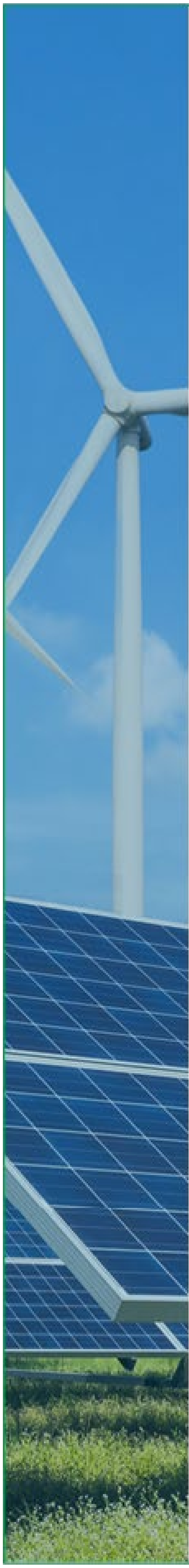


New York ISO
Independent System Operator

Appendix K: Capacity Expansion Model Sensitivities

2023-2042 System & Resource Outlook

A Report from the New York Independent System Operator

July 22, 2024

Appendix K: Capacity Expansion Model Sensitivities

Capacity Expansion Sensitivities

The NYISO conducted extensive sensitivity analysis in its capacity expansion model to assess key drivers for resource mix and impacts on projected resource growth for the 2023-2042 study horizon. A sensitivity is intended to show the impact on results of a single relatively small assumption change to a reference case (e.g., Policy Case scenarios).

In performing sensitivities, the capacity expansion model is re-simulated with the adjusted assumption(s) and the results are compared to the reference case scenario to which the change was applied. The remainder of this section outlines the sensitivities that were performed, and the outcomes observed for this Outlook.

Figure K-1: Policy Case Sensitivities and Descriptions

Sensitivity Name	Short Description
Capacity Margin Targets	Raise the IRM (NYCA Value) by 5%
Large Load	Remove all Future Large Loads
Flexible Load	Model EV Load as Flexible
HQ Import	Remove HQ Imports
Nuclear Retirement	Retire all Nuclear Units on their Licensing Date
Annual Build Limitations	Limit Renewable Builds to 1 GW per Year
Bulk Relaxation	Relax all NYCA Internal Limits
Upward Flow	Reduce Offshore Wind Build Cost by 75%
Extend Annual Build Limitations	Limit Renewable, Storage and DEFR Builds to 1 GW per Year
NY CO_2 Allowance Price Forecast Increase	Increase NY RGGI Price by 400% (5x original price)

Capacity Margin Targets Sensitivity – Higher Demand Scenario

Description

This sensitivity evaluates an increase in the assumed Installed Reserve Margin (IRM) for the NYCA.[1]

Model Adjustments

The NYCA IRM is increased by 5% for all years in the capacity expansion model.

[1] The capacity margin targets (NYCA wide and Locality specific) are translated to the UCAP equivalent and applied consistently to all model years.

Results

As a result of the increase in the NYCA IRM, the model builds additional capacity starting in 2035, with the annual deltas from the Higher Demand scenario in total capacity equaling 1.9 GW in 2035, 2.9 GW in 2040, and 3.2 GW in 2042. The model chooses to add primarily Low Capital/High Operating cost (LcHo) DEFRs in those years. These resources are built primarily for purpose of meeting capacity margin targets, as minimal changes are seen in generation energy and CO2 emissions.

Large Load Sensitivity –Higher Demand Scenario

Description

This study examines the impact of large loads by removing all future large load buildouts from the model. Existing large loads are assumed to remain in service.

Results

The removal of the large loads causes an annual decrease of approximately 18 TWh of load from 2030 to 2042. As a result of this reduction in load, the model builds approximately 4.8 GW less of generation capacity in 2030 and 2.7 GW less in 2035. The majority of this decrease comes from solar with a 4 GW decrease in 2030 and a 0.5 GW decrease in 2035. The remainder of the capacity decreases come from land-based wind (LBW), dispatchable emission-free resources (DEFRs), and battery storage. This decrease of generation results in approximately 17 TWh less of generation from those generation types annually with the model further reducing net imports by approximately 1 TWh annually. The model also reduces fossil capacity each year from 2025 to 2035 by about 200 MW (since the annual peak load is assumed to be reduced), which results in an annual CO_2 emissions reduction of approximately 2 million tons.

Flexible Load Sensitivity – Higher Demand Scenario

Description

This study examines the impact of treating the electric vehicle charging fleet as a flexible load that can be shifted away from the peak load hour. A peak reduction from flexible electric vehicle charging should reduce the required capacity buildout. Assumptions for the electric vehicle stock growth and peak shaving ability assumptions are informed by NYSERDA's Integration Analysis.[2]

[2] Draft Scoping Plan Integration Analysis

Model Adjustments

To simulate the effects of flexible load, a 100% efficient, zero-cost battery was placed in each zone. A battery can shift both energy and load from one hour to another as needed. These "flexible load" battery objects are modeled at 100% efficiency to shift load from one hour to another. Using any efficiency less than 100% would add additional load to the system.

The generation capacity of the "flexible load" batteries was assumed in accordance with NYSERDA's Integration Analysis by taking the annual difference in peak between the "without end-use flexibility" case and the "with medium end-use flexibility" case. The battery object duration was simplified to four hours and it was assumed to contribute to the capacity margin targets at 100% load carrying capability for use in this sensitivity. The battery objects were constrained to have their daily generation equal their daily load.

Results

The model builds less storage compared to the Higher Demand scenario in 2035 to 2042, with the capacity delta peaking in 2042 at -2.6 GW. Less LcHo DEFRs are also built, with their capacity delta peaking in 2035 at -1.4 GW. An uptick in solar buildout is seen only in 2040 at 582 MW. The delta in total capacity peaks in 2042 at -3.4 GW. The delta in total generation energy also peaks in 2042 at -4.9 TWh, coming almost entirely from storage. The model also shows a reduction in DEFR energy in 2040 of approximately 800 GWh. The additional solar causes a generation delta in 2040 of 1.1 TWh. Net interchanges decrease somewhat throughout the study with the delta peaking at -520 GWh in 2042.

HQ Import Sensitivity – Higher Demand Scenario

Description

This scenario evaluates the impact of a reduction in imports from Hydro-Québec (HQ) by setting HQ imports to zero.

Model Adjustments

The capacity for the Cedar and Chateauguay lines from HQ are set to zero in the capacity expansion model.

Results

Restricting imports from HQ results in an annual decrease in imports of 5.7 TWh, or approximately 29 TWh combined over the five study years. As a result, the model builds additional capacity throughout the study period with total capacity delta from the Higher Demand scenario peaking in 2040 at 5.3 GW. The added capacity comes primarily from solar with the delta peaking in 2040 at 3.8 GW. Some amount of wind is also built, with its capacity delta peaks in 2035 at 1.4 GW. In 2025, the energy deficit is made up primarily by fossil fuel capacity, that generates 4.5 TWh and an increase of 1.2 TWh from other imports. The increased fossil fuel generation also increases CO_2 emissions in 2025 by 2 million tons. In the study years from 2030 to 2042, the deficit is made up by the candidate generation, led by solar producing an additional 19 TWh in the four remaining study years.

Nuclear Retirement Sensitivity – Higher Demand Scenario

Description

This sensitivity examines a hypothetical future where nuclear generators in New York are retired instead of being re-licensed. In this case, each nuclear generator in New York is retired at its licensing date.

Model Adjustments

As per current license expiration dates, Nine Mile 1 is retired as of August 22, 2029, Ginna is retired as of September 18, 2029, Fitzpatrick is retired as of October 18, 2034, and Nine Mile 2 is retired as of October 31, 2046 (which is outside of this Outlook's study period).

Results

In 2030 and 2035, the loss of 28 TWh combined of nuclear generation energy is primarily made up by 19 TWh of generation from fossil fuel generators and 4 TWh of generation from wind units, as well as a reduction in exports. In 2040 and 2042, when fossil generators are unavailable, the model chooses to primarily make up the 35 TWh lost from nuclear generators from an increase in High Capital/Low Operating cost (HcLo) DEFRs. These years also see a small increase in utility-scale solar (UPV) builds. All four model years experience a small overall decrease in total generation energy with net imports increasing a total of approximately 8 TWh.

Annual Build Limitations Sensitivity – Higher Demand Scenario

Description

This sensitivity examines a hypothetical annual limitation on capacity of annual buildout for each renewable generation technology, namely UPV, LBW, and offshore wind (OSW). The limitations apply only to candidate buildouts in the capacity expansion.

Model Adjustments

For each generation type requiring a limit, the NYISO modeled a build constraint to enforce an annual build limit of 1 GW.

Results

Implementing annual build limits on just renewable capacity results in an increase in LBW capacity in 2030 and 2035, as compared to the Higher Demand scenario. The Higher Demand scenario's increase in LBW capacity from 2035 to 2040 would violate the sensitivity limitation, resulting in the capacity being "spread out" over earlier years. An additional 683 MW is built in 2030, and the delta in 2035 is 1,467 MW. The Higher Demand scenario's increase in UPV from 2025 to 2030 would also violate the sensitivity limitation. Accordingly, the sensitivity case sees approximately 1 GW less built in 2030 with the deltas in 2035 and 2040 equaling 1.7 GW and 2.3 GW, respectively. A decrease of approximately 1 GW is also seen in 2042. No change in OSW buildout is seen. These changes displace a combined total of approximately 5 TWh of fossil fuel generation in years 2030 and 2035 and a combined total of 2.5 TWh of DEFR generation in years 2040 and 2042. The increased renewable energy capacity results in approximately 9 TWh of additional renewable generation and a CO_2 emissions reduction of approximately 2 million tons all over the study period.

Bulk Relaxation Sensitivity – Higher Demand Scenario

Description

This sensitivity examines an unconstrained New York State transmission system by removing the limits on interfaces and interface groups between New York zones.

Model Adjustments

For each interface and interface group in New York, the limit was set arbitrarily high such that the limit is infinite in effect.

Results

In this sensitivity, the model chooses to build a small amount of additional generation capacity. For the 2030-2042 study years, the delta in solar capacity from the Higher Demand scenario in 2030 is 825 MW, 558 MW in 2035, 1,251 MW in 2040, and 800 MW in 2042. The delta in DEFR capacity is 127 MW in 2035, 422 MW in 2040, and 1,882 MW in 2042. This new capacity displaces some storage and LBW with the delta in storage capacity at -1,888 MW and the delta in wind capacity at -483 MW in 2042. This yields a total capacity delta of 300-800 MW in each study year, but internal resources run 2.9 TWh less, with year 2042 seeing a decrease of 3 TWh. Over the same period, net imports increase by a total of 3.9 TWh. In 2025, fossil fuel generators run for an additional 1.7 TWh, roughly making up for a decrease in net imports of 1.9 TWh. This generation causes an increase in CO_2 emissions of approximately 0.5 million tons in 2025.

Upward Flow Sensitivity – Higher Demand Scenario

Description

This sensitivity reduces the build cost of candidate offshore wind resources by 75%.

Results

As a result of the reduced build cost, the model builds 500 MW of additional OSW capacity in 2035, 8.3 GW in 2040, and 2.1 GW in 2042, for a total increase in the three study years of 10.9 GW. In the same study years, the model builds an additional 2.9 GW of LcHo DEFRs but displaces 1.4 GW of HcLo DEFRs, 6.9 GW of LBW, 7.4 GW of UPV, and 1.4 GW of storage. In total, the model builds approximately 3.3 GW less of generation capacity from 2035 to 2042. The new OSW resources run for 2.1 TWh in 2035, 35.6 TWh in 2040, and 42.6 GWh in 2042, for a total of 80.3 TWh. In 2040 and 2042, the generation from the incremental OSW capacity displaces 17.7 TWh of DEFRs, 37.8 TWh of land-based wind, 20.9 TWh of solar, and 4.2 TWh of storage. From 2035 to 2042, the model produces a small overall decrease of 4.7 TWh of internal generation energy. Minimal changes are seen in net imports.

Extend Annual Build Limits Sensitivity – Higher Demand Scenario

Description

This sensitivity examines a hypothetical annual limitation on capacity of annual buildout for renewable generation technologies, as well as DEFRs and energy storage.

Model Adjustments

For each generation type requiring a limit, the NYISO modeled a build constraint to enforce an annual build limit of 1 GW.

Results

With the annual build limits on renewable generation, DEFRs, and battery storage, output results for wind and solar are comparable. However, as the buildout for LcHo DEFRs would violate the limitation in the Higher Demand scenario, the model builds approximately 24 GW less by 2042 while still building the maximum. This deficit is made up by a medium capital cost/medium operating cost (Mc/Mo) DEFR buildout of 9 GW by 2042, an increase in storage buildout of 20 GW by 2042, and an increase in net imports of 5 TWh in 2030. The model also displaces 14 GW of fossil fuel generation from 2025 to 2035. The total capacity delta from the Higher Demand scenario is -

2.9 GW in 2025, -5.7 GW in 2030, 7.5 GW in 2035, 7 GW in 2040, and 4.8 GW in 2042. These changes result in 5 TWh of additional DEFR generation, 11 TWh of additional renewable generation, 23 TWh of additional storage generation, and a decrease of 18 TWh of fossil fuel generation. The decrease in fossil fuel generation results in a decrease of 7.5 million tons of CO_2 emissions combined in 2030 and 2035.

New York CO_2 Allowance Price Forecast Increase Sensitivity – Higher Demand Scenario

Description

This sensitivity examines the uncertainty of the future RGGI CO_2 allowance price[3] by increasing the allowance price 400% for all fossil fuel generators in New York.

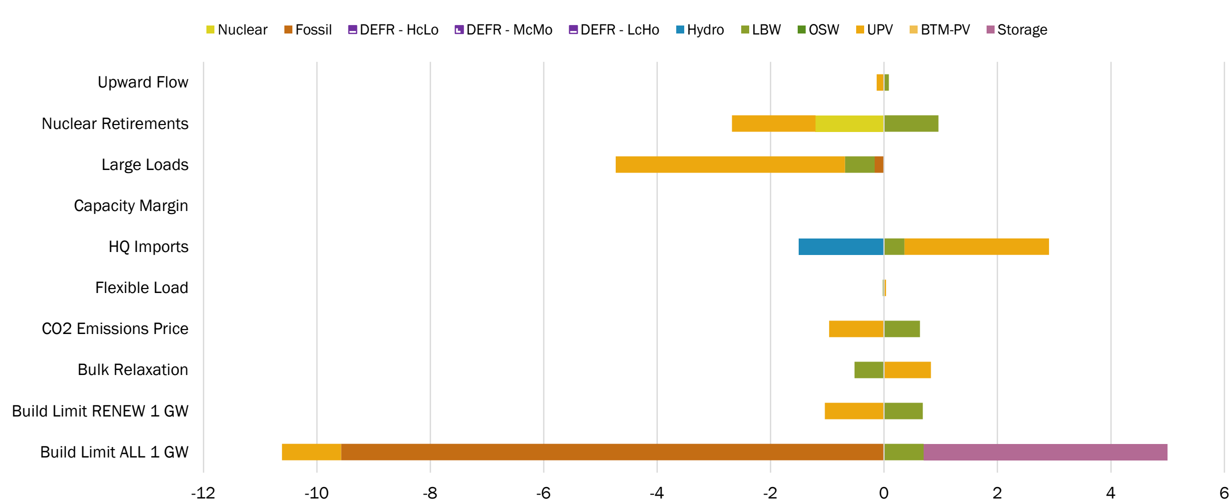
Results

As a result of the increased allowance price, fossil fuel capacity runs less each year from 2025 to 2035 when compared to the High Demand scenario—specifically, 24.5 TWh in 2025, 20.3 TWh in 2030, and 25.6 TWh in 2035. Total CO_2 emissions decrease correspondingly by 9.79 million tons in 2025, 8.56 million tons in 2030, and 10.94 million tons in 2035. The results are summarized below.

Capacity Expansion Sensitivity Results

The following figures summarize the deltas from the Higher Demand scenario in capacity and generation by resource type for years 2030 and 2040.

Figure K-2: 2030 NYCA Installed Capacity (GW) by Type, Delta from High Demand Policy Case



[3] 2023-2042 System & Resource Outlook forecast assumptions.

Figure K-3: 2030 NYCA Generation (TWh) by Type, Delta from High Demand Policy Case

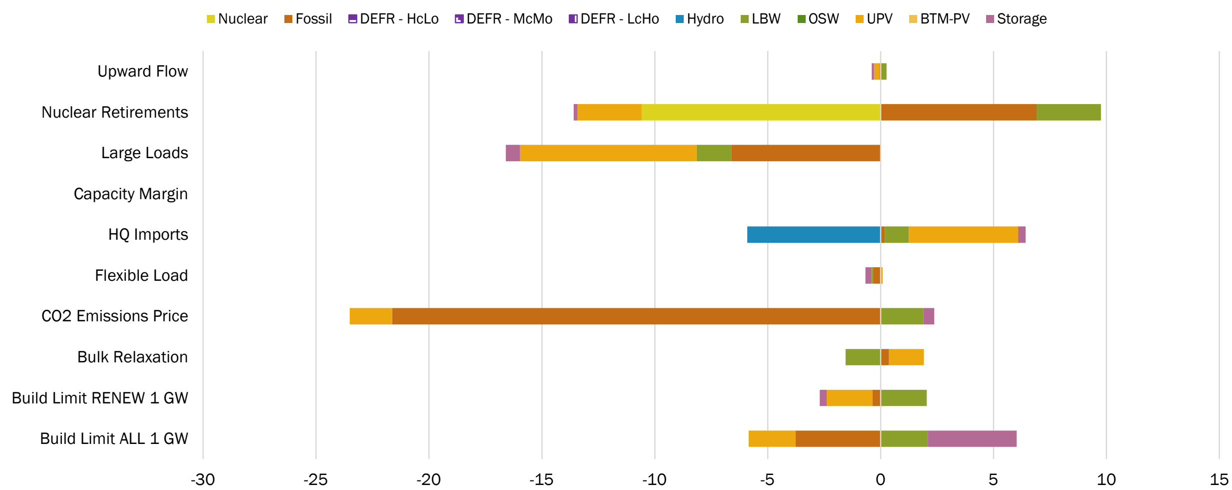


Figure K-4: 2040 NYCA Installed Capacity (GW) by Type, Delta from Higher Demand Scenario

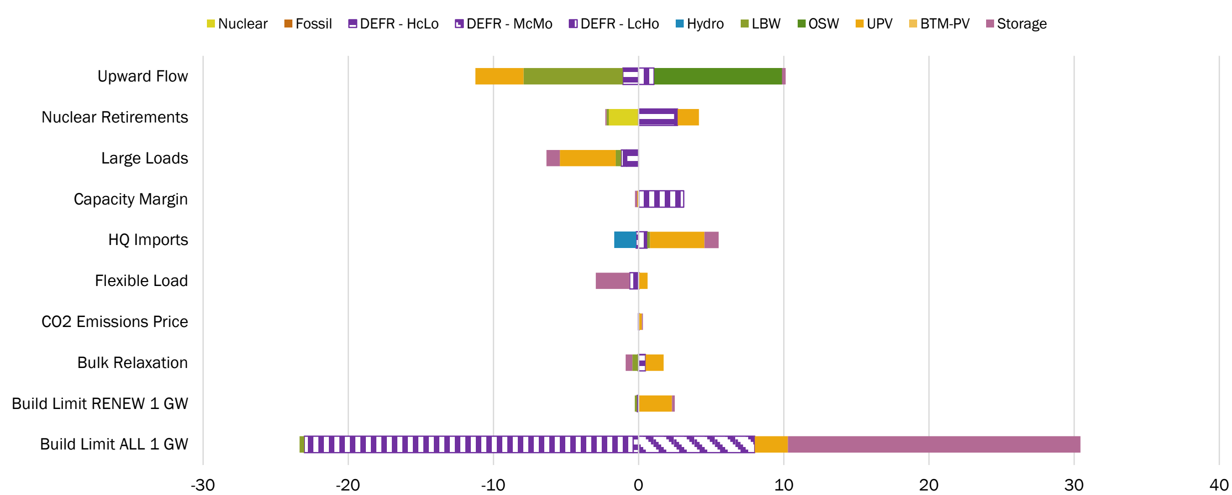
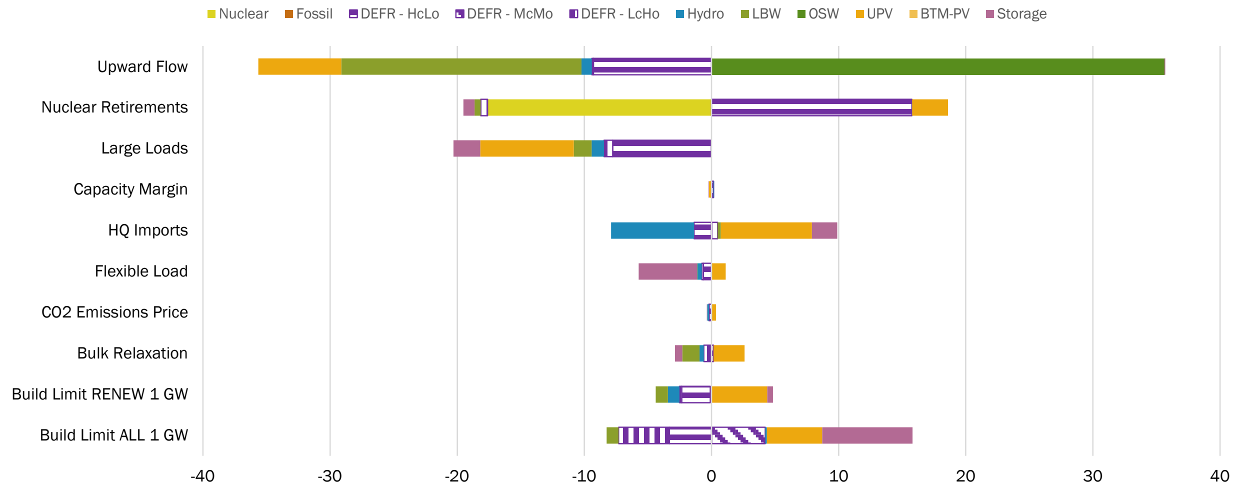


Figure K-5: 2040 NYCA Generation (TWh), Delta from Higher Demand Scenario



Key Findings

- Candidate resources are primarily built for one of two reasons: to satisfy capacity needs or to serve energy demand.
  - Sensitivity analysis in the capacity expansion model can provide insight on the key drivers for resource mix and impacts on projected resource growth.
- Assumption changes that impact energy needs have a larger impact on model results.
  - Total energy demand and availability of clean emitting resources (e.g., hydro, nuclear) to meet projected demand are two of the primary drivers in the resulting resource mix.
- The capacity mix at the end of the study period is generally comparable to the main scenario results, with two exceptions:
  - The “Extend Annual Build Limits” sensitivity has the largest impact to installed capacity of new resources. This is a consequence of limiting all renewable, DEFR, and storage builds to 1 GW per year, which also limits the total that could be built, requiring a large change in capacity mix to meet the new constraint.
  - The “Upward Flow” sensitivity has the largest impact to generation. Reducing the cost to build offshore wind results in the model replacing a substantial amount of utility-scale solar, land-based wind, and DEFR generation with the newly built offshore wind generation.