New York ISO
Independent System Operator

Joint Utilities Requested Economic Planning Study (REPS)

Economic Planning

NYISO, System and Resource Planning

November 16, 2022

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- The New York Independent System Operator ("NYISO") conducted this study at the request of, and based on the scope and assumptions provided by, the requestor, the Joint Utilities (AVANGRID, CECONY, Central Hudson, National Grid, Orange and Rockland, PSEG, and Concentric Energy Advisors). The NYISO assumes no responsibility to the reader or any other party for the consequences of any errors or omissions. The NYISO may revise these materials at any time in its sole discretion without notice to the reader.
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- The results provided herein are treated as Confidential Information under Attachment F to the OATT; provided, however, the ISO will post the results of the Requested Economic Planning Study if and when: (i) Requestor requests that the ISO post the results of the Requested Economic Planning Study; (ii) the ISO is informed that the results of the Requested Economic Planning Study have been made public; or (iii) Requestor seeks regulated cost recovery for a Regulated Economic Transmission Project under the ISO Tariff based upon the results of the Requested Economic Planning Study, and the ISO will note in such posting whether the database and base case assumptions used in the study are different from such study assumptions that are required for seeking regulated cost recovery under the Economic Transmission Project Evaluation NYISO System.
- Resource Planning staff can be reached at 518-356-6000 to address any questions regarding this Requested Economic Planning Study ("REPS") or the NYISO's economic planning processes.

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Capacity Expansion Model Overview

Capacity Expansion Model Framework

- **Capacity expansion models simulate investment and retirement of resources to meet load, policy targets, and other operational/capacity constraints by optimizing over the entire 20-year study period for the NYCA only**
  - The capacity expansion model assumes linear expansion, which allows for partial build/retirement decisions
    - Capacity builds are assumed at the zonal level, such that a single generator by technology type can be built in each applicable zone
    - Economic retirements are enabled such that individual generators could retire in part or in its entirety within the overall optimization
- **The NYISO capacity expansion model uses 17 time slices per year to represent the 8,760-hour load and generation profiles**
  - For each year, 16 of the load blocks are represented by splitting hours of the year by season (Spring, Summer, Fall, Winter) and time of day (overnight, morning, afternoon, evening) and the 17th load block represents a period of peak load hours
  - The time slices capture seasonal and diurnal variation in wind, solar, and load profile
- **PLEXOS creates a reduced "pipe-and-bubble" model by performing a nodal to zonal reduction of the transmission system**

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Capacity Expansion Model Limitations

- The capacity expansion model was developed as an initial reasoned trade-off between balancing model fidelity, runtime, and future uncertainty/knowledge of input assumptions (characterized by scenario testing) to produce representations of outcomes of the future NY generation fleet and operations
- The capacity expansion modeling framework employed will not capture curtailment of renewable resources due to specific transmission constraints.

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Capacity Expansion Model Caveats

- The results of capacity expansion models are sensitive to the input assumptions related to cost and performance of resources and the modeling framework used to represent chronology and nodal/zonal representations
- The capacity expansion model does not capture capacity market dynamics beyond simplified assumptions of satisfying current published IRM and LCR requirements on an unforced capacity basis
  - **Phase 2B Project Case** assumes a reduction in the Zone J LCR requirement per recommendations from the Joint Utilities for purposes of this REPS

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Capacity Expansion Model Caveats (cont.)

- A set of proxy generic Dispatchable Emission Free Resources (DEFRs) was used to approximate a range of capital and operating costs given uncertainty of future technology pathways to serve this role
- All DEFRs are modeled as highly flexible resources with operational parameters (i.e., heat rate, ramp rate, reserve contribution, start time, etc.) similar to a new natural gas combined cycle (but with zero emission rate)
- While these proxy DEFR options may ultimately prove to not be representative of actual future technologies, they were used as a modeling framework to highlight the operational needs that would have to be met by the DEFRs when performing production cost simulations

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Study Scope

Study Scope

- This REPS scope has been developed by the Joint Utilities to evaluate Phase 2 projects leveraging the NYISO's capacity expansion model and database as developed in the 2021-2040 System & Resource Outlook.
- Under this scope of work, the NYISO capacity expansion model was used along with additional screening criteria in an iterative process to determine the most cost-effective set of local T&D upgrades with associated renewable resources on the bulk power system or local transmission system among the cases analyzed.
- The assumptions for this REPS were updated as requested by the Joint Utilities.
- The zonal maximum capacity limitations utilized in this study were retrieved from the Climate Action Council Integration Analysis

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Assumptions

Study Assumptions

- **The Reference Case for this study is based on the NYISO's 2021-2040 System & Resource Outlook Policy Case S2, dated May 2022, with updates to align certain assumptions with the Climate Action Council (CAC) Draft Scoping Plan Integration Analysis**
  - Years 2021-2040 will be modeled, with results provided for years 2025, 2030, 2035, and 2040
  - Assumption changes from S2 pertain to the following:
    - Addition of NYSERDA solar awards announced June 2, 2022
    - Addition of 8-hour battery storage option as a candidate for capacity expansion
    - Capital & fixed O&M costs for candidate renewable generators to align with CAC
    - Capital & operating costs for candidate dispatchable emission free resources (DEFRs) to Low Capital/High Operating cost option
    - Start year for DEFR builds to 2035
    - Maximum capacity limitations for applicable renewable generators to align with assumptions from Climate Action Council analysis
    - Impose maximum capacity limitation for new OSW generators to be 12 GW by 2035
    - 70x30 policy target: assume achievement of 70x30 with incremental Tier 1, offshore wind, and distributed generation in 2030
    - 70x30 policy target: generation provided via the Champlain Hudson Power Express (CHPE) and Clean Path New York (CPNY) projects is assumed to be incremental to the Tier 1, offshore wind, and distributed generation in 2030
    - Policy target: Storage capacity target by 2030 increased to 6 GW
    - Policy target: Specify minimum OSW distribution between Zones J&K as 6 GW and 3 GW respectively

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Study Assumptions (cont.)

- **To assess the proposed projects for the LT&D upgrades, the Phase 2B Project Case will be evaluated in the capacity expansion model, as outlined below:**
  - Reference Case assumes zonal headroom constraints for projects that the Utilities have filed with the PSC (e.g., Phase 1 and Phase 2A projects) and an upgrade to the interface limit between Zones K and I as a proxy for future transmission
  - Phase 2B Project Case assumes zonal headroom constraints for proposed Phase 2B projects as well as assumed costs associated with the Phase 2B projects as a proxy for future transmission upgrades
- **Headroom will be modeled as constraints in PLEXOS, such that generators within a given zone must adhere to the headroom constraint imposed for all intervals**
  - For upstate Zones A-G, headroom will be modeled such that the combined generation from new LBW & UPV generators cannot exceed the zonal limit for any given interval
    - The average of the hourly generation from each renewable resource within each interval is applied to the headroom constraints, excluding the interval that represents the peak time slice. For the peak time slice, the maximum hourly generation from each renewable resource is applied to the headroom constraint.
    - Imposing the headroom constraint on generation limits does not explicitly limit the amount of capacity built by the renewables as it is a limitation on generation.
  - For Zone J, headroom will be modeled such that the combined installed capacity from new OSW generators & energy storage resources cannot exceed the respective Zone J limit for any given interval

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Phase 2B Projects

Zone		Project	Estimated ISD	Headroom Increase (MW)	Headroom Cost ($2020 M)	TX Cost ($/kW)
A	WEST	NYSEG_Cobble_Hill_115	2027	245	108	**442**
B	GENESEE	RGE_New_Station_182	2027	45	79	**1,762**
C	CENTRAL	NYSEG_Candor_115	2027	45	45	**1,007**
F	CAPITAL	Leeds_345	2029	560	146	**261**
G	HUDSON	NewShoemaker	2028	253	73	**287**
G	HUDSON	Upgrade_69kV	2029	201	104	**519**
G	HUDSON	H&SB	2030	23	12	**524**
G	HUDSON	NC Line & Northwest Area	2030	65	64	**986**
G	HUDSON	Q Line & New Smithfield Area Line	2030	12	40	**3,436**
G	HUDSON	10 & T7 Station Connection Upgrade	2030	24	1	**37**
G	HUDSON	Upgrade_34.5kV	2032	170	64	**375**
J	NYC	EasternQueens_138	2029	600	754	**1,257**
J	NYC	EasternQueens_345	2029	1500	1,176	**784**
J	NYC	HellGate_138	2030	600	996	**1,660**

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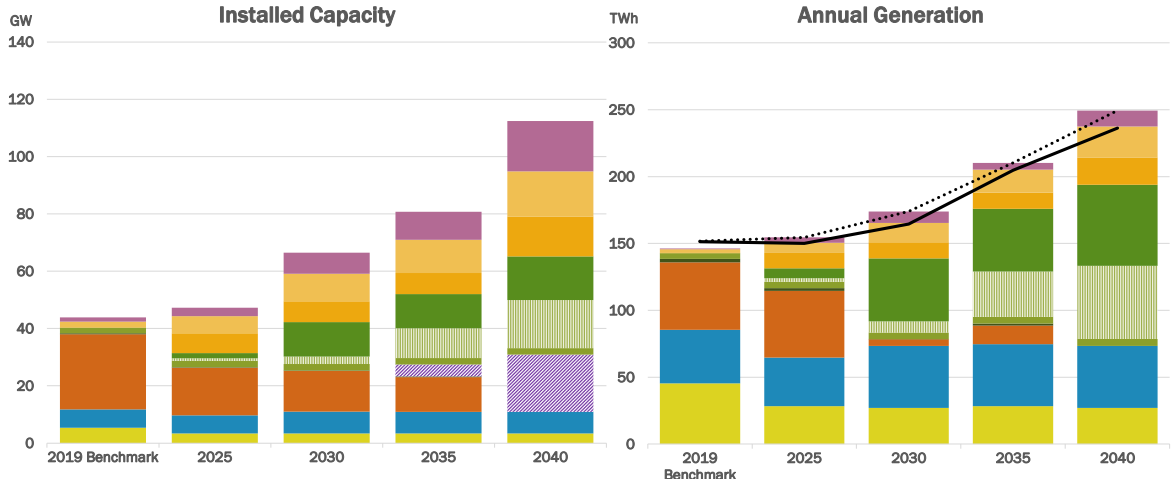
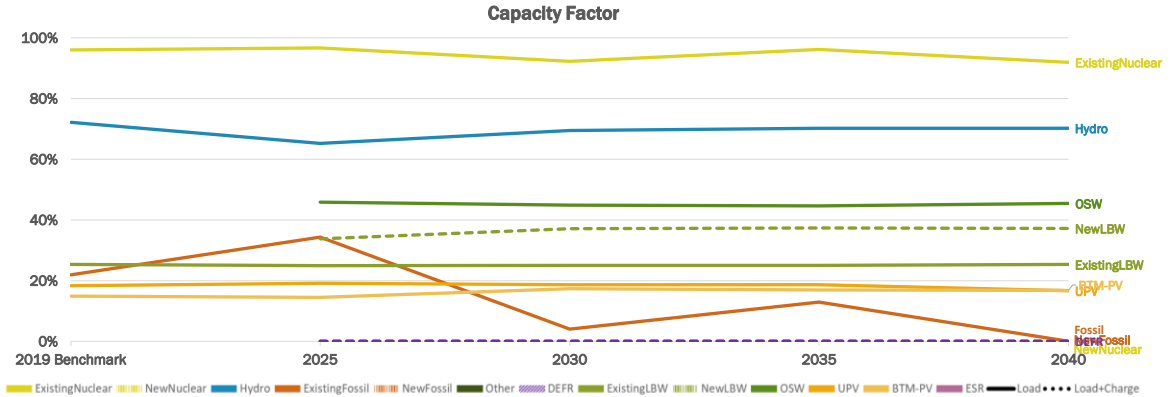
Results

Reference Case





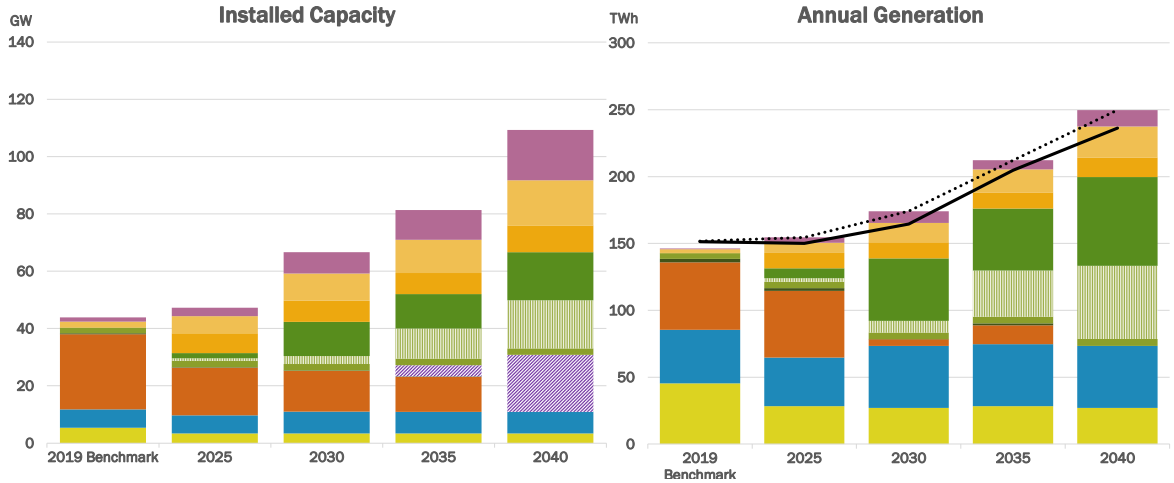
Installed Capacity (MW)	2019	2025	2030	2035	2040
Nuclear	5,400	3,346	3,346	3,364	3,364
Fossil	26,262	16,558	14,220	12,151	-
DEFR - HcLo	-	-	-	-	-
DEFR - McMo	-	-	-	-	-
DEFR - LcHo	-	-	-	4,153	19,948
Hydro	6,331	6,370	7,616	7,540	7,540
LBW	1,985	3,138	4,831	12,650	19,087
OSW	-	1,826	12,000	12,000	15,246
UPV	32	6,854	7,344	7,344	13,904
BTM-PV	2,116	6,000	9,523	11,601	15,764
Storage	1,405	2,910	7,410	9,746	17,510
4-hour Battery	-	*1,490*	*4,444*	*4,444*	*5,590*
8-hour Battery	-	-	*1,546*	*3,882*	*10,500*
Total	43,838	47,216	66,473	84,885	112,363

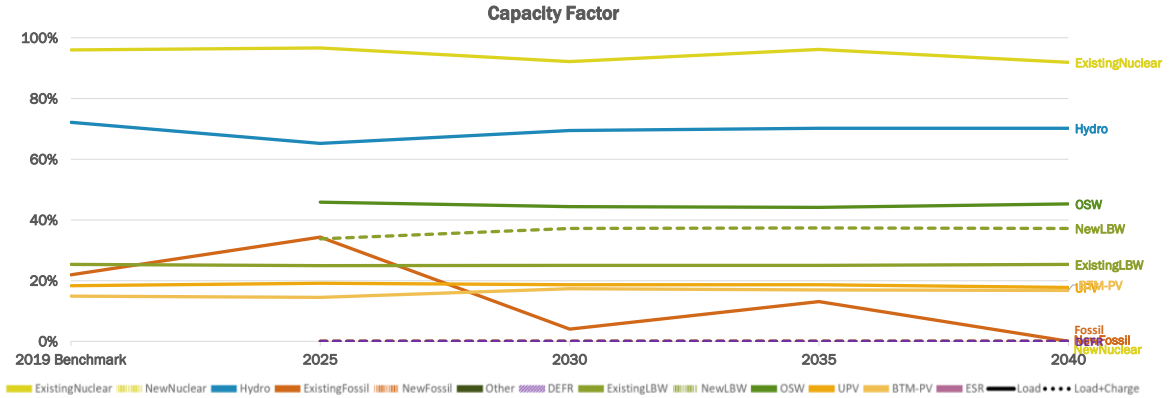
Generation (GWh)	2019	2025	2030	2035	2040
Nuclear	45,429	28,338	27,052	28,338	27,092
Fossil	50,520	49,864	4,981	13,811	-
DEFR - HcLo	-	-	-	-	-
DEFR - McMo	-	-	-	-	-
DEFR - LcHo	-	-	-	-	-
Hydro	40,034	36,418	46,342	46,392	46,391
LBW	4,416	7,518	13,287	38,921	59,836
OSW	-	7,331	47,161	46,922	60,681
UPV	51	11,492	12,018	12,018	20,310
BTM-PV	2,761	7,631	14,461	17,223	23,220
Storage	612	4,087	8,624	5,037	11,927
Total Generation	146,262	154,577	173,961	210,283	249,456
RE Generation	47,261	69,906	122,863	151,070	210,437
ZE Generation	93,301	102,331	158,539	184,445	249,456
Load	151,386	150,047	164,460	204,701	236,334
Load+Charge	151,773	154,577	173,962	210,283	249,456
% RE [RE/Load]	31%	47%	75%	74%	89%
% ZE [ZE/(Load+Charge)]	61%	66%	91%	88%	100%

Emissions (million tons)	2019	2025	2030	2035	2040
CO_2 Emissions	22.24	21.76	2.76	6.17	-

* Storage includes Pumped Storage Hydro and Batteries; Battery Installed Capacity is broken out by duration
* Utility solar (UPV) includes existing (77 MW) and new UPV
* Hydro includes hydro imports from Hydro Quebec
* Land-Based Wind (LBW), Offshore Wind (OSW), Zero Emissions (ZE)
* Dispachable Emission Free Resource (DEFR), High Capital Low Operating (HcLo)

Phase 2B Project Case





Installed Capacity (MW)					
	2019	2025	2030	2035	2040
Nuclear	5,400	3,346	3,346	3,364	3,364
Fossil	26,262	16,557	14,219	12,210	-
DEFR - HcLo	-	-	-	-	-
DEFR - McMo	-	-	-	-	-
DEFR - LcHo	-	-	-	3,892	19,870
Hydro	6,331	6,370	7,616	7,540	7,540
LBW	1,985	3,138	4,981	12,806	19,087
OSW	-	1,826	12,000	12,000	16,746
UPV	32	6,854	7,344	7,344	9,368
BTM-PV	2,116	6,000	9,523	11,601	15,764
Storage	1,405	2,910	7,410	10,397	17,510
4-hour Battery	-	*1,490*	*5,247*	*5,247*	*5,590*
8-hour Battery	-	-	*743*	*3,730*	*10,500*
Total	43,838	47,215	66,621	85,228	109,249

Generation (GWh)					
	2019	2025	2030	2035	2040
Nuclear	45,429	28,338	27,027	28,338	27,092
Fossil	50,520	49,864	4,997	14,003	-
DEFR - HcLo	-	-	-	-	-
DEFR - McMo	-	-	-	-	-
DEFR - LcHo	-	-	-	-	-
Hydro	40,034	36,418	46,342	46,392	46,391
LBW	4,416	7,518	13,790	39,457	59,880
OSW	-	7,331	46,658	46,386	66,389
UPV	51	11,492	12,018	12,018	14,592
BTM-PV	2,761	7,631	14,461	17,223	23,220
Storage	612	4,088	8,740	6,811	12,261
Total Generation	146,262	154,578	174,086	212,249	249,826
RE Generation	47,261	69,906	122,863	151,070	210,473
ZE Generation	93,301	102,332	158,630	186,219	249,826
Load	151,386	150,047	164,457	204,701	236,334
Load+Charge	151,773	154,579	174,086	212,249	249,826
% RE [RE/Load]	31%	47%	75%	74%	89%
% ZE [ZE/(Load+Charge)]	61%	66%	91%	88%	100%

Emissions (million tons)					
	2019	2025	2030	2035	2040
CO_2 Emissions	22.24	21.78	2.77	6.27	-

* Storage includes Pumped Storage Hydro and Batteries; Battery Installed Capacity is broken out by duration
* Utility solar (UPV) includes existing (77 MW) and new UPV
* Hydro includes hydro imports from Hydro Quebec
* Land-Based Wind (LBW), Offshore Wind (OSW), Zero Emissions (ZE)
* Dispachable Emission Free Resource (DEFR), High Capital Low Operating (HcLo)

Phase 2B Project Case: Summary

- **Phase 2B Project Case** assumes additional headroom as a result of the proposed Phase 2B projects
  - Phase 2B projects are all assumed to be in service consistent with the assumptions outlined on slide 13 (e.g., in service date, incremental headroom, transmission cost)
  - Additionally, the Feeder Q13 and X53 projects assume an increased transfer limit of the Sprain Brook Dunwoodie interface by 700 MW and reduction in Zone J LCR requirement by 1.7% starting in year 2030
- **Key findings include the following:**
  - Less renewable capacity built by 2040
    - More renewable generation in 2040, even though there is a lower amount of total installed capacity
  - The maximum capacity and/or headroom constraints are binding in all Zones
    - Maximum capacity constraints are binding for some, if not all, generator types in Zones A, B, C, D, E, F & G
    - Headroom constraints are binding in Zones A, C, D, E & J
    - Maximum capacity constraints are more limiting than the headroom constraints in Zones B & G, which prohibit renewable generation in these zones from being able to fully utilize available headroom

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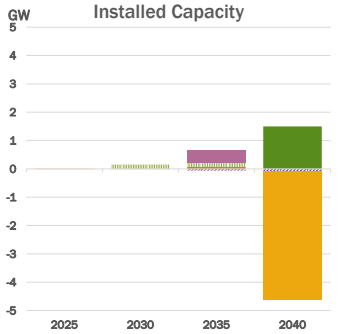
Phase 2B Project Case: Summary (cont.)

- **Installed capacity:**
  - Increase in OSW capacity built, directly driven from increase in Phase 2B headroom in Zone J
  - Decrease in UPV capacity built, due to increase in OSW capacity built

Compare Phase 2B Project Case to Reference Case



Installed Capacity (MW)	2025	2030	2035	2040
Nuclear	-	-	-	-
Fossil	(1)	(1)	59	-
Other	-	-	-	-
DEFR	-	-	(57)	(78)
Hydro	-	-	-	-
LBW	-	149	157	-
OSW	-	-	-	1,500
UPV	-	-	-	(4,536)
BTM-PV	-	-	-	-
Storage	-	(0)	432	-
Total	(1)	148	591	(3,114)

ExistingNuclear NewNuclear Hydro ExistingFossil NewFossil Other
DEFR ExistingLBW NewLBW OSW UPV BTM-PV Storage

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Our Mission & Vision

Mission

Ensure power system reliability and competitive markets for New York in a clean energy future

Vision

Working together with stakeholders to build the cleanest, most reliable electric system in the nation

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