating infrastructure costs at approximately $1.3 billion per year in its Long Range Plan. To put this into today's context, electric infrastructure investment has risen to $1.9 billion in 2017 and is estimated to be $1.93 billion for 2018-year end. Source: Consolidated Edison. "Con Edison Annual Report 2017". 2017.

Figure 39. Estimated transmission and distribution costs in NYC due to building electrification

	Incremental Peak Load (MW)	Total T&D costs ($ billion)	Annual T&D costs ($ billion)
Base Case	3,148	$11.11	$1.44
Case 1	3,732	$13.17	$1.71
Case 2	1,808	$6.38	$0.83
Case 3	764	$2.70	$0.35
Case 4	10,358	$36.55	$4.75

Note: LEI annualized the T&D investment costs using a generic 13% factor, which is meant to cover financing costs as well as O&M costs for the transmission investment

As depicted in the above figure, T&D costs range from $2.70 billion in Case 3 to as much as $36.55 billion in sensitivity Case 4. ConEd would spread out the investment over a period of years prior to 2035, so that the T&D system is ready by the time the full additional load from building electrification is realized. Using a generic annualization factor to convert the investment cost into annual revenue requirement for ConEd, LEI estimated that annual costs for NYC consumers from 2035 onward could range from $0.35 billion to $4.75 billion.

While the above calculation of potential T&D costs is a very high-level approximation, it is still apparent that T&D upgrade costs in NYC necessary to accommodate an increase in peak load following building electrification, should Intro 1745 be adopted as proposed, are significant and could potentially be higher than the cost related to additional generation infrastructure.

6 Building electrification impact on Clean Energy Standard

Electrification of NYC buildings will have consequences for New York's Clean Energy Standard ("CES") targets and overall carbon content of the New York system. The 2015 New York State Energy Plan introduced the state's strategy to "build a clean, resilient, and affordable energy system for all New Yorkers."[45] Among other objectives, the plan aims to put the state on a path to achieving the following clean energy goals by 2030: [46]

- 40% reduction in Greenhouse Gas ("GHG") emissions from 1990 levels; and
- 50% of electricity generated from carbon-free renewable energy sources such as solar, wind, hydropower and biomass ("50 by 30 goal").

On August 1st, 2016, the NY PSC published the "Order Adopting a Clean Energy Standard".[47] In its order, the NY PSC adopted the 50 by 30 and GHG reduction clean energy goals as stated in the State Energy Plan.

New York's Clean Energy Standard

In addition to adopting the 50 by 30 goal, the CES also featured:

- obligations on LSEs to financially support new renewable generation resources;
- a requirement for regular REC procurement solicitations;
- obligations on distribution utilities to financially support the maintenance of certain existing at-risk small hydro, wind and biomass generation attributes;
- a program to maximize the value of potential of new offshore wind resources; and
- obligations on LSEs to preserve existing nuclear zero-emissions attributes through the purchase of Zero-Emission Credits ("ZEC").

LEI's analysis shows that additional electric load in NYC resulting from building electrification could range from 4.2 TWh to approximately 13.4 TWh annually by the time the proposed limits are enforced (2030 to 2035). Assuming the 50 by 30 goals are extended, this would result in an additional 2.1 TWh to 6.7 TWh of renewable energy required. If however the increased load from building electrification is realized faster than the additional renewable energy can come online, this could result in a temporary uptick in carbon emissions in NYC.

---

[45] 2015 New York State Energy Plan. Web. <http://energyplan.ny.gov/Plans/2015>

[46] 2015 New York State Energy Plan Frequently Asked Questions. Web. <http://energyplan.ny.gov/-/media/nysenergyplan/2015-faqs.pdf>

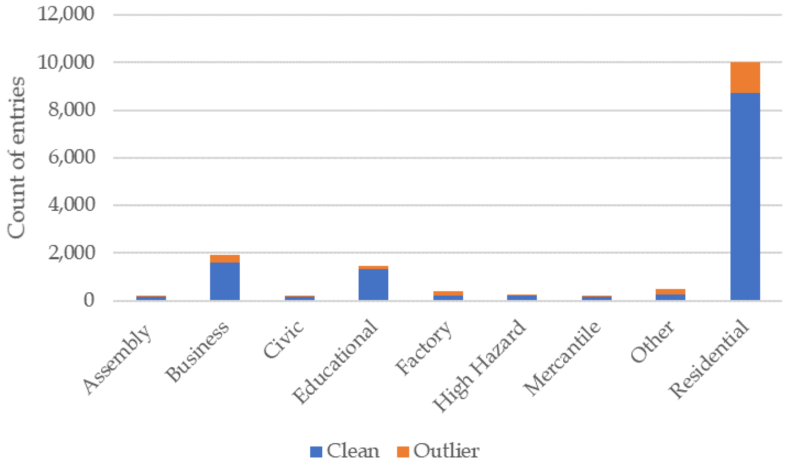
[47] NY PSC. Order Adopting a Clean Energy Standard. Case 15-E-0302. August 1, 2016.

7 Appendix A: Detailed methodology for estimating building energy usage

7.1 Data cleaning methodology

LEI's review of the LL84 data revealed that the dataset contained erroneous entries that required cleaning. LEI focused on cleaning outlier entries which were at the extreme ends of weather normalized, source EUI. LEI took the natural logarithm of the weather normalized, source EUI in order to make the distribution symmetrical, then identified outliers as entries as that were greater or less than two standard deviations from the mean.[48] In order to maintain the largest possible dataset, LEI did not remove outlier entries but rather replaced them with entries corresponding to the average EUI by building type. Similarly, entries that were missing borough, block and lot numbers were not removed as LEI's analysis did not require this data. From a total of 15,112 entries, LEI cleaned a total of 2,202 outliers.

Figure 40. Number of outliers by building type



The outlier entries were reviewed in order to determine their possible impact on results – the results can be seen in the figure below. Residential building outliers made up 1,287 of the 2,202 outliers cleaned, which was the largest group. The clean data for a residential buildings has a site EUI of ~86 kBtu/sq ft, which is realistic. Analysis showed residential outliers have a site EUI of 1,390 kBtu/sq ft, which is not realistic and therefore would have skewed the results of the analysis.

---

[48] A similar methodology was utilized by the Urban Green Council in their latest report using the LL84 data. (Urban Green Council. *New York City's Energy and Water Use 2014 and 2015 Report.* October 2017)

Figure 41. Outlier EUI compared to clean data

Avg. Site EUI	Clean	Outlier
Assembly	129.1	3.3
Business	91.0	1,463.9
Civic	94.3	0.0
Educational	71.7	20.1
Factory	75.0	245.1
High Hazard	172.6	79.9
Mercantile	113.1	28.7
Other	83.8	485.5
Residential	85.9	1,390.2

7.2 Estimation of mid-sized buildings

The 2016 Energy and Water Data Disclosure contained mainly large buildings over 50,000 square feet. Since the proposed legislation is to cover buildings larger than 25,000 square feet, LEI developed a methodology to extrapolate results for buildings between 25,000 and 50,000 square feet.[49] These mid-sized buildings have a total square footage of approximately 342 million square feet as per the Urban Green Council.[50] LEI assumed that there are three major building types with a square footage of 25,000 to 50,000 square feet: commercial, residential, and other or mixed-use. Of these, LEI assumed 39% of mid-sized buildings are commercial, 38% are residential, and 23% are mixed-use.[51] Using the average site EUI as calculated from the dataset, LEI determined the total energy use in kBtu as shown below.

Figure 42. Square footage of mid-sized buildings

Building Type	Building Breakdown	Square Feet	Average Site EUI (kBtu/sq.ft.)	Total Energy (kBtu)
Mixed Use	23%	78,660,000	84	6,593,380,277
Commercial	39%	133,380,000	91	12,143,249,491
Residential	38%	129,960,000	86	11,157,096,437

LEI then used the percent of site energy consumption by building type and energy type to determine the breakdown of total energy use into each energy type.

---

[49] Note that in 2016, Local Laws 84 and 88 were expanded to include buildings larger than 25,000 square feet in benchmarking, however this data is not yet available in current LL84 datasets. (Source: https://www.urbangreencouncil.org/content/news/greener-greater-mid-sized-buildings-nyc)

[50] Urban Green Council. *Greener, Greater Mid-Sized Buildings in NYC.* October 13, 2016 https://www.urbangreencouncil.org/content/news/greener-greater-mid-sized-buildings-nyc

[51] New York City. *A Stronger, More Resilient New York.* June 11, 2013. < https://www1.nyc.gov/assets/sirr/downloads/pdf/Ch4_Buildings_FINAL_singles.pdf>

Figure 43. Energy breakdown of mid-sized buildings

	Electricity	District Steam	Natural Gas	FO #2	FO # 4	FO #5&6	Total Energy (kBtu)
Mixed Use	2,967,021,125	329,669,014	2,109,881,689	527,470,422	527,470,422	131,867,606	6,593,380,277
Commercial	7,285,949,695	607,162,475	3,885,839,837	242,864,990	60,716,247	60,716,247	12,143,249,491
Residential	2,789,274,109	557,854,822	5,801,690,147	892,567,715	892,567,715	223,141,929	11,157,096,437

Using these assumptions, LEI's model projects an increase in NYC annual load of 554 GWh for buildings between 25,000 and 50,000 square feet, compared to the Base Case.

8 Appendix B: LEI's NYISO capacity market modeling methodology

LEI replicates the processes embedded in the NYISO market for determining the equilibrium capacity price, given the supply of capacity in New York State and a downward sloping demand curve.

Overall capacity supply offers are matched with an administratively determined downward sloping demand curve. Capacity prices are determined by the intersection of the offer and demand curves.

LEI relies on the zonal peak load forecast by the NYISO and its own outlook on other parameters such as the IRM and LCR to determine the annual Installed Capacity ("ICAP") requirement. LEI further uses the annual forced outage rates from its generator database to forecast an Estimated Forced Outage Rate on demand ("EFORd") which is used to determine the Unforced Capacity ("UCAP") requirement.

8.1 Supply

Existing supply in New York is based on the 2018 Load & Capacity Data Report ("Gold Book") published by the NYISO,[52] which provides the recent rated capacity for both summer and winter seasons as of April 2018, and is supplemented with plant parameters (such as forced outage rate) from a commercial database.

Going forward, for short-term new entry, LEI reviewed the NYISO interconnection queue to incorporate known projects that are relatively certain to reach completion and commercial operation. Furthermore, renewable new entry is introduced throughout the modeling horizon to align with the state's recently adopted CES, as discussed in Section 8.1.1.

Over the long term, LEI assumes that generators make "just-in-time" capacity investment decisions. New combined cycle or simple cycle natural gas entry is based on economic analysis as described in Section 8.1.2.

8.1.1 Renewable generation

The REC procurement as outlined in the CES is agnostic on the nature of new renewable supply (i.e. there is no carve-out for specific technologies), as long as they meet the requirements of Tier 1 resources.[53] The economics of new technologies, as well as possible preference by some LSEs for deliverability of some amounts of energy to their respective service territories,[54] are going to drive development of new renewable resources. As such, among the various resources listed in

---

[52] NYISO. 2017 Load & Capacity Data. April 2017.

[53] Generally speaking, eligible technologies include small hydro, biogas/biomass, solar, and wind. The full eligibility requirements can be found in Appendix A to the NY PSC Clean Energy Standard order.

[54] As evidenced in the recent NYPA RFP for 1 TWh of renewable energy, which indicated a preference for delivery of energy into zone J.

the CES as eligible for Tier 1, the most likely source for the majority of the new renewable energy are wind and solar resources. Using several sources of information such as targets for NYSERDA programs,[55] or analysis by DPS Staff,[56] LEI created an estimate of the amount of new resources, by technology, which would come online in order to meet the 50 by 30 goal.

As shown in Figure 44, only a small proportion of incremental renewable installed capacity is assumed to be sited in NYC and would therefore have a limited impact on the NYC capacity price over time. For refence purposes, NYC represents approximately 35% of the State's load while only 5% of renewable generation capacity is projected to be located in the City.

Figure 44. Incremental renewable installed capacity by region by 2030

Incremental Capacity (MW) by 2030	West NY	Capital	LHV	NYC	LI
Land-based wind	4,000	2,000	0	0	0
Offshore wind	0	0	0	500	500
Utility-scale solar	2,593	2,201	504	0	427
BTM Solar	862	384	608	292	492
Hydro	285	177	37	0	0
Biomass/ADG	200	0	0	0	0
Total	**7,940**	**4,762**	**1,149**	**792**	**1,419**

8.1.2 New entry

Apart from policy-driven entry of new renewable generation, new entry decisions are conditioned on modeled outcomes such that additional new entry is introduced if and when it is economically feasible given the simulated market dynamics. Notably, new entry in LEI's baseline (i.e. before any increase in peak load resulting from building electrification) capacity forecast, in addition to policy-driven new renewable resources, include both announced economically-driven thermal new entry by 2035 in the NYCA in order to meet resource adequacy reliability requirements.

8.1.3 Retirements

LEI models retirements when they have been announced by the owner, or if their revenues cannot cover the minimum going forward fixed costs three years in a row, consistent with economically rational business behavior. LEI also studies recent retirements trends and assumes retirement of old generators with a very low capacity factor at a rate conservatively based on the recent trend.

---

[55] These include the Clean Energy Fund, NY-Sun, offshore wind procurement targets, and other programs developed as part of the Reforming the Energy Vision ("REV") proceeding.

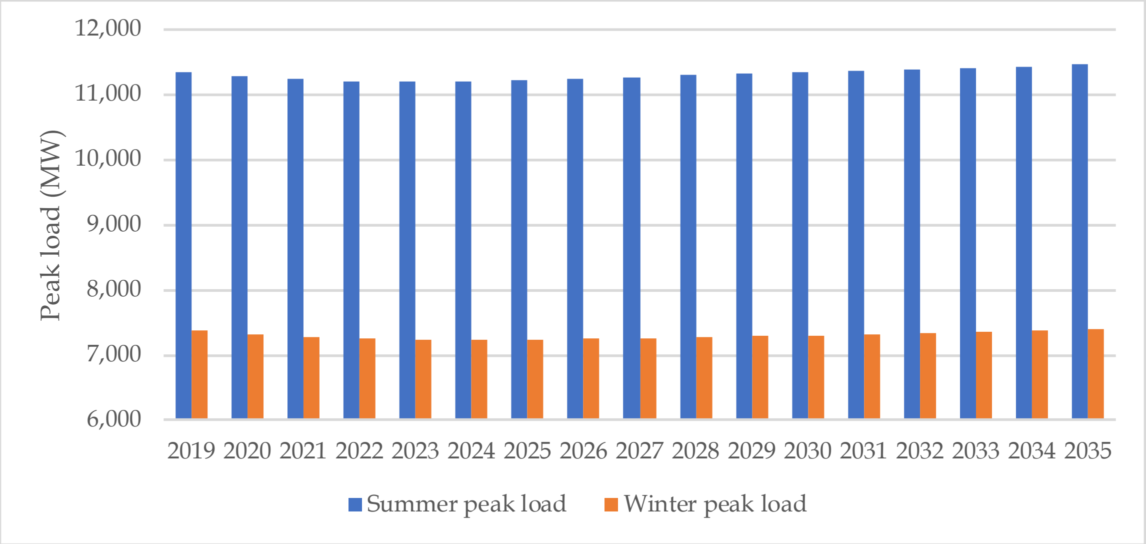
[56] NY DPS. Final Supplemental Environment Impact Statement. Case 15-E-0302. May 19, 2016.

Notably, LEI assumes approximately 100 MW of installed capacity retires annually on average in New York City.

8.2 Demand

LEI relies on the NYISO 2018 Gold Book ten-year forecast for the annual zonal peak load forecast in the state. NYISO's forecast includes a baseline econometric forecast, which is then modified to account for Energy Efficiency efforts and Behind-the-Meter ("BTM") generation (both conventional and renewable). Figure 45 illustrates the Gold Book 2019-2035 NYC peak load forecast for the summer and winter seasons.

Figure 45. Forecast peak demand in NYC



Source: NYISO 2018 Gold Book

Over the forecast horizon, NYC summer peak load averages approximately 11,250 MW, while the winter peak load is approximately 35% lower, averaging 7,270 MW. In both cases, peak load decreases for the first five years as a result of energy efficiency and BTM resource incentives, before increasing again and ending up in 2035 at levels only slightly higher than the 2019 levels.

8.3 Capacity market demand curve

LEI calculated the change in demand curve market parameters (including reference price, IRM, LCR, and EFORd) until 2035, so as to be in a position to prepare the baseline estimates for 2030 and 2030 which are used in Section 5.2 of this document.

Figure 46. Demand curve parameters, current values and forecast for 2030 and 2035

	NYCA			G-J Locality			NYC		
	2018	2030	2035	2018	2030	2035	2018	2030	2035
net CONE	100.19	127.0651	140.2902	148.67	188.5495	208.1739	168.6767	213.9229	236.1882
IRM/LCR	118.20%	138.80%	138.80%	94.50%	85.84%	85.84%	80.50%	81.33%	81.33%
EFORd	8.56%	21.64%	21.64%	6.26%	10.22%	10.22%	7.09%	6.75%	6.75%
Demand curve length	112%	112%	112%	115%	115%	115%	118%	118%	118%

Figure 46 illustrates the 2030 and 2035 net CONE, IRM/LCR, EFORd, and demand curve length parameters which together define the spot auction demand curves, as compared to the current values.

The net CONE values for all three relevant capacity zones increase over time as a function of the increase in gross CONE (based on inflation) together with the change in energy and ancillary services revenues, which partially offset the gross CONE.

The IRM (for NYCA) and LCRs (for G-J and NYC) evolve differently from one another. The NYCA IRM is forecast to increase from approximately 118% currently to almost 139% in 2030 and beyond, mainly because of the increased penetration of intermittent renewable energy resources over time and need for reserve capacity to balance their output. The G-J locality LCR decreases in the early 2020s following the completion of policy-driven AC transmission upgrades, before increasing again following addition of intermittent generation in the locality. The G-J LCR for 2030 and beyond is still lower than the current value. Finally, the NYC LCR is only slightly affected by the transmission upgrades and new renewable generation (mainly behind-the-meter) in the zone, and is slightly higher in 2030 and beyond than in 2018.

8.4 Impact of additional load

When considering the capacity market forecast in the NYCA, G-J, and NYC regions for the building electrification scenarios, there are some capacity market drivers that will not change but others will.

For instance, as mentioned in Section 5.2, LEI assumes that the net CONE for new generic resources in all three regions remains the same in the building electrification scenarios as for the baseline forecast. Similarly, the EFORd remains identical in the baseline as in the building electrification scenarios. While the NYCA IRM remains also identical as in the baseline, the increased peak load in the NYC (and G-J locality, since NYC is nested within G-J) for the building electrification scenarios lead to an increased LCR for those localities, considering that the transmission capacity into those localities from does not change – there is thus a need for additional capacity located within the zones to meet the increased load.

8.5 Baseline capacity market forecast

Based on the capacity market drivers discussed in the prior sections for the baseline forecast as well as building electrification scenarios, Figure 47 represents the NYCA, G-J locality, and NYC load and capacity forecast for 2030 and 2035.

Figure 47. Load and capacity forecast for baseline and building electrification scenarios

NYCA	2030						2035					
	Baseline	Base Case	Case 1	Case 2	Case 3	Case 4	Baseline	Base Case	Case 1	Case 2	Case 3	Case 4
net CONE [$/kW-yr]	$127.1	$127.1	$127.1	$127.1	$127.1	$127.1	$140.3	$140.3	$140.3	$140.3	$140.3	$140.3
EFORd	21.64%	21.64%	21.64%	21.64%	21.64%	21.64%	21.64%	21.64%	21.64%	21.64%	21.64%	21.64%
Peak load [MW]	32,598	33,918	34,336	33,052	32,598	39,280	32,873	36,021	36,605	34,681	33,637	43,231
IRM	138.8%	138.8%	138.8%	138.8%	138.8%	138.8%	138.8%	138.8%	138.8%	138.8%	138.8%	138.8%
UCAP requirement [MW]	35,455	36,890	37,345	35,948	35,455	42,722	35,754	39,178	39,813	37,720	36,585	47,020
UCAP available [MW]	38,863	39,584	39,974	38,776	38,863	44,584	38,575	41,000	41,545	39,750	38,777	47,723
% excess	9.6%	7.3%	7.0%	7.9%	9.6%	4.4%	7.9%	4.7%	4.3%	5.4%	6.0%	1.5%
Clearing price [$/kW-yr]	**$25.26**	**$49.75**	**$52.53**	**$43.77**	**$25.26**	**$80.92**	**$48.05**	**$85.91**	**$89.44**	**$77.37**	**$70.24**	**$122.79**

G-J	2030						2035					
	Baseline	Base Case	Case 1	Case 2	Case 3	Case 4	Baseline	Base Case	Case 1	Case 2	Case 3	Case 4
net CONE	$188.5	$188.5	$188.5	$188.5	$188.5	$188.5	$208.2	$208.2	$208.2	$208.2	$208.2	$208.2
EFORd	10.22%	10.22%	10.22%	10.22%	10.22%	10.22%	10.22%	10.22%	10.22%	10.22%	10.22%	10.22%
Peak load	15,600	16,920	17,338	16,054	15,600	22,282	15,744	18,892	19,476	17,552	16,508	26,102
LCR	85.8%	86.9%	87.3%	86.2%	85.8%	90.1%	85.8%	88.2%	88.6%	87.3%	86.5%	91.5%
UCAP requirement	12,023	13,208	13,583	12,430	12,023	18,022	12,134	14,960	15,485	13,757	12,820	21,433
UCAP available	13,601	14,321	14,711	13,513	13,601	19,321	13,727	16,152	16,697	14,902	13,929	22,875
% excess	13.1%	8.4%	8.3%	8.7%	13.1%	7.2%	13.1%	8.0%	7.8%	8.3%	8.7%	6.7%
Clearing price	**$25.26**	**$82.59**	**$84.18**	**$79.00**	**$25.26**	**$97.92**	**$48.05**	**$97.62**	**$99.54**	**$92.64**	**$88.11**	**$122.79**

NYC	2030						2035					
	Baseline	Base Case	Case 1	Case 2	Case 3	Case 4	Baseline	Base Case	Case 1	Case 2	Case 3	Case 4
net CONE	$213.9	$213.9	$213.9	$213.9	$213.9	$213.9	$236.2	$236.2	$236.2	$236.2	$236.2	$236.2
EFORd	6.75%	6.75%	6.75%	6.75%	6.75%	6.75%	6.75%	6.75%	6.75%	6.75%	6.75%	6.75%
Peak load	11,346	12,666	13,084	11,800	11,346	18,028	11,458	14,606	15,190	13,266	12,222	21,816
LCR	81.3%	83.3%	83.8%	82.0%	81.3%	88.2%	81.3%	85.4%	85.9%	83.9%	82.5%	90.2%
UCAP requirement	8,605	9,835	10,225	9,027	8,605	14,835	8,690	11,625	12,170	10,375	9,402	18,348
UCAP available	9,115	9,835	10,225	9,027	9,115	14,835	9,200	11,625	12,170	10,375	9,402	18,348
% excess	5.9%	0.0%	0.0%	0.0%	5.9%	0.0%	5.9%	0.0%	0.0%	0.0%	0.0%	0.0%
Clearing price	**$143.42**	**$213.92**	**$213.92**	**$213.92**	**$143.42**	**$213.92**	**$159.10**	**$236.19**	**$236.19**	**$236.19**	**$236.19**	**$236.19**

For NYC, the additional load from building electrification causes the baseline capacity price, which is below net CONE, to increase to the same level as the NYC net CONE to incentivize construction of new capacity resources and ensure adequacy of resources. The NYC peak load increase cascades to the G-J and NYCA regions, causing price increase in these regions although there still remains surplus generation in both zones. NYCA and G-J prices are relevant as NYC load, in addition to purchasing in-city capacity to meet its LCR, needs to pay for additional capacity purchased in the G-J locality to meet the G-J LCR and additional capacity purchased in the NYCA zone to meet the overall statewide installed capacity requirement.